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NASA CR-112244

FINAL REPORT

A STUDY OF THE DYNAMICS OF ROTATING SPACE STATIONS WITH ELASTICALLY CONNECTED COUNTERWEIGHT AND ATTACHED FLEXIBLE APPENDAGES

Volume II Computer Program User's Manual

By

Eugene J. Lowe and Fred Austin

Prepared under Contract No. NAS 1-10973 by
Grumman Aerospace Corporation
Bethpage, New York 11714

for

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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FOREWORD

This volume of the final report is submitted to the NASA Langley Research Center in partial fulfillment of Contract NAS 1-10973. This contract involves the formulation of a mathematical model for predicting the dynamic behavior of a class of rotating flexible space-station configurations, and the preparation of associated computer programs.

Volume I contains the development of the required theoretical techniques, and Volume II is a computer-program user's manual.

Dr. Robert W. Fralich of the NASA Langley Research Center is the Technical Monitor. Dr. Fred Austin of the Grumman Aerospace Corporation is the Project Engineer.

Mr. Eugene J. Lowe prepared all of the computer programs described in this manual and wrote the descriptions of the programs and the method of setting up the cards. Dr. Fred Austin wrote the engineering descriptions contained in this manual.

The authors gratefully acknowledge the useful comments provided by Dr. R. Fralich and Mr. J. Smedfjeld. Also, Miss B. Durling's help in converting the computer program is sincerely appreciated.

NOTE ON UNITS

The program may be used with all consistent sets of units. For example, if the input data is in the lb-ft-sec-slug system, the output will also be in that set of units; if the input data is in the Newton-meter-sec-kg system, the program will express the solutions in that system.

In the Phase I program only, the user may input the weight and weight moment of inertia of each mass and the acceleration of gravity, G. The program then divides these weight properties by G to obtain the mass properties. If the mass properties are known, the user may input these instead of the weight properties; however, in this case, a value of G equal to one must be input.

1.0 INTRODUCTION

This user's manual provides the information required to use and modify two computer programs. The programs were developed on the IBM 370-165 computer located at Grumman Data Systems and then converted for use on the CDC 6600 computer located at the NASA Langley Research Center.

The first program, known as Phase I, is used to obtain the vibration modes of a structure using the modes of the component modules. The structure may consist of up to seventeen modules. The second program, known as Phase II, is used to solve, by numerical integration, the equations of motion of a flexible two-mass Space Station consisting of a Laboratory, a Counterweight, and a Connecting Structure. The modal characteristics and mass distribution of the Laboratory and Counterweight are required input data for the Phase II program. These properties may be generated by using the Phase I program or may be obtained elsewhere. The output format of the Phase I program is compatible with the input of the Phase II program, and the two programs can be run together in one submittal.

The Phase I program requires 70,000 octal core-storage locations, and the Phase II program requires 300,000 octal core-storage locations on the CDC 6600 computer.

2.0 PHASE I -- MODAL COUPLING OF SUBSTRUCTURES

2.1 INTRODUCTION

The Phase I computer program is used to obtain the modes of vibration for a structure using the modes and mass properties of each of its component substructures. Figure 2.1 illustrates, schematically, the most general configuration which may be treated. There is a maximum of seventeen substructures. Also, less complex configurations may be considered since any of the substructures may be absent from the idealization provided, of course, that the absent substructures do not disconnect the configuration. The modules are shown in-plane and perpendicular to each other for schematic purposes only. Actually, they may be skewed at any orientation in three dimensions. In fact, substructure modes can be supplied in a coordinate system which is skewed relative to the total-structure coordinate system. The central modules (numbers 1, 11, 14, 16 and 17) are called core modules, and the outer modules are called appendages.

While the total-structure modes to be used as input data for the Phase II Program are free-free, the Phase I Program may also be used to obtain cantilever modes for the total structure with Module 1 fixed at some point.

It is assumed that the junction surface between modules has no deformation. Another assumption is that appendages may not be connected to each other; i.e., a closed loop may not be formed. However, the user may bypass the Phase I computer program and supply the normal modes and modal masses of any Laboratory and/or Counterweight to Phase II.

One feature of the procedure is that the user is permitted to supply constrained substructure modes. These are modes which were obtained for idealizations where constraints were employed; for example, in a beam analysis axial extension may have been neglected. Constraints may be handled by two different methods. In the first, the user supplies modes containing six rectangular coordinates for each mass point; however, constrained coordinates are either related by equations of constraint or may be zero. By the second method, the user may supply modes containing less than six coordinates to describe the motion of each mass point; however, he must either identify which if any of the six coordinates are zero or he must supply constraint relations which transform the supplied coordinates to

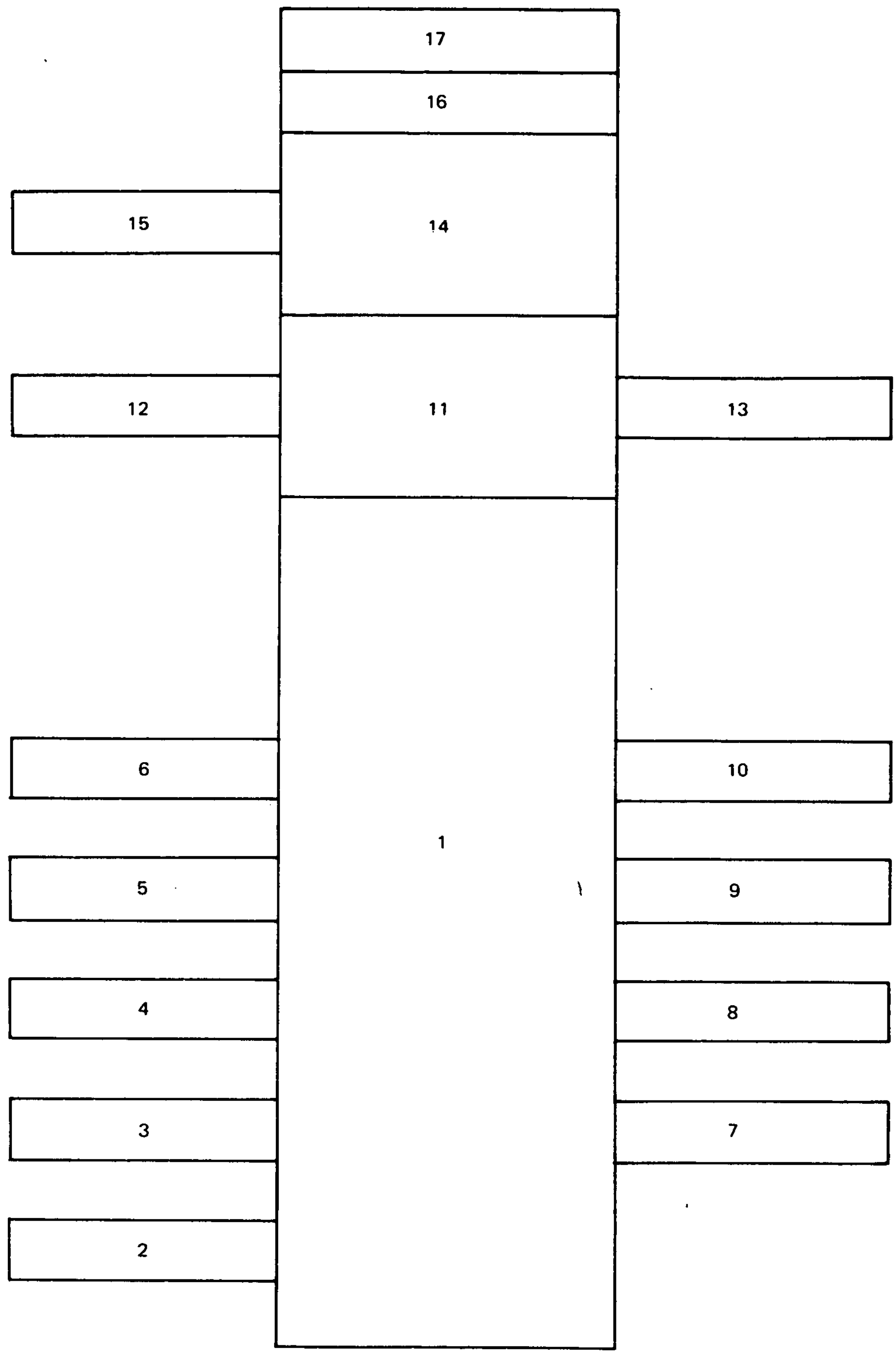

Fig. 2.1 General 17-Module Configuration for Modal Synthesis

the six rectangular coordinates. As described in Section 2.3.2, only certain types of contraint relations may be supplied. This feature was limited by the available computer storage space.

2.2 SELECTION OF SUBSTRUCTURE MODES

The normal modes of vibration of each of the substructures must first be determined from conventional lumped-parameter vibration-analysis procedures. The required input data includes the natural frequencies, mode shapes, generalized masses, and discrete mass matrices associated with each flexible body. As indicated in Figure 2.2, if free-free modes of the coupled structure are desired, then the free-free modes of Module 1 must be supplied; if the cantilevered modes of the coupled structure are desired, the the cantilevered modes of Module 1 must be supplied. Module 1 may also be contrained in some directions and not others. When obtaining the modes of Module 1, it must be supported in the same way as the total structure. Accordingly, the modes of Module 1 may have from 0 to 6 frequencies which are zero. Cantilevered modes are used for all other modules. All of the substructure modes with the exception of the rigid-body modes for Module 1 must be orthogonal; therefore the user must ensure that any equal-frequency elastic modes have been orthogonalized before use in this program.

As with any synthesis technique, the procedures discussed here will yield an exact representation of the coupled system if all of the substructure modes are used. In practice, however, each substructure is approximately represented by its lower-frequency modes. Thus the synthesized modes are approximate, with the lower-frequency modes generally being most accurate. How well the synthesis procedure works is dependent on how many modes are used to represent the substructures, and how accurately these substructure modes represent the motions of the coupled structure.

The analyst can exercise some control over the accuracy of the synthesis through the judicious selection of the substructure modes to be used. Another means of improving accuracy is to use so-called "mass-loaded" modes. This means that the mass and inertia properties of all influencing substructures are included in the preliminary idealization used for obtaining the modes of a core module. For example, referring to Figure 2.2, the modes of Module 1 would be calculated

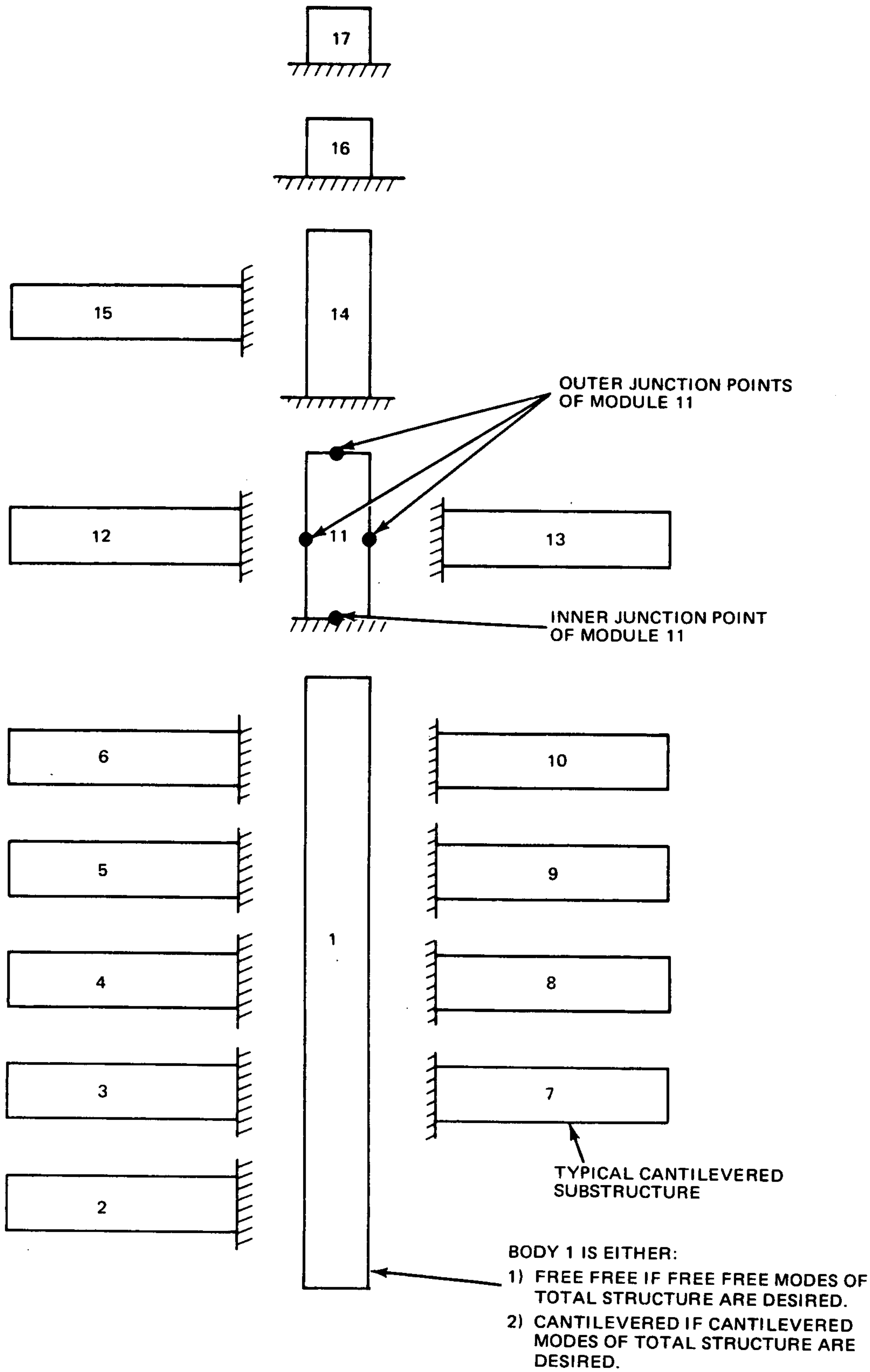

Fig. 2.2 Arrangement of Substructures for Modal Synthesis

with Module 2 through 17 attached as rigid masses, those of 11 with 12 through 17 attached, those of 14 with 15, 16, and 17 attached, and those of 16 with 17 attached. The modes obtained in this manner are closer to those of the coupled system than modes computed without mass loading, and thus produce consistently better results when used in the synthesis procedure. See Section 3.4 of Volume I for a numerical comparison of frequencies using mass-loaded modes and frequencies using conventional modes.

2.3 PREPARATION OF DATA

2.3.1 Numbering System and Coordinates

Each module is assigned a module number. Its mass points are numbered consecutively beginning with 1 as shown in Figure 2.3. The input modes are expressed in terms of these numbers. The program renumbers the mass points consecutively for the entire structure, starting with Module 1 and continuing, in order, with each higher module number. The coupled structure numbers are shown in parenthesis in Figure 2.3. The output for the entire structure is expressed in terms of these numbers.

Each module (except Module 1) must attach to a mass point of the previous module; however, if there is no mass present at the connection point, an artificial mass may be created which has zero mass.* In the example, Module 14 of Figure 2.3 connects to Mass 3 of Module 11. The attachment point (Point 0) of each module is located by its global coordinates (X_0, Y_0, and Z_0). Point 0 for Module 14 and the global coordinates (X, Y, and Z) are also shown in Figure 2.3. The global coordinates are also the mean axes (the $\underset{\sim}{X}$ axes for the Laboratory and the $\underset{\sim}{Y}$ axes for the Counterweight) of the Phase II program.

Since the user's modes are supplied in a local (x, y, z) coordinate system which is not generally parallel to the global coordinate system, the orientation of the local coordinates must be specified for each module. This is accomplished by the method illustrated in Figure 2.4. As indicated, the local coordinate system of a typical module is translated so that its origin will coincide with the origin of the global coordinate system. Then points a and b are selected as follows:

* In this case, it is advisable to use the mass-loaded modes discussed in the previous subsection.

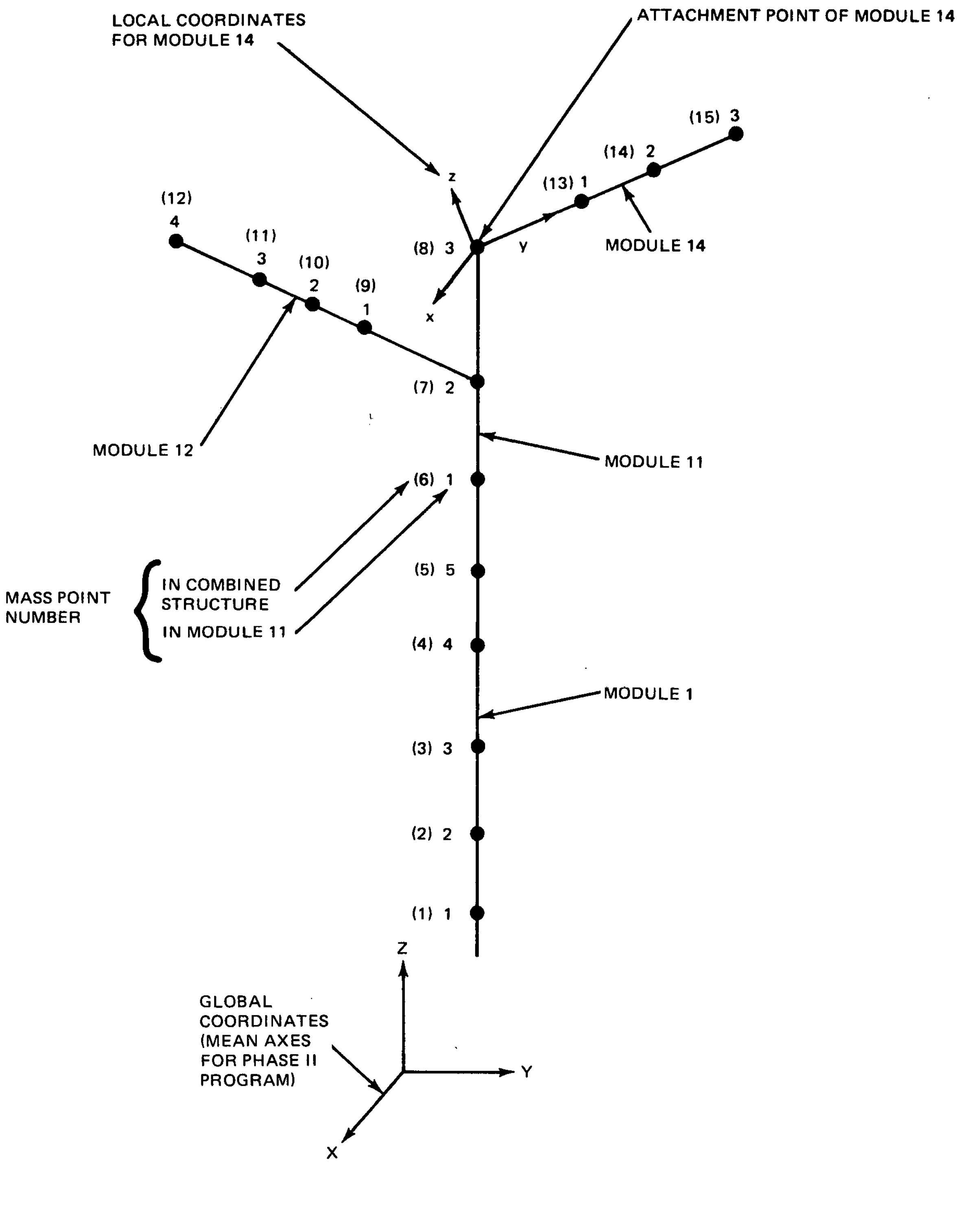

Fig. 2.3 Example of Structure to be Coupled

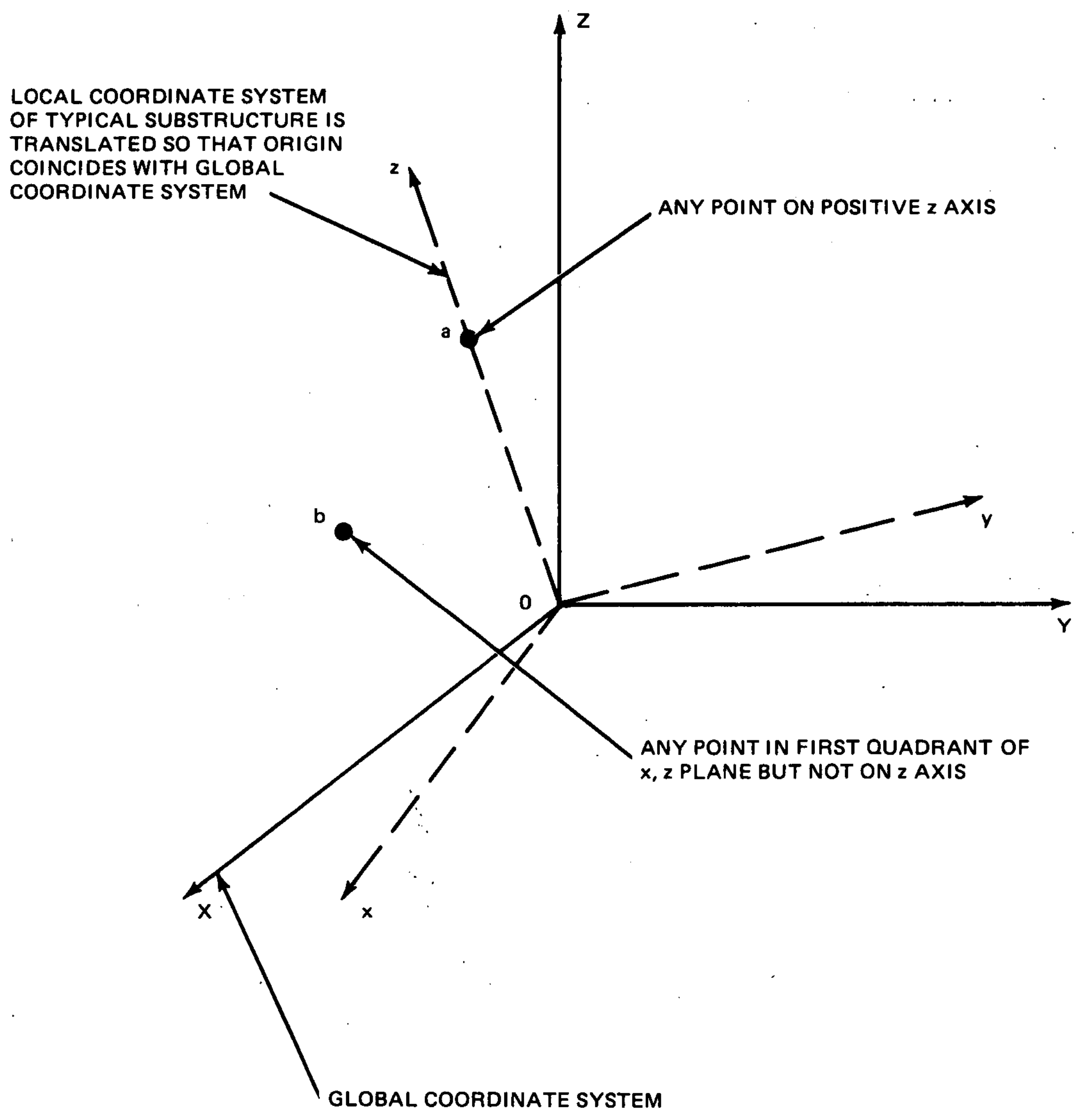

Fig. 2.4 Information Required to Specify Orientation of Local Coordinate System

- Point a is any point on the positive z axis
- Point b is any point in the first quadrant of the x, z plane that is not on the z axis

It is usually convenient to select point b as a point on the positive x axis. The global coordinates of points a and b (X_a, Y_a, Z_a and X_b, Y_b, Z_b) are specified and this information is used by the program to orient the local coordinate system.

2.3.2 Constrained Substructure Modes and Nonrectangular Coordinates

The program normally requires, as input data, substructure mode shapes expressing the motion of each mass point using three rotations and three translations expressed in the local coordinate system for that substructure. However, as a result of the method used for idealizing the substructure, the user may have modes available with less than six degrees of freedom at each mass point. As an example, if the substructure is a beam, axial extension may be neglected. In other types of constraints some coordinates are dependent on others. In addition, coordinates which are not rectangular (for example, polar coordinates) may have been used in describing the substructure modes. The program can accommodate modes which do not use the usual standard six rectangular coordinates to describe the position of each mass provided the N ($N \le 6$) coordinates used $\{q_y^i\}$ at each mass point M_i can be related to the six rectangular coordinates $\{q_x^i\}$ at M_i by the following equation:

$$\{q_x^i\} = [T_i]^T \{q_y^i\} \tag{2.1}$$

The computer must be informed of the value of the N by 6 T matrix $[T_i]$ at each mass point; the following program features simplify the required input data in most cases:

- A T matrix need only be input once if it applies to an entire module or to consecutively numbered mass points within a module. This matrix is known as the default T matrix.
- If all degrees of freedom present at a mass point are expressed in the rectangular local coordinate system (e.g., x, y, z for Module 14 in Figure 2.3), it is only necessary to indicate which coordinates are absent in the mode shapes as a result of zero deformation in that direction. The program will construct the T matrices from this information. If all coordinates are present, the T matrix will simply be the identity matrix.

2.4 PROGRAM LIMITATIONS

1) Module 1 must be present
2) Modules 2-11 if present must attach to Module 1
3) Modules 12-14 if present must attach to Module 11
4) Modules 15, 16 if present must attach to Module 14
5) Module 17 if present must attach to Module 16
6) There is a maximum of 30 input-data modes per module
7) There is a maximum of 100 total input-data modes
8) There is a maximum of 30 mass points per module
9) There is a maximum of 100 mass points total

2.5 INSTRUCTIONS FOR SETTING UP INPUT DATA DECK FOR PHASE I PROGRAM

The input deck to the program is organized as follows for each run: a TYPE I deck, then several TYPE II decks, followed by a TYPE III deck. The user may supply two runs back-to-back. If only one run is supplied the program automatically detects the end of the input data deck and terminates execution.

The TYPE I deck describes which modules are present, the number of modes per module, the number of mass points per module, junction points for attached modules or appendages, and the gravity constant (G) for the program. A TYPE II deck is enclosed for each module and gives the location of the attachment point (X_0) and orientation of the local coordinates (X_a and X_b) for the module, each mass point location in local coordinates, the mass matrix in local coordinates corresponding to each mass point, the module modes in local coordinates, and data identifying the degrees of freedom present at each mass point. The TYPE III deck includes the diagonal elements of the modal mass matrix and the substructure eigenvalues (frequencies squared).

Specific instructions are presented below. An example of the input data is given in Appendix A-1

TYPE I Deck

The TYPE I deck consists of 5 cards.

Card 1: Seventeen two-column fields for modules 1-17. Place a 1 in the two-column field corresponding to a module which is present.

Card 2: Similar to Card 1. Place the number of modes for each module present in the appropriate two-column field.

Card 3: Similar to Card 1. Place the number of mass points for each module present in the appropriate two-column field.

Card 4: Sixteen two-column fields for modules 2-17. Place the number of the mass point to which the module is attached in the appropriate two-column field. Use the mass point number of the root module. (E.g., Module 14 would be connected to mass point 3 in Figure 2.3.)

Card 5: Enter the gravity constant G in the first 15 columns. The elements of the mass matrix are divided by G. It is read with a FORTRAN format of (E 15.8).

TYPE II Deck (For Each Module Present)

Group 1: Enter the global coordinates, (X, Y, Z), of points O, a and b with (X_O, Y_O, Z_O) on the first card, (X_a, Y_a, Z_a) on the second card and (X_b, Y_b, Z_b) on the third. Each card has three 15 column fields corresponding to the X, Y and Z coordinates respectively. The FORTRAN format is (3E 15.8) for each card.

Group 2: Enter the local (x, y, z) coordinates of mass points 1, 2, 3, etc. for the module. Use one mass point per card with FORTRAN format (3E 15.8).

Group 3: Enter the mass and the 3 x 3 inertia matrix for each mass point 1, 2, 3, etc. consecutively. Mass and inertia properties may be supplied in mass or weight units, along with the appropriate value of "G". The actual mass and inertia properties are input without mass loading. Four cards for each mass point must be supplied:

Card 1: Enter mass in first 15 columns. The FORTRAN format is (E 15.8).

Card 2: Enter row 1 of inertia matrix. The FORTRAN format is (3E 15.8) for each column.

Card 3: Enter row 2.

Card 4: Enter row 3.

Group 4: This group specifies the module mode shapes and the constraint matrices (T matrices) discussed in Section 2.3.2.

(a) Enter a T-matrix card to define the default T-matrix for the modules. This matrix will be used for all mass points unless overridden. A T-matrix card is a seven-field card. The first column contains a 0 if the coordinates used for the mode shapes are parallel to the local axes and it is desired that the program generate the T matrix. Otherwise, enter a 1 in the first column. If a zero is entered in the first column, the next six columns contain a 1 if the degree of freedom is present in the mode shape and a zero if not. If a 1 is entered in the first column, the next six columns should be left blank.

(i) (If column 1 is set to 1) - Enter N on a card, where N is the number of degrees of freedom used to describe the motion of the constrained mass point in the mode. Use a FORTRAN format of (I2).

(ii) (If column 1 is set to 1) - Enter the NX6 T matrix row by row, four numbers to a card, using format (4E 15.8).

(b) Enter the coupled-structure mass-point number of the first mass point at which the default T matrix is to be overriden. Use 50 if the default T matrix is not to be overridden. Use a FORTRAN format of (I2).

(c) For each mass point:

(i) (If override was specified for the current mass point) Perform steps (a) and (b) above to define the override T matrix for the mass point and the number of the next mass point at which the default is to be overridden. Do not enter the next mass-point number when overriding the T matrix at the last point.

(ii) Enter module modes in local coordinates. If any rigid-body modes are present, these must be the first modes in Module 1. The modes are read in as an NXM matrix row by row where N is the number of degrees of freedom at the current mass point and M is the number of modes for the module. The FORTRAN format is (3 (8X, E15.8, 1X)).

Repeat the TYPE II Deck for each module present.

<u>TYPE III Deck</u>

Group 1: For each module present enter the diagonal elements of the modal mass matrix using format (3 (8X, E15.8, 1X)). Begin a new card for each module.

Group 2: Similar to Group 1. Enter the eigenvalues (frequencies squared in rad^2 per unit time squared).

Group 3: Consists of 2 cards.

Card 1: Enter the number of rigid-body modes in column one. If the program is to be used together with the Phase II program, 6 rigid-body modes should always be used.

Card 2: Enter the number of eigenvectors to be computed, and the number of eigenvalues to be computed. The FORTRAN format is (2I3). The number of eigenvectors must be less than or equal to the number of eigenvalues, and the number of eigenvalues must be less than or equal to the total number of substructure modes.

2.6 PROGRAM OUTPUT

The results of this program are the flexible modes of the coupled structure in the global coordinate system. The trivial rigid-body modes are not printed. The input data for the Phase II program must not contain the rigid body modes*; thus the Phase I output modes are in the form required for the Phase II program. The Phase I output modes are normalized to unit modal mass. In addition to the combined-structure mode shapes and frequencies, the Phase I program output includes the mass-point locations in global coordinates and the mass and inertia matrices in global coordinates for each mass point. This information is also required input for the Phase II computer program. A sample of Phase I output is presented in Appendix A2.

The Phase I and Phase II computer programs may be connected and run together by using the proper job control instructions. To accomplish this, the output of a Phase I run is placed on a file which is then passed to the Phase II run. If two back-to-back Phase I runs are made, two separate files are created. The output files of the Phase I program are discussed in Appendix A5, and the input files of the Phase II program are discussed in Appendix B6.

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* The Phase I input data, however, must contain the rigid-body modes of Module I.

3.0 PHASE II - DEVELOPMENT OF TIME HISTORY

3.1 INTRODUCTION

The Phase II computer program solves the equations of motion developed in Volume I by numerical integration and, in this way, develops the time history of the system's motion. The entire vehicle under consideration is referred to as the Space Station, the main body is called the Laboratory and the other body is called the Counterweight. The structure separating these bodies is referred to as the Connecting Structure. Both the Laboratory and the Counterweight are flexible structures with arbitrary shape and mass distribution. The Connecting Structure is also flexible and arbitrary, but its mass is neglected. Figure 3.1 illustrates the general configuration which may be treated, and Figure 3.2 illustrates a particular example.

Problems which may be studied using the simulation include deployment and retraction of the Connecting Structure with simultaneous or sequential spin up and spin down, the effects of moving rigid masses such as a cargo elevator or crew members on board the Laboratory, and the effect of fluid pumped through a piping system on the Laboratory. Five control systems are included to study various types of controlled maneuvers including mass balancing and wobble damping. Various features including control systems and Connecting-Structure characteristics have been included in subroutine form so that these items may be easily replaced with minimum disruption to the main program. Special constraint options permit the user to rigidize the Laboratory, the Counterweight, or the entire Space Station; thus the easier-understood rigid-body results can be compared with the more complex flexible-body solutions.

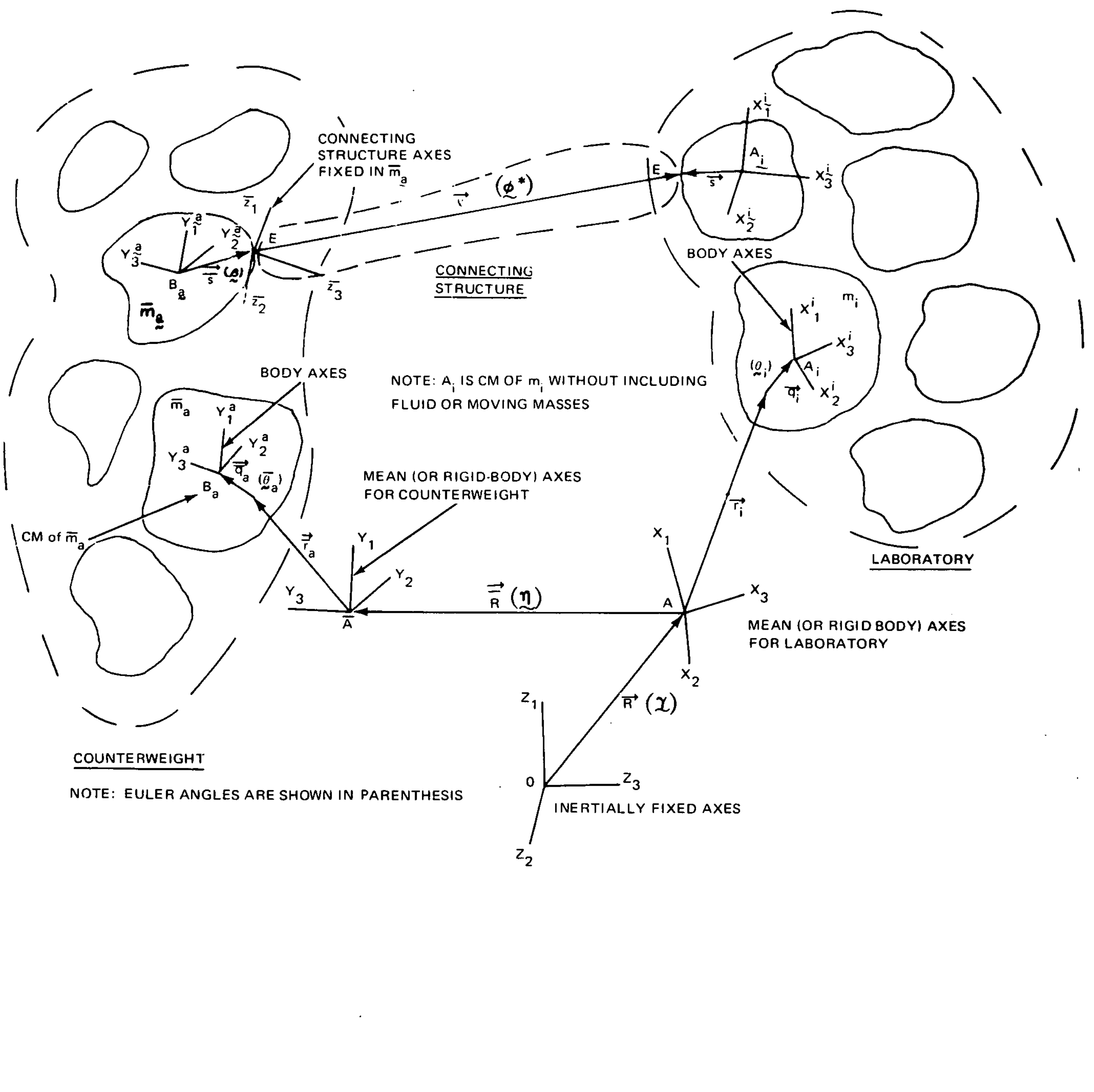

Fig. 3.1 Idealization and Coordinate Systems

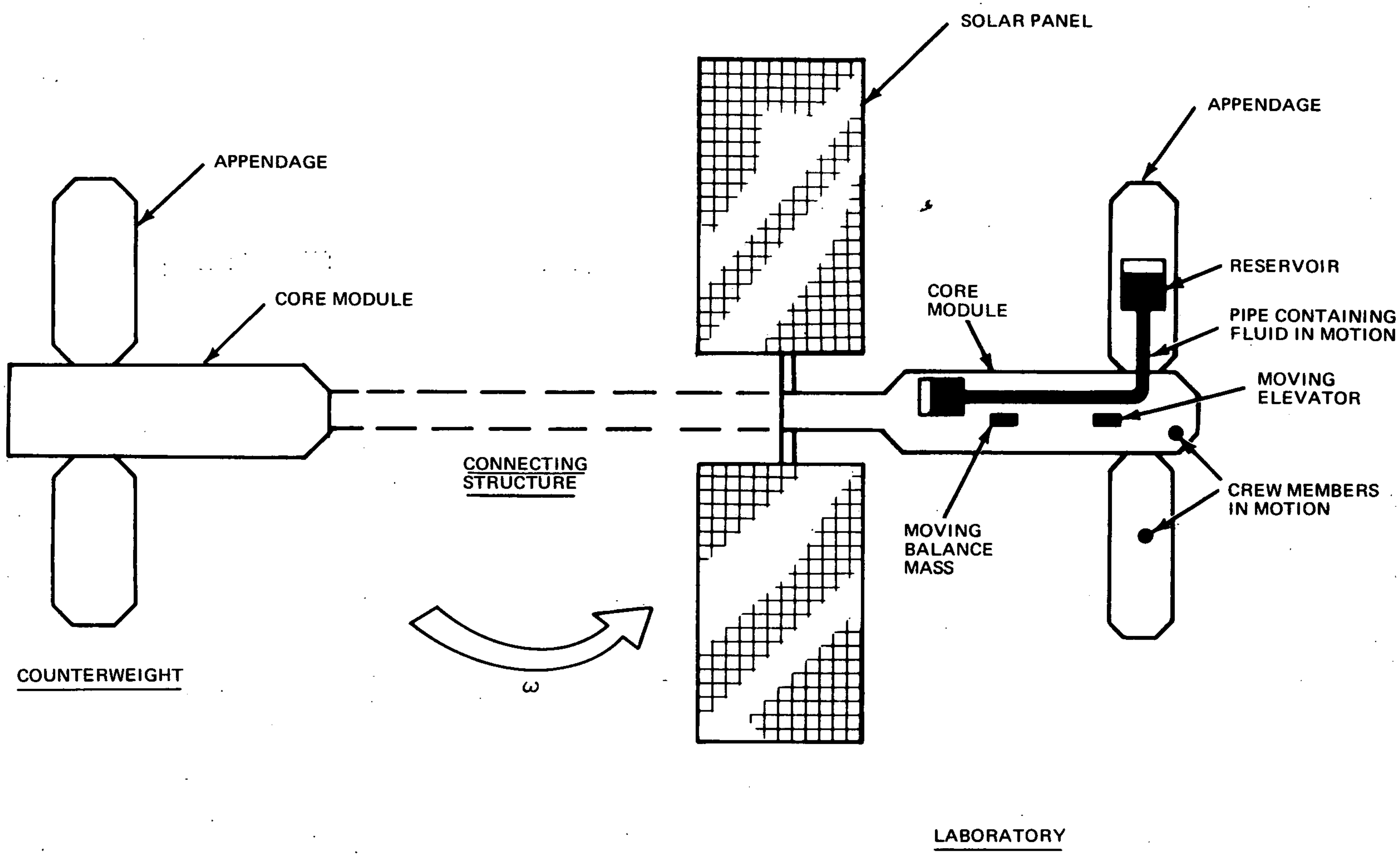

Fig. 3.2 One Example of a Space Station that Can be Studied Using the General Mathematical Model

3.2 SYMBOLS

The analytical symbols used in Section 3 and in Appendix B5 are defined below.

A	cross sectional area of inside of pipe
AE	Axial stiffness of beam-type connecting structure
a	undeformed distance from Laboratory mass center to attachment point of beam-type Connecting Structure
$\underset{\sim}{a}$	index number of mass point on Counterweight to which Connecting Structure is attached
acc_{01C}	magnitude of spin-speed acceleration command
$acc_{\ell 03\ MAG}$	magnitude of deployment acceleration command
acc_{MAG}	magnitude of acceleration command
b	undeformed distance from Counterweight mass center to beam attachment point for beam-type Connecting Structure
b_i	inside radius of reservoir on m_i
$E, \bar{E}$	points at which Laboratory and Counterweight, respectively, attach to Connecting Structure
EI	bending stiffness of beam-type Connecting Structure
$e_{\omega 1DB}$	spin speed control error dead band
$e_{\theta DB}$	attitude angle error dead band
$\dot{e}_{\theta MAX}$	magnitude of maximum desired attitude angle error rate at which torque is applied
err_{KT}, err_{KTI}; err_{LL}, err_{LLI}	used in both gimbal-angle and gimbal-angle rate law (see Figures 3.14 and 3.15)
$\{e_i\}$	unit vector tangent to pipe centerline along nominal direction of fluid velocity (1)
$\{\Delta e_i\}$	value of $\{e_i\}$ at nominal pipe outlet less value at nominal pipe inlet (1)

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(1) See Footnotes at end of symbol list

$\{e_i^B\}$	$\{e_i\}$ for pipe section on m_i which is connected to reservoir on m_i. $\{e_i^B\}$ is always directed outward from control volume (see Figure 3.6)
$\{e_i^R\}$	unit vector along reservoir center line in mass m_i directed from reservoir base toward reservoir-pipe connection [1] (see Figure 3.6)
f_{JET}	jet thrust
$\{f'_\ell\},\{\bar{f}'_{\bar{\ell}}\}$	internal force at point on m_ℓ, and $\bar{m}_{\bar{\ell}}'$, expressed $\underset{\sim}{X}^{\ell'}$ and $\underset{\sim}{Y}^{\ell'}$ axes, respectively
$\{f_s^i\},\{\bar{f}_s^a\}$	supplementary forces on m_i and $\bar{m}_a$, respectively [1] [2]
$\{f_E^*\}$	force applied by Laboratory on Connecting Structure at point E; vector is expressed in $\underset{\sim}{\bar{z}}$ axes
$\{f_c{}^i\},\{\bar{f}_c{}^a\}$	force applied by control system on m_i or $\bar{m}_a$, respectively [1] [2]
$\{G_i\}$	see Equations (3.4a) and (3.4b) for a through pipe [1]
$\{G_i^P\}$	$\{G_i\}$ for a reservoir pipe [1]
GJ	torsional stiffness for beam-type Connecting Structure
$\{\Delta H_i\}$	$[\Gamma(U_i)]\ \{e_i\}$ at nominal pipe outlet less value at nominal pipe inlet for pipe on m_i [1] [6]
h_i	fluid height in reservoir on m_i
$h_{io}, h_{i\,max}, h_{i\,min}$	initial, maximum and minimum values of h_i, respectively
I_L, I_C	transverse moments of inertia of undeformed Laboratory and Counterweight, respectively, used in simplified model to determine damping coefficients of beam-type Connecting Structure in bending
$I_{\beta\ GIM}$	moment of inertia of CMG wheel including gimbal about transverse wheel axis
$[I_i],[\bar{I}_a]$	moment of inertia matrices of m_i and $\bar{m}_a$, respectively [1] [2]
$[I_i^P]$, $[I_i^f]$	moment of inertia matrices of fluid in reservoir pipe on through pipe on m_i, respectively

$\underset{\sim}{i}$ — index of mass on Laboratory to which Connecting Structure is attached

i_s — index of mass on Laboratory at which sensor and CMG are located

J_L, J_C — axial (roll) moments of inertia of undeformed Laboratory and Counterweight, respectively used in simple model to obtain damping coefficient of beam-type Connecting Structure in torsion

$\lceil J_i \rfloor$ — area moment of inertia of the elements dA_n on the fluid boundary about point A_i (see Figure 3.5b)(1)

$\lceil J_i^B \rfloor$ — $\lceil J_i \rfloor$ evaluated for area associated with point B on reservoir pipe (see Figure 3.6A)

$\lceil \Delta J_i \rfloor$ — $\lceil J_i \rfloor$ at nominal outlet of through pipe less value monimal inlet (1) (6)

K_{eXSE} — gain in balance-mass control system multiplying filtered sensor acceleration error

K_{DESE} — gain in balance-mass control system multiplying balance mass velocity

K_T — gain in wobble control system multiplying error in gimbal angle and gimbal-angle rate in gimbal-angle and gimbal-angle rate control system respectively

$K_{\dot{\beta}}$ — gain in wobble control system multiplying gambal-angle rate

ℓ_{03} — component 3 of $\{\ell_0\}$, length of beam-type Connecting Structure

ℓ_{03U} — update value of ℓ_{03} specified for use in position command routine when deployment or retraction is commanded

$\{\ell\},\{\ell_0\}$ — deformed and undeformed vectors, respectively, from Connecting-Structure attachment point on Counterweight to attachment point on Laboratory (5)

$\ell_{0\,min}$ — minimum value of ℓ_{03} used in evaluating stiffness and damping coefficients for beam-type Connecting Structure

M_L, M_C	in list of input data, these values are masses of Laboratory and Counterweight, respectively, used in beam-type Connecting Structure to establish damping coefficients
$m_i, \bar{m}_i$	mass of i^{th} lumped mass point of Laboratory or Counterweight, respectively
m_i^f	mass of fluid in pipe on m_i
m_i^P	mass of fluid in reservoir pipe on m_i
mom_{CMG}	momentum of CMG used for wobble control
$n, \bar{n}$	number of mass points on Laboratory and Counterweight, respectively
n_{CMG}	value is 1 when CMG is nominally controlling wobble (gimbal-angle mode) otherwise value is 0 (CMG gimbal angle-rate mode)
$p, \bar{p}$	number of flexible modes used for Laboratory and Counterweight, respectively
$\{q_i\}, \{\bar{q}_a\}$	linear deflection of cm of m_i or $\bar{m}_a$, respectively (3) (4)
$\{R\}$	vector from origin of $\underset{\sim}{Z}$ axes to origin of $\underset{\sim}{X}$ axes (3)
$\{\bar{R}\}$	vector from origin of $\underset{\sim}{X}$ axes to origin of $\underset{\sim}{Y}$ axes (4)
$\{\bar{R}_o\}$	undeformed value of $\{\bar{R}\}$
$\{\Delta\bar{R}\}$	$\{\bar{R}\} - \{\bar{R}_o\}$
$\{R_i\}$	vector from origin of $\underset{\sim}{Z}$ axes cm of m_i (3)
$\{r_i\}$	vector from origin of $\underset{\sim}{X}$ axes to cm of m_i when Laboratory is undeformed (3)
$\{\bar{r}_a\}$	vector from origin of $\underset{\sim}{Y}$ axes to cm of $\bar{m}_a$ when Counterweight is undeformed
$\{S_i\}$	see Equation (3.3b) (1)
$\{S_i^P\}$	value of $\{S_i\}$ for reservoir pipe on m_i (1)

$\{s\}$	vector from cm of m_i to Connecting-Structure attachment point on Laboratory $\sim$(1)
$\{\bar{s}\}$	vector from cm of m_a to Connecting-Structure attachment point on Counterweight (2)
t	time
t_U	time of update
t_{fU}	time at which fluid velocity is updated
$t_{\ell 03U}$	time at which ℓ_{03} is updated
t_{qLIM}	limiting torque of CMG gimbal motor
$t_{\omega 1CU}$	time at which angular-velocity command is updated
$\{t_{\ell'}\}$	vector from cm of $m_{\ell'}$ to point on $m_{\ell'}$ where internal load is required(1)
$\{\bar{t}_{\bar{\ell}'}\}$	vector from cm of $\bar{m}_{\bar{\ell}'}$ to point on $\bar{m}_{\bar{\ell}'}$ where internal load is required
U_U	position update of moving mass
$\{U_j\},\{U_j(0)\}$	position and initial position, respectively, of moving mass when Laboratory is undeformed (3) (j = 1 designates elevator, j = 2 designates balance mass)
$\{U_j\}_3$	third component of $\{U_j\}$
$\{u_i\}$	vector from cm of m_i to center line of pipe on m_i (1)
$\{\Delta u_i\}$	$\{u_i\}$ at nominal pipe outlet lass value at nominal pipe inlet (1) (6)
$\{u_i^{\beta}\},\{u_i^R\}$	$\{u_i\}$ at points R and B respectively (see Figure 3.6)
V	fluid velocity in pipe
V_U	command update of fluid velocity in pipe
$vel_{\ell 03\ MAX}$	maximum value of $\dot{\ell}_{03}$
vel_{MAX}	maximum commanded velocity
XJ1	jet moment arm (see Figure 3.8)

$\underset{\sim}{X}$	mean axes for Laboratory
$\underset{\sim}{X}^{i}$	body axes in m_i with origin at cm of m_i
$\{X_A^{i_s}\}$	coordinates of accelerometer in $\underset{\sim}{X}^{i_s}$ axes
$\{X_{SENS/CM}^{CMND}\}, \{X_{SENS/CM}\}$	commanded vector and actual vector, respectively, from Space Station center of mass to sensor (accelerometer) for use in balance mass control system (3)
$\underset{\sim}{Y}$	mean axes for Counterweight
$\underset{\sim}{Y}^{a}$	body axes in $\bar{m}_a$ with origin at cm of $\bar{m}_a$
$\{\underset{\sim}{Y}^{a'}\}_{ⓐ}, \{\underset{\sim}{Y}^{a'}\}_{ⓑ}$	see Section 3.3.4
$\underset{\sim}{Z}$	inertial coordinate system
$\underset{\sim}{\bar{z}}$	Connecting-Structure coordinate system fixed in $\bar{m}_{\underset{\sim}{a}}$
β_G	CMG gimbal angle
$\{\beta\}$	Euler angles orienting the $\underset{\sim}{\bar{z}}$ axes with respect to the $\underset{\sim}{Y}^{a}$ axes
$\Gamma(\;)$	cross-product function
$\gamma_A, \gamma_B, \gamma_T$	ratio of actual to critical damping coefficient of beam-type Connecting structure for axial, bending, and torsional vibration modes, respectively
$\{\gamma\}$	Euler angles locating $\underset{\sim}{X}$ axes with respect to $\underset{\sim}{Z}$ axes
$\{\delta\}$	deformation of Connecting Structure, $\{\ell\}-\{\ell_0\}$
$\{\eta\}$	Euler angles orienting $\underset{\sim}{Y}$ axes with respect to $\underset{\sim}{X}$ axes
$\{\eta*\}$	$\{\eta\} - \begin{Bmatrix} \pi \\ 0 \\ 0 \end{Bmatrix}$
$\{\theta_i\}, \{\bar{\theta}_a\}$	angular deformation of m_i and $\bar{m}_a$, respectively
μ_j	mass of j^{th} moving mass
μ_{1EST}	estimated mass of elevator for use in balance mass control system
$\{\xi\}, \{\bar{\xi}\}$	model coordinates for Laboratory and Counterweight, respectively

$[\Pi(\ )]$	coordinate transformation matrix
ρ	mass density of fluid
τ_{BAL}	filter time constant used in balance mass control system (set to zero to bypass filter)
$\{\tau_E^*\}$	torque exerted by Laboratory on Connecting Structure at point E; vector is expressed in $\bar{\underset{\sim}{z}}$ axes
$\{\tau'_{\ell'}\},\{\bar{\tau}'_{\bar{\ell}'}\}$	internal torque at point on $m_{\ell'}$ and $m_{\bar{\ell}'}$, expressed in $\underset{\sim}{X}^{\ell'}$ and $\underset{\sim}{Y}^{\ell'}$ axes, respectively
$\{\phi^*\}$	Euler angles expressing angular deformation of $\underset{\sim}{m}^i$ relative to $\underset{\sim}{\bar{m}}^a$ in $\bar{\underset{\sim}{z}}$ axes
$\omega_{1C}, \omega_{1CU}$	commanded angular velocity and angular velocity update, respectively
$\omega_{1C\ BAL}$	minimum value of ω_{1C} at which balance mass control system is in operation
$\{\omega^X\},\{\omega^Y\}$	angular velocity of $\underset{\sim}{X}$ and $\underset{\sim}{Y}$ axes, resepectively (3) (4)
$\{\omega^{X^i}\}$	angular velocity of $\underset{\sim}{X}^i$ axes (1)

Footnotes:

(1) The matrix form is expressed in the $\underset{\sim}{X}^i$ axes for the symbol pertaining to the Laboratory

(2) The matrix form is expressed in the $\underset{\sim}{Y}^a$ axes for the symbol pertaining to the Counterweight

(3) The matrix form is expressed in the $\underset{\sim}{X}$ axes for the symbol pertaining to the Laboratory

(4) The matrix form is expressed in the $\underset{\sim}{Y}$ axes for the symbol pertaining to the Counterweight

(5) The components of the vector are expressed in the $\bar{\underset{\sim}{z}}$ axes

(6) Nominal pipe outlet and inlet refers to outlet and inlet, respectively, when fluid velocity V is positive

3.3 COORDINATES USED IN THE PROBLEM

3.3.1 Coordinate Systems

Figure 3.1 illustrates the coordinates used in the problem. The axes of each coordinate system used are always denoted as the 1, 2, and 3 axes; for example, the $\underset{\sim}{Z}$ coordinate-system axes are Z_1, Z_2, and Z_3. The main coordinate systems are the $\underset{\sim}{Z}$ axes, the $\underset{\sim}{X}$ axes and the $\underset{\sim}{Y}$ axes. The $\underset{\sim}{Z}$ axes are an inertially fixed reference coordinate system. The $\underset{\sim}{X}$ axes are a system of mean axes moving with the average motion of the Laboratory and are used as the reference system for elastic motion of the Laboratory. The $\underset{\sim}{Y}$ axes are similarly a set of mean axes for the Counterweight. The $\underset{\sim}{X}$ and $\underset{\sim}{Y}$ coordinate systems are also the global coordinate systems in which the modes of the Laboratory and Counterweight, respectively, have been computed.

The axes fixed in each mass m_i of the Laboratory are the $\underset{\sim}{X}^i$ axes with their origin at A_i, the mass center of m_i. The $\underset{\sim}{Y}^a$ axes are similarly a set of axes fixed in a typical Counterweight mass m_a.

The axes must be selected so that they meet the following orientation specifications <u>when the system is undeformed</u>. First, the $\underset{\sim}{X}$ axes are selected as any convenient reference system for the Laboratory. All of the $\underset{\sim}{X}^i$ axes must be parallel to $\underset{\sim}{X}$. The $\underset{\sim}{Y}$ coordinate system is rotated 180^o about the number 1 axis with respect to the $\underset{\sim}{X}$ coordinate system. Thus, the $\underset{\sim}{X}$ and $\underset{\sim}{Y}$ coordinates are parallel; however the Y_2 and Y_3 axes are opposite in direction to the X_2 and X_3 axes, respectively. The $\underset{\sim}{Y}^a$ axes are parallel to the $\underset{\sim}{Y}$ axes. These parallel requirements on the nominal positions of the coordinate systems do not limit the generality of the program since it is always possible to select the coordinates with the orientations required. In fact, if mass distribution and modal properties of a structure are available in other coordinate systems, the Phase I program may be used to transform these properties into the required coordinate systems.

3.3.2 Euler Angles

Each set of Euler angles is designated by a 1, 2, and a 3 angle; for example, the set of angles used for the coordinate transformation from the $\underset{\sim}{Z}$ to $\underset{\sim}{X}$ axes of Figure 3.1 are called $\{\gamma\}$ and the specific angles are γ_1, γ_2, γ_3. The order of rotation is always as follows: the number 1 angle about the 1 axis, the number 2 angle about the carried number 2 axis, and the number

3 angle about the twice-carried number 3 axis. This is illustrated in Figure 3.3 for the angles $\{\gamma\}$. In the figure the $\underset{\sim}{X}$ axes have been translated so that their origin coincides with that of the $\underset{\sim}{Z}$ axes for the purpose of illustrating the method of orienting the $\underset{\sim}{X}$ axes with respect to the $\underset{\sim}{Z}$ axes. For brevity $\{\gamma\}$ is simply described as the "set of Euler angles orienting the $\underset{\sim}{X}$ axes relative to the $\underset{\sim}{Z}$ axes." Similar brief descriptions will be used to define the other Euler-angle sets.

3.3.3 Main Coordinates Used in the Problem

As indicated in Figure 3.1, $\{R\}$ and the Euler Angles $\{\gamma\}$ locate the $\underset{\sim}{X}$ axes in space, and $\{\bar{R}\}$ and $\{\eta\}$ locate the $\underset{\sim}{Y}$ axes with respect to the $\underset{\sim}{X}$ axes. The elastic linear and angular deflections are $\{q_i\}$ and $\{\theta_i\}$, respectively, for a typical mass point m_i (i = 1, ..., n) on the Laboratory and $\{\bar{q}_a\}$ and $\{\bar{\theta}_a\}$ for a typical mass point $\bar{m}_a$ (a = 1, ..., $\bar{n}$) on the Counterweight. These elastic coordinates were linearized whenever there was an analytical or computational advantage to do so; however, the rigid-body coordinates $\{R\}$, $\{\gamma\}$, $\{\bar{R}\}$, and $\{\eta\}$ are not linearized so that large rigid-body motions may be studied. Instead of Euler-angle rates ($\{\dot{\gamma}\}$ and $\{\dot{\eta}\}$), angular velocities ($\{\omega^X\}$ and $\{\omega^Y\}$) of the $\underset{\sim}{X}$ and $\underset{\sim}{Y}$ axes, respectively, are used as coordinates. To improve numerical accuracy, the following perturbation parameters were used as integration coordinates in place of $\{\bar{R}\}$ and $\{\eta\}$:

$$\{\Delta\bar{R}\} = \{\bar{R}\} - \{\bar{R}_o\} \tag{3.1}$$

$$\{\eta^*\} = \{\eta\} - \begin{Bmatrix} \pi \\ 0 \\ 0 \end{Bmatrix} \tag{3.2}$$

The derivatives of $\{R\}$, $\{\gamma\}$, $\{\omega^X\}$, the $\{q_i\}$'s, the $\{\theta_i\}$'s, $\{\Delta\bar{R}\}$, $\{\eta^*\}$, $\{\omega^Y\}$, the $\{\bar{q}_a\}$'s and the $\{\bar{\theta}_a\}$'s are obtained in the program and numerically integrated. In addition certain control-system variables are also integrated. The integrated variables are given in Equation (3.5).

3.3.4 Coordinates Used to Describe the Connecting-Structure Deformations

It is assumed that the Connecting-Structure is fastened to $\underset{\sim}{\bar{m}_a}$ on the Counterweight and $\underset{\sim}{m_i}$ on the Laboratory. (See Figure 3.1.) The $\underset{\sim}{\bar{z}}$ axes which are fixed to $\underset{\sim}{\bar{m}_a}$ at point $\bar{E}$ are a convenient set of coordinates for expressing the Connecting-Structure deformations. The origin of these axes, point $\bar{E}$, is

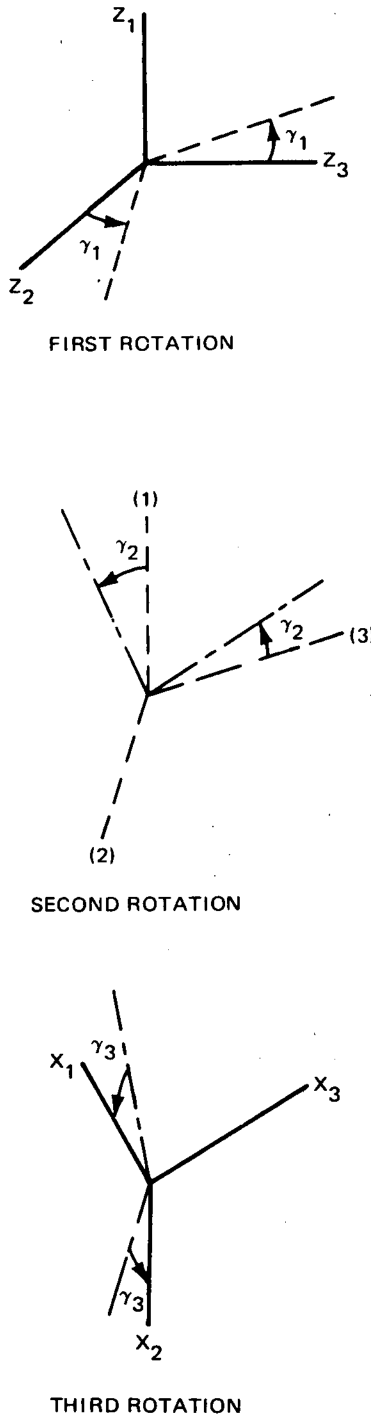


Fig. 3.3 Typical Set of Euler Angles

located with respect to the center of mass of $\underset{\sim}{\bar{m}_a}$ by specifying the vector $\{\bar{s}\}$. The orientation of the $\underset{\sim}{\bar{z}}$ axes is specified in the same manner as discussed in Section 2.3.1; i.e., by specifying the vectors $\{\underset{\sim}{Y}^{a'}\}_{Ⓐ}$ and $\{\underset{\sim}{Y}^{a'}\}_{Ⓑ}$ in the $\underset{\sim}{Y}^{a'}$ coordinate system which is parallel to the $\underset{\sim}{Y}^{a}$ coordinate system but has its origin at $\bar{E}$. These vectors locate point Ⓐ which is any point on the positive $\bar{z}_3$ axis and point Ⓑ which is any point in the first quadrant of the $\bar{z}_1\bar{z}_3$ plane.

Point E is a reference point on $\underset{\sim}{m_i}$ on the Laboratory. The vector $\{\ell\}$, from $\bar{E}$ to E, may be thought of as the length vector of the Connecting-Structure. $\{\ell\}$ is expressed in the $\underset{\sim}{\bar{z}}$ axes and is composed of the undeformed length $\{\ell_0\}$ plus the deformation $\{\delta\}$. During deployment and retraction maneuvers, $\{\ell_0\}$ is a specified function of time. When there is no deformation, a coordinate system $\underset{\sim}{z}$ may be imagined as fixed in $\underset{\sim}{m_i}$ and parallel to $\underset{\sim}{\bar{z}}$. During deformation, the Euler angles expressing the angular deformation of the $\underset{\sim}{z}$ axes relative to the $\underset{\sim}{\bar{z}}$ axes are $\{\phi^*\}$. Thus, the Connecting-Structure deformation is specified by the vectors $\{\delta\}$ and $\{\phi^*\}$.

3.4 ENGINEERING CONSIDERATIONS WHEN PREPARING DATA

The input data deck is to be constructed in accordance with the procedure described in Section 3.5. Special engineering considerations are discussed in this section.

3.4.1 Constraint Options

Constraint options may be used to run the program with portions of the vehicle rigid even though the available data deck was prepared for a flexible vehicle. This enables the analyst to compare the more complex flexible-vehicle results with simpler rigid-body results. It is possible to:

- rigidize the Laboratory
- rigidize the Counterweight
- rigidize the entire Space Station
- rigidize both the Laboratory and the Counterweight while maintaining a flexible Connecting Structure.

3.4.2 Basic Input Data for the Laboratory

The following basic input data is required to define the mass and flexibility characteristics of the Laboratory:

- Coordinates of the center of mass A_i of each mass point m_i in the $\underset{\sim}{X}$ coordinate when there is no deformation. (See Figure 3.1).
- Mass m_i of each mass point and the inertia matrix $[I_i]$ in local coordinates $\underset{\sim}{X}^i$
- Elastic frequencies and mode shapes relative to the $\underset{\sim}{X}$ coordinate system. The free-free modes are required and the six rigid-body modes must be omitted. The modes must be orthogonal. Each mode must contain the three translational coordinates and the three rotational coordinates, in sequence, for each mass point. If the moment of inertia at a mass point is neglected and there is no torque at that mass point, the rotational coordinates are not used; thus, the corresponding field on the data card may be left blank if desired.

As indicated in Section 2.6, it is possible to generate all of the above information with the Phase I computer program, and, if desired, connect the two programs so that the information is passed directly to the Phase II program. This information may also be generated elsewhere and input directly into the Phase II computer program.

3.4.3 Basic Input Data for the Counterweight

The basic input data for the Counterweight is analogous to that described above for the Laboratory, and the above comments are also applicable to the Counterweight data. The modes and inertia matrices for the Counterweight must be expressed in the $\underset{\sim}{Y}$ and $\underset{\sim}{Y}^a$ axes, respectively (see Figure 3.1).

3.4.4 Initial Conditions and Mean Axes

While the positions of the $\underset{\sim}{X}$ axes for the Laboratory are arbitrary when there is no deformation, when the structure is deformed the coordinates move with the mean, or rigid-body, motion of the Laboratory. The program computes the position and rate of movement of these axes and prints out this information as $\{R\}$, $\{\gamma\}$, $\{\dot{R}\}$, $\{\omega^X\}$. When the system is initially deformed it would be a burden for the user to average the deformation and deformation rates and compute the initial position and rate of movement of the mean axes. To avoid this burden, the user may supply the initial deformation data ($\{q_i\}$, $\{\theta_i\}$, $\{\dot{q}_i\}$, and $\{\dot{\theta}_i\}$) in terms of any neighboring axes (defined by the initial values of $\{R\}$, $\{\gamma\}$, $\{\dot{R}\}$ and $\{\omega^X\}$) and the program will compute the initial position and rate of the mean axes and convert the initial deformation data to these axes. For this reason the values of $\{R\}$, $\{\gamma\}$, $\{\dot{R}\}$, $\{\omega^X\}$, $\{q_i\}$, $\{\theta_i\}$, $\{\dot{q}_i\}$, and $\{\dot{\theta}_i\}$ (for i=1, ..., n) that are printed out at t=0 may not agree with the values that are input to the program.

The Counterweight is located relative to the Laboratory, at t=0, by specifying the initial undeformed location of the Connecting Structure its deformation, ($\{\delta\}$ and $\{\phi^*\}$) and the deformation rates $\{\dot{\delta}\}$ and $\{\dot{\phi}^*\}$. The elastic coordinates of the Counterweight $\{\bar{q}_a\}$, $\{\bar{\theta}_a\}$ and their rates $\{\dot{\bar{q}}_a\}$, and $\{\dot{\bar{\theta}}_a\}$ for a=1, ..., $\bar{n}$ are initially described relative to the $\underset{\sim}{Y}$ axes. The $\underset{\sim}{Y}$ axes are a set of mean axes for the Counterweight, and, as is the case for the $\underset{\sim}{X}$ axes, the program will initially recompute the location of the $\underset{\sim}{Y}$ axes and transform the elastic coordinates.

3.4.5 Damping in the Laboratory and Counterweight Structures

Modal damping is assumed. The ratio of the damping coefficient to the critical damping coefficient is specified for each mode.

3.4.6 Fluid Motion

The dynamic effect of fluid being pumped through a piping system may be studied using this program. It is assumed that the pipes terminate in two reservoirs, one called the <u>emptying reservoir</u> and the other called the <u>filling reservoir</u>. (See Figure 3.4A.) These reservoirs are emptying and filling, respectively, when the fluid velocity V is positive; however if the fluid reverses direction, the emptying reservoir would be filling and vise versa so that the names of the reservoirs are reference designations only.

The first step in preparing the fluids data is to separate the fluid system into its elements. To do this, control surfaces are drawn about each structural mass point associated with fluid motion as shown in Figure 3.4A. The fluid contained within each control surface is assumed to vibrate with the associated mass point as shown in Figure 3.4B, in exaggerated form; thus, the selection of the control surface boundaries involves judgement of the user. Each control surface will contain either a through pipe (as shown in Figure 3.5) or a reservoir and reservoir pipe (as shown in Figure 3.6).

3.4.6.1 <u>Through Pipe</u>

For each through pipe, the user must specify the mass distribution and geometrical properties of the fluid in the through pipe. Some of these terms, such as $\vec{S}_i$, require discussion. $\vec{S}_i$ is defined as follows:

$$\vec{S}_i = \int \vec{u}\,' \, dm \tag{3.3a}$$

where dm is a differential fluid mass on m_i, $\vec{u}\,'$ is the vector from A_i to dm and the integral is taken over all of the fluid in the through pipe. Alternately, the following formula may be used to evaluate $\vec{S}_i$:

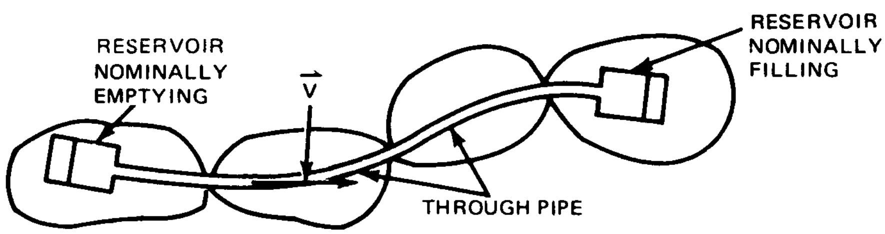
$$\vec{S}_i = \rho A \int \vec{u} \, ds \tag{3.3b}$$

where ds is the differential arc length along the centerline as shown in Figure 3.5, $\vec{u}$ is the value of $\vec{u}\,'$ on the centerline, and the integral is taken from the nominal inlet to the nominal outlet. It may also be helpful to notice that $\vec{S}_i$ is simply equal to the mass of the fluid times the vector from A_i to the cm of the fluid.

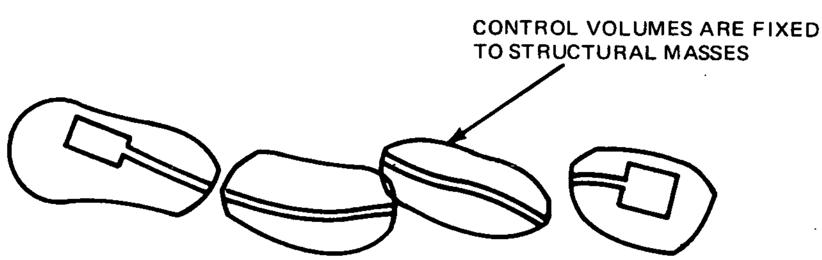
Another vector required as input data is:

$$\vec{G}_i = \int_{\text{NOMINAL INLET}}^{\text{NOMINAL OUTLET}} \vec{u} \times d\vec{u} \tag{3.4a}$$

Note: Only two intermediate masses containing through pipes are shown; however, the analysis was done for an arbitrary number of masses



(A) Undeformed System



(B) Deformed System

Fig. 3.4 Fluid Control-Volume Idealization Used for Computing Rates of Change of Linear and Angular Momenta

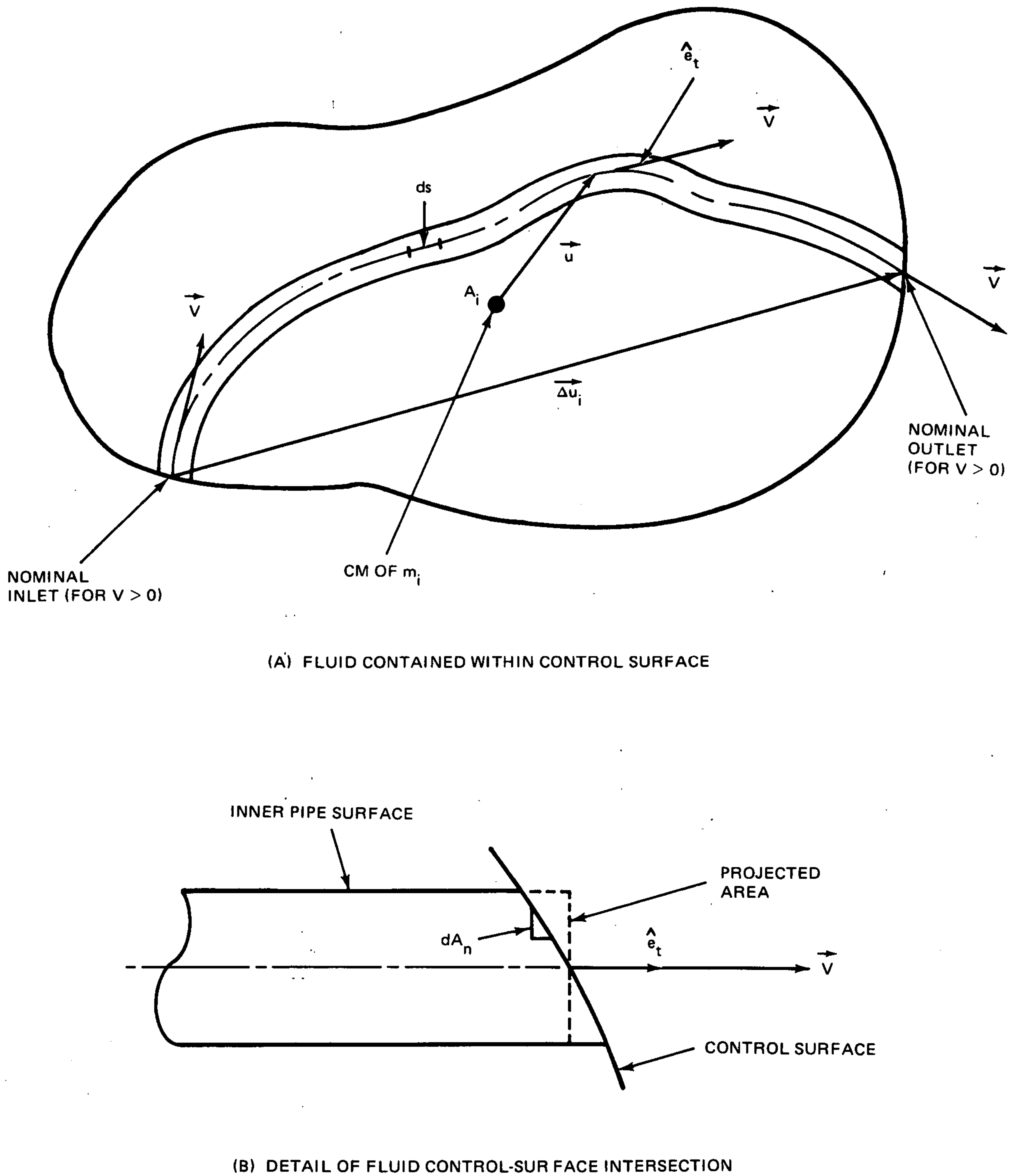


Fig. 3.5 Mass Containing a Through Pipe

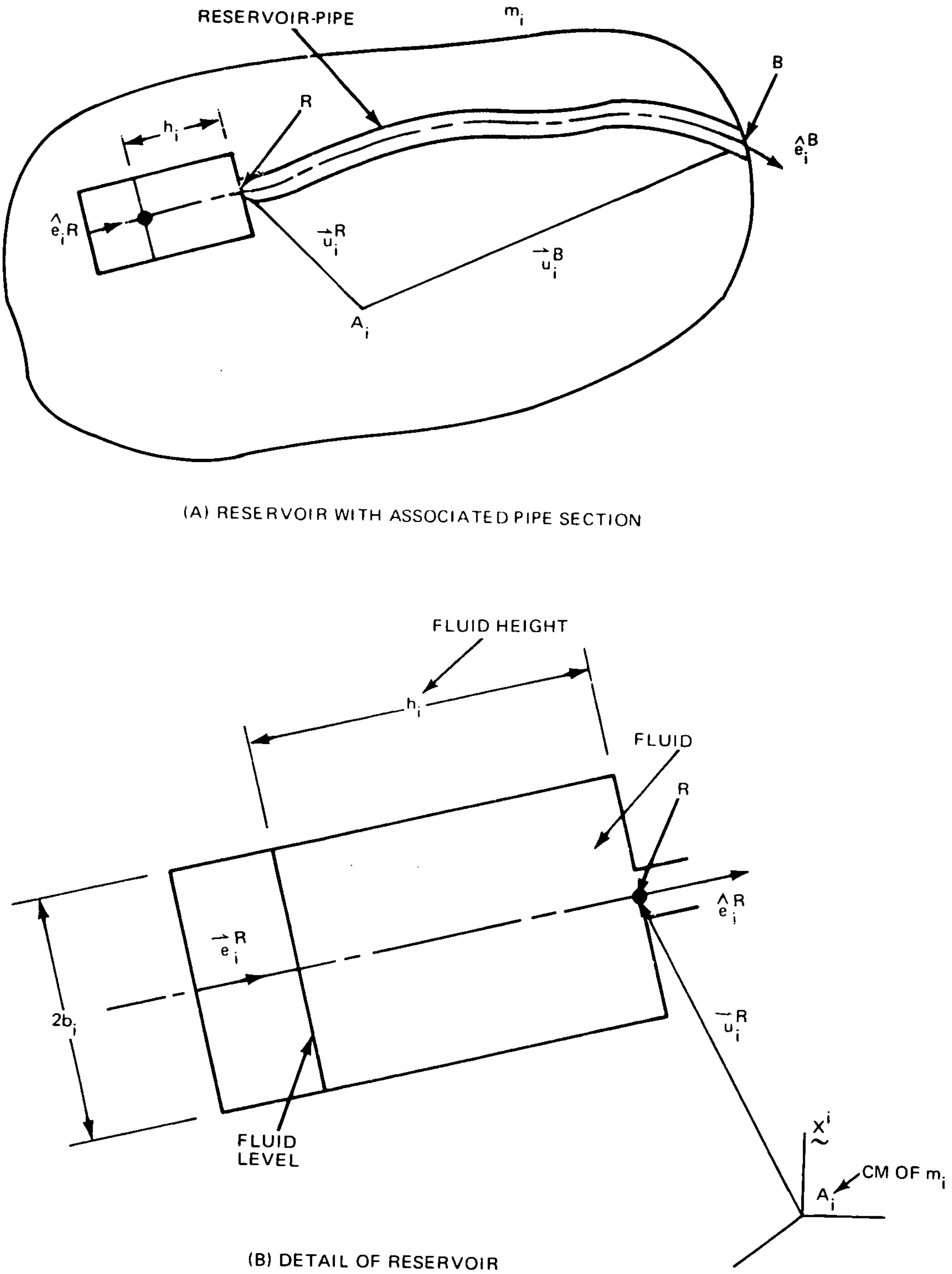


Fig. 3.6 Structural Mass Containing a Reservoir

$\vec{G}_i$ can be evaluated by expanding $\vec{u}$ into components or by noting that $\vec{G}_i$ is the following function of the area A_p swept out by $\vec{u}$ (see Figure 3.7):

$$\vec{G}_i = 2 \int_{\text{NOMINAL INLET}}^{\text{NOMINAL OUTLET}} \hat{e}_p \, dA_p \tag{3.4b}$$

where $\hat{e}_p$ is the unit normal vector which is perpendicular to the plane of $\vec{u}$ and $d\vec{u}$ and directed along $\vec{u} \times d\vec{u}$. When the surface swept out by $\vec{u}$ is a plane, $\hat{e}_p$ is constant and the evaluation of Equation (3.4b) is particularly simple.

The matrix $[J_i]$ is defined as the moment-of-inertia matrix of the elements dA_n shown in Figure 3.5b about point A_i in $\underset{\sim}{X}_i$ axes. As an approximation, the moment of inertia of the projected area shown in the illustration could be used. The diagonal elements of $[J_i]$ are the moments of inertia and the off-diagonal elements are the negatives of the cross products of inertia.

3.4.6.2 Reservoirs and Reservoir-Pipes

The reservoir is assumed to be cylindrical with radius b_i. The pipe-reservoir connection is assumed to be along the reservoir axis. The user specifies the maximum and minimum fluid heights in each reservoir. If either of these limits is reached, the pump is assumed to stop, and no further fluid flow occurs in the problem. Input data for the pump command subroutine, which specifies the fluid velocity V as a function of time, is discussed in Section 3.4.9.2.2.

Much of the input data for each of the two masses containing a reservoir and reservoir pipe is similar to that described in the previous section for a through pipe. For example, $[I_i^P]$ and $\vec{S}_i^P$ denote the values of $[I_i^f]$ and $\vec{S}_i$ for the reservoir pipe shown in Figure 3.6A.

3.4.7 Moving Masses

There may be up to eight moving masses present on the Laboratory. These are designated $\mu_1, \mu_2, \ldots, \mu_8$. The subroutines that specify the motion of these masses are designed so that they may easily be replaced by the user. A subroutine, discussed in Section 3.4.9.2.1, is supplied with the program so that the user may specify a variety of three-dimensional motions for each mass other than μ_2. μ_2 is a balance mass which is designed to balance the motion of an elevator along axis X_3. The motion of μ_2 is determined by the balance mass control system which is discussed in Section 3.4.9.2.6.

D

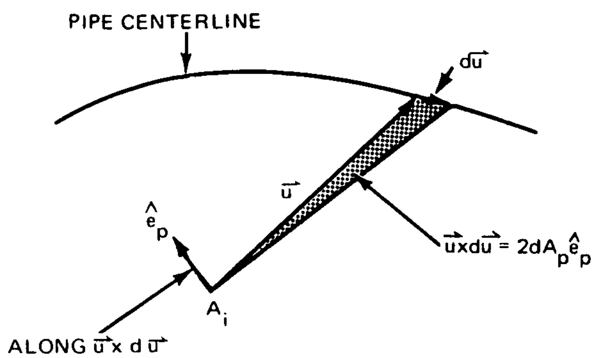


Fig. 3.7 Diagram for the Evaluation of G_i

The motion due to structural deformation is added to the rigid-body motion of each moving mass. In order to determine this structural deformation when the moving mass is between structural mass points (nodes), an averaging procedure is used in the program. The elastic motion of the moving mass is approximated as the weighted average of the motion of those nodes that (in the user's judgement) influence the motion of the moving mass. The weighted average has the following characteristics:

- As a moving mass approaches an influencing node, its motion will approach the motion of that node.
- The greater the distance a moving mass is from a node, the smaller the influence of that node in the averaging procedure.

The set of influencing nodes could differ for each mass point and could vary with time as the moving mass moves through different regions of the Laboratory. This set of node numbers should be programmed into Subroutine LOOK (described in Appendix B5) in table look-up form; i.e., as tables of node numbers versus time. In the version of LOOK supplied with the program, the influencing nodes are 1 through 8 for each moving mass point and remain constant with time.

3.4.8 Internal Loads

The facility is provided to compute internal structural loads between modules or at any other point where the structure (Laboratory or Counterweight) can be separated into two free bodies. This is accomplished by separating the structure at the load-computation point and considering one portion of the structure as a free body. The load applied by the free body is then computed by taking the resultant of all of the inertia and applied loads on the free body. Since Connecting-Structure loads are included in the equations as external loads, the remaining portion of the Laboratory (or Counterweight) may also be used as the free body. Of course, results which are opposite in sign would then be obtained. The index numbers of all mass points in the free body must be supplied as input data in addition to the coordinate vector $\{t_{\ell'}\}$ ($\{\bar{t}_{\bar{\ell}'}\}$ on the Counterweight) to the load-computation point. $\{t_{\ell'}\}$ is stated in the local $\underset{\sim}{X}^{\ell'}$ coordinate system which is fixed in $m_{\ell'}$, the mass containing the load-computation point. The forces $\{f'_{\ell'}\}$ and torques $\{\tau'_{\ell'}\}$ for the Laboratory are expressed in the $\underset{\sim}{X}$ axes, and the forces $\{\bar{f}_{\bar{\ell}'}\}$ and torques $\{\bar{\tau}'_{\bar{\ell}'}\}$ for the Counterweight are expressed in the $\underset{\sim}{Y}$ axes. If the option to compute structural loads is exercised, the program will also print the structural loads applied by the Connecting Structure to the Laboratory (projected onto $\underset{\sim}{X}$ axes) and the Counterweight (projected onto $\underset{\sim}{Y}$ axes).

The internal structural loads are neither computed nor printed at t=0 for the reason discussed in Section 4.5 of Volume I.

3.4.9 Data for Replaceable Subroutines

The physical properties of the Connecting Structure, the control systems, the motion of the moving masses, and the externally applied forces have been programmed in subroutines which were designed to be easily replaced so that different classes of problems could be studied. Details on replacing these subroutines are provided in Appendix B5. The input data required for these subroutines will now be described.

3.4.9.1 Beam-Type Connecting Structure

The Connecting-Structure subroutine computes the force and torque applied by the Laboratory on the Connecting Structure in the $\underset{\sim}{\bar{z}}$ coordinate system. The Connecting Structure is assumed massless, and the program uses equilibrium to compute the loads on the Counterweight. The subroutine supplied with the program contains the equations for a circular beam fixed at each end. During deployment or retraction maneuvers it is simply assumed that the undeformed beam length increases or decreases, and the beam stiffness and damping coefficients are recomputed every cycle based on the updated beam length. Some of the stiffness coefficients go to infinity as the beam length ℓ_0 approaches zero. While this occurs in theory, in practice fixed supports are never perfectly rigid; thus there is always some flexibility. To approximately account for this flexibility and to avoid the numerical problems associated with high stiffnesses, a minimum length, $\ell_{0\ min}$, is input to the program. Whenever ℓ_0 is less than $\ell_{0\ min}$, the program uses $\ell_{0\ min}$ to compute the stiffness and damping coefficients.

Damping is based on a simple model of the Space Station. The user inputs the desired proportion of critical damping, and the mass properties of a rigid Laboratory and Counterweight. The program computes the critical damping of this model for each mode, multiplies the critical modal damping coefficients by the damping ratios and transforms the modal damping matrix to a physical damping matrix. This latter matrix is used in the program. Since the beam is circular, the damping coefficients should be the same for in-plane and out-of-plane bending; therefore the two transverse moments of inertia of each end body in the simple model must be identical. It is suggested that the average of the two values be used for each body.

3.4.9.2 General Data for Control Systems

The control system subroutines compute the forces and torques applied by the control system actuators to mass points of the Laboratory and/or the Counterweight. In addition, they may determine the motion of moving rigid masses, the undeformed geometry of the Connecting Structure, and the velociy of the fluid being pumped through the Laboratory.

In the control-system subroutines supplied with the program, there are sixteen jets. These are arranged to control spin rate and nonspinning vehicle attitude for the demonstration Space-Station model discussed in Section 6 of Volume I. As indicated in Figure 3.8, there are two clusters of four jets each located on mass point 1 (m_1) of the Laboratory and two clusters of four jets located on mass point 5 of the Laboratory. The jet thrust f_{jet} (which has the same value for each jet) and the jet moment arm XJ1 are input data. The jet assignments are indicated in the table on Figure 3.8. Twice as many jets are used for spin control about axis 1 than for attitude control.

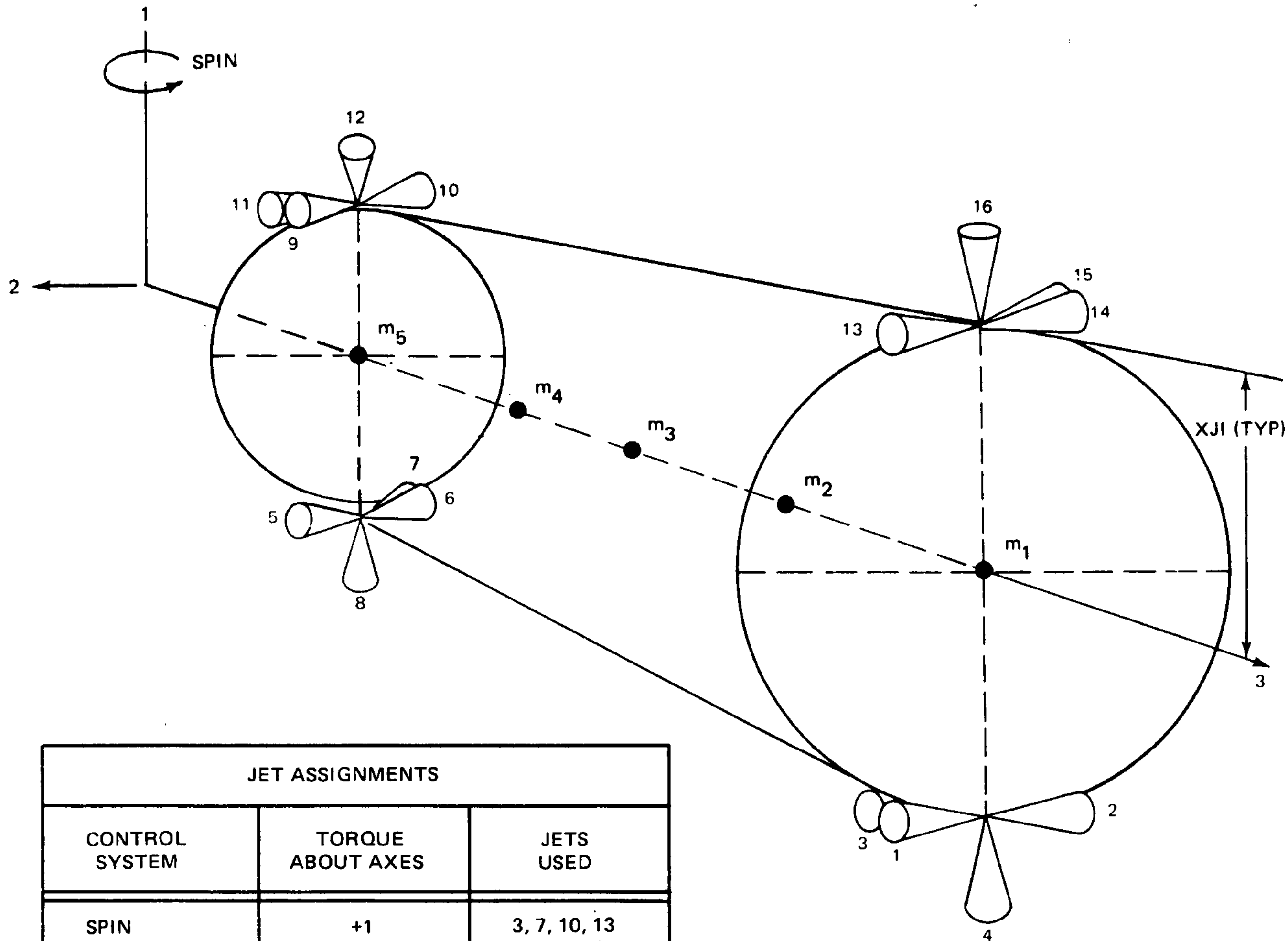
A sensor package may be located at any mass point i_s on the Laboratory. The sensor is assumed to measure the angular position, angular velocity, and angular acceleration as well as the linear acceleration of mass i_s.

The controls subroutine group consists of command routines and control routines. A command routine is used to specify a certain motion, whereas a controls routine is used to achieve that motion. For example, if it is desired to vary the vehicle's spin rate at a prespecified function of time, a command routine would be used to generate the desired spin speed as a function of time. A controls routine might then fire jets in order to achieve the commanded angular velocity. First, the command routines and then the control routines will be described.

3.4.9.2.1 Position Command (For Deployment and Moving Masses)

The same law is used to command the undeformed position of the Counterweight relative to the Laboratory (i.e., third component of $\{\ell_0\}$), and the position of moving masses 1, and 3 through 8 ($\{U_i\}$ with i=1, 3, 4, ..., 8).

The position-command law is illustrated in Figures 3.9 and 3.10. The input data for developing the command consists of the initial position, position update,



JET ASSIGNMENTS		
CONTROL SYSTEM	TORQUE ABOUT AXES	JETS USED
SPIN	+1 −1	3, 7, 10, 13 2, 5, 9, 14
ATTITUDE	+1 −1 +2 −2 +3 −3	10, 13 9, 14 4, 12 8, 16 1, 15 6, 11

NOTE: THE POWER BOOM IS NOT SHOWN

Fig. 3.8 Jet Configuration on Laboratory Core Module

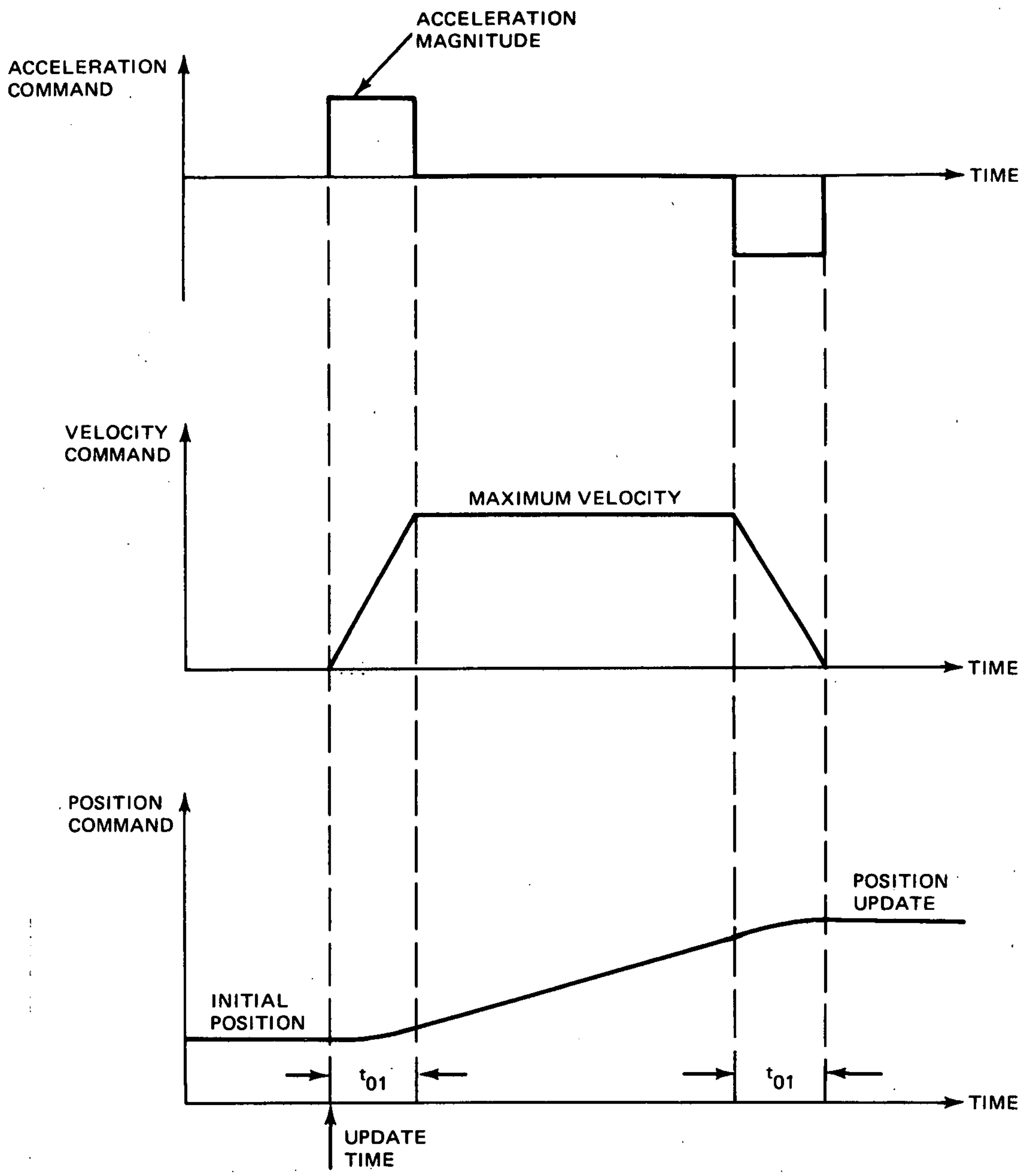


Figure 3.9 Position Command Law for Case Where Velocity Command Archieves Maximum Velocity

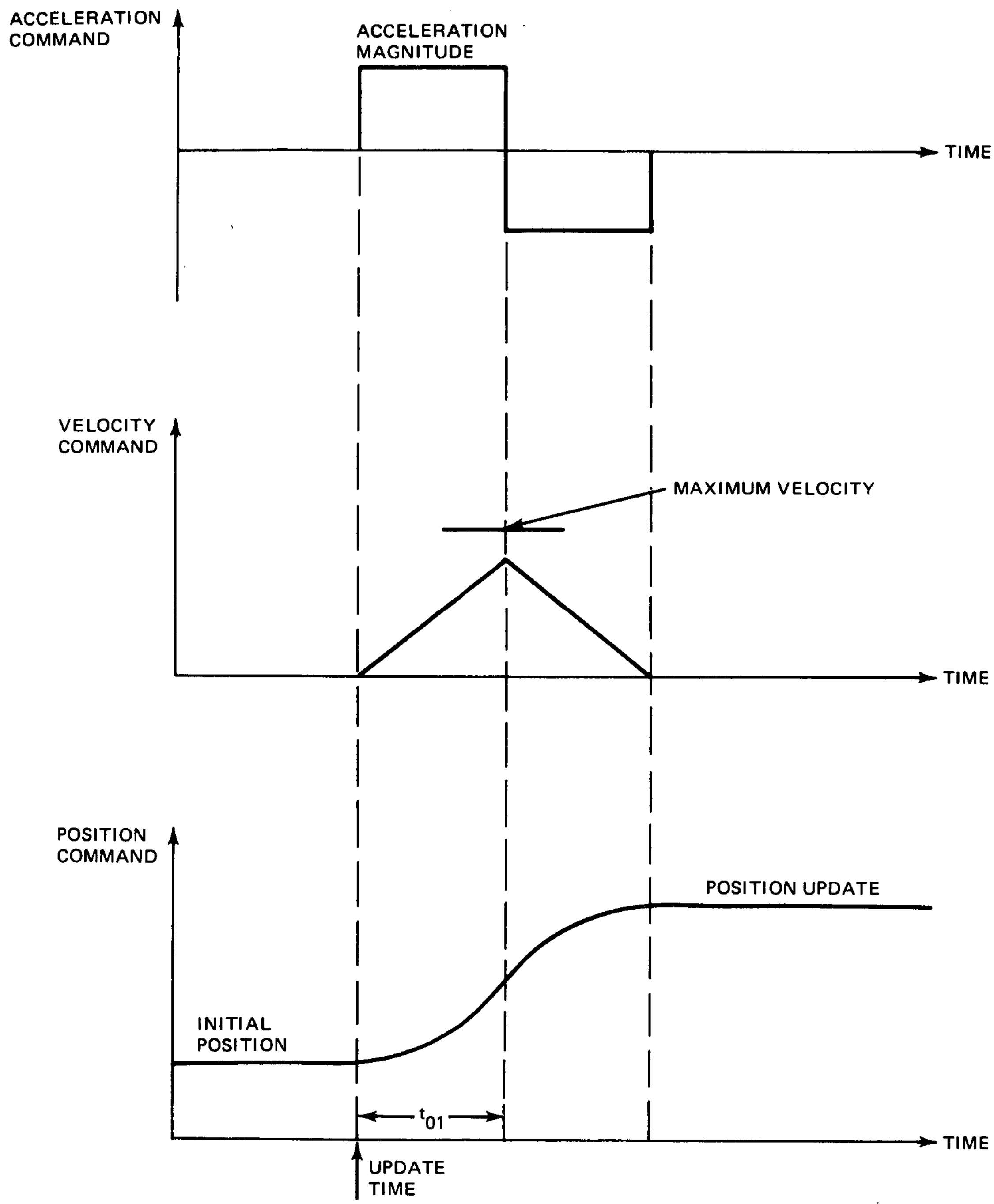


Fig. 3.10 Position Command Law for Case Where Velocity Command Does Not Achieve Maximum Velocity

update time, magnitude of acceleration, and maximum velocity. For the case of moving masses, a different set of input data may be used for each axis. In Figure 3.9 the motion begins at the update time when a constant acceleration occurs until the maximum velocity is achieved. Then cruising occurs at the maximum velocity until deceleration occurs at the negative of the acceleration magnitude.

If the position update is close to the initial position, the maximum velocity is never achieved. In this case the command law is illustrated in Figure 3.10.

In the event that the position update is less than the initial position the negatives of the motions illustrated in Figures 3.9 and 3.10 occur.

The user must always select a numerical integration time interval that is less than the time increment t_{01} illustrated in Figures 3.9 and 3.10. t_{01} may be computed as follows:

$$t_{01} = \text{smaller of} \begin{cases} \dfrac{\text{maximum velocity}}{\text{acceleration magnitude}} \\ \sqrt{\dfrac{|\text{position update} - \text{initial position}|}{\text{acceleration magnitude}}} \end{cases}$$

The acceleration magntude must not be set to zero. If it is desired to maintain a constant position command throughout the run, the user should input an update time which is greater than the final time designating the end of the run.

3.4.9.2.2 Velocity Command (For Spin Speed and Fluid Velocity)

The same law is used to command the spin speed of the Space Station and the fluid velocity. This law is illustrated in Figure 3.11. The required input data consists of the initial velocity, the velocity update, the update time, and the acceleration magnitude.

The selected numerical-integration time interval must always be less than t_{01} of Figure 3.11. t_{01} may be computed as follows:

$$t_{01} = \frac{|\text{update velocity - initial velocity}|}{\text{acceleration command}}$$

Another precaution that must be taken is never to set the acceleration command to zero. If it is desired to hold the velocity command constant, the user should set the update time greater than the final (end-of-run) time.

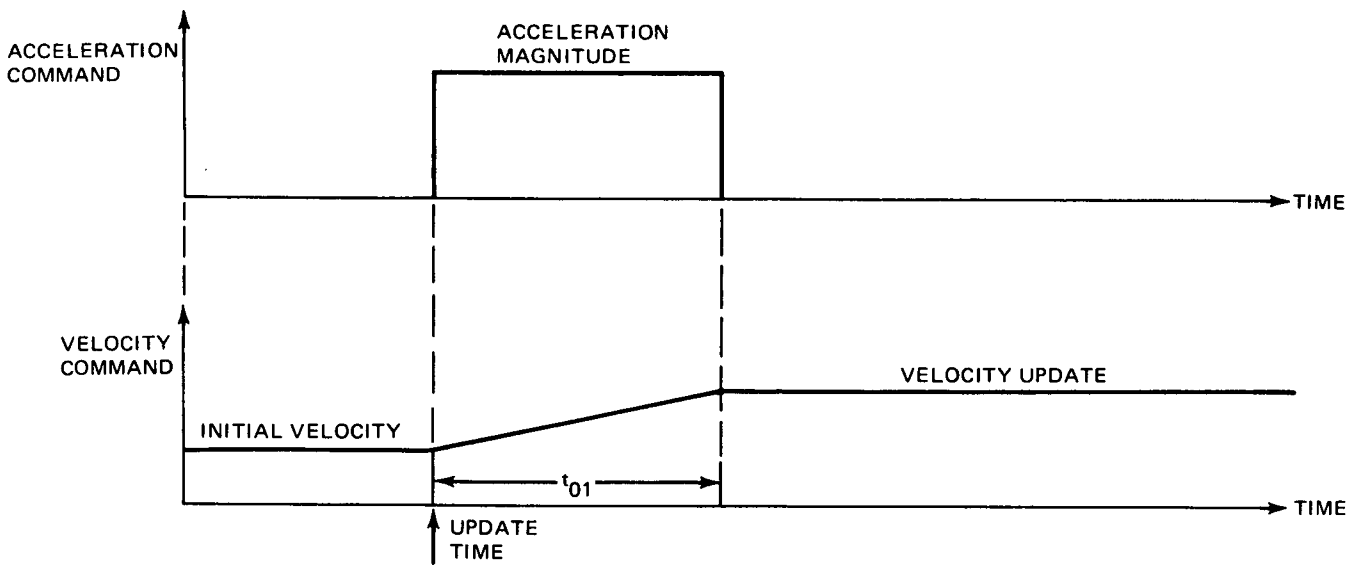


Fig. 3.11 Velocity Command Law

3.4.9.2.3 Attitude Control

The attitude control system is designed to drive the attitude angles $\{\gamma\}$ to zero for the case of the nonrotating Space Station. The same control law is used for each axis. This law is illustrated in Figure 3.12.

3.4.9.2.4 Spin Control

A hysteresis type spin control law is used. This law is illustrated in Figure 3.13.

3.4.9.2.5 Wobble Control

A CMG control law known as the 90° h-lag law is used to eliminate gyroscopic wobble from the rotating Space Station.* The CMG is assumed to be located on the same mass (m_{i_s}) as the sensor package. There are two modes of control, gimbal-angle control and gimbal-angle-rate control. The CMG angle law is used for wobble control. When the wobble drops below a predetermined threshold, wobble control is ended. The CMG angle-rate law is then used to rotate the gimbal relative to the Space Station at the negative of component 1 of the Space-Station angular velocity; thus the gimbal angular velocity is approximately zero in inertial space. The CMG gimbal angle law and the CMG angle-rate law are illustrated in Figures 3.14 and 3.15, respectively.

3.4.9.2.6 Balance Mass Control

The balance mass control system is used to balance mass shifts along the long axis of the Space Station (i.e., the X_3 axis of Figure 3.1). For example, mass shifts would occur due to the motion of a freight elevator. An accelerometer senses the acceleration at a point on mass i_s. The control system moves the balance mass until the centrifugal acceleration at the sensor is equal to a commanded value. The commanded vector from the Space-Station center of mass to the accelerometer $\{X^{CMND}_{SENS/CM}\}$ is input data. The user should include the elastic deformation of the structure when determining this vector. One method of determining this deformation is discussed in Section 3.4.10. A block diagram of the control system is illustrated in Figure 3.16.

3.4.9.3 Supplementary Loads

The user may program any set of loads as a function of time on the Laboratory and the Counterweight into subroutine SUPPLM. The equation for the result-

---

* The spin speed must be greater than .02 rad/sec for the wobble control system to turn on.

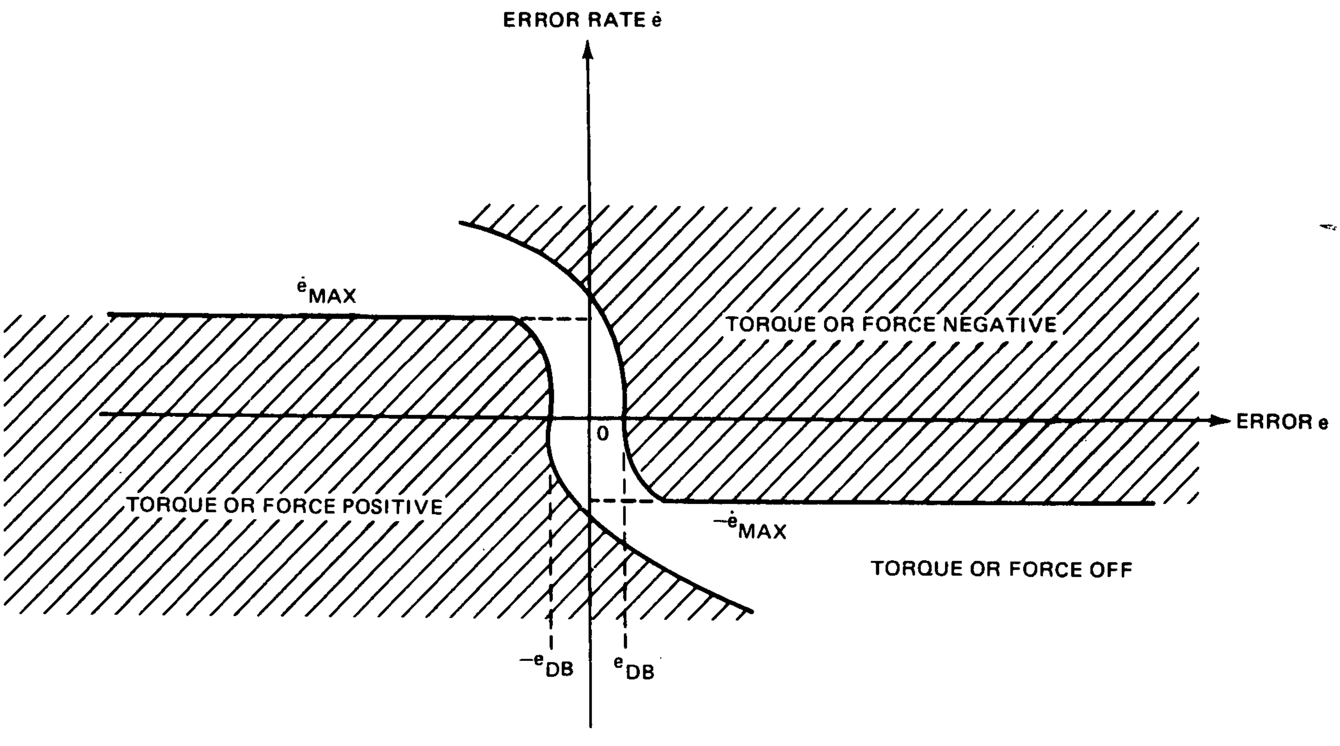


Fig. 3.12 Position Control

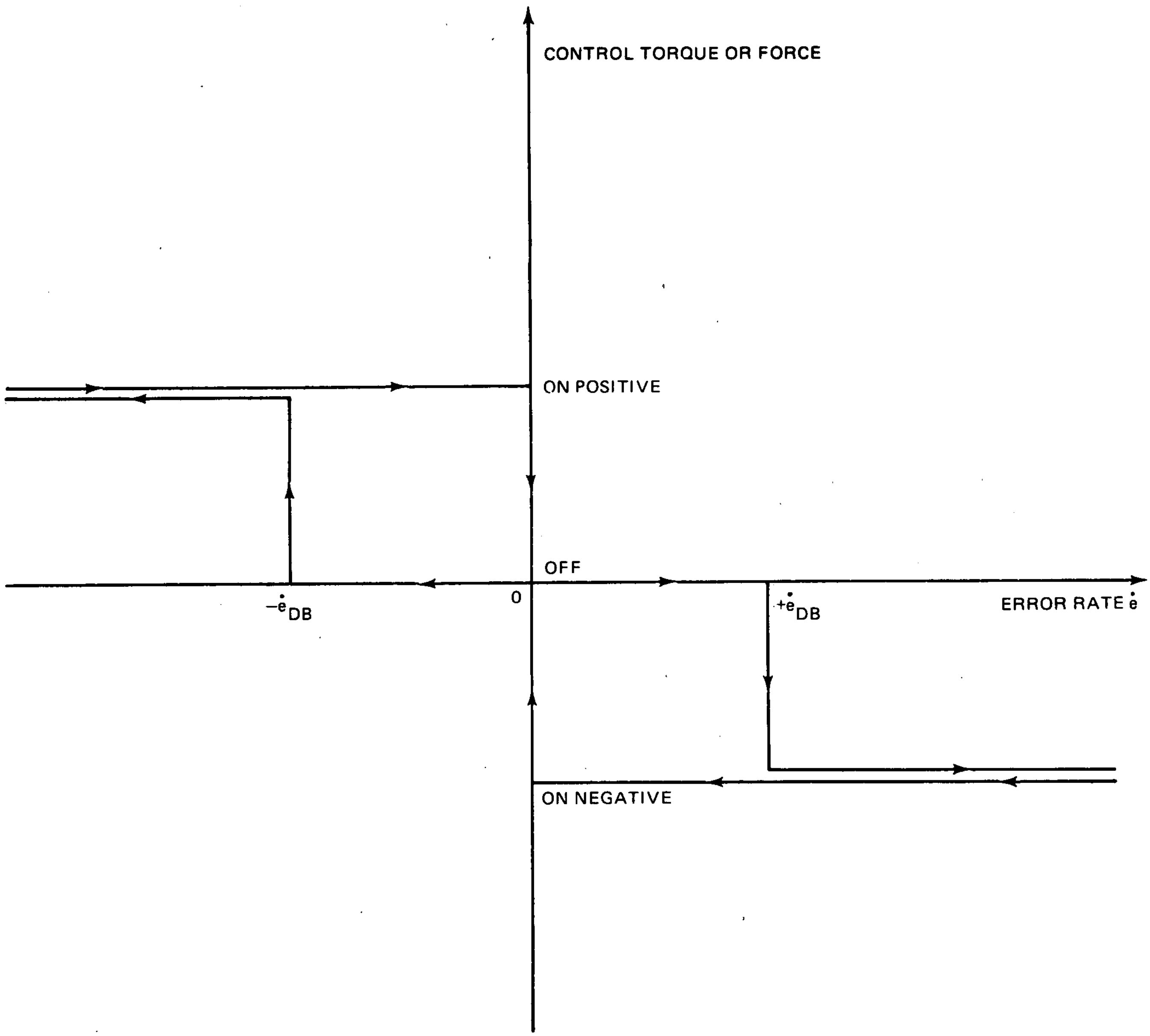


Fig. 3.13 Velocity Control

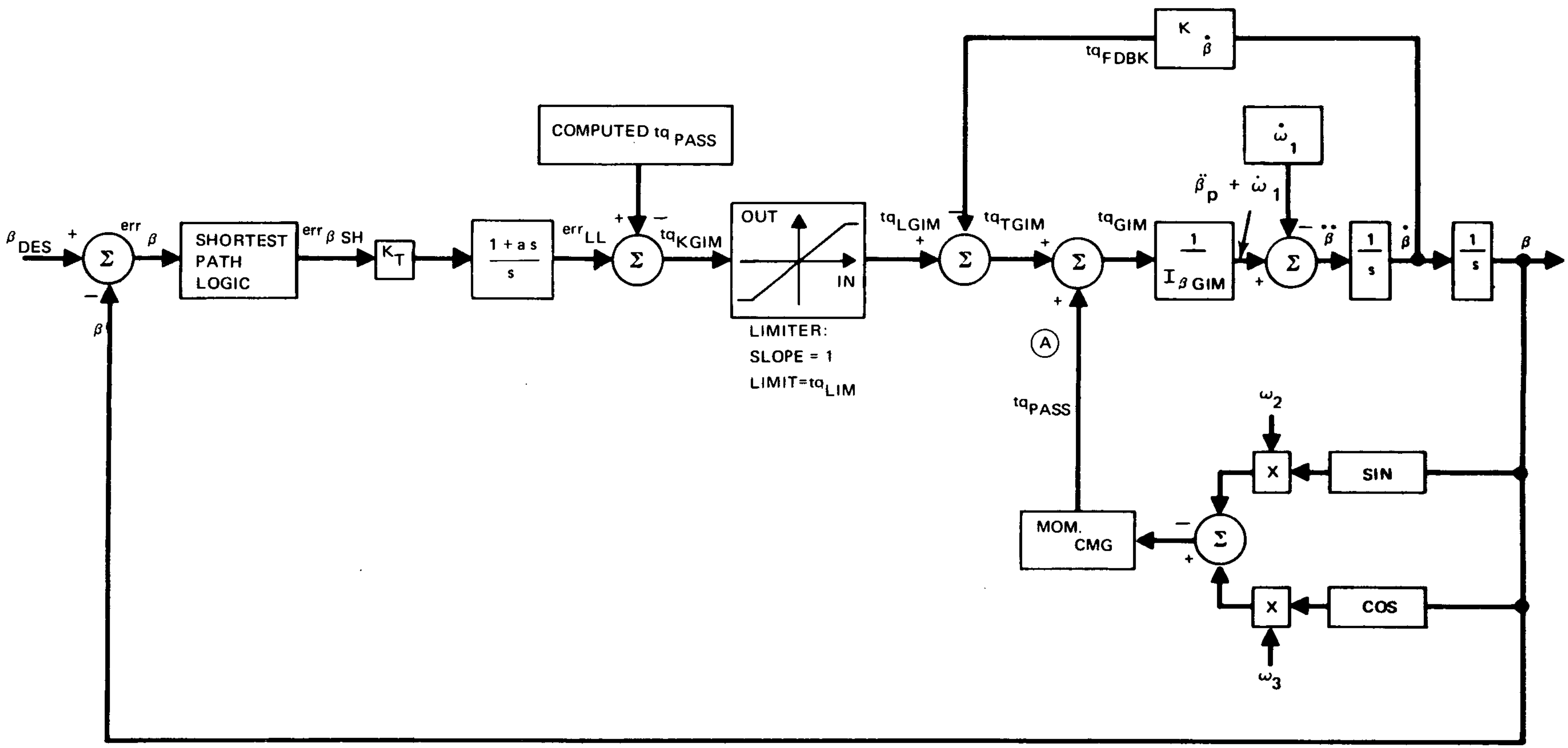


Fig. 3.14 CMG Gimbal Angle Control System

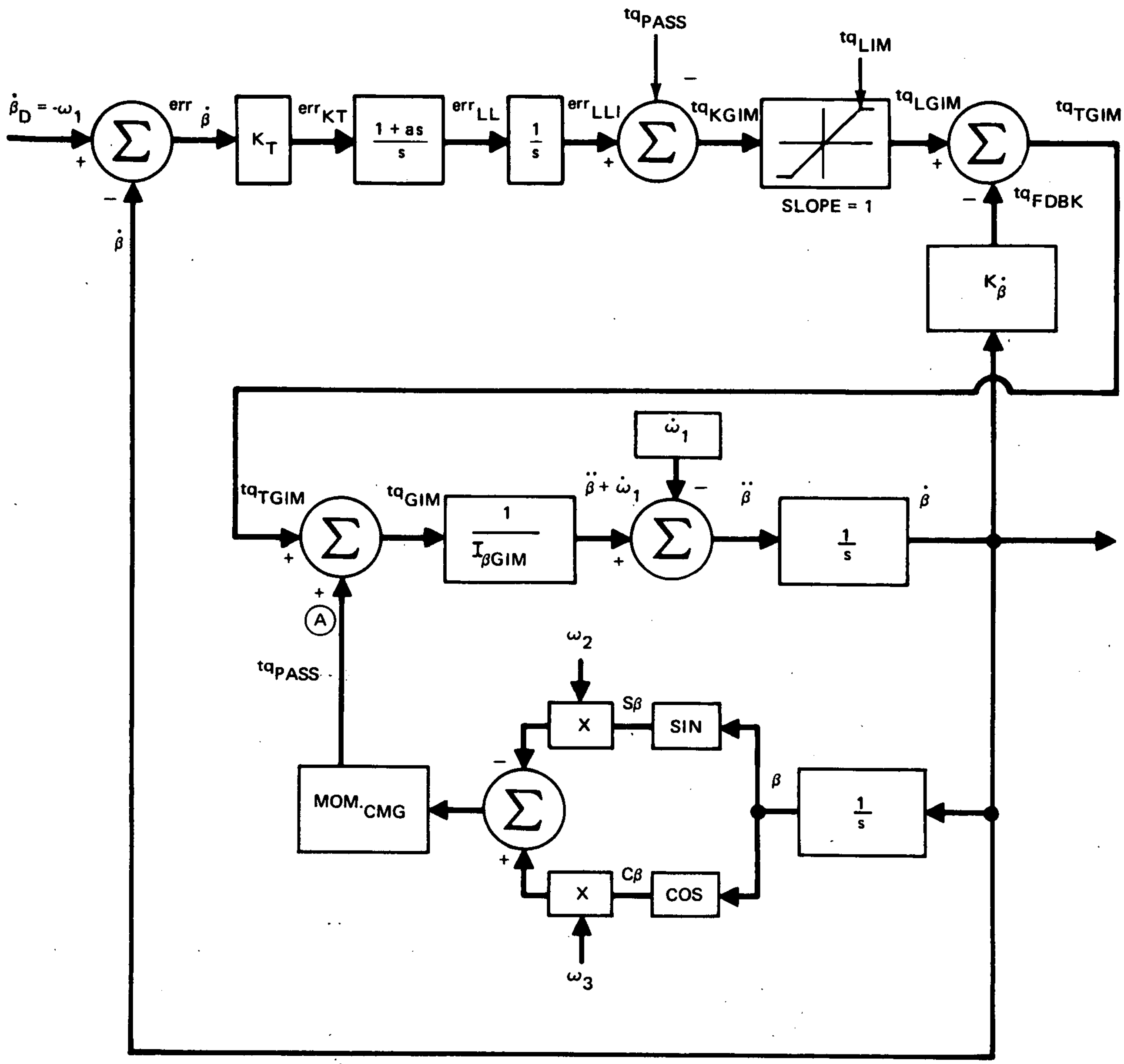


Fig. 3.15 CMG Gimbal Angle Rate Control System

E

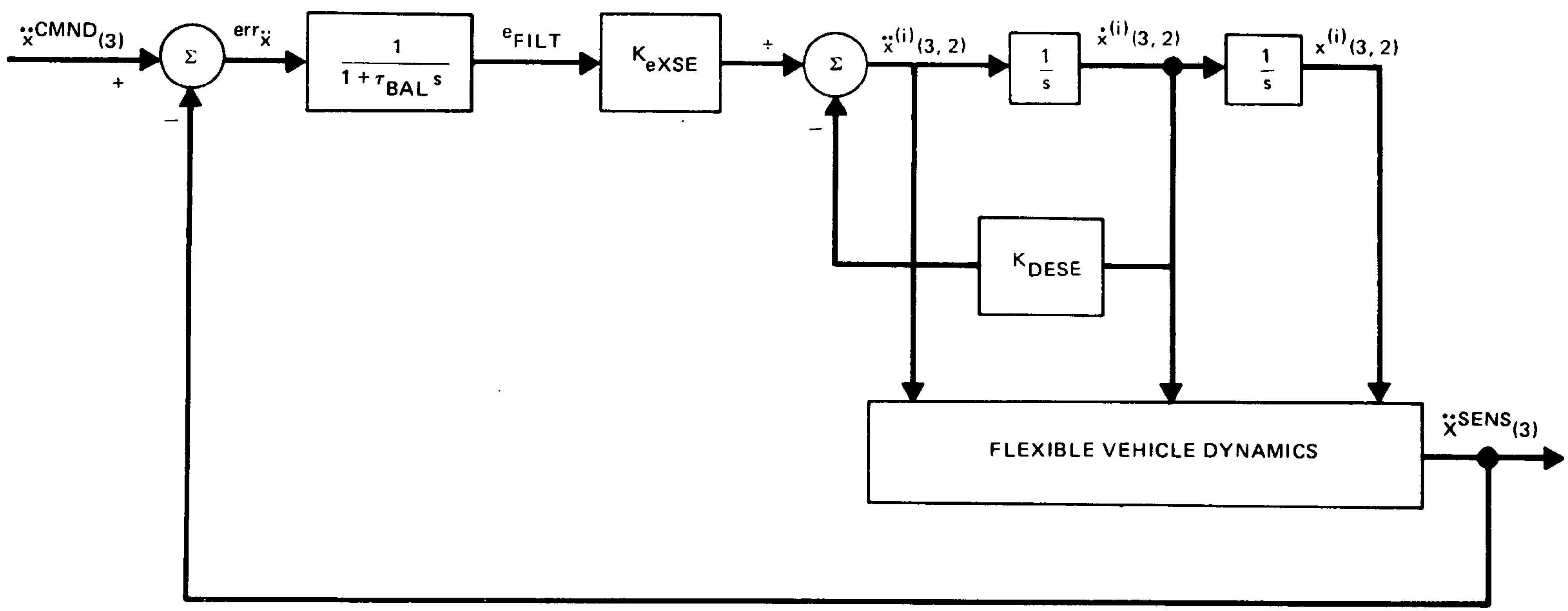


Fig. 3.16 Space-Station Center-of-Mass Position Control System for Flexible Vehicle Idealization

ant force $\{f_s^i\}$ and the resultant torque $\{\tau_s^i\}$ on each mass point m_i of the Laboratory must be programmed. Also, the resultant force $\{\bar{f}_s^a\}$ and $\{\bar{\tau}_s^a\}$ on each mass point $\bar{m}_a$ of the Counterweight must be programmed.

3.4.10 Determining Quiescent Deflections

When the Space Station is in a state of pure spin with no vibration, constant elastic deflections will occur because of the centrifugal forces. This state of motion is known as the quiescent state. In most rotating problems the user will want to set the initial deflections equal to the quiescent deflections or equal to some perturbation about these values. One way of determining the quiescent deflections is to make a short preliminary run with 80% of critical damping in the Laboratory, the Counterweight, and the Connecting Structure. The deflections will quickly damp out to their quiescent values.

3.5 PROGRAM LIMITATIONS

1) A maximum of 20 modes may be used to represent the elastic motion of the Laboratory
2) A maximum of 20 modes may be used to represent the elastic motion of the Counterweight
3) There is a maximum of 100 mass points on the Laboratory
4) There is a maximum of 100 mass points on the Counterweight
5) There is a maximum of 8 moving masses present
6) A maximum of 30 masses may contain pipe segments
7) There is a maximum of 16 points on the Laboratory at which internal loads may be printed
8) There is a maximum of 16 points on the Counterweight at which internal loads may be printed

3.6 INSTRUCTIONS FOR SETTING UP INPUT-DATA DECK FOR PHASE II PROGRAM

TYPE I

Initial Card - To be supplied at the beginning of the group of multiple runs.

Supply the number of runs to be made, plotting clue [(2I2) format]

plotting clue = { 0 if no plotting for any run
{ 1 if at least 1 run has plotting

TYPE II - To be supplied for each run

PART 1 - General data for the run

Group a

Card 1 - final time, plot scale [(2E15.8) format]
(program disregards plot scale if there is no plotting)
plot scale = number of seconds/inch along abscissa

Card 2 - plot clue for the run, fluid clue, number of pipes, number of moving masses [(4I3) format]
plot clue = { 0 no plotting
{ 1 plotting
fluid clue = { 0 no fluids present
{ 1 fluids present

Card 3 - (insert blank card if no moving masses are present)
enter clues for each moving mass (1-8) [(8I3) format]
each clue = { 0 moving mass not present
{ 1 moving mass present

Card 4 - (insert blank card if no fluids are present)
mass point index numbers of the emptying and filling reservoirs, respectively [(2I3) format]

Card 5 - (Card 6 if needed) (insert 1 blank card if no pipes are present) mass point index number of each pipe present [(15I3) format]
Second card needed if more than 15 pipes are present

Group b

(Skip to group C if there is no plotting on this run)

Card 1 - enter clues for the 13 plotting groups [(13I1) format] enter 1 if the group is to be plotted, 0 if not. Choose 7 groups maximum. If plotting is selected on a run $\{\omega^x\}$ is always plotted first, followed by the plotting groups selected on this card.

The 13 optional groups are:

Group No.	Variables Plotted
1	$\{\gamma\}$
2	$\{\delta\}$
3	$\{\varphi^*\}$
4	$\{q_a\}$ for some mass no. a
5	$\{\theta_b\}$ for some mass no. b
6	$\{q_c\}$ for some mass no. c
7	$\{\theta_d\}$ for some mass no. d
8	$\{q_e\}$ for some mass no. e
9	ℓ_{o3}, $\dot{\ell}_{o3}$, $\ddot{\ell}_{o3}$
10	$\{U_1\}_3 - \{U_1(0)\}_3$, $\{U_2\}_3 - \{U_2(0)\}_3$ $\{X^{CMND}_{SENS/CM}\}_3 - \{X_{SENS/CM}\}_3$
11	V, $\dot{V}$, h_i for emptying reservoir
12	$\{f'_r\}$ for some mass no. r
13	$\{\tau'_s\}$ for some mass no. s

Each group consists of three plots, one above the other, when vectors are plotted, the first component is always plotted on top, followed by the second component, with the third component on the bottom.

Card 2 - enter the mass-point index numbers a, b, c, d, e, r, s as above [(7I3) format]
(insert blank card if none are selected for plotting)

Group c

Card 1 - enter clues KLUE, IFLAB, IFCW, IFCN [(4I4) format]
KLUE denotes the type of problem being run

KLUE =
- 1 flexible Space Station
- 2 rigid Laboratory
- 3 rigid Counterweight
- 4 rigid Space Station
- 5 rigid Laboratory and Counterweight

IFLAB enables the user to run a rigid-Laboratory problem using a (slightly modified) flexible-Laboratory deck.

IFLAB = { 1 is always used when the Laboratory is flexible; also when the Laboratory is rigid and input data for the flexible Laboratory is present in the deck. (In this case the data is read in but disregarded).
0 is used when elastic displacements and velocities of the Laboratory($\{q_i\}$, $\{\dot{q}_i\}$, $\{\theta_i\}$, $\{\dot{\theta}_i\}$) are not present in the deck. Also, when IFLAB = 0 and the Phase I input tape is not present, the Laboratory modal data (number of modes, modal masses, frequencies, and mode shapes) must be absent from the deck.

IFCW - same as IFLAB except that it applies to the Counterweight input data.

IFCN - if IFCN = 0, no Connecting Structure data is read in; use IFCN=0 only when the Space Station is rigid (see description of Part 8). Otherwise set IFCN = 1.

Card 2 - enter IFDEPL, IFCON, IFSUPP [(3I4) format]

IFDEPL = { 0 no deployment
1 deployment

IFCON = { 0 no controls
1 controls present

IFSUPP = { 0 no supplementary forces
1 supp. forces present

PART 2 - Type 1 controls input (skip this portion if no controls are present)

Card 1 - i_s, f_{JET}

(I3, E15.8) format

Card 2 - Counterweight command input

ℓ_{03U}, $t_{\ell 03U}$, $acc_{\ell 03MAG}$, $vel_{\ell 03MAX}$

(4E15.8) format

Card 3 - spin command input

ω_{1C} (initial value), $t_{\omega 1CU}$, $acc_{\omega 1C}$

(3E15.8) format

Card 4 - spin control input

$e_{\omega IDB}$

(E15.8) format

Card 5 - attitude control input

$e_{\theta DB}$, $\dot{e}_{\theta MAX}$, XJ1

(3E15.8) format

Card 6 - wobble control input

β_G, $\dot{\beta}_G$, K_T, t_{qLim}

(4E15.8) format

Card 7 - wobble control input (continued)

$K_{\dot{\beta}}$, mom_{CMG}, $I_{\beta GIM}$

(3E15.8) format

PART 3 - Internal loads

(if no internal load computations are required, use blank card and skip to Part 4)

Group a - (one card)

Card 1 - enter clues KLUCS, KLULAB, KLUCW, N, NB

(5I2) format

use KLUCS = 1 if structural loads applied by the Connecting Structure are computed. Use 0 otherwise

use KLULAB = 1 if internal loads on the Laboratory are to be computed. Use 0 otherwise

use KLUCW = 1 if internal loads on the Counterweight are to be computed. Use 0 otherwise

N = number of load-computation points on Laboratory

NB = number of load-computation points on Counterweight

Group b - input for each load computation point on Laboratory (skip to Group c if N = 0)

Card 1 - ℓ' (the load computation mass-point index number), number of mass points comprising the free body [(2I2) format]

Card 2 - the load coordinates $\{t_{\ell'}\}$

(3E15.8) format

remaining cards (10 maximum)

the index numbers of the mass points comprising the free body, 10 per card

(10I2) format

Group c - input for each load computation point on the Counterweight
(skip to part 4 if NB=0)
construct similarly to Group b

PART 4 - Laboratory input data

Group a - (one card)

Card 1 - IPHS1, JUMP
(2I4) format

IPHS1 = { 0 no Phase I tape provided
{ 1 Phase I tape provided

JUMP = 1 is used to set the elastic displacements and velocities = 0 without reading them in.

Group b

(If IPHS1 = 1, skip to group d)

Subgroup 1 - (one card)

Card 1 - enter the number of mass points on the Laboratory
(I4) format

Subgroup 2 - mass point locations $\{r_i\}$. One card for each mass point
(3E15.8) format

Subgroup 3 - masses, Inertia matrices
(repeat for each mass point)

Card 1 - mass m_i [(E15.8) format]

Card 2 - column 1 of inertia matrix $[I_i]$

Card 3 - column 2 of inertia matrix

Card 4 - column 3 of inertia matrix
(3E15.8) format

Group c

(if IFLAB = 0, skip to Part 5)

Subgroup 1 - (One card)

Card 1 - enter p (number of modes)
(I4) format

Subgroup 2

enter the p modal masses
3 per card
(3E15.8) format

Subgroup 3

enter the p frequencies

3 per card

(3E15.8) format

Subgroup 4

enter the modal matrix - column by column

Use 3 elements of a column per card

(3E15.8) format

Group d

(if IFLAB = 0 skip to Part 5)

Subgroup 1

(if JUMP = 1 skip to Subgroup 2)

enter the elastic displacements and velocities

all $\{q_i\}$, one card per mass pt [(3E15.8) format]

all $\{\dot{q}_i\}$, one card per mass pt [(3E15.8) format]

all $\{\theta_i\}$, one card per mass pt [(3E15.8) format]

all $\{\dot{\theta}_i\}$, one card per mass pt [(3E15.8) format]

Subgroup 2

enter the ratio of damping to critical damping for each mode.

3 per card

(3E15.8) format

PART 5 - Rigid-body displacements and velocities

Card 1

$\{R\}$

(3E15.8) format

Card 2

$\{\dot{R}\}$

(3E15.8) format

Card 3

$\{\gamma\}$

(3E15.8) format

Card 4 $\{\omega^X\}$

(3E15.8) format

PART 6 - Fluids and moving mass input

Group a - reservoir input

(skip to Group c if no fluids are present)

Subgroup 1 - (one card)

Card 1 - entry ρ, A
(2E15.8) format

Subgroup 2 - emptying reservoir

Card 1 -	M_i^p	(E15.8) format
Cards 2-4	$[I_i^p]$ 1 row per card	(3E15.8) format
Card 5	$\{S_i^p\}$	(3E15.8) format
Card 6	$\{e_i^R\}$	(3E15.8) format
Card 7	$\{u_i^R\}$	(3E15.8) format
Card 8	$\{u_i^B\}$	(3E15.8) format
Card 9	$\{e_i^B\}$	(3E15.8) format
Cards 10-12	$[J_i^B]$ 1 row per card	(3E15.8) format
Card 13	b_i, h_{io}, $h_{i\,max}$, $h_{i\,min}$,	(4E15.8) format
Card 14	$\{G_i^P\}$	(3E15.8) format

Subgroup 3 - filling reservoir

same as Subgroup 2

Group b - input for through pipes

(skip to Group c if no fluids or if no pipes)

REPEAT for each pipe.

Card 1	m_i^f	(E15.8) format
Card 2	$\{S_i\}$	(3E15.8) format
Card 3	$\{\Delta u_i\}$	(3E15.8) format
Card 4	$\{\Delta e_i\}$	(3E15.8) format
Card 5	$\{G_i\}$	(3E15.8) format
Card 6	$\{\Delta H_i\}$	(3E15.8) format
Cards 7-9	$[\Delta J_i]$ 1 row per card	(3E15.8) format
Cards 10-12	$[I_i^f]$ 1 row per card	(3E15.8) format

Group c - moving masses input

(skip to part 7 if no moving masses are present)

enter μ_i for each moving mass present

1 per card

(E15.8) format

PART 7 - Counterweight input data

same as instructions for PART 4, but for Counterweight

Group a (one card)

Card 1 - IPHS1, JUMP

(2I4) format

IPHS1 = { 0 no Phase I tape provided
{ 1 Phase I tape provided

JUMP = 1 is used to set the elastic displacements and velocities = 0 without reading them in.

Group b

(If IPHS1 = 1, skip to group d)

Subgroup 1 (one card)

Card 1 - enter the no. mass points on the Counterweight

(I4) format

Subgroup 2

mass point locations $\{\bar{r}_a\}$. One card for each mass point

(3E15.8) format

Subgroup 3 - masses, inertia matrices

(repeat for each mass point)

Card 1

mass $\bar{m}_{\bar{a}}$

(E15.8) format

Card 2 - column 1 of inertia matrix $[\bar{I}_{\bar{a}}]$

Card 3 - column 2 of inertia matrix

Card 4 - column 3 of inertia matrix

(3E15.8) format

<u>Group c</u>

(If IFCW = 0, skip to PART 8)

<u>Subgroup 1</u> - (one card)

<u>Card 1</u> - enter $\bar{p}$ (number of modes)

(I4) format

<u>Subgroup 2</u>

enter the $\bar{p}$ modal masses

3 per card

(3E15.8) format

<u>Subgroup 3</u>

enter the $\bar{p}$ frequencies

3 per card

(3E15.8) format

<u>Subgroup 4</u>

enter the modal matrix - column by column.

Use 3 elements of a column per card

(3E15.8) format

<u>Group d</u>

(if IFCW = 0, skip to PART 8)

<u>Subgroup 1</u>

(if JUMP = 1 skip to Subgroup 2)

enter the elastic displacements and velocities

all $\{\bar{q}_a\}$, one card per mass pt (3E15.8) format

all $\{\dot{q}_a\}$, one card per mass pt (3E15.8) format

all $\{\bar{\theta}_a\}$, one card per mass pt (3E15.8) format

all $\{\dot{\theta}a\}$, one card per mass pt (3E15.8) format

<u>Subgroup 2</u>

enter the ratio of damping to critical damping for each mode.

3 per card

(3E15.8) format

PART 8 - Connecting Structure input data (skip to part 9 only if IFCN = 0 and KLUE = 4)

Card 1 $\underset{\sim}{i}$, $\underset{\sim}{a}$

(2I4) format

Card 2 $\{s\}$ (3E15.8) format

Card 3 $\{\bar{s}\}$ (3E15.8) format

Card 4 $\{\delta\}$ (3E15.8) format

Card 5 $\{\dot{\delta}\}$ (3E15.8) format

Card 6 $\{\phi^*\}$ (3E15.8) format

Card 7 $\{\dot{\phi}^*\}$ (3E15.8) format

Card 8 $\{Y^{\underset{\sim}{a}'}\}_{ⓐ}$ (3E15.8) format

Card 9 $\{Y^{\underset{\sim}{a}'}\}_{ⓑ}$ (3E15.8) format

PART 9 - Type 2 controls input

Group a - (one card)

Card 1 - enter $\{\ell_o\}$

(3E15.8) format

Group b - pump command (PMPCOM) input (skip to Group c if there are no fluids present)

Card 1 - V, V_U, t_{fU}, acc_{MAG}

(4E15.8) format

Group c - moving mass command (MUCOM) input for Mass 1 (j = 1); elevator (skip to Group e if moving mass j = 1 is not present)

Subgroup 1

Card 1 - enter 3 clues, 0 or 1, denoting absence or presence of motion along X_1, X_2, and X_3 axes respectively

(3I2) format

Card 2 - enter initial value of $\{U_j\}$

(3E15.8) format

Subgroup 2

Repeat Card 1 below for each axis present. If the mass does not move, skip to Group d.

Card 1 - enter U_U, t_U, acc_{MAG}, vel_{MAX}

(4E15.8) format

Group d - Balance mass control input (controls motion of moving mass j = 2) (skip to Group e if moving mass j = 2 is not present)

Card 1 - $\{U_2\}$

(3E15.8) format

Card 2 - $\{\dot{U}_2\}^*$

(3E15.8) format

Card 3 - μ_{1EST}, K_{eXSE}, K_{DESE}, τ_{BAL}, $\omega_{1C\ BAL}$

(5E15.8) format

Card 4 - $\{X_A^{i_s}\}$

(3E15.8) format

Card 5 - $\{X_{SENS/CM}^{CMND}\}$

(3E15.8) format

Group e - moving mass command (MUCOM) input for masses 3, 4, ... (j > 2) (skip to Part 10 if there are no other moving masses present)

repeat input for each moving mass as described in Group c

PART 10 - Beam-type connecting structure, numerical integration, and printout data

Group a - beam connecting structure subroutine input (skip to Group b if KLUE = 4)

Card 1 - M_C, M_L, I_C (3E15.8) format

Card 2 - I_L, J_C, J_L (3E15.8) format

Card 3 - a, b, AE (3E15.8) format

Card 4 - EI, GJ, $\ell_{o_{MIN}}$ (3E15.8) format

Card 5 - γ_A, γ_B, γ_T

Group b - numerical integration input - see MAGIC writeup in Appendix B2

Card 1 - DELTA, EPSIL, STEP

(3E15.8) format

----

* For the control systems provided with this program, the first two components of $\{\dot{U}_2\}$ must be read in as zero.

F

<u>Card 2</u> - DTAU, NTIME

(E15.8, I3) format

DTAU is the MAGIC output time interval. In this program a distinction is made between the plot output interval and the print output interval. DTAU is used as the plot output interval and NTIME * DTAU is used as the print output interval.

Remaining Cards - enter ERR parameters. 1 parameter for each integrated variable. 3 parameters per card (3E15.8) format

The order of the integrated variables Y_i is as follows:

$$
\{Y\} = \left\{ \begin{array}{ll}
\{\dot{R}\} & \\
\{\omega^{x}\} & \text{always present} \\
\{\dot{\xi}\} & \text{present if Laboratory is flexible} \\
\{\Delta\dot{\bar{R}}\} & \\
\{\omega^{Y}\} & \text{present if Space Station is flexible} \\
\{\dot{\bar{\xi}}\} & \text{present if Counterweight is flexible} \\
\{R\} & \\
\{\gamma\} & \text{always present} \\
\{\xi\} & \text{present if Laboratory is flexible} \\
\{\Delta\bar{R}\} & \\
\{\eta^{*}\} & \text{present if Space Station is flexible} \\
\{\bar{\xi}\} & \text{present if Counterweight is flexible} \\
\dot{\beta}_{G} & \\
\beta_{G} & \text{(wobble damping parameters) present if} \\
err_{KTI} & \text{controls are present} \\
err_{LLI} & \\
\dot{U}_{2,3} & \\
U_{2,3} & \text{(balance mass parameters) present if} \\
e_{FILT} & \text{mass balancing is present}
\end{array} \right\} \qquad (3.5)
$$

Group c - flexible problem printout data (skip if KLUE > 3)

Subgroup 1 - (one card)

Card 1 - KLOUTL, KLOUTC

(2I3) format

KLOUTL = number of mass pts for the Laboratory at which the elastic displacements and velocities are printed each output cycle

KLOUTC = similar to KLOUTL but for the Counterweight

Subgroup 2 - (skip if KLOUTL = 0)

enter the index numbers of the KLOUTL mass points

20 per card

(20I3) format

Subgroup 3 - (skip if KLOUTC = 0)

enter the index numbers of the KLOUTC mass points

20 per card

(20I3) format

3.7 PROGRAM OUTPUT

Examples of the program output are presented and discussed in Appendix B2.

APPENDIX A

DETAILED INFORMATION
FOR THE PHASE I COMPUTER PROGRAM

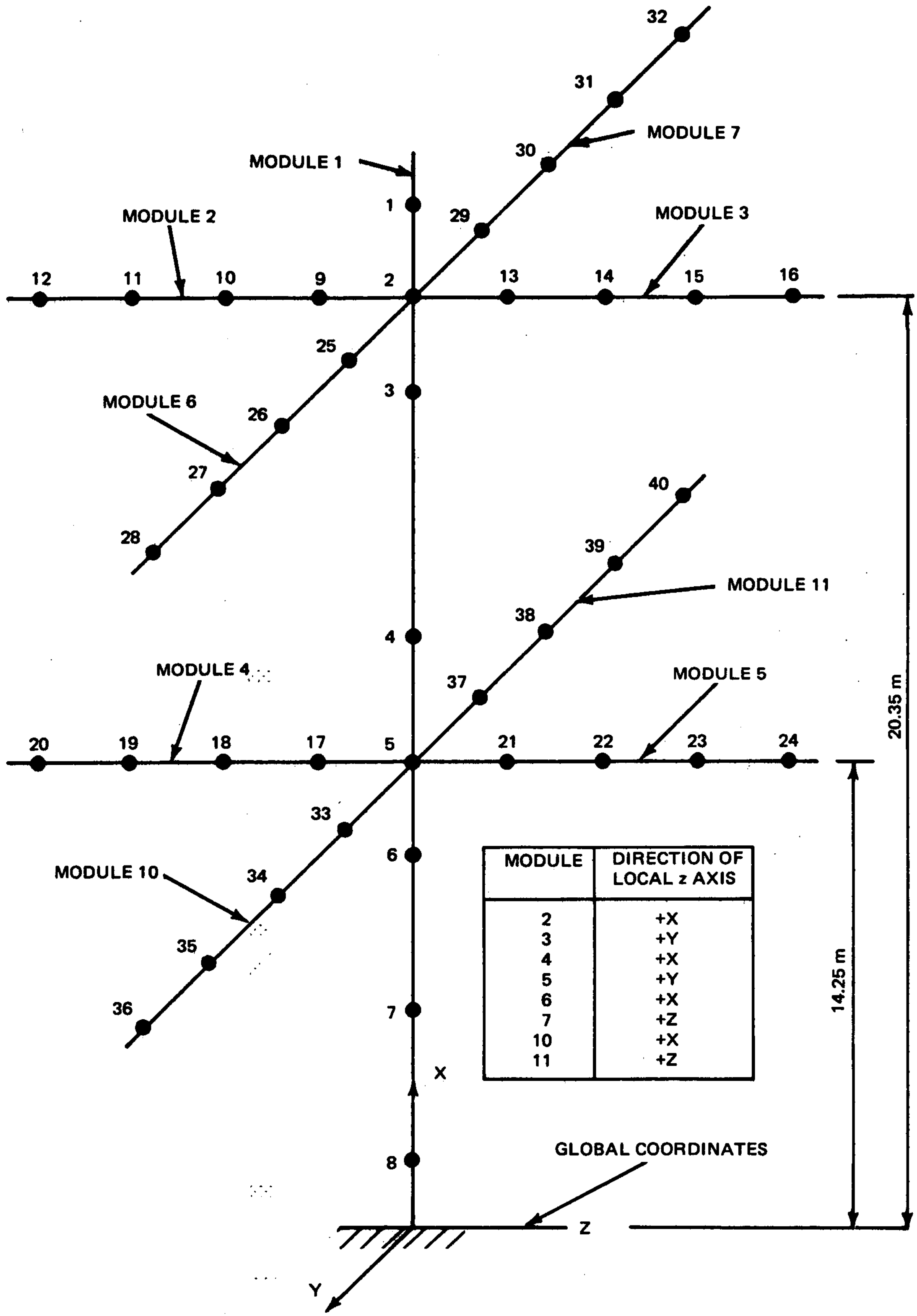
This appendix contains detailed programming information for the Phase I computer program. In addition, samples of input and output data are presented.

APPENDIX A1

EXAMPLE OF INPUT DATA

The example on the following pages shows input data for the 9-module cantilevered configuration shown in Figure A1. Module 1 is the core module described in Appendix F of Volume 1, and the remaining modules are identical and have the properties of the typical appended module described in that appendix. The local x axis of each appended module is oriented along the module, and the local z axis is oriented as indicated in the table on Figure A1. The last mass point of the idealized core module is fastened to the ground and therefore does not enter the problem. Mass points 2 and 5 have zero mass and were artifically introduced to serve as connection points. 20 modes of Module 1, and 10 modes of all other modules are used in the synthesis. Mass-loaded modes are used for Module 1 (see Section 2.2). As the T-matix data indicates, the x-direction deflections in the input modes of masses 7 and 8 are not present. These deflections were constrained to be zero in the core-module idealization. All other mass points have six degrees of freedom.

The results of this problem include printout of all input substructure modes (see Appendix A2).



MODULE	DIRECTION OF LOCAL z AXIS
2	+X
3	+Y
4	+X
5	+Y
6	+X
7	+Z
10	+X
11	+Z

Fig. A1 Configuration Used to Illustrate Input Data for Phase I Program

```
TYPE I DECK                              1 1 1 1 1 1 1 0 0 1 1                MODID
                                         20101010101010      1010             NMO
                                         8 4 4 4 4 4 4        4 4             NMPO
                                         2 2 5 5 2 2         5 5              JUNCTION POINTS
                                            386.4           G-CONSTANT
TYPE II DECK            Xo -                  0.                0.              0.        MASS POINTS -1
FOR MODULE 1            Xa -                  0.                0.              1.
                        Xb -                  1.                0.              0.
                                            861.                0.              0.
                                            801.                0.              0.
                                            741.                0.              0.
MASS POINT                                  621.                0.              0.
LOCATIONS                                   561.                0.              0.
FOR MODULE 1                                501.                0.              0.
                                            441.                0.              0.
                                            220.5               0.              0.
                        MASS -             6250.                                          MASS MATRIX -1
                                               16.9E6           0.              0.
                        INERTIA                0.               15.6E6          0.
                                               0.               0.              15.4E6
                        MASS -                 0.
                                               0.               0.              0.
                        INERTIA                0.               0.              0.
                                               0.               0.              0.
                        MASS -             6250.
                                               16.9E6           0.              0.
                        INERTIA                0.               15.6E6          0.
                                               0.               0.              15.4E6
                        MASS -             6250.
MASS                                           16.9E6           0.              0.
DATA                    INERTIA                0.               15.6E6          0.
FOR                                            0.               0.              15.4E6
MODULE 1                MASS -                 0.
                                               0.               0.              0.
                        INERTIA                0.               0.              0.
                                               0.               0.              0.
                        MASS -             6250.
                                               16.9E6           0.              0.
                        INERTIA                0.               15.6E6          0.
                                               0.               0.              15.4E6
                        MASS -             3375.
                                               3.15E6           0.              0.
                        INERTIA                0.               4.93E6          0.
                                               0.               0.              4.88E6
                        MASS -             6750.
                                               6.30E6           0.              0.
                        INERTIA                0.               30.5E6          0.
                                               0.               0.              30.2E6
            T-MATRIX CARD -          0111111     DEFAULT T
MASS POINT # OF OVERRIDE T-MATRIX -  7       MODE SHAPES FOLLOW - 1
                                         -0.11885560E-17        -0.27002758E-11        0.41559248E-16
START OF                                  0.67255229E-14        -0.42299298E-11        0.663099[illegible]
MODES FOR                                -0.8528[illegible]     -0.79493825E-11        -0.[illegible]
MODULE 1                                                        [illegible]11097984E-02
(46x20 MATRIX)
                                                                       •
                                                                       •
                                                                       •
```

```
0.27222044E-11
0.10599865E-06    -0.5
0.10600626E-11    -0.53636                    0919E-12
-0.49743279E-10   -0.12655826E-04   -0.68356501E-11
0.33369840E-09    -0.82342121E-05    0.19447280E-09
-0.36391957E-05    0.51022131E-13    0.79868911E-08
-0.12255741E-05    0.28362976E-08   -0.46700234E-06
-0.77885504E-10   -0.93949268E-07   -0.73552314E-07
0.51464450E-07     0.10521245E-06
```

OVERRIDE T-MATRIX - NEXT OVERRIDE

```
0011111
8     MODE SHAPES FOLLOW - 1
```

PARTITION OF MODAL MATRIX FOR MODULE 1 CORRESPONDING TO MASS POINT 7

```
0.45478710E-09    -0.13979170E-01    0.10505745E-09
0.21326930E-07     0.53713284E-02   -0.51842464E-09
-0.50876359E-07    0.10091742E-02    0.59144412E-07
-0.12417606E-02    0.49082349E-10   -0.80449236E-05
0.12325044E-02    -0.12038270E-04    0.19775543E-02
0.62031            0.10873823E-03    0.85294945E-04
-0.               -0.10809704E-03
                     3497606E-09
        •                •
        •                •
        •                •
0.35992798E-05
-0.27605438E-05                         2018E-06
0.67157099E-10    -0.462             -0.35998696E-07
0.29985046E-07     0.61575292E-07
0011111
```

PARTITION OF MODAL MATRIX FOR MODULE 1 CORRESPONDING TO MASS POINT 8

```
0.13690130E-09    -0.41042492E-02    0.72022735E-10
0.12873201E-07     0.32484070E-02   -0.79453066E-09
-0.45855749E-07    0.98520843E-03    0.22594119E-07
-0.475364          0.16543285E-08   -0.23799177E-
                   0.40108024E-05   -0.
                   0.24177119E-04
        •                •
        •                •
        •                •
      1320E-05    -0.137134                    E-07
0.26236321E-05    -0.40263451E-07    0.65956829E-05
0.83648732E-09     0.46376005E-06    0.36551052E-06
-0.25606090E-06   -0.52213392E-06
```

TYPE II DECK FOR MODULE 2

MASS POINT LOCATIONS

```
Xo -  801.     0.      0.    MASS POINTS -2
XA -  1.       0.      0.
XB -  0.       0.     -1.
      132.     0.      0.
      252.     0.      0.
      372.     0.      0.
      492.     0.      0.
     6250.                   MASS MATRIX - 2
      19.3E6   0.      0.
      0.       18.8E6  0.
```

```
     0.              0.              18.6E6
6250.
     19.3E6          0.              0.
     0.              18.8E6          0.
     0.              0.              18.6E6
6250.
     19.3E6          0.              0.
     0.              18.8E6          0.
     0.              0.              18.6E6
6250.
     19.3E6          0.              0.
     0.              18.8E6          0.
     0.              0.              18.6E6
```

INDICATES NO T-MATRIX OVERRIDE → 50

```
0111111    DEFAULT T
50
MODE SHAPES FOLLOW - 2
```

MODES FOR MODULE 2 (24x10 MATRIX)

```
  -0.19C10506E-13          0.11422608E-11          0.42109510E-10
  -0.74030879E-10         -0.23546117E-12         -0.17600010E-03
  -0.11526763E-09          0.36286238E-10         -0.15743515E-09
  -0.18177[illegible]
                           0.29617269E-03         -0.11881178E-0[illegible]
                           [illegible]9326E-09     0.190[illegible]
                                  •
                                  •
                                  •
   [illegible]04E-05
   0.54707634E-08
   0.14190640E-08          0.95977011E-0[illegible]  [illegible]E-08
   0.58481510E-05          0.28841417E-11         -0.17867747E-11
  -0.56819904E-09          0.26273874E-05         -0.53934457E-08
   0.18939036E-05
```

TYPE II DECK FOR MODULE 3

```
X_O - 801.           0.              0.          MASS POINTS -3
X_A - 0.             1.              0.
X_B - 0.             0.              1.
      132.           0.              0.
      252.           0.              0.
      372.           0.              0.
      492.           0.              0.
```

MASS MATRIX FOR MODULE 3

```
6250.                                            MASS MATRIX - 3
     19.3E6          0.              0.
     0.              18.8E6          0.
     0.              0.              18.6E6
6250.
     19.3E6          0.              0.
     0.              18.8E6          0.
     0.              0.              18.6E6
6250.
     19.3E6          0.              0.
     0.              18.8E6          0.
     0.              0.              18.6E6
6250.
     19.3E6          0.              0.
     0.              18.8E6          0.
     0.              0.              18.6E6
```

MODULE 3 MODES

```
0111111     DEFAULT T
50        MODE SHAPES FOLLOW - 3
           -0.19010506E-13          0.11422608E-11          0.42109510E-10
           -0.74030879E-10         -0.23546117E-12         -0.17600010E-03
           -0.11526763E-09          0.36286238E-10         -0.15743515E-09
           -0.18177335E-10
            0.                      0.29617269E-03         -0.11881178E-06
                                   -0.36929326E-09          0.19039799
                                      1977875E-03           0.84
```

•
•
•

SKIP TO MODULE 11

•
•
•

```
                        0.
            0.          18.8E6          0.
            0.          0.              18.6E6
         6250.
            19.3E6      0.              0.
            0.          18.8E6          0.
            0.          0.              18.6E6
0111111     DEFAULT T
50        MODE SHAPES FOLLOW - 11
           -0.19010506E-13          0.11422608E-11          0.42109510E-10
           -0.74030879E-10         -0.23546117E-12         -0.17600010E-03
           -0.11526763E-09          0.36286238E-10         -0.15743515E-09
           -0.181
                                    0.29617269E-03         -0.11881178E-06
                                        29326E-09           0.190
```

START OF MODULE 11 MODES

•
•
•

⋮

END OF MODULE 11 MODES	0.11453504E-04		
	-0.37353120E-02	0.55694539E-06	-0.49397163E-03
	0.14056076E-06	-0.50935833E-09	-0.17129076E-09
	0.15822977E-03	0.45102368E-07	-0.99157096E-05
	-0.29505678E-07		
	0.26880021E-14	-0.42529567E-15	0.22769522E-10
	0.85768823E-11	-0.13830129E-04	0.28622619E-13
	0.27940905E-11	0.56041578E-11	0.11358674E-11
	0.84623463E-11		
	0.95994383E-05	-0.14313177E-08	0.58549822E-05
	-0.16646970E-08	0.38737399E-11	0.21175206E-11
	-0.26374564E-05	-0.78068796E-09	0.19211348E-05
	0.54707634E-08		
	0.14190640E-08	0.95977011E-05	0.15936690E-08
	0.58481510E-05	0.28841417E-11	-0.17867747E-11
	-0.56819904E-09	0.26273874E-05	-0.53934457E-08
	0.18939036E-05		
TYPE III DECK — MODAL MASSES FOR MODULE 1	0.56086957E 00	0.55993354E 00	0.37350321E 00
	0.16982917E-01	0.16880568E-01	0.96777789E-02
	0.22559012E-02	0.22344198E-02	0.18671064E-02
	0.18632100E-02	0.42018224E-03	0.26273169E-03
	0.26269048E-03	0.84677653E-04	0.84644154E-04
	0.67674802E-04	0.61886822E-04	0.61846105E-04
	0.57138968E-04	0.57128025E-04	
MODAL MASSES FOR MODULE 2	0.36346563E-03	0.36333827E-03	0.22968801E-04
	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
MODAL MASSES FOR MODULE 3	0.36346563E-03	0.36333827E-03	0.22968801E-04
	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
MODAL MASSES FOR MODULE 4	0.36346563E-03	0.36333827E-03	0.22968801E-04
	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
MODAL MASSES FOR MODULE 5	0.36346563E-03	0.36333827E-03	0.22968801E-04
	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
MODAL MASSES FOR MODULE 6	0.36346563E-03	0.36333827E-03	0.22968801E-04
	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
MODAL MASSES FOR MODULE 7	0.36346563E-03	0.36333827E-03	0.22968801E-04
	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
	0.36346563E-03	0.36333827E-03	0.22968801E-04

	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
MODAL MASSES FOR MODULE 11	0.36346563E-03	0.36333827E-03	0.22968801E-04
	0.22940032E-04	0.21471686E-04	0.17857150E-04
	0.62864710E-05	0.62819954E-05	0.39144079E-05
	0.39112711E-05		
EIGENVALUES FOR MODULE 1	0.17829456E 01	0.17859259E 01	0.26773539E 01
	0.58882690E 02	0.59239685E 02	0.10332953E 03
	0.44328198E 03	0.44754370E 03	0.53558813E 03
	0.53670825E 03	0.23799202E 04	0.38061641E 04
	0.38067629E 04	0.11809496E 05	0.11814172E 05
	0.14776551E 05	0.16158535E 05	0.16169172E 05
	0.17501191E 05	0.17504547E 05	
EIGENVALUES FOR MODULE 2	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
EIGENVALUES FOR MODULE 3	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
EIGENVALUES FOR MODULE 4	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
EIGENVALUES FOR MODULE 5	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
EIGENVALUES FOR MODULE 6	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
EIGENVALUES FOR MODULE 7	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
EIGENVALUES FOR MODULE 10	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
EIGENVALUES FOR MODULE 11	0.27512937E 04	0.27522568E 04	0.43537352E 05
	0.43591945E 05	0.46572965E 05	0.56000023E 05
	0.15907181E 06	0.15918513E 06	0.25546650E 06
	0.25567150E 06		
NUMBER OF RIGID BODY MODES -	0		
SPECIFIES 20 EIGENVECTORS, AND 100 EIGENVALUES TO BE COMPUTED	20100		

APPENDIX 2

EXAMPLE OF PROGRAM OUTPUT

The computer printout of the problem described in Appendix A1 appears on the following pages. The illustration of Appendix A1 indicates that 100 frequencies are to be computed; however, the input was revised so that only 20 frequencies were computed.

CONFIGURATION SPECIFIED

MODULE NO. *	NO. MODES *	NO. MASS POINTS
1	20	8
2	10	4
3	10	4
4	10	4
5	10	4
6	10	4
7	10	4
10	10	4
11	10	4

CONSTANT G FOR THE PROGRAM = 0.38639990E 03

JUNCTION POINT DATA

MODULE	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
JUNCTION POINT	2	2	5	5	2	2	0	0	5	5	0	0	0	0	0	0

** MODULE 1 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.	COORDINATES		
1	0.66100000E 03	0.0	0.0
2	0.80100000E 03	0.0	0.0
3	0.74100000E 03	0.0	0.0
4	0.62100000E 03	0.0	0.0
5	0.56100000E 03	0.0	0.0
6	0.50100000E 03	0.0	0.0
7	0.44100000E 03	0.0	0.0
8	0.22050000E 03	0.0	0.0

COORDINATES OF POINT 0

0.0	0.0	0.0

COORDINATES OF POINT A

0.0	0.0	0.1000000E 01

COORDINATES OF POINT B

0.1000000E 01	0.0	0.0

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.	COORDINATES		
1	0.66100000E 03	0.0	0.0
2	0.80100000E 03	0.0	0.0
3	0.74100000E 03	0.0	0.0
4	0.62100000E 03	0.0	0.0
5	0.56100000E 03	0.0	0.0
6	0.50100000E 03	0.0	0.0
7	0.44100000E 03	0.0	0.0
8	0.22050000E 03	0.0	0.0

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
2	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
3	0.1617494E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
4	0.1617494E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
5	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
6	0.1617494E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
7	0.9734474E 01	0.8152176E 04	0.0	0.0
		0.0	0.1275880E 05	0.0
		0.0	0.0	0.1262940E 05
8	0.1746555E 02	0.1630435E 05	0.0	0.0
		0.0	0.7893375E 05	0.0
		0.0	0.0	0.7815731E 05

DEFAULT T-MATRIX FOR MODULE 1
6 ROWS, 6 COLUMNS

0.100000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1189556E-17	-0.2700276E-11	0.4155923E-16	0.6725520E-14	-0.4229930E-11	0.6636998E-17
	-0.8528536E-12	-0.7949382E-11	-0.2096011E-11	0.6435324E-11	0.1109798E-02	0.3496914E-10
	0.6541372E-09	0.5823155E-09	-0.5594170E-08	-0.2145625E-03	0.4179520E-07	-0.2087455E-06
	0.2803363E-07	-0.2870117E-06				
2	0.1150278E-08	-0.3741656E-01	0.2028304E-10	-0.4703008E-08	-0.9191649E-03	0.6866685E-09

G

	-0.1111345E-07	0.4347209E-03	-0.6923466E-07	0.1470935E-02	0.9774821E-09	-0.9900526E-07
	0.1151497E-04	0.1590799E-07	0.3892220E-04	-0.2870975E-06	-0.1148366E-02	-0.8975135E-03
	-0.5035933E-03	-0.1048713E-02				
3	0.3741733E-01	0.1209732E-08	-0.2176829E-09	0.8963018E-03	-0.3483505E-08	0.4442045E-09
	-0.4396248E-03	-0.2577458E-07	-0.1474976E-02	-0.1316589E-06	0.2533502E-09	-0.1158140E-04
	-0.6578667E-07	0.3861397E-04	-0.3701305E-06	0.2997627E-06	0.9047878E-03	-0.1147731E-02
	0.1038101E-02	-0.5241125E-03				
4	0.1126723E-12	-0.3811007E-11	0.8008610E-04	-0.1316836E-10	0.1549211E-10	0.1222102E-04
	-0.3127863E-11	0.4648244E-10	0.4869517E-10	-0.2736993E-10	-0.3925121E-11	-0.2684677E-09
	-0.6586882E-09	0.8875505E-09	0.2523252E-08	-0.9155878E-09	-0.9513045E-08	0.1753776E-08
	-0.8818645E-03	-0.1529791E-08				
5	-0.5544656E-04	-0.2763759E-11	-0.7778706E-12	-0.2084937E-04	0.7896270E-10	-0.4042535E-11
	0.7558279E-05	0.4689975E-09	-0.3385974E-05	-0.3373155E-09	-0.5492782E-11	-0.4779735E-07
	-0.4289276E-09	0.1983793E-08	0.4048095E-09	-0.1385445E-08	-0.5013108E-05	0.6311925E-06
	-0.7066396E-05	0.3499607E-06				
6	0.2241613E-11	-0.5543660E-04	0.6959335E-12	-0.8838294E-10	-0.2087431E-04	-0.1859438E-11
	-0.3465421E-09	0.7572381E-05	0.1493198E-09	-0.3395985E-05	-0.7967753E-13	0.3051137E-09
	-0.4836923E-07	0.9232060E-10	-0.1691288E-08	-0.1501504E-09	-0.6285540E-06	-0.4913744E-06
	-0.3396695E-06	-0.7079634E-06				

COORDINATES OF MASS POINT 2

7	-0.2590143E-17	-0.2700273E-11	0.2483208E-16	0.6719265E-14	-0.4229215E-11	-0.1213351E-16
	-0.5516269E-12	-0.7943244E-11	-0.2092417E-11	0.6432051E-11	0.1101226E-02	0.3453705E-10
	0.3726737E-03	0.5599960E-09	-0.9342511E-08	-0.2042714E-03	0.3959096E-07	-0.1996721E-06
	0.2643484E-07	-0.2992567E-06				
8	0.1043214E-08	-0.3408671E-01	-0.3083792E-10	0.1801900E-08	-0.3365213E-03	0.1086949E-08
	0.1109104E-07	-0.3124132E-04	-0.7972119E-07	0.1626079E-02	-0.6979076E-10	-0.7360529E-07
	0.1170137E-04	-0.8787407E-07	0.1080143E-04	0.1997650E-07	0.2786228E-04	0.2154868E-04
	0.5744617E-04	0.1184857E-03				
9	0.3408635E-01	0.1059921E-08	-0.2571556E-09	-0.3577841E-03	0.1496986E-08	-0.4047396E-10
	0.2551149E-04	0.1058641E-08	-0.1629395E-02	-0.1382514E-06	-0.2741675E-10	-0.1174489E-04
	-0.7764587E-07	0.1081188E-04	0.9016816E-07	-0.1437381E-07	-0.2237782E-04	0.2778514E-04
	-0.1182279E-03	0.5796688E-04				
10	0.5967422E-13	-0.1589302E-13	0.8008465E-04	-0.1213543E-11	-0.1744923E-13	0.1221208E-04
	-0.1235566E-11	-0.1077639E-10	0.8730249E-11	0.1975018E-11	0.5572386E-14	0.5210765E-12
	0.3106990E-11	-0.1509110E-11	-0.4008865E-11	0.1311872E-11	0.1099797E-10	0.3179052E-11
	0.1905411E-10	0.6511226E-11				
11	-0.5544579E-04	-0.1722992E-11	-0.5951918E-12	-0.2084351E-04	0.8333094E-10	-0.1593267E-11
	0.7540378E-05	0.4447736E-09	-0.3410164E-05	-0.3117815E-09	0.3906196E-13	-0.4875176E-07
	-0.3143696E-09	0.1658567E-07	0.6771554E-10	0.2503411E-10	0.8143206E-07	-0.1037153E-06
	0.2398239E-07	-0.1340055E-07				
12	0.2309047E-11	-0.5543382E-04	0.7747847E-12	-0.8808197E-10	-0.2086845E-04	0.1293244E-11
	-0.3458329E-09	0.7554518E-05	-0.1515521E-09	-0.3420174E-05	-0.1579352E-12	-0.3172125E-09
	-0.4940553E-07	0.9568962E-10	-0.1879881E-07	0.1707763E-10	0.1046743E-06	0.8199333E-07
	0.1154643E-07	0.2519166E-07				

COORDINATES OF MASS POINT 3

13	-0.2294539E-10	-0.2857676E-09	0.2689401E-11	0.9826459E-10	-0.2141731E-09	-0.3536890E-11
	0.9215059E-10	-0.7302141E-09	-0.4143894E-09	0.2961853E-08	0.9565454E-03	-0.8768244E-10
	-0.1545156E-07	-0.9474494E-09	0.4559613E-07	-0.3727338E-04	-0.1126559E-06	-0.8534533E-07

	-0.1425691E-07	-0.3564891E-07				
14	0.9610566E-09	-0.3070067E-01	-0.5082038E-10	0.6018304E-08	0.1526760E-02	0.5543315E-09
	0.1868707E-07	-0.3577941E-03	-0.4002984E-07	0.8602906E-03	-0.1096483E-09	0.2952444E-06
	-0.3650400E-04	0.1043748E-05	-0.1486836E-03	-0.7519445E-08	0.7382191E-03	0.5804258E-03
	-0.4034515E-03	-0.8201369E-03				
15	0.3069973E-01	0.9546763E-09	0.2394676E-09	-0.1545201E-02	0.6238366E-08	-0.9111172E-09
	0.3540719E-03	0.2118355E-07	-0.8627232E-03	-0.7608497E-07	-0.3073783E-10	0.3871367E-04
	0.2519772E-05	-0.1485080E-03	-0.6600330E-06	-0.7916032E-07	-0.5745108E-03	0.7383972E-03
	0.5266773E-03	-0.3895779E-03				
16	0.5432715E-13	-0.1571291E-13	0.7901853E-04	0.6987793E-12	-0.1770262E-13	0.5937027E-05
	0.2763307E-11	-0.2901860E-10	0.1950082E-10	-0.1333590E-10	0.4232756E-14	0.5690328E-11
	0.1134336E-09	-0.6699730E-10	0.2195349E-10	0.8653789E-12	-0.2959712E-09	0.7872973E-09
	0.6187890E-09	-0.6266487E-09				
17	-0.5527903E-04	-0.1717817E-11	-0.6371608E-12	-0.1932922E-04	0.7723652E-10	-0.1929997E-11
	0.3382595E-05	0.1964459E-09	-0.1764188E-05	-0.1536972E-09	0.8950939E-14	0.1490958E-06
	0.9859613E-09	-0.1239106E-06	-0.8123873E-09	0.6972757E-11	-0.7964320E-07	0.1039988E-06
	0.3531829E-06	-0.1704807E-06				
18	0.2203272E-11	-0.5526801E-04	0.2925650E-12	-0.8127778E-10	-0.1935715E-04	0.1695464E-11
	-0.1562430E-09	0.3391501E-05	0.7865154E-10	-0.1784922E-05	-0.1747514E-13	-0.9603400E-09
	0.1435428E-06	-0.7738017E-09	0.1239053E-06	0.4215728E-10	-0.1017190E-06	-0.8105832E-07
	0.1720027E-06	0.3509505E-06				

COORDINATES OF MASS POINT 4

19	0.7484249E-10	-0.1151092E-09	-0.8614568E-11	-0.3075298E-09	0.1203624E-09	-0.7980417E-11
	-0.2054466E-09	0.2461564E-08	0.1395857E-08	-0.9853061E-08	0.6524066E-03	0.8414431E-09
	-0.1290687E-07	0.2696741E-07	0.1054995E-07	0.3004130E-03	-0.1162473E-06	0.5037599E-06
	-0.2456525E-06	0.1241720E-06				
20	0.6570671E-09	-0.2396381E-01	-0.1737291E-10	0.1452325E-07	0.3627090E-02	-0.1376408E-08
	0.4285159E-03	-0.2423984E-03	0.4287939E-07	-0.8531620E-03	-0.1498361E-09	0.9839223E-06
	-0.1437955E-03	0.1645887E-05	-0.2567414E-03	-0.4244573E-07	0.6551309E-03	0.5158854E-03
	-0.4363304E-03	-0.8874990E-03				
21	0.2396189E-01	0.7452712E-09	0.1856772E-09	-0.3639506E-02	0.1458770E-07	-0.6393643E-09
	0.2435219E-03	0.1572089E-07	0.8545085E-03	0.6709871E-07	-0.1925486E-10	0.1490031E-03
	0.9712521E-06	-0.2566457E-03	-0.1428589E-05	-0.6152050E-07	-0.5100141E-03	0.6563414E-03
	0.6539596E-03	-0.4239893E-03				
22	0.5296172E-13	-0.1524365E-13	0.7688318E-04	0.1805013E-11	-0.2661743E-13	-0.6621453E-05
	-0.3874136E-11	-0.4763583E-11	0.6108716E-11	-0.6471845E-11	0.1188970E-14	0.9114119E-11
	0.3090522E-10	-0.3158611E-10	-0.5671506E-10	0.2774763E-12	-0.1030965E-09	0.2375542E-09
	0.2143467E-09	-0.4553158E-09				
23	-0.5470113E-04	-0.1699642E-11	-0.7203331E-12	-0.1637175E-04	0.6536653E-10	-0.2199270E-11
	-0.4921819E-05	-0.3041667E-09	-0.1883142E-05	-0.1228375E-09	-0.1034583E-12	0.3913569E-06
	0.2559674E-08	-0.9776846E-07	-0.6137988E-09	0.3066024E-10	0.2066664E-06	-0.2650776E-06
	-0.2279478E-06	0.1067293E-06				
24	0.1244808E-11	-0.5469158E-04	-0.4783902E-12	-0.6642124E-10	-0.1640110E-04	-0.3632181E-11
	0.1969754E-09	-0.4913157E-05	0.1007245E-09	-0.1925280E-05	-0.1114018E-12	-0.2562825E-08
	0.3945348E-06	-0.5149037E-09	0.9843302E-07	0.3701564E-10	0.2654370E-06	0.2084936E-06
	-0.1112843E-06	-0.2257092E-06				

COORDINATES OF MASS POINT 5

25	-0.2025407E-11	0.4947466E-10	0.3626043E-12	0.1455359E-10	-0.4255277E-10	0.1001195E-12
	-0.5804014E-11	-0.1092002E-09	-0.9280718E-10	0.4383376E-09	0.4952974E-03	-0.7980963E-10
	0.4822407E-08	-0.2193785E-08	0.1713576E-07	0.4548884E-03	-0.8747810E-07	0.4340567E-06
	-0.4024467E-07	0.6858803E-06				
26	0.5908027E-09	-0.2062369E-01	0.3587816E-10	0.1810431E-07	0.4532572E-02	-0.9090351E-09
	-0.1779936E-07	0.1945959E-03	0.7611968E-07	-0.1606538E-02	-0.4469679E-10	0.1152222E-05
	-0.1772589E-03	0.7234834E-06	-0.1200759E-03	-0.3645026E-08	-0.4944221E-04	-0.3888304E-04
	0.2936117E-04	0.5968021E-04				
27	0.2062131E-01	0.6414702E-09	0.1496815E-09	-0.4542034E-02	0.1819025E-07	-0.5117300E-09
	-0.1912209E-03	-0.1066227E-07	0.1610749E-02	0.1325091E-06	0.1891440E-10	0.1773425E-03
	0.1155906E-05	-0.1200832E-03	-0.7437700E-06	0.4812129E-08	0.3845221E-04	-0.4945096E-04
	-0.6017811E-04	0.2845982E-04				
28	0.5201635E-13	-0.1505502E-13	0.7581396E-04	0.2379202E-11	-0.3108368E-13	-0.1289583E-04
	0.1234193E-11	0.3361112E-11	-0.4752212E-11	-0.5636690E-11	-0.1277456E-15	-0.7164858E-13
	-0.1246804E-11	0.1662546E-11	0.5215286E-12	-0.3073124E-14	0.4485644E-11	-0.4987680E-11
	-0.6076345E-11	0.9322394E-11				
29	-0.5428631E-04	-0.1686615E-11	-0.7961897E-12	-0.1494066E-04	0.5963827E-10	-0.2791226E-11
	-0.9046850E-05	-0.5541496E-09	-0.3648036E-05	-0.2475404E-09	-0.8024061E-13	0.4598316E-06
	0.3000750E-08	-0.1111895E-06	-0.6666707E-09	-0.4021852E-11	-0.2309046E-07	0.2964742E-07
	0.3222703E-07	-0.1516934E-07				
30	0.1016415E-11	-0.3427728E-04	-0.8535527E-12	-0.5884819E-10	-0.1496846E-04	-0.6663229E-11
	0.3577634E-09	-0.9033069E-05	0.1993674E-09	-0.3700818E-05	0.8616760E-15	-0.3038775E-08
	0.4646393E-06	-0.6853837E-09	0.1123298E-06	0.3332493E-11	-0.2988921E-07	-0.2350006E-07
	0.1588921E-07	0.3226749E-07				

COORDINATES OF MASS POINT 6

31	-0.4319578E-11	0.3226533E-10	0.6584678E-12	0.2113264E-10	-0.3857816E-11	0.2983980E-11
	0.8321475E-11	-0.1199430E-09	-0.1096018E-09	0.7687579E-09	0.2769716E-03	-0.1913886E-09
	0.3947527E-08	-0.3058295E-08	0.1325372E-07	0.2602290E-03	-0.6569047E-07	0.2411117E-06
	-0.1888417E-07	0.4300683E-06				
32	0.5187779E-07	-0.1727842E-01	0.8133851E-10	0.2014149E-07	0.5057231E-02	-0.6427974E-09
	-0.3616569E-07	0.6441453E-03	0.6938978E-07	-0.1446391E-02	0.1345171E-09	-0.3381541E-05
	0.5175641E-03	-0.8844861E-05	0.1451969E-02	0.9921081E-07	0.5552621E-04	0.4343176E-04
	-0.2359065E-04	-0.4772886E-04				
33	0.1727572E-01	0.5375156E-09	0.1049262E-09	-0.5064871E-02	0.2025892E-07	-0.6144276E-09
	-0.6409585E-03	-0.3682637E-07	0.1453175E-02	-0.1224710E-06	-0.1457667E-10	-0.5178580E-03
	-0.2383097E-05	0.1451319E-02	0.8839655E-05	-0.2146430E-08	-0.4283381E-04	0.5495522E-04
	0.4859311E-04	-0.2280121E-04				
34	0.5097553E-13	-0.1473330E-13	0.7373682E-04	0.2442374E-11	-0.2924509E-13	-0.1255348E-04
	0.1100371E-12	-0.4946515E-11	0.8619373E-11	-0.2943769E-11	0.1469339E-15	0.3425569E-11
	-0.3572634E-11	-0.6131956E-10	-0.1114561E-09	-0.6124177E-14	-0.4222072E-09	0.3372937E-09
	0.5959527E-09	-0.2001997E-08				
35	-0.5364374E-04	-0.1666565E-11	-0.7695166E-12	-0.1262840E-04	0.5040626E-10	-0.2531673E-11
	-0.8245705E-05	-0.5072869E-09	-0.3591671E-05	-0.2507896E-09	0.9977501E-13	-0.1230306E-05
	-0.5039393E-08	0.4679310E-06	0.2740178E-08	-0.2722204E-11	-0.7223980E-07	0.9363470E-07
	0.1059986E-06	-0.5101155E-07				
36	0.1060062E-11	-0.5363605E-04	-0.8405091E-12	-0.4974328E-10	-0.1265583E-04	-0.6835649E-11
	0.3336982E-09	-0.8234211E-05	0.1944728E-09	-0.3639195E-05	0.5102213E-13	0.7986888E-08
	-0.1235573E-05	0.2936237E-08	-0.4670023E-06	-0.7788530E-10	-0.9394927E-07	-0.7355226E-07
	0.5146445E-07	0.1052124E-06				

T-MATRIX FOR MASS POINT 7
5 ROWS, 6 COLUMNS

0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

COORDINATES OF MASS POINT 7

37	0.4547971E-09	-0.1797917E-01	0.1050574E-09	0.2132693E-07	0.5371325E-02	-0.5184246E-09
	-0.5087635E-07	0.1009174E-02	0.5914441E-07	-0.1241761E-02	0.4908234E-10	-0.8044924E-05
	0.1232504E-02	-0.1203827E-04	0.1977554E-02	0.6203157E-07	0.1087382E-03	0.8529493E-04
	-0.5337065E-04	-0.1080970E-03				
38	0.1397523E-01	0.4349761E-09	0.6172658E-10	-0.5377244E-02	0.2148296E-07	-0.7243346E-09
	-0.1006329E-02	-0.5810084E-07	0.1250555E-02	0.1080321E-06	-0.4845242E-10	-0.1233110E-02
	-0.8050404E-05	0.1977176E-02	0.1210366E-04	-0.7685852E-08	-0.8415259E-04	0.1081812E-03
	0.1095245E-03	-0.5143217E-04				
39	0.4556344E-13	-0.1422694E-13	0.7031880E-04	0.2173461E-11	-0.2860187E-13	-0.1197532E-04
	0.2004014E-11	0.1291845E-12	0.2814795E-11	-0.2115907E-11	0.6632052E-15	-0.3188224E-11
	-0.1491716E-10	-0.5005737E-10	-0.1957227E-09	0.1602701E-12	-0.4756628E-09	0.1938809E-09
	0.4477489E-09	-0.3760633E-08				
40	-0.5237517E-04	-0.1626981E-11	-0.7289709E-12	-0.9458077E-05	0.3783190E-10	-0.2289604E-11
	-0.7071520E-05	-0.4489262E-09	-0.3559404E-05	-0.2247516E-09	0.1311944E-12	-0.2764711E-05
	-0.1802837E-07	-0.6444932E-06	-0.3976916E-08	0.5341873E-12	-0.3547722E-07	0.4549558E-07
	0.6263633E-07	-0.2696979E-07				
41	0.1020465E-11	-0.5236930E-04	-0.6554517E-12	-0.3717950E-10	-0.9484636E-05	-0.5136964E-11
	0.2540023E-09	-0.7060294E-05	0.1898172E-09	-0.3599279E-05	0.5163443E-12	0.1800074E-07
	-0.2760544E-05	-0.3940109E-08	0.6450202E-06	0.6715709E-10	-0.4620402E-07	-0.3599870E-07
	0.2998505E-07	0.6157524E-07				

T-MATRIX FOR MASS POINT 8
5 ROWS, 6 COLUMNS

0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

COORDINATES OF MASS POINT 8

42	0.1369013E-09	-0.4104249E-02	0.7202273E-10	0.1287320E-07	0.3248407E-02	-0.7945304E-09
	-0.4565575E-07	0.9852082E-03	0.2259412E-07	-0.4753647E-03	0.1654328E-08	-0.2379916E-04
	0.3647377E-02	0.4010803E-05	-0.6574520E-03	-0.6033451E-07	-0.2417710E-04	-0.1893405E-04
	0.1075395E-04	0.2175942E-04				
43	0.4102472E-02	0.1278637E-09	-0.1069388E-10	-0.3249677E-02	0.1300631E-07	-0.4640281E-09
	-0.9833591E-03	-0.6058309E-07	0.4826672E-03	0.5302029E-07	0.7322955E-10	-0.3647703E-02
	-0.2380204E-04	-0.6578790E-03	-0.4025610E-05	0.9222829E-09	0.1879892E-04	-0.2402415E-04
	-0.2215530E-04	0.1034410E-04				
44	0.2419194E-13	-0.6840276E-14	0.3516150E-04	0.1651300E-11	-0.2380074E-13	-0.6001543E-05
	0.1173757E-10	0.1050477E-09	0.1122418E-09	-0.2654557E-10	0.4399476E-15	0.3552406E-10
	0.1375327E-09	-0.5496739E-09	-0.6195926E-09	0.7482902E-12	-0.3758675E-08	0.3108364E-08

```
           0.4512155E-08   -0.1347262E-07

   45     -0.3102778E-04   -0.9665931E-12   -0.2296839E-12    0.1016520E-04   -0.4121033E-10    0.1150043E-11
           0.1601643E-05    0.1356176E-09   -0.2757901E-05   -0.2404092E-09    0.6780264E-12    0.2629457E-05
           0.1711913E-07   -0.6633697E-05   -0.4076200E-07    0.4508534E-10    0.3590136E-06   -0.4703703E-06
          -0.5343840E-06    0.2453702E-06

   46      0.6365316E-12   -0.3103318E-04    0.1559817E-12    0.4085743E-10    0.1015168E-04   -0.1420963E-11
          -0.8372651E-10    0.1608211E-05    0.1313937E-09   -0.2742132E-05   -0.1371348E-11   -0.1713027E-07
           0.2623632E-05   -0.4026345E-07    0.6595683E-05    0.8364871E-09    0.4637600E-06    0.3655105E-06
          -0.3560508E-06   -0.5221339E-06

** MODULE  2 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.                   COORDINATES

    1      0.1320000E 03   0.0              0.0
    2      0.2520000E 03   0.0              0.0
    3      0.3720000E 03   0.0              0.0
    4      0.4920000E 03   0.0              0.0

COORDINATES OF POINT 0
           0.8010000E 03   0.0              0.0
COORDINATES OF POINT A
           0.1000000E 01   0.0              0.0
COORDINATES OF POINT B
           0.0             0.0             -0.1000000E 01

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.                   COORDINATES

    1      0.8010000E 03   0.0             -0.1320000E 03
    2      0.8010000E 03   0.0             -0.2520000E 03
    3      0.8010000E 03   0.0             -0.3720000E 03
    4      0.8010000E 03   0.0             -0.4920000E 03

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.       MASS                        INERTIA MATRIX

    1      0.1617494E 02        0.4994825E 05   0.0             0.0
                                0.0             0.4865425E 05   0.0
                                0.0             0.0             0.4813666E 05

    2      0.1617494E 02        0.4994825E 05   0.0             0.0
                                0.0             0.4865425E 05   0.0
                                0.0             0.0             0.4813666E 05

    3      0.1617494E 02        0.4994825E 05   0.0             0.0
                                0.0             0.4865425E 05   0.0
                                0.0             0.0             0.4813666E 05
```

4	0.1517494E 03	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 2
6 ROWS, 6 COLUMNS

0.100000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1901051E-13	0.1142261E-11	0.4210950E-10	-0.7403088E-10	-0.2354611E-12	-0.1760001E-03
	-0.1152976E-09	0.3629624E-10	-0.1574351E-09	-0.1817733E-10		
2	0.4374490E-07	0.2961727E-03	-0.1188117E-06	-0.4335255E-03	-0.3692930E-09	0.1903980E-09
	-0.9978591E-07	0.4197787E-03	0.8460453E-06	-0.2973401E-03		
3	-0.2961126E-03	0.4417892E-07	0.4333991E-03	-0.1234335E-06	0.3884362E-09	-0.2632639E-09
	0.4198232E-03	0.1239013E-06	0.2970498E-03	0.8450562E-06		
4	-0.5393573E-13	-0.2336877E-13	0.8576369E-11	0.3087777E-11	-0.4231177E-05	-0.2978269E-13
	-0.1821075E-11	-0.2410089E-11	-0.2406160E-11	-0.1445873E-10		
5	0.3963408E-05	-0.5838570E-09	-0.4955231E-06	0.1313326E-09	0.3007885E-13	-0.2654950E-12
	0.3539278E-06	0.8781902E-10	0.1029374E-05	0.2901647E-08		
6	0.5855690E-09	0.3963214E-05	-0.1324487E-09	-0.4955928E-06	0.4009986E-12	0.1851103E-12
	0.7928490E-10	-0.3541915E-06	-0.2892503E-08	0.1019246E-05		

COORDINATES OF MASS POINT 2

7	-0.4856295E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.2486531E-09	0.7638178E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1654229E-06	0.1254493E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254383E-02	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1281250E-03	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3374790E-14	-0.3992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257809E-11	-0.4512868E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1132935E-05	0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1083638E-09	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756898E-08	0.9656496E-06		

COORDINATES OF MASS POINT 3

13	-0.2613017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	0.5805596E-11	-0.6148973E-03
	0.4295595E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		
14	0.3657034E-05	0.2474043E-02	-0.1116898E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.8175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		
15	-0.2473972E-02	0.3688750E-06	0.4116769E-03	-0.1168454E-06	0.4072838E-09	0.1825706E-09
	-0.3801817E-03	-0.1134342E-05	0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.6836399E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.9099062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666199E-11	0.1464055E-11
	-0.6445630E-06	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345139E-08	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416846E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022739E-11	0.2815221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521939E-06	0.3735249E-02	0.1351884E-06	0.4946615E-03	0.3227008E-09	-0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	-0.4939714E-03	0.1405608E-06	-0.5093581E-09	-0.1712908E-09
	0.1582298E-03	0.4510236E-07	-0.9915710E-05	-0.2950568E-07		
22	0.2583002E-14	-0.4252957E-15	0.2276951E-10	0.8576882E-11	-0.1383013E-04	0.2862262E-13
	0.2794030E-11	0.5604158E-11	0.1135867E-11	0.8462346E-11		
23	0.5593438E-05	-0.1431318E-08	0.5854982E-05	-0.1664697E-08	0.3873740E-11	0.2117521E-11
	-0.2637456E-05	-0.7806880E-09	0.1921135E-05	0.5470763E-08		
24	0.1419064E-08	0.9597700E-05	0.1593669E-08	0.5848151E-05	0.2884141E-11	-0.1786774E-11
	-0.5581988E-09	0.2627386E-05	-0.5393446E-08	0.1893904E-05		

** MODULE 3 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.		COORDINATES	
1	0.1320000E 03	0.0	0.0
2	0.2520000E 03	0.0	0.0
3	0.3720000E 03	0.0	0.0
4	0.4920000E 03	0.0	0.0

COORDINATES OF POINT 0

0.8010000E 03	0.0	0.0

COORDINATES OF POINT A

0.0	0.1000000E 01	0.0

COORDINATES OF POINT 3

0.0	0.0	0.1000000E 01

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.	COORDINATES		
1	0.8010000E 03	0.0	0.1320000E 03
2	0.8010000E 03	0.0	0.2520000E 03
3	0.8010000E 03	0.0	0.3720000E 03
4	0.8010000E 03	0.0	0.4920000E 03

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
2	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
3	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
4	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 3
6 ROWS, 6 COLUMNS

0.1000000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.1000000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.1000000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.1000000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1901051E-13	0.1142261E-11	0.4210950E-10	-0.7403088E-10	-0.2354611E-12	-0.1760001E-03
	-0.1152676E-09	0.3628624E-10	-0.1574351E-09	-0.1817733E-10		
2	0.4374490E-07	0.2961727E-03	-0.1188117E-06	-0.4335255E-03	-0.3692930E-09	0.1903980E-09
	-0.8578691E-07	0.4197787E-03	0.8460453E-06	-0.2973401E-03		
3	-0.2561126E-03	0.4417892E-07	0.4333991E-03	-0.1234335E-06	0.3884362E-09	-0.2632639E-09
	0.4199232E-03	0.1239013E-06	0.2970498E-03	0.8450562E-06		

4	-0.5393573E-13	-0.2336877E-13	0.8576369E-11	0.3087777E-11	-0.4231177E-05	-0.2978269E-13
	-0.1921075E-11	-0.2410089E-11	-0.2406160E-11	-0.1445873E-10		
5	0.3963405E-05	-0.5838570E-09	-0.4955231E-06	0.1313326E-09	0.3007885E-13	-0.2654950E-12
	0.3539278E-06	0.8781902E-10	0.1029374E-05	0.2901647E-08		
6	0.5855680E-09	0.3963214E-05	-0.1324487E-09	-0.4955928E-06	0.4009986E-12	0.1851103E-12
	0.7929430E-10	-0.3541915E-06	-0.2892503E-08	0.1019246E-05		

COORDINATES OF MASS POINT 2

7	-0.4856296E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.2486531E-09	0.7638178E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1854229E-06	0.1254493E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254383E-02	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1281260E-03	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3334790E-14	-0.3992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257809E-11	-0.4512868E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1132835E-05	0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1088638E-08	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756888E-08	0.9656496E-06		

COORDINATES OF MASS POINT 3

13	-0.2613017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	0.5805596E-11	-0.6148973E-03
	0.4295565E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		
14	0.3657054E-06	0.2474043E-02	-0.1116898E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.8175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		
15	-0.2473972E-02	0.3688750E-06	0.4116769E-03	-0.1168454E-06	0.4072838E-09	0.1825706E-09
	-0.3801617E-03	-0.1134342E-06	0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.6836399E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.9099062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666199E-11	0.1464055E-11
	-0.6445630E-06	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345139E-08	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416846E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022739E-11	0.2915221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521939E-05	0.3735249E-02	0.1351884E-06	0.4946615E-03	0.3227008E-09	-0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	-0.4939714E-03	0.1405609E-06	-0.5093581E-09	-0.1712908E-09
	0.1593229E-03	0.4510236E-07	-0.9915710E-05	-0.2950569E-07		

22	0.2663002E-14	-0.4252957E-15	0.2276951E-10	0.8576882E-11	-0.1383017E-04	0.2862262E-13
	0.2794093E-11	0.5504158E-11	0.1135867E-11	0.8462346E-11		
23	0.5599438E-05	-0.1431318E-08	0.5654982E-05	-0.1664697E-08	0.3873740E-11	0.2117521E-11
	-0.2537456E-05	-0.7906880E-09	0.1921175E-05	0.5470763E-08		
24	0.1419264E-08	0.0597700E-05	0.1593669E-08	0.5848151E-05	0.2884141E-11	-0.1786774E-11
	-0.5631988E-09	0.2627386E-05	-0.5393446E-08	0.1893904E-05		

** MODULE 4 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.	COORDINATES		
1	0.1320000E 03	0.0	0.0
2	0.2520000E 03	0.0	0.0
3	0.3720000E 03	0.0	0.0
4	0.4920000E 03	0.0	0.0

COORDINATES OF POINT O
0.5610000E 03 0.0 0.0
COORDINATES OF POINT A
0.1000000E 01 0.0 0.0
COORDINATES OF POINT B
0.0 0.0 -0.1000000E 01

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.	COORDINATES		
1	0.5610000E 03	0.0	-0.1320000E 03
2	0.5610000E 03	0.0	-0.2520000E 03
3	0.5610000E 03	0.0	-0.3720000E 03
4	0.5610000E 03	0.0	-0.4920000E 03

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
2	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
3	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
4	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0

0.0	0.0	0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 4
6 ROWS, 6 COLUMNS

0.100000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1901051E-13	0.1142261E-11	0.4210950E-10	-0.7403088E-10	-0.2354611E-12	-0.1760001E-03
	-0.1152676E-09	0.3628624E-10	-0.1574351E-09	-0.1817733E-10		
2	0.4374490E-07	0.2561727E-03	-0.1188117E-06	-0.4335255E-03	-0.3692930E-09	0.1903980E-09
	-0.8978691E-07	0.4197787E-03	0.8460453E-06	-0.2973401E-03		
3	-0.2951126E-03	0.4417892E-07	0.4333991E-03	-0.1234335E-06	0.3884362E-09	-0.2632639E-09
	0.4198232E-03	0.1239013E-06	0.2970498E-03	0.8450562E-06		
4	-0.8393573E-13	-0.2336877E-13	0.8576369E-11	0.3087777E-11	-0.4231177E-05	-0.2978269E-13
	-0.1821075E-11	-0.2410089E-11	-0.2406160E-11	-0.1445873E-10		
5	0.3963408E-05	-0.5838570E-09	-0.4955231E-06	0.1313326E-09	0.3007885E-13	-0.2654950E-12
	0.3539278E-06	0.8781902E-10	0.1029374E-05	0.2901647E-08		
6	0.5855680E-09	0.3963214E-05	-0.1324487E-09	-0.4955928E-06	0.4009986E-12	0.1851103E-12
	0.7928480E-10	-0.3541915E-06	-0.2892503E-08	0.1019246E-05		

COORDINATES OF MASS POINT 2

7	-0.4856296E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.2486531E-09	0.7638178E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1854229E-05	0.1254493E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254383E-02	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1281250E-03	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3334790E-14	-0.3992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257809E-11	-0.4512868E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1132835E-05	0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1088638E-08	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756888E-08	0.9656496E-06		

COORDINATES OF MASS POINT 3

A-23

13	-0.3513017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	0.5805596E-11	-0.6148973E-03
	0.4295595E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		
14	0.3657054E-06	0.2474043E-02	-0.1116898E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.9175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		
15	-0.2473972E-02	0.3688750E-06	0.4116769E-03	-0.1168454E-06	0.4072838E-09	0.1825706E-09
	-0.3801817E-03	-0.1134342E-06	-0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.6835399E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.9099062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666199E-11	0.1464055E-11
	-0.6445630E-06	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345139E-08	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416846E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022739E-11	0.2815221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521939E-06	0.3735249E-02	0.1351884E-06	0.4946615E-03	0.3227008E-09	-0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	-0.4939714E-03	0.1405608E-06	-0.5093581E-09	-0.1712908E-09
	0.1552293E-03	0.4510236E-07	-0.9915710E-05	-0.2950568E-07		
22	0.2683003E-14	-0.4252957E-15	0.2276951E-10	0.8576882E-11	-0.1383013E-04	0.2862262E-13
	0.2734090E-11	0.5604158E-11	0.1135867E-11	0.8462346E-11		
23	0.5559438E-05	-0.1431318E-08	0.5854982E-05	-0.1664697E-08	0.3873740E-11	0.2117521E-11
	-0.2637456E-05	-0.7806880E-09	0.1921135E-05	0.5470763E-08		
24	0.1419064E-08	0.9597700E-05	0.1593669E-08	0.5848151E-05	0.2884141E-11	-0.1786774E-11
	-0.5691989E-09	0.2627386E-05	-0.5393446E-08	0.1893904E-05		

** MODULE 5 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.	COORDINATES		
1	0.1320000E 03	0.0	0.0
2	0.2520000E 03	0.0	0.0
3	0.3720000E 03	0.0	0.0
4	0.4920000E 03	0.0	0.0

COORDINATES OF POINT O

0.5510000E 03	0.0	0.0

COORDINATES OF POINT A

0.0	0.1000000E 01	0.0

COORDINATES OF POINT B

0.0	0.0	0.1000000E 01

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.	COORDINATES		
1	0.5610000E 03	0.0	0.1320000E 03
2	0.5610000E 03	0.0	0.2520000E 03
3	0.5610000E 03	0.0	0.3720000E 03
4	0.5610000E 03	0.0	0.4920000E 03

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
2	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
3	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
4	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 5
6 ROWS, 6 COLUMNS

0.100000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1901051E-13	0.1142261E-11	0.4210950E-10	-0.7403088E-10	-0.2354611E-12	-0.1760001E-03
	-0.1152676E-09	0.3628624E-10	-0.1574351E-09	-0.1817733E-10		
2	0.4374490E-07	0.2961727E-03	-0.1188117E-06	-0.4335255E-03	-0.3692930E-09	0.1903980E-09
	-0.8978691E-07	0.4197787E-03	0.8460453E-06	-0.2973401E-03		
3	-0.2961126E-03	0.4417892E-07	0.4333991E-03	-0.1234335E-06	0.3884362E-09	-0.2632639E-09
	0.4198232E-03	0.1239013E-06	0.2970498E-03	0.8450562E-06		
4	-0.6393573E-13	-0.2336877E-13	0.8576369E-11	0.3087777E-11	-0.4231177E-05	-0.2978269E-13
	-0.1921075E-11	-0.2410089E-11	-0.2406160E-11	-0.1445873E-10		

5	0.3963408E-05	-0.5838570E-09	-0.4955231E-06	0.1313326E-09	0.3007885E-13	-0.2654950E-12
	0.3539278E-05	0.8781902E-10	0.1029374E-05	0.2901647E-08		
6	0.3555630E-09	0.3963214E-05	-0.1324487E-09	-0.4955928E-06	0.4009986E-12	0.1951103E-12
	0.7923430E-10	-0.3541915E-06	-0.2892503E-08	0.1019246E-05		

COORDINATES OF MASS POINT 2

7	-0.4556296E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.2495531E-09	0.7638178E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1654223E-05	0.1254493E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254393E-02	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1291250E-03	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3334790E-14	-0.3992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257909E-11	-0.4512868E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1122835E-05	0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1089633E-08	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756888E-09	-0.9656496E-06		

COORDINATES OF MASS POINT 3

13	-0.2513017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	0.5805596E-11	-0.6148973E-03
	0.4395565E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		
14	0.3657054E-06	0.2474043E-02	-0.1116898E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.6175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		
15	-0.2473972E-02	0.3688750E-06	0.4116769E-03	-0.1168454E-06	0.4072838E-09	0.1825706E-09
	-0.3301817E-03	-0.1134342E-06	0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.6836399E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.9099062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666199E-11	0.1464055E-11
	-0.6445630E-06	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345139E-08	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416846E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022739E-11	0.2815221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521939E-06	0.3735249E-02	-0.1351884E-06	-0.4946615E-03	-0.3227008E-09	0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	0.4939714E-03	-0.1405608E-06	0.5093581E-09	0.1712908E-09
	0.1582298E-03	0.4510236E-07	-0.9915710E-05	-0.2950568E-07		
22	0.2583002E-14	-0.4252957E-15	0.2276951E-10	0.8576982E-11	-0.1383013E-04	0.2862262E-13
	0.2794090E-11	0.5604158E-11	0.1135867E-11	0.8462346E-11		

C2

23	0.5599438E-05	-0.1431318E-08	0.5854982E-05	-0.1664697E-08	0.3873740E-11	0.2117521E-11
	-0.2637455E-05	-0.7806880E-09	0.1921135E-05	0.5470763E-08		
24	0.1419064E-03	0.9597700E-05	0.1593669E-08	0.5848151E-05	0.2884141E-11	-0.1786774E-11
	-0.5581589E-09	0.2627386E-05	-0.5393446E-08	0.1893904E-05		

** MODULE 6 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.	COORDINATES		
1	0.1320000E 03	0.0	0.0
2	0.2520000E 03	0.0	0.0
3	0.3720000E 03	0.0	0.0
4	0.4920000E 03	0.0	0.0

COORDINATES OF POINT 0

0.8010000E 03	0.0	0.0

COORDINATES OF POINT A

0.1000000E 01	0.0	0.0

COORDINATES OF POINT B

0.0	0.1000000E 01	0.0

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.	COORDINATES		
1	0.8010000E 03	0.1320000E 03	0.0
2	0.8010000E 03	0.2520000E 03	0.0
3	0.8010000E 03	0.3720000E 03	0.0
4	0.8010000E 03	0.4920000E 03	0.0

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
2	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
3	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
4	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 6
6 ROWS, 6 COLUMNS

0.100000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1901051E-13	0.1142261E-11	0.4210950E-10	-0.7403088E-10	-0.2354611E-12	-0.1760001E-03
	-0.1152675E-09	0.3628624E-10	-0.1574351E-09	-0.1817733E-10		
2	0.4374490E-07	0.2961727E-03	-0.1188117E-06	-0.4335255E-03	-0.3692930E-09	0.1903980E-09
	-0.8578691E-07	0.4197787E-03	0.8460453E-06	-0.2973401E-03		
3	-0.2961126E-03	0.4417892E-07	0.4333991E-03	-0.1234335E-06	0.3884362E-09	-0.2632639E-09
	0.4199232E-03	0.1239013E-06	0.2970498E-03	0.8450562E-06		
4	-0.8393573E-13	-0.2336877E-13	0.6576369E-11	0.3087777E-11	-0.4231177E-05	-0.2978269E-13
	-0.1921075E-11	-0.2410089E-11	-0.2406160E-11	-0.1445873E-10		
5	0.3963409E-05	-0.5838570E-09	-0.4955231E-06	0.1313326E-09	0.3007885E-13	-0.2654950E-12
	0.3539278E-06	0.8781902E-10	0.1029374E-05	0.2901647E-08		
6	0.5556980E-09	0.3963214E-05	-0.1324487E-09	-0.4955928E-06	0.4009986E-12	0.1851103E-12
	0.7329480E-10	-0.3541915E-06	-0.2892503E-08	0.1019246E-05		

COORDINATES OF MASS POINT 2

7	-0.4856296E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.2486531E-09	0.7638179E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1654229E-06	0.1254493E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254383E-02	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1281260E-03	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3334790E-14	-0.3992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257809E-11	-0.4512868E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1132835E-05	0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1086638E-08	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756888E-08	0.9656496E-06		

COORDINATES OF MASS POINT 3

13	-0.3513017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	-0.5805596E-11	-0.6148973E-03
	0.4295585E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		

14	0.3657054E-06	0.2474043E-02	-0.1116898E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.8175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		
15	-0.2473972E-02	0.3688750E-06	0.4116769E-03	-0.1168454E-06	0.4072838E-09	0.1825706E-09
	-0.3801817E-03	-0.1134342E-06	0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.6936389E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.5099062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666199E-11	0.1464055E-11
	-0.6445830E-05	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345139E-09	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416846E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022739E-11	0.2815221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521939E-06	0.3735249E-02	0.1351884E-06	0.4946615E-03	0.3227008E-09	-0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	-0.4939714E-03	0.1405608E-06	-0.5093581E-09	-0.1712908E-09
	0.1592298E-03	0.4510236E-07	-0.9915710E-05	-0.2950568E-07		
22	0.2688002E-14	-0.4252957E-15	0.2276951E-10	0.8576882E-11	-0.1383013E-04	0.2862262E-13
	0.2794090E-11	0.5604158E-11	0.1135867E-11	0.8462346E-11		
23	0.9599439E-05	-0.1431318E-08	0.5854982E-05	-0.1664697E-08	0.3873740E-11	0.2117521E-11
	-0.2637456E-05	-0.7806980E-09	0.1921135E-05	0.5470763E-08		
24	0.1419064E-08	0.9597700E-05	0.1593669E-08	0.5848151E-05	0.2884141E-11	-0.1786774E-11
	-0.5681938E-09	0.2627386E-05	-0.5393446E-08	0.1893904E-05		

** MODULE 7 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.	COORDINATES		
1	0.1320000E 03	0.0	0.0
2	0.2520000E 03	0.0	0.0
3	0.3720000E 03	0.0	0.0
4	0.4920000E 03	0.0	0.0

COORDINATES OF POINT 0

0.8010000E 03 0.0 0.0

COORDINATES OF POINT A

0.0 0.0 0.1000000E 01

COORDINATES OF POINT B

0.0 -0.1000000E 01 0.0

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.	COORDINATES		
1	0.8010000E 03	-0.1320000E 03	0.0
2	0.8010000E 03	-0.2520000E 03	0.0
3	0.8010000E 03	-0.3720000E 03	0.0
4	0.8010000E 03	-0.4920000E 03	0.0

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
2	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
3	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05
4	0.1617494E 02	0.4994825E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 7
6 ROWS, 6 COLUMNS

0.100000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1901051E-13	0.1142261E-11	0.4210950E-10	-0.7403088E-10	-0.2354611E-12	-0.1760001E-03
	-0.1152676E-09	0.3628624E-10	-0.1574351E-09	-0.1817733E-10		
2	0.4374490E-07	0.2961727E-03	-0.1188117E-06	-0.4335255E-03	-0.3692930E-09	0.1903980E-09
	-0.6978691E-07	0.4197787E-03	0.8460453E-06	-0.2973401E-03		
3	-0.2961126E-03	0.4417892E-07	0.4333991E-03	-0.1234335E-06	0.3884362E-09	-0.2632639E-09
	0.4198232E-03	0.1239013E-06	0.2970498E-03	0.8450562E-06		
4	-0.6393573E-13	-0.2336877E-13	0.6576369E-11	0.3087777E-11	-0.4231177E-05	-0.2978269E-13
	-0.1921075E-11	-0.2410089E-11	-0.2406160E-11	-0.1445873E-10		
5	0.3963409E-05	-0.5838570E-09	-0.4955231E-06	0.1313326E-09	0.3007885E-13	-0.2654950E-12
	0.3539278E-06	0.8781902E-10	0.1029374E-05	0.2901647E-08		

6	0.5655690E-09	0.3963214E-05	-0.1324487E-09	-0.4955928E-06	0.4009986E-12	0.1851103E-12
	0.7928430E-10	-0.3541915E-06	-0.2892503E-08	0.1019246E-05		

COORDINATES OF MASS POINT 2

7	-0.4856296E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.2486531E-09	0.7638178E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1654229E-06	0.1254493E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254383E-02	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1281260E-03	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3334790E-14	-0.3992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257909E-11	-0.4512868E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1132835E-05	-0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1088639E-08	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756888E-08	0.9656496E-06		

COORDINATES OF MASS POINT 3

13	-0.2613017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	0.5805596E-11	-0.6148973E-03
	0.4295585E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		
14	0.3657054E-06	0.2474043E-02	-0.1116898E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.8175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		
15	-0.2473972E-02	0.3688750E-06	0.4116769E-03	-0.1168454E-06	0.4072838E-09	0.1825706E-09
	-0.3801817E-03	-0.1134342E-06	0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.6836393E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.9099062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666199E-11	0.1464055E-11
	-0.6445630E-06	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345139E-08	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416846E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022739E-11	0.2815221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521939E-06	0.3735249E-02	-0.1351884E-06	0.4946615E-03	0.3227008E-09	-0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	-0.4939714E-03	0.1405608E-06	-0.5093581E-09	-0.1712908E-09
	0.1582298E-03	0.4510236E-07	-0.9915710E-05	-0.2950568E-07		
22	0.2688002E-14	-0.4252957E-15	0.2276951E-10	0.8576882E-11	-0.1383013E-04	0.2062262E-13
	0.2794090E-11	0.5604158E-11	0.1135867E-11	0.8462346E-11		
23	0.9599438E-05	-0.1431318E-08	0.5854982E-05	-0.1664697E-08	0.3873740E-11	0.2117521E-11
	-0.2637456E-05	-0.7806880E-09	0.1921135E-05	0.5470763E-08		

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 24      0.1419064E-08    0.9597700E-05    0.1593669E-08    0.5848151E-05    0.2884141E-11   -0.1786774E-11
        -0.5581983E-09    0.2627386E-05   -0.5393446E-08    0.1893904E-05

** MODULE 10 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.                   COORDINATES

   1       0.1320000E 03   0.0            0.0
   2       0.2520000E 03   0.0            0.0
   3       0.3720000E 03   0.0            0.0
   4       0.4920000E 03   0.0            0.0

COORDINATES OF POINT O
           0.5610000E 03   0.0            0.0
COORDINATES OF POINT A
           0.1000000E 01   0.0            0.0
COORDINATES OF POINT B
           0.0             0.1000000E 01  0.0

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.                   COORDINATES

   1       0.5610000E 03   0.1320000E 03  0.0
   2       0.5610000E 03   0.2520000E 03  0.0
   3       0.5610000E 03   0.3720000E 03  0.0
   4       0.5610000E 03   0.4920000E 03  0.0

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.       MASS                         INERTIA MATRIX

   1       0.1617494E 02      0.4994825E 05   0.0             0.0
                              0.0             0.4865425E 05   0.0
                              0.0             0.0             0.4813666E 05

   2       0.1617494E 02      0.4994825E 05   0.0             0.0
                              0.0             0.4865425E 05   0.0
                              0.0             0.0             0.4813666E 05

   3       0.1617494E 02      0.4994825E 05   0.0             0.0
                              0.0             0.4865425E 05   0.0
                              0.0             0.0             0.4813666E 05

   4       0.1617494E 02      0.4994825E 05   0.0             0.0
                              0.0             0.4865425E 05   0.0
                              0.0             0.0             0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 10
 6 ROWS, 6 COLUMNS
```

0.100000E 01	0.0	0.0	0.0	0.0	0.0
0.0	0.100000E 01	0.0	0.0	0.0	0.0
0.0	0.0	0.100000E 01	0.0	0.0	0.0
0.0	0.0	0.0	0.100000E 01	0.0	0.0
0.0	0.0	0.0	0.0	0.100000E 01	0.0
0.0	0.0	0.0	0.0	0.0	0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

COORDINATES OF MASS POINT 1

1	-0.1901051E-13	0.1142261E-11	0.4210950E-10	-0.7403088E-10	-0.2354611E-12	-0.1760001E-03
	-0.1152676E-07	0.3628524E-10	-0.1574351E-09	-0.1817733E-10		
2	0.4374490E-07	0.2961727E-03	-0.1188117E-06	-0.4335255E-03	-0.3692930E-09	0.1903980E-09
	-0.9578691E-07	0.4197787E-03	0.8460453E-06	-0.2973401E-03		
3	-0.2961126E-03	0.4417892E-07	0.4333991E-03	-0.1234335E-06	0.3884362E-09	-0.2632639E-09
	0.4198323E-03	0.1239013E-06	0.2970498E-03	0.8450562E-06		
4	-0.8393573E-13	-0.2336877E-13	0.8576369E-11	0.3087777E-11	-0.4231177E-05	-0.2978269E-13
	-0.1821075E-11	-0.2410089E-11	-0.2408160E-11	-0.1445873E-10		
5	0.3563408E-05	-0.5838570E-09	-0.4955231E-06	0.1313326E-09	0.3007885E-13	-0.2654950E-12
	0.3533279E-05	0.8781902E-10	0.1029374E-05	0.2901647E-08		
6	0.5555680E-09	0.3963214E-05	-0.1324487E-09	-0.4955928E-06	0.4009986E-12	0.1851103E-12
	0.7929480E-10	-0.3541915E-06	-0.2892503E-08	0.1019246E-05		

COORDINATES OF MASS POINT 2

7	-0.4956296E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.2486531E-09	0.7638178E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1854229E-06	0.1254493E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254383E-02	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1281260E-03	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3334790E-14	-0.3992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257809E-11	-0.4512868E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1132835E-05	0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1088638E-08	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756888E-08	0.9656496E-06		

COORDINATES OF MASS POINT 3

13	-0.2513017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	0.5805596E-11	-0.6140973E-03
	0.4295585E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		
14	0.3557054E-06	0.2474043E-02	-0.1116898E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.8175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		

15	-0.2473972E-02	0.3688750E-06	0.4116769E-03	-0.1169454E-06	0.4072838E-09	0.1825706E-09
	-0.3901517E-03	-0.1134342E-06	0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.5836339E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.9091062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666190E-11	0.1464055E-11
	-0.6445630E-06	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345139E-03	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416846E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022739E-11	0.2815221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521933E-05	0.3735249E-02	0.1351884E-06	0.4946615E-03	0.3227008E-09	-0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	-0.4939714E-03	0.1405608E-06	-0.5093581E-09	-0.1712908E-09
	0.1592253E-03	0.4510236E-07	-0.9915710E-05	-0.2950558E-07		
22	0.2580032E-14	-0.4252957E-15	0.2276951E-10	0.8576882E-11	-0.1383013E-04	0.2862262E-13
	0.2794093E-11	0.5604159E-11	0.1175867E-11	0.8462346E-11		
23	0.5599439E-05	-0.1431318E-08	0.5854982E-05	-0.1664697E-08	0.3873740E-11	0.2117521E-11
	-0.2637456E-05	-0.7806880E-09	0.1921135E-05	0.5470763E-08		
24	0.1419064E-03	0.9597700E-05	0.1593669E-08	0.5848151E-05	0.2884141E-11	-0.1786774E-11
	-0.5531983E-09	0.2627385E-05	-0.5393446E-08	0.1893904E-05		

** MODULE 11 **

MASS POINT LOCATIONS IN LOCAL COORDINATES

MASS NO.	COORDINATES		
1	0.1320000E 03	0.0	0.0
2	0.2520000E 03	0.0	0.0
3	0.3720000E 03	0.0	0.0
4	0.4920000E 03	0.0	0.0

COORDINATES OF POINT O
0.5610000E 03 0.0 0.0
COORDINATES OF POINT A
0.0 0.0 0.1000000E 01
COORDINATES OF POINT B
0.0 -0.1000000E 01 0.0

MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES

MASS NO.	COORDINATES		
1	0.5610000E 03	-0.1320000E 03	0.0

```
 2      0.5610000E 03  -0.2520000E 03   0.0
 3      0.5610000E 03  -0.3720000E 03   0.0
 4      0.5610000E 03  -0.4920000E 03   0.0

MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES

MASS NO.      MASS                        INERTIA MATRIX

  1     0.1617494E 02      0.4994825E 05   0.0             0.0
                           0.0             0.4865425E 05   0.0
                           0.0             0.0             0.4813666E 05

  2     0.1617494E 02      0.4994825E 05   0.0             0.0
                           0.0             0.4865425E 05   0.0
                           0.0             0.0             0.4813666E 05

  3     0.1617494E 02      0.4994825E 05   0.0             0.0
                           0.0             0.4865425E 05   0.0
                           0.0             0.0             0.4813666E 05

  4     0.1617494E 02      0.4994825E 05   0.0             0.0
                           0.0             0.4865425E 05   0.0
                           0.0             0.0             0.4813666E 05

DEFAULT T-MATRIX FOR MODULE 11
 6 ROWS, 6 COLUMNS
  0.100000E 01   0.0            0.0            0.0            0.0            0.0
  0.0            0.100000E 01   0.0            0.0            0.0            0.0
  0.0            0.0            0.100000E 01   0.0            0.0            0.0
  0.0            0.0            0.0            0.100000E 01   0.0            0.0
  0.0            0.0            0.0            0.0            0.100000E 01   0.0
  0.0            0.0            0.0            0.0            0.0            0.100000E 01

SUBSTRUCTURE MODAL MATRIX

ROW NO.

            COORDINATES OF MASS POINT   1

  1    -0.1901051E-13   0.1142261E-11   0.4210950E-10  -0.7403088E-10  -0.2354611E-12  -0.1760001E-03
       -0.1152676E-09   0.3628624E-10  -0.1574351E-09  -0.1817733E-10

  2     0.4374490E-07   0.2961727E-03  -0.1188117E-06  -0.4335255E-03  -0.3692930E-09   0.1903980E-09
       -0.9978691E-07   0.4197787E-03   0.8460453E-06  -0.2973401E-03

  3    -0.2961126E-03   0.4417892E-07   0.4333991E-03  -0.1234335E-06   0.3884362E-09  -0.2632639E-09
        0.4198232E-03   0.1239013E-06   0.2970498E-03   0.8450562E-06

  4    -0.9393573E-13  -0.2336877E-13   0.8576369E-11   0.3087777E-11  -0.4231177E-05  -0.2978269E-13
       -0.1921075E-11  -0.2410089E-11  -0.2406160E-11  -0.1445873E-10

  5     0.3963406E-05  -0.5838570E-09  -0.4955231E-06   0.1313326E-09   0.3007885E-13  -0.2654950E-12
        0.3539278E-06   0.8781902E-10   0.1029374E-05   0.2901647E-08

  6     0.5655680E-09   0.3963214E-05  -0.1324487E-09  -0.4955928E-06   0.4009986E-12   0.1851103E-12
        0.7928480E-10  -0.3541915E-06  -0.2892503E-08   0.1019246E-05
```

COORDINATES OF MASS POINT 2

7	-0.4556296E-13	0.2919636E-11	0.1031810E-09	-0.1823023E-09	-0.5751668E-12	-0.4256910E-03
	-0.3496531E-09	0.7639179E-10	-0.3010829E-09	-0.2836582E-10		
8	0.1954229E-05	0.1254453E-02	-0.2217059E-06	-0.8070320E-03	-0.3655343E-09	0.2203610E-09
	-0.2791793E-07	0.1274800E-03	-0.9008836E-06	0.3171777E-03		
9	-0.1254383E-03	0.1870263E-06	0.8070411E-03	-0.2296765E-06	0.7820735E-09	0.2684424E-09
	0.1281260E-07	0.3981160E-07	-0.3172413E-03	-0.9001471E-06		
10	0.3334790E-14	-0.7992733E-15	0.1568526E-10	0.5219753E-11	-0.8699092E-05	0.1701074E-13
	-0.2257809E-11	-0.4512866E-11	-0.2875850E-12	-0.1265825E-10		
11	0.7364430E-05	-0.1098059E-08	0.1403117E-05	-0.3995317E-09	0.1155445E-11	0.2590962E-12
	0.1172835E-05	0.3329839E-09	0.9827036E-06	0.2788931E-08		
12	0.1298679E-08	0.7363753E-05	0.3822107E-09	0.1402237E-05	0.3675712E-11	-0.2910222E-12
	0.2415441E-09	-0.1132445E-05	-0.2756888E-08	0.9656496E-06		

COORDINATES OF MASS POINT 3

13	-0.2613017E-11	0.2827315E-11	0.2244906E-09	-0.2035671E-09	0.5805596E-11	-0.6148973E-03
	0.4395555E-10	0.9298687E-10	-0.2363469E-11	-0.1055531E-09		
14	0.3557054E-06	0.2474043E-02	-0.1116838E-06	-0.4111426E-03	-0.3432190E-09	0.1351719E-09
	0.5175977E-07	-0.3804024E-03	0.5262114E-06	-0.1858108E-03		
15	-0.3473972E-02	0.3688750E-06	0.4116769E-03	-0.1168454E-06	0.4072838E-09	0.1825706E-09
	-0.3801817E-03	-0.1134342E-05	0.1847546E-03	0.5246650E-06		
16	0.2405223E-14	-0.4137737E-15	0.1982489E-10	0.7436334E-11	-0.1204278E-04	0.2461058E-13
	0.6836389E-12	0.1243150E-11	-0.4077314E-12	0.7508257E-11		
17	0.9099062E-05	-0.1356711E-08	0.4376129E-05	-0.1245374E-08	0.3666199E-11	0.1464055E-11
	-0.6445630E-05	-0.1840963E-09	0.7505835E-06	0.2143015E-08		
18	0.1345130E-08	0.9097773E-05	0.1192687E-08	0.4372656E-05	0.1568056E-11	-0.1223043E-11
	-0.1412011E-09	0.6416845E-06	-0.2091098E-08	0.7316312E-06		

COORDINATES OF MASS POINT 4

19	-0.4022730E-11	0.2815221E-11	0.2846121E-09	-0.2252179E-09	-0.8105800E-11	-0.7167356E-03
	0.2137262E-09	0.4504359E-10	0.2271534E-09	-0.9008722E-10		
20	0.5521939E-05	0.3735249E-02	0.1351884E-06	0.4946615E-03	0.3227008E-09	-0.1404600E-09
	-0.3401112E-07	0.1588804E-03	-0.3145836E-07	0.1145350E-04		
21	-0.3735312E-02	0.5569453E-06	-0.4939714E-03	0.1405608E-06	-0.5093581E-09	-0.1712908E-09
	0.1582298E-03	0.4510236E-07	-0.9915710E-05	-0.2950568E-07		
22	0.2683002E-14	-0.4252957E-15	-0.2276951E-10	0.8576882E-11	-0.1383013E-04	0.2862262E-13
	0.2794090E-11	0.5604158E-11	0.1135867E-11	0.8462346E-11		
23	0.5599438E-05	-0.1431318E-08	0.5854982E-05	-0.1664697E-08	-0.3873740E-11	0.2117521E-11
	-0.2637455E-05	-0.7806880E-09	0.1921135E-05	0.5470763E-08		
24	0.1419064E-08	0.9597709E-05	0.1593669E-08	0.5848151E-05	0.2884141E-11	-0.1786774E-11
	-0.5581989E-09	0.2627386E-05	-0.5393446E-08	0.1893904E-05		

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 1

MASS NO.	MASS	INERTIA MATRIX		
1	0.16174945E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
2	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
3	0.16174945E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
4	0.16174945E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
5	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
6	0.16174945E 02	0.4373707E 05	0.0	0.0
		0.0	0.4037268E 05	0.0
		0.0	0.0	0.3985508E 05
7	0.6734474E 01	0.8152176E 04	0.0	0.0
		0.0	0.1275880E 05	0.0
		0.0	0.0	0.1262940E 05
8	0.1745995E 02	0.1630435E 05	0.0	0.0
		0.0	0.7893375E 05	0.0
		0.0	0.0	0.7815731E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 2

MASS NO.	MASS	INERTIA MATRIX		
1	0.16174945E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05
2	0.16174945E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05
3	0.16174945E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05
4	0.16174945E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 3

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05
2	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05
3	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05
4	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 4

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05
2	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05
3	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05
4	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4865425E 05	0.0
		0.0	0.0	0.4994825E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 5

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05
2	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05
3	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05
4	0.1617494E 02	0.4865425E 05	0.0	0.0

		0.0	0.4813666E 05	0.0
		0.0	0.0	0.4994825E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 6

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05
2	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05
3	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05
4	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 7

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
2	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
3	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
4	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 10

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05
2	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05

B

3	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05
4	0.1617494E 02	0.4813666E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4865425E 05

MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FOR MODULE 11

MASS NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
2	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
3	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
4	0.1617494E 02	0.4865425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05

MODULE	FREQ NO.	MODAL MASS	EIGENVALUE FREQUENCY SQUARED
1	1	0.5509695E 00	0.1782945E 01
	2	0.5509335E 00	0.1785926E 01
	3	0.3735032E 00	0.2677354E 01
	4	0.1698292E-01	0.5888268E 02
	5	0.1688056E-01	0.5923967E 02
	6	0.2577775E-02	0.1073295E 03
	7	0.2255901E-02	0.4432917E 03
	8	0.2234420E-02	0.4475435E 03
	9	0.1867106E-02	0.5355879E 03
	10	0.1863210E-02	0.5367080E 03
	11	0.4301820E-03	0.2379920E 04
	12	0.2527317E-03	0.3806164E 04
	13	0.2526905E-03	0.3806763E 04
	14	0.8457765E-04	0.1180949E 05
	15	0.8464414E-04	0.1181417E 05
	16	0.5757479E-04	0.1477655E 05
	17	0.6188682E-04	0.1615853E 05
	18	0.6194609E-04	0.1616917E 05
	19	0.5713895E-04	0.1750119E 05
	20	0.5712801E-04	0.1750455E 05
2	21	0.3634654E-03	0.2751293E 04
	22	0.3633780E-03	0.2752257E 04
	23	0.2296979E-04	0.4353735E 05
	24	0.2294002E-04	0.4359194E 05
	25	0.2147169E-04	0.4657296E 05

	26	0.1765715E-04	0.5600002E 05
	27	0.6286470E-05	0.1590718E 06
	28	0.6231995E-05	0.1591851E 06
	29	0.3914408E-05	0.2554665E 06
	30	0.3911271E-05	0.2556715E 06
3	31	0.3634654E-03	0.2751293E 04
	32	0.3633380E-03	0.2752257E 04
	33	0.2296879E-04	0.4353735E 05
	34	0.2294002E-04	0.4359194E 05
	35	0.2147169E-04	0.4657296E 05
	36	0.1765715E-04	0.5600002E 05
	37	0.6286470E-05	0.1590718E 06
	38	0.6231995E-05	0.1591851E 06
	39	0.3914408E-05	0.2554665E 06
	40	0.3911271E-05	0.2556715E 06
4	41	0.3634654E-03	0.2751293E 04
	42	0.3633380E-03	0.2752257E 04
	43	0.2296879E-04	0.4353735E 05
	44	0.2294002E-04	0.4359194E 05
	45	0.2147169E-04	0.4657296E 05
	46	0.1765715E-04	0.5600002E 05
	47	0.6286470E-05	0.1590718E 06
	48	0.6231995E-05	0.1591851E 06
	49	0.3914408E-05	0.2554665E 06
	50	0.3911271E-05	0.2556715E 06
5	51	0.3634654E-03	0.2751293E 04
	52	0.3633380E-03	0.2752257E 04
	53	0.2296879E-04	0.4353735E 05
	54	0.2294002E-04	0.4359194E 05
	55	0.2147169E-04	0.4657296E 05
	56	0.1765715E-04	0.5600002E 05
	57	0.6286470E-05	0.1590718E 06
	58	0.6231995E-05	0.1591851E 06
	59	0.3914408E-05	0.2554665E 06
	60	0.3911271E-05	0.2556715E 06
6	61	0.3634654E-03	0.2751293E 04
	62	0.3633380E-03	0.2752257E 04
	63	0.2296879E-04	0.4353735E 05
	64	0.2294002E-04	0.4359194E 05
	65	0.2147169E-04	0.4657296E 05
	66	0.1765715E-04	0.5600002E 05
	67	0.6286470E-05	0.1590718E 06
	68	0.6231995E-05	0.1591851E 06
	69	0.3914408E-05	0.2554665E 06
	70	0.3911271E-05	0.2556715E 06
7	71	0.3634654E-03	0.2751293E 04
	72	0.3633380E-03	0.2752257E 04
	73	0.2296879E-04	0.4353735E 05
	74	0.2294002E-04	0.4359194E 05
	75	0.2147169E-04	0.4657296E 05
	76	0.1765715E-04	0.5600002E 05
	77	0.6286470E-05	0.1590718E 06
	78	0.6231995E-05	0.1591851E 06
	79	0.3914408E-05	0.2554665E 06
	80	0.3911271E-05	0.2556715E 06

10	81	0.3634654E-03	0.2751293E 04
	82	0.3633390E-03	0.2752257E 04
	83	0.2296879E-04	0.4353735E 05
	84	0.2294002E-04	0.4359194E 05
	85	0.2147169E-04	0.4657296E 05
	86	0.1785715E-04	0.5600002E 05
	87	0.5286470E-05	0.1590718E 06
	88	0.6281995E-05	0.1591851E 06
	89	0.3914408E-05	0.2554665E 06
	90	0.3911271E-05	0.2556715E 06
11	91	0.3634654E-03	0.2751293E 04
	92	0.3633390E-03	0.2752257E 04
	93	0.2296879E-04	0.4353735E 05
	94	0.2294002E-04	0.4359194E 05
	95	0.2147169E-04	0.4657296E 05
	96	0.1785715E-04	0.5600002E 05
	97	0.5286470E-05	0.1590718E 06
	98	0.6281995E-05	0.1591851E 06
	99	0.3914408E-05	0.2554665E 06
	100	0.3911271E-05	0.2556715E 06

CIRCULAR FREQUENCIES OF THE COUPLED SYSTEM

0.133618E 01	0.133620E 01	0.163539E 01	0.763929E 01	0.763944E 01	0.998457E 01
0.197131E 02	0.197134E 02	0.221189E 02	0.221205E 02	0.378503E 02	0.494243E 02
0.524566E 02	0.524581E 02	0.524586E 02	0.524596E 02	0.583406E 02	0.583547E 02
0.623634E 02	0.624547E 02				

MODE SHAPE 1 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.8094518E-12	0.7316336E-04	0.4598885E-01	-0.1467795E-10	-0.7406382E-04	0.1084008E-06
2	-0.8213724E-12	0.6665148E-04	0.4553958E-01	-0.1474000E-10	-0.7406015E-04	0.1083956E-06
3	-0.3116320E-10	0.6003023E-04	0.4101579E-01	-0.1453448E-10	-0.7383853E-04	0.1080707E-06
4	0.5862930E-10	0.4685739E-04	0.3201531E-01	-0.1410057E-10	-0.7306831E-04	0.1069415E-06
5	-0.4285553E-11	0.4032665E-04	0.2755290E-01	-0.1388330E-10	-0.7251480E-04	0.1061313E-06
6	-0.6579351E-11	0.3378527E-04	0.2308361E-01	-0.1350489E-10	-0.7165801E-04	0.1048776E-06
7	0.0	0.2733403E-04	0.1867583E-01	-0.1287823E-10	-0.6996545E-04	0.1024006E-06
8	0.0	0.8025001E-05	0.5483083E-02	-0.6460828E-11	-0.4145961E-04	0.6068041E-07
9	0.9778120E-02	0.6663527E-04	0.4554002E-01	0.4510545E-10	-0.7408741E-04	0.1083971E-06
10	0.1867199E-01	0.6666829E-04	0.4554066E-01	0.9124440E-10	-0.7411012E-04	0.1083988E-06
11	0.2755744E-01	0.6668373E-04	0.4554114E-01	0.1117360E-09	-0.7412126E-04	0.1084001E-06
12	0.3646307E-01	0.6669908E-04	0.4554140E-01	0.1168255E-09	-0.7412437E-04	0.1084007E-06
13	-0.9778120E-02	0.6665915E-04	0.4554002E-01	-0.7457358E-10	-0.7408741E-04	0.1083971E-06
14	-0.1867199E-01	0.6667568E-04	0.4554066E-01	-0.1206299E-09	-0.7411011E-04	0.1083988E-06
15	-0.2755744E-01	0.6669463E-04	0.4554114E-01	-0.1410993E-09	-0.7412124E-04	0.1084001E-06
16	-0.3646306E-01	0.6671350E-04	0.4554140E-01	-0.1461734E-09	-0.7412434E-04	0.1084007E-06
17	0.9574071E-02	0.4032829E-04	0.2755317E-01	0.2233792E-10	-0.7254150E-04	0.1061329E-06
18	0.1828238E-01	0.4033555E-04	0.2755355E-01	0.5025874E-10	-0.7256375E-04	0.1061345E-06
19	0.2699221E-01	0.4034428E-04	0.2755395E-01	0.6266042E-10	-0.7257465E-04	0.1061358E-06
20	0.3570222E-01	0.4035301E-04	0.2755400E-01	0.6574158E-10	-0.7257769E-04	0.1061363E-06
21	-0.9574071E-02	0.4033191E-04	0.2755317E-01	-0.5009385E-10	-0.7254150E-04	0.1061329E-06
22	-0.1828238E-01	0.4034254E-04	0.2755355E-01	-0.7793553E-10	-0.7256372E-04	0.1061345E-06
23	-0.2699221E-01	0.4035459E-04	0.2755395E-01	-0.9031589E-10	-0.7257461E-04	0.1061358E-06
24	-0.3570222E-01	0.4036661E-04	0.2755400E-01	-0.9338222E-10	-0.7257765E-04	0.1061363E-06
25	-0.1431145E-04	0.6665212E-04	0.4554350E-01	0.4085215E-07	-0.7406122E-04	0.1084355E-06
26	-0.2732857E-04	0.6665305E-04	0.4555360E-01	0.7236741E-07	-0.7406237E-04	0.1084686E-06
27	-0.4034821E-04	0.6665375E-04	0.4556533E-01	0.8636221E-07	-0.7406322E-04	0.1084849E-06

28	-0.5335800E-04	0.6665415E-04	0.4557702E-01	0.8983653E-07	-0.7406369E-04	0.1084894E-06
29	0.1431150E-04	0.6665212E-04	0.4554350E-01	-0.4088108E-07	-0.7406122E-04	0.1084355E-06
30	0.2732861E-04	0.6665305E-04	0.4555361E-01	-0.7239453E-07	-0.7406237E-04	0.1084687E-06
31	0.4074923E-04	0.6665375E-04	0.4556535E-01	-0.8638864E-07	-0.7406322E-04	0.1084850E-06
32	0.5336906E-04	0.6665415E-04	0.4557704E-01	-0.8986200E-07	-0.7406369E-04	0.1084896E-06
33	-0.1401253E-04	0.4032704E-04	0.2755527E-01	0.2471188E-07	-0.7251586E-04	0.1061704E-06
34	-0.2675774E-04	0.4032761E-04	0.2756138E-01	0.4377961E-07	-0.7251698E-04	0.1062029E-06
35	-0.3950535E-04	0.4032803E-04	0.2756848E-01	0.5224703E-07	-0.7251781E-04	0.1062188E-06
36	-0.5225328E-04	0.4032825E-04	0.2757555E-01	0.5434913E-07	-0.7251826E-04	0.1062232E-06
37	0.1401255E-04	0.4032704E-04	0.2755527E-01	-0.2473933E-07	-0.7251586E-04	0.1061704E-06
38	0.2675773E-04	0.4032761E-04	0.2756139E-01	-0.4380599E-07	-0.7251698E-04	0.1062029E-06
39	0.3950538E-04	0.4032803E-04	0.2756849E-01	-0.5227295E-07	-0.7251781E-04	0.1062189E-06
40	0.5225332E-04	0.4032825E-04	0.2757556E-01	-0.5437452E-07	-0.7251826E-04	0.1062234E-06

MODE SHAPE 2 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.8807483E-11	0.4998950E-01	-0.7316968E-04	-0.1518382E-09	0.1084165E-06	0.7406472E-04
2	-0.8413897E-11	0.4554021E-01	-0.6665602E-04	-0.1568887E-09	0.1084092E-06	0.7406101E-04
3	0.3765296E-09	0.4101637E-01	-0.6003273E-04	-0.1451284E-09	0.1080851E-06	0.7383943E-04
4	0.1621736E-09	0.3201579E-01	-0.4685450E-04	-0.1215890E-09	0.1069523E-06	0.7306923E-04
5	-0.5089634E-10	0.2755331E-01	-0.4032077E-04	-0.1098239E-09	0.1061361E-06	0.7251564E-04
6	-0.3434751E-10	0.2308397E-01	-0.3377955E-04	-0.1067995E-09	0.1048807E-06	0.7165887E-04
7	0.0	0.1867611E-01	-0.2732853E-04	-0.1018446E-09	0.1024015E-06	0.6996637E-04
8	0.0	0.5483188E-02	-0.8022063E-05	-0.5091552E-10	0.6066995E-07	0.4146025E-04
9	-0.1431316E-04	0.4554411E-01	-0.6665669E-04	0.4071124E-07	0.1084481E-06	0.7406209E-04
10	-0.2733168E-04	0.4555419E-01	-0.6665764E-04	0.7222741E-07	0.1084804E-06	0.7406322E-04
11	-0.4035252E-04	0.4556591E-01	-0.6665838E-04	0.8622266E-07	0.1084965E-06	0.7406408E-04
12	-0.5337373E-04	0.4557759E-01	-0.6665877E-04	0.8969710E-07	0.1085010E-06	0.7406455E-04
13	0.1431309E-04	0.4554414E-01	-0.6665669E-04	-0.4102431E-07	0.1084465E-06	0.7406209E-04
14	0.2733125E-04	0.4555427E-01	-0.6665764E-04	-0.7253857E-07	0.1084774E-06	0.7406322E-04
15	0.4035154E-04	0.4556603E-01	-0.6665837E-04	-0.8653308E-07	0.1084928E-06	0.7406408E-04
16	0.5337223E-04	0.4557773E-01	-0.6665874E-04	-0.9000644E-07	0.1084971E-06	0.7406455E-04
17	-0.1401306E-04	0.2755567E-01	-0.4032128E-04	0.2461653E-07	0.1061736E-06	0.7251669E-04
18	-0.2675345E-04	0.2756177E-01	-0.4032199E-04	0.4368471E-07	0.1062047E-06	0.7251783E-04
19	-0.3950615E-04	0.2756885E-01	-0.4032256E-04	0.5215230E-07	0.1062201E-06	0.7251865E-04
20	-0.5225406E-04	0.2757592E-01	-0.4032285E-04	0.5425445E-07	0.1062244E-06	0.7251911E-04
21	0.1401296E-04	0.2755570E-01	-0.4032128E-04	-0.2483617E-07	0.1061732E-06	0.7251669E-04
22	0.2675524E-04	0.2756182E-01	-0.4032199E-04	-0.4390355E-07	0.1062041E-06	0.7251783E-04
23	0.3950582E-04	0.2756893E-01	-0.4032256E-04	-0.5237084E-07	0.1062194E-06	0.7251865E-04
24	0.5225367E-04	0.2757602E-01	-0.4032285E-04	-0.5447248E-07	0.1062236E-06	0.7251911E-04
25	-0.9778231E-02	0.4554065E-01	-0.6668265E-04	-0.2152221E-09	0.1084106E-06	0.7408827E-04
26	-0.1867221E-01	0.4554129E-01	-0.6671615E-04	-0.2581073E-09	0.1084122E-06	0.7411098E-04
27	-0.2756776E-01	0.4554177E-01	-0.6675122E-04	-0.2750600E-09	0.1084134E-06	0.7412213E-04
28	-0.3646349E-01	0.4554203E-01	-0.6678574E-04	-0.2785234E-09	0.1084140E-06	0.7412524E-04
29	0.9778231E-02	0.4554065E-01	-0.6664109E-04	-0.9865384E-10	0.1084106E-06	0.7408827E-04
30	0.1867221E-01	0.4554129E-01	-0.6663686E-04	-0.5537167E-10	0.1084122E-06	0.7411097E-04
31	0.2756776E-01	0.4554177E-01	-0.6663438E-04	-0.3772352E-10	0.1084135E-06	0.7412210E-04
32	0.3646348E-01	0.4554203E-01	-0.6663144E-04	-0.3391985E-10	0.1084140E-06	0.7412520E-04
33	-0.9574194E-02	0.2755358E-01	-0.4033864E-04	-0.1458062E-09	0.1061376E-06	0.7254235E-04
34	-0.1828260E-01	0.2755396E-01	-0.4036068E-04	-0.1737846E-09	0.1061391E-06	0.7256458E-04
35	-0.2699253E-01	0.2755426E-01	-0.4038427E-04	-0.1862839E-09	0.1061402E-06	0.7257549E-04
36	-0.3570266E-01	0.2755442E-01	-0.4040782E-04	-0.1893301E-09	0.1061409E-06	0.7257852E-04
37	0.9574194E-02	0.2755358E-01	-0.4030969E-04	-0.7408352E-10	0.1061376E-06	0.7254235E-04
38	0.1828260E-01	0.2755396E-01	-0.4030537E-04	-0.4672887E-10	0.1061391E-06	0.7256457E-04
39	0.2699253E-01	0.2755426E-01	-0.4030246E-04	-0.3482892E-10	0.1061402E-06	0.7257545E-04
40	0.3570255E-01	0.2755442E-01	-0.4029936E-04	-0.3207595E-10	0.1061408E-06	0.7257849E-04

MODE SHAPE 3 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.1117763E-11	0.9095362E-07	-0.2501746E-08	0.1309103E-03	0.3432674E-09	0.3426113E-09
2	-0.1112030E-11	0.7004843E-07	0.1864707E-07	0.1309079E-03	0.3431311E-09	0.3424843E-09
3	0.3450621E-11	0.5023125E-07	0.3623333E-07	0.1291652E-03	0.3145422E-09	0.3255045E-09
4	-0.1463475E-10	0.1347037E-07	0.6644535E-07	0.1256748E-03	0.2654990E-09	0.2923635E-09
5	0.1195377E-12	-0.3430511E-08	0.8027899E-07	0.1239271E-03	0.2460852E-09	0.2760163E-09
6	0.8134932E-12	-0.1619684E-07	0.8879067E-07	0.1205318E-03	0.2068116E-09	0.2499785E-09
7	0.0	-0.2665844E-07	0.9361452E-07	0.1149446E-03	0.1528705E-09	0.2137265E-09
8	0.0	-0.2553080E-07	0.5560094E-07	0.5747570E-04	-0.1779649E-09	-0.4039284E-10
9	-0.4505403E-07	0.1728569E-01	0.1904132E-07	0.1309801E-03	0.3417628E-09	0.3424951E-09
10	-0.6580754E-07	0.3301224E-01	0.1960065E-07	0.1310402E-03	0.3409781E-09	0.3425060E-09
11	-0.1266655E-06	0.4974297E-01	0.2002455E-07	0.1310697E-03	0.3411516E-09	0.3425145E-09
12	-0.1675426E-06	0.6447417E-01	0.2025272E-07	0.1310779E-03	0.3413616E-09	0.3425182E-09
13	0.4507265E-07	-0.1728555E-01	0.1904140E-07	0.1309801E-03	0.3417402E-09	0.3424903E-09
14	0.8566055E-07	-0.3301210E-01	0.1960083E-07	0.1310403E-03	0.3411531E-09	0.3425007E-09
15	0.1257460E-06	-0.4874283E-01	0.2002455E-07	0.1310698E-03	0.3413074E-09	0.3425080E-09
16	0.1577353E-06	-0.6447405E-01	0.2025262E-07	0.1310789E-03	0.3414926E-09	0.3425111E-09
17	-0.3211590E-07	0.1635386E-01	0.8042474E-07	0.1239955E-03	0.2430283E-09	0.2760254E-09
18	-0.5051833E-07	0.3125178E-01	0.8063148E-07	0.1240524E-03	0.2408056E-09	0.2760343E-09
19	-0.9951650E-07	0.4614365E-01	0.8078820E-07	0.1240803E-03	0.2402287E-09	0.2760414E-09
20	-0.1183063E-06	0.6103593E-01	0.8087255E-07	0.1240881E-03	0.2402150E-09	0.2760445E-09
21	0.3203031E-07	-0.1635386E-01	0.8042480E-07	0.1239955E-03	0.2415030E-09	0.2760208E-09
22	0.5940915E-07	-0.3125179E-01	0.8063165E-07	0.1240524E-03	0.2381222E-09	0.2760294E-09
23	0.9363135E-07	-0.4614366E-01	0.8078820E-07	0.1240804E-03	0.2368017E-09	0.2760352E-09
24	0.1165543E-06	-0.6103601E-01	0.8087250E-07	0.1240882E-03	0.2365515E-09	0.2760376E-09
25	-0.4522101E-07	0.7005139E-07	0.1728563E-01	0.1309801E-03	0.3419385E-09	0.3428826E-09
26	-0.9638466E-07	0.7005559E-07	0.3301218E-01	0.1310402E-03	0.3406802E-09	0.3429901E-09
27	-0.1275716E-06	0.7005866E-07	0.4874290E-01	0.1310697E-03	0.3397378E-09	0.3430944E-09
28	-0.1587434E-06	0.7006037E-07	0.6447411E-01	0.1310779E-03	0.3392349E-09	0.3431051E-09
29	0.4522102E-07	0.7005144E-07	-0.1728560E-01	0.1309801E-03	0.3421292E-09	0.3427505E-09
30	0.8538776E-07	0.7005571E-07	-0.3301216E-01	0.1310403E-03	0.3410670E-09	0.3430092E-09
31	0.1275733E-05	0.7005917E-07	-0.4874289E-01	0.1310699E-03	0.3402727E-09	0.3431269E-09
32	0.1567577E-06	0.7006099E-07	-0.6447411E-01	0.1310780E-03	0.3398490E-09	0.3431522E-09
33	-0.3644173E-07	-0.3430100E-08	0.1636392E-01	0.1239955E-03	0.2447758E-09	0.2763534E-09
34	-0.6961625E-07	-0.3429515E-08	0.3125185E-01	0.1240524E-03	0.2433937E-09	0.2764222E-09
35	-0.1028101E-06	-0.3429141E-08	0.4614372E-01	0.1240803E-03	0.2423592E-09	0.2765055E-09
36	-0.1359953E-06	-0.3428942E-08	0.6103605E-01	0.1240881E-03	0.2418068E-09	0.2765117E-09
37	0.3543986E-07	-0.3430154E-08	-0.1636378E-01	0.1239955E-03	0.2448686E-09	0.2761715E-09
38	0.6960345E-07	-0.3429639E-08	-0.3125171E-01	0.1240525E-03	0.2436209E-09	0.2763356E-09
39	0.1027744E-06	-0.3429068E-08	-0.4614359E-01	0.1240804E-03	0.2426730E-09	0.2764080E-09
40	0.1359524E-06	-0.3428758E-08	-0.6103594E-01	0.1240882E-03	0.2421670E-09	0.2764220E-09

MODE SHAPE 4 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.5327259E-08	-0.5179081E-02	-0.4299458E-02	0.1450821E-07	0.1009436E-03	-0.1215709E-03
2	-0.5286943E-08	0.2133046E-02	0.1772010E-02	0.1434879E-07	0.1009153E-03	-0.1215372E-03
3	-0.3656872E-08	0.9053439E-02	0.7518079E-02	0.6588703E-08	0.9357420E-04	-0.1126966E-03
4	-0.1137609E-08	0.2125757E-01	0.1765130E-01	-0.8926694E-08	0.7924491E-04	-0.9543952E-04
5	-0.2506057E-09	0.2651638E-01	0.2201772E-01	-0.1667851E-07	0.7231494E-04	-0.8709366E-04
6	-0.1397795E-08	0.2956089E-01	0.2454564E-01	-0.1623613E-07	0.6111462E-04	-0.7360453E-04
7	0.0	0.3137835E-01	0.2605475E-01	-0.1548757E-07	0.4575984E-04	-0.5511208E-04
8	0.0	0.1895670E-01	0.1574036E-01	-0.7767415E-08	-0.4925672E-04	0.5931982E-04
9	-0.1342026E-01	0.2141059E-02	0.1772576E-02	0.7837474E-07	0.1021557E-03	-0.1215953E-03
10	-0.2583243E-01	0.2158603E-02	0.1773378E-02	0.1278653E-06	0.1031891E-03	-0.1216569E-03
11	-0.3331619E-01	0.2178742E-02	0.1773986E-02	0.1499159E-06	0.1036962E-03	-0.1217029E-03

12	-0.5030390E-01	0.2198823E-02	0.1774313E-02	0.1554127E-06	0.1038374E-03	-0.1217275E-03
13	0.1342025E-01	0.2137249E-02	0.1772574E-02	-0.4939749E-07	0.1021554E-03	-0.1215953E-03
14	0.2381236E-01	0.2151234E-02	0.1773375E-02	-0.9865909E-07	0.1031884E-03	-0.1216569E-03
15	0.3821602E-01	0.2167894E-02	0.1773982E-02	-0.1205989E-06	0.1036953E-03	-0.1217029E-03
16	0.5130953E-01	0.2184447E-02	0.1774308E-02	-0.1260651E-06	0.1038364E-03	-0.1217275E-03
17	-0.9516813E-02	0.2659008E-01	0.2202481E-01	0.7770455E-06	0.7320370E-04	-0.8713540E-04
18	-0.1351124E-01	0.2678424E-01	0.2203486E-01	0.1390441E-05	0.7394416E-04	-0.8717946E-04
19	-0.2745707E-01	0.2701049E-01	0.2204249E-01	0.1663660E-05	0.7430749E-04	-0.8721244E-04
20	-0.3640991E-01	0.2723505E-01	0.2204658E-01	0.1731743E-05	0.7440870E-04	-0.8723007E-04
21	0.9516923E-02	0.2659452E-01	0.2202481E-01	-0.8109087E-06	0.7320338E-04	-0.8713540E-04
22	0.1351115E-01	0.2679282E-01	0.2203486E-01	-0.1424708E-05	0.7394351E-04	-0.8717946E-04
23	0.2745690E-01	0.2702322E-01	0.2204249E-01	-0.1698130E-05	0.7430663E-04	-0.8721244E-04
24	0.3640970E-01	0.2725295E-01	0.2204658E-01	-0.1766261E-05	0.7440773E-04	-0.8723007E-04
25	0.1515271E-01	0.2133732E-02	0.1779998E-02	0.6756710E-07	0.1009537E-03	-0.1230309E-03
26	0.3111115E-01	0.2134705E-02	0.1793887E-02	0.1086153E-06	0.1010148E-03	-0.1242754E-03
27	0.4614623E-01	0.2135444E-02	0.1810896E-02	0.1267873E-06	0.1010531E-03	-0.1248862E-03
28	0.6119166E-01	0.2135840E-02	0.1827326E-02	0.1312686E-06	0.1010735E-03	-0.1250563E-03
29	-0.1516270E-01	0.2133732E-02	0.1775160E-02	-0.3840174E-07	0.1009637E-03	-0.1230304E-03
30	-0.3111107E-01	0.2134705E-02	0.1786482E-02	-0.7912570E-07	0.1010148E-03	-0.1242743E-03
31	-0.4614630E-01	0.2135444E-02	0.1799923E-02	-0.9720321E-07	0.1010531E-03	-0.1248847E-03
32	-0.6119123E-01	0.2135840E-02	0.1813298E-02	-0.1016777E-06	0.1010735E-03	-0.1250547E-03
33	0.1158216E-01	0.2652491E-01	0.2207853E-01	0.6425159E-06	0.7234965E-04	-0.8816407E-04
34	0.2229431E-01	0.2653700E-01	0.2223944E-01	0.1152017E-05	0.7238529E-04	-0.8905590E-04
35	0.3306617E-01	0.2654617E-01	0.2242702E-01	0.1379009E-05	0.7241371E-04	-0.8949357E-04
36	0.4384975E-01	0.2655110E-01	0.2261403E-01	0.1435584E-05	0.7242836E-04	-0.8961547E-04
37	-0.1159215E-01	0.2652491E-01	0.2203300E-01	-0.6764881E-06	0.7234963E-04	-0.8816371E-04
38	-0.2229423E-01	0.2653700E-01	0.2224807E-01	-0.1186445E-05	0.7238626E-04	-0.8905517E-04
39	-0.3306803E-01	0.2654617E-01	0.2243983E-01	-0.1413630E-05	0.7241366E-04	-0.8949258E-04
40	-0.4384945E-01	0.2655110E-01	0.2263102E-01	-0.1470236E-05	0.7242832E-04	-0.8961435E-04

MODE SHAPE 5 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.3057902E-08	-0.4300223E-02	0.5177639E-02	0.1885199E-07	-0.1215727E-03	-0.1009460E-03
2	-0.3029916E-08	0.1771346E-02	-0.2134499E-02	0.1883443E-07	-0.1215391E-03	-0.1009180E-03
3	-0.9768132E-09	0.7517628E-02	-0.9054799E-02	0.1275905E-07	-0.1125981E-03	-0.9357692E-04
4	-0.3006504E-08	0.1765125E-01	-0.2125857E-01	0.5840832E-09	-0.9544096E-04	-0.7924758E-04
5	-0.1262493E-08	0.2201787E-01	-0.2651713E-01	-0.5498833E-08	-0.8709547E-04	-0.7231759E-04
6	-0.5211434E-09	0.2454584E-01	-0.2956175E-01	-0.5357567E-08	-0.7360808E-04	-0.6111597E-04
7	0.0	0.2605506E-01	-0.3137915E-01	-0.5113716E-08	-0.5511314E-04	-0.4576183E-04
8	0.0	0.1574064E-01	-0.1895719E-01	-0.2564989E-08	0.5932283E-04	0.4925612E-04
9	0.1516293E-01	0.1779921E-02	-0.2135175E-02	0.7209178E-07	-0.1230324E-03	-0.1009664E-03
10	0.3111149E-01	0.1794343E-02	-0.2136137E-02	0.1132635E-06	-0.1242766E-03	-0.1010175E-03
11	0.4614655E-01	0.1811921E-02	-0.2136865E-02	0.1316126E-06	-0.1248872E-03	-0.1010557E-03
12	0.6119229E-01	0.1829455E-02	-0.2137259E-02	0.1361885E-06	-0.1250573E-03	-0.1010761E-03
13	-0.1516292E-01	0.1773915E-02	-0.2135177E-02	-0.3401753E-07	-0.1230319E-03	-0.1009664E-03
14	-0.3111141E-01	0.1784718E-02	-0.2136141E-02	-0.7484380E-07	-0.1242756E-03	-0.1010175E-03
15	-0.4614645E-01	0.1797653E-02	-0.2136870E-02	-0.9302238E-07	-0.1248859E-03	-0.1010557E-03
16	-0.6119193E-01	0.1810541E-02	-0.2137263E-02	-0.9754882E-07	-0.1250558E-03	-0.1010761E-03
17	0.1158237E-01	0.2208017E-01	-0.2652563E-01	0.6537298E-06	-0.8816554E-04	-0.7235224E-04
18	0.2229465E-01	0.2224244E-01	-0.2653770E-01	0.1163198E-05	-0.8905710E-04	-0.7238882E-04
19	0.3306571E-01	0.2243135E-01	-0.2654685E-01	0.1390135E-05	-0.8949463E-04	-0.7241622E-04
20	0.4385040E-01	0.2261970E-01	-0.2655177E-01	0.1446690E-05	-0.8961651E-04	-0.7243086E-04
21	-0.1158237E-01	0.2208164E-01	-0.2652563E-01	-0.6649308E-06	-0.8816535E-04	-0.7235224E-04
22	-0.2229463E-01	0.2224528E-01	-0.2653770E-01	-0.1174542E-05	-0.8905672E-04	-0.7238882E-04
23	-0.3306953E-01	0.2243558E-01	-0.2654685E-01	-0.1401548E-05	-0.8949409E-04	-0.7241622E-04
24	-0.4385025E-01	0.2262531E-01	-0.2655177E-01	-0.1458109E-05	-0.8961586E-04	-0.7243085E-04
25	0.1342061E-01	0.1771915E-02	-0.2138040E-02	-0.4455918E-07	-0.1215972E-03	-0.1021584E-03
26	0.2563309E-01	0.1772723E-02	-0.2151425E-02	-0.9375555E-07	-0.1216587E-03	-0.1031918E-03

27	0.3371720E-01	0.1773335E-02	-0.2167439E-02	-0.1158932E-06	-0.1217047E-03	-0.1036989E-03
28	0.5081017E-01	0.1773665E-02	-0.2183458E-02	-0.1214998E-06	-0.1217293E-03	-0.1038402E-03
29	-0.1342060E-01	0.1771915E-02	-0.2143071E-02	0.8266198E-07	-0.1215972E-03	-0.1021580E-03
30	-0.2563299E-01	0.1772723E-02	-0.2161094E-02	0.1320848E-06	-0.1216587E-03	-0.1031909E-03
31	-0.3371701E-01	0.1773336E-02	-0.2181727E-02	0.1542147E-06	-0.1217047E-03	-0.1036978E-03
32	-0.5080983E-01	0.1773665E-02	-0.2202342E-02	0.1597839E-06	-0.1217293E-03	-0.1038389E-03
33	0.9617165E-02	0.2202495E-01	-0.2659375E-01	-0.7994686E-06	-0.8713719E-04	-0.7320642E-04
34	0.1951193E-01	0.2203499E-01	-0.2679065E-01	-0.1413020E-05	-0.8718124E-04	-0.7394694E-04
35	0.2745810E-01	0.2204260E-01	-0.2701762E-01	-0.1686267E-05	-0.8721420E-04	-0.7431036E-04
36	0.3541041E-01	0.2204670E-01	-0.2724789E-01	-0.1754343E-05	-0.8723182E-04	-0.7441158E-04
37	-0.9517157E-02	0.2202495E-01	-0.2659230E-01	0.7883531E-06	-0.8713717E-04	-0.7320610E-04
38	-0.1851193E-01	0.2203499E-01	-0.2679784E-01	0.1401853E-05	-0.8718122E-04	-0.7394634E-04
39	-0.2745795E-01	0.2204260E-01	-0.2701547E-01	0.1675139E-05	-0.8721416E-04	-0.7430954E-04
40	-0.3541016E-01	0.2204670E-01	-0.2724242E-01	0.1743239E-05	-0.8723182E-04	-0.7441067E-04

MODE SHAPE 5 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	0.5077030E-07	-0.2087203E-05	-0.1537038E-05	-0.1198681E-03	0.3207228E-08	-0.4236166E-07
2	0.5037574E-07	0.3571896E-06	-0.9868054E-06	-0.1197804E-03	0.2952533E-08	-0.4244658E-07
3	0.4371915E-07	0.2924240E-05	-0.5122479E-06	-0.5923380E-04	0.2870308E-08	-0.3957006E-07
4	0.3992113E-07	0.7137298E-05	0.9524122E-06	0.6494156E-04	0.8824852E-09	-0.3387296E-07
5	0.2260804E-07	0.8951060E-05	0.1850003E-05	0.1264816E-03	-0.1401855E-08	-0.3116452E-07
6	0.1261477E-07	0.1006699E-04	0.1802261E-05	0.1231238E-03	-0.1556933E-08	-0.2644717E-07
7	0.0	0.1075318E-04	0.1689507E-05	0.1174532E-03	-0.1829817E-08	-0.1998565E-07
8	0.0	0.6560625E-05	0.8936541E-06	0.5886276E-04	-0.3497447E-08	0.2027960E-07
9	-0.2595242E-06	-0.1501513E-01	-0.9372890E-06	-0.1223332E-03	0.2031892E-08	-0.4248049E-07
10	-0.3924354E-06	-0.3101097E-01	-0.8670402E-06	-0.1244609E-03	0.1296446E-08	-0.4251625E-07
11	-0.4706232E-06	-0.4615466E-01	-0.8139107E-06	-0.1255055E-03	0.1000085E-08	-0.4254303E-07
12	-0.5694920E-06	-0.6131641E-01	-0.7851610E-06	-0.1257965E-03	0.9538124E-09	-0.4255732E-07
13	0.3326675E-06	0.1601589E-01	-0.9385485E-06	-0.1223342E-03	0.2114384E-08	-0.4248021E-07
14	0.5285576E-06	0.3101193E-01	-0.8700869E-06	-0.1244629E-03	0.1403633E-08	-0.4251589E-07
15	0.6225935E-06	0.4615593E-01	-0.8182025E-06	-0.1255081E-03	0.1091790E-08	-0.4254253E-07
16	0.7287719E-06	0.6131797E-01	-0.7902758E-06	-0.1257994E-03	0.1029516E-08	-0.4255679E-07
17	0.2322378E-06	0.1692049E-01	0.1845558E-05	0.1291777E-03	-0.3025743E-08	-0.3118964E-07
18	0.9015845E-06	0.3275540E-01	0.1839252E-05	0.1314248E-03	-0.4388184E-08	-0.3121621E-07
19	0.1566153E-05	0.4874644E-01	0.1834475E-05	0.1325280E-03	-0.5011326E-08	-0.3123607E-07
20	0.2222616E-05	0.6475651E-01	0.1831905E-05	0.1328353E-03	-0.5157492E-08	-0.3124671E-07
21	-0.2919258E-06	-0.1690252E-01	0.1845561E-05	0.1291777E-03	-0.3115288E-08	-0.3118983E-07
22	-0.6321974E-06	-0.3273737E-01	0.1839258E-05	0.1314249E-03	-0.4559435E-08	-0.3121639E-07
23	-0.1576124E-05	-0.4872832E-01	0.1834475E-05	0.1325284E-03	-0.5227811E-08	-0.3123631E-07
24	-0.2262652E-05	-0.6473845E-01	0.1831901E-05	0.1328359E-03	-0.5386624E-08	-0.3124698E-07
25	0.5722653E-05	0.3581505E-06	-0.1601658E-01	-0.1223346E-03	0.2843477E-08	-0.4331920E-07
26	0.1102793E-04	0.3595138E-06	-0.3101282E-01	-0.1244632E-03	0.2728288E-08	-0.4403790E-07
27	0.1638345E-04	0.3605492E-06	-0.4615692E-01	-0.1255079E-03	0.2642101E-08	-0.4439195E-07
28	0.2174464E-04	0.3611067E-06	-0.6131887E-01	-0.1257989E-03	0.2596005E-08	-0.4448975E-07
29	-0.5620642E-05	0.3581500E-06	0.1601448E-01	-0.1223332E-03	0.2857753E-08	-0.4330221E-07
30	-0.1092288E-04	0.3595122E-06	0.3101021E-01	-0.1244614E-03	0.2757816E-08	-0.4401726E-07
31	-0.1627439E-04	0.3605379E-06	0.4615395E-01	-0.1255066E-03	0.2683000E-08	-0.4436822E-07
32	-0.2153311E-04	0.3610898E-06	0.6131596E-01	-0.1257980E-03	0.2642981E-08	-0.4446588E-07
33	0.4183009E-05	0.8955266E-05	0.1691328E-01	0.1291758E-03	-0.1571251E-08	-0.3180002E-07
34	0.8093815E-05	0.8963652E-05	0.3274773E-01	0.1314212E-03	-0.1750091E-08	-0.3233790E-07
35	0.1201631E-04	0.8969247E-05	0.4873811E-01	0.1325236E-03	-0.1883949E-08	-0.3259996E-07
36	0.1595379E-04	0.8972258E-05	0.6474757E-01	0.1328307E-03	-0.1955475E-08	-0.3267361E-07
37	-0.4142644E-05	0.8956260E-05	-0.1690798E-01	0.1291798E-03	-0.1554335E-08	-0.3180574E-07
38	-0.3038522E-05	0.8963638E-05	-0.3274512E-01	0.1314290E-03	-0.1715502E-08	-0.3233910E-07
39	-0.1197145E-04	0.8969236E-05	-0.4873690E-01	0.1325334E-03	-0.1836088E-08	-0.3260129E-07
40	-0.1529903E-04	0.8972249E-05	-0.6474757E-01	0.1328411E-03	-0.1900521E-08	-0.3267451E-07

MODE SHAPE 7 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	0.7493102E-07	-0.7451735E-02	-0.4500497E-02	0.1344408E-08	0.7081064E-04	-0.1171411E-03
2	0.7354168E-07	-0.2513505E-03	-0.1480928E-03	0.2181366E-08	0.7064681E-04	-0.1168699E-03
3	0.5412203E-07	0.5102780E-02	0.3086525E-02	0.1319354E-08	0.2150516E-04	-0.5211523E-04
4	-0.3743713E-07	0.3859642E-02	0.2331313E-02	-0.1460117E-08	-0.4730020E-04	0.7826856E-04
5	-0.1359623E-07	-0.2729077E-02	-0.1652673E-02	-0.2711064E-08	-0.8677461E-04	0.1435865E-03
6	-0.6819732E-08	-0.9769570E-02	-0.5907558E-02	-0.2525846E-08	-0.7904226E-04	0.1307920E-03
7	0.0	-0.1550950E-01	-0.9376261E-02	-0.2468548E-08	-0.6776302E-04	0.1121300E-03
8	0.0	-0.1515458E-01	-0.9160168E-02	-0.2794744E-08	0.1476429E-04	-0.2441472E-04
9	-0.9849072E-02	-0.2563491E-03	-0.1484025E-03	-0.5449166E-07	0.7723256E-04	-0.1172455E-03
10	-0.1993042E-01	-0.2700614E-03	-0.1488417E-03	-0.9882103E-07	0.8273842E-04	-0.1176421E-03
11	-0.3039392E-01	-0.2862224E-03	-0.1491745E-03	-0.1189089E-06	0.8545279E-04	-0.1179389E-03
12	-0.4091616E-01	-0.3024044E-03	-0.1493537E-03	-0.1240207E-06	0.8621207E-04	-0.1180975E-03
13	0.9849142E-02	-0.2569770E-03	-0.1484026E-03	0.5954815E-07	0.7723016E-04	-0.1172455E-03
14	0.1993003E-01	-0.2713788E-03	-0.1488422E-03	0.1044422E-06	0.8273363E-04	-0.1176421E-03
15	0.3039794E-01	-0.2882720E-03	-0.1491752E-03	0.1248171E-06	0.8544636E-04	-0.1179389E-03
16	0.4091423E-01	-0.3051914E-03	-0.1493545E-03	0.1300076E-06	0.8620482E-04	-0.1180975E-03
17	0.1209777E-01	-0.2787161E-02	-0.1656243E-02	-0.6221970E-06	-0.9486706E-04	0.1440479E-03
18	0.2449135E-01	-0.2940227E-02	-0.1661308E-02	-0.1107015E-05	-0.1016328E-03	0.1445351E-03
19	0.3734071E-01	-0.3120129E-02	-0.1665147E-02	-0.1326830E-05	-0.1049683E-03	0.1448998E-03
20	0.5025997E-01	-0.3300281E-02	-0.1667212E-02	-0.1382800E-05	-0.1059013E-03	0.1450947E-03
21	-0.1209755E-01	-0.2786438E-02	-0.1656243E-02	0.6167116E-06	-0.9486341E-04	0.1440479E-03
22	-0.2448050E-01	-0.2938842E-02	-0.1661308E-02	0.1101498E-05	-0.1016256E-03	0.1445351E-03
23	-0.3733890E-01	-0.3116080E-02	-0.1665146E-02	0.1321309E-05	-0.1049589E-03	0.1448998E-03
24	-0.5025679E-01	-0.3297578E-02	-0.1667211E-02	0.1377277E-05	-0.1058908E-03	0.1450947E-03
25	0.1629352E-01	-0.2518918E-03	-0.1510010E-03	-0.3211315E-07	0.7087395E-04	-0.1277671E-03
26	0.3297155E-01	-0.2525597E-03	-0.1592075E-03	-0.5890037E-07	0.7111381E-04	-0.1368776E-03
27	0.5029019E-01	-0.2532415E-03	-0.1688792E-03	-0.7093877E-07	0.7129331E-04	-0.1413690E-03
28	0.6763948E-01	-0.2535547E-03	-0.1785292E-03	-0.7395221E-07	0.7138925E-04	-0.1426255E-03
29	-0.1629322E-01	-0.2518918E-03	-0.1516343E-03	0.3732983E-07	0.7087394E-04	-0.1277627E-03
30	-0.3297038E-01	-0.2525597E-03	-0.1605675E-03	0.6494264E-07	0.7111380E-04	-0.1368689E-03
31	-0.5028776E-01	-0.2532415E-03	-0.1710455E-03	0.7745143E-07	0.7129330E-04	-0.1413575E-03
32	-0.6769549E-01	-0.2535549E-03	-0.1815268E-03	0.8061937E-07	0.7138924E-04	-0.1426125E-03
33	-0.2001815E-01	-0.2734955E-02	-0.1638041E-02	-0.3786623E-06	-0.8705334E-04	0.1569747E-03
34	-0.4050873E-01	-0.2743294E-02	-0.1781043E-02	-0.6730260E-06	-0.8734767E-04	0.1681678E-03
35	-0.6178645E-01	-0.2749612E-02	-0.1890385E-02	-0.8066260E-06	-0.8756793E-04	0.1736860E-03
36	-0.8316314E-01	-0.2753013E-02	-0.1999907E-02	-0.8406828E-06	-0.8768566E-04	0.1752296E-03
37	0.2001794E-01	-0.2734955E-02	-0.1687237E-02	0.3720477E-06	-0.8705335E-04	0.1569694E-03
38	0.4050750E-01	-0.2743294E-02	-0.1779300E-02	0.6653055E-06	-0.8734770E-04	0.1681572E-03
39	0.6178365E-01	-0.2749612E-02	-0.1887611E-02	0.7983199E-06	-0.8756797E-04	0.1736719E-03
40	0.8315843E-01	-0.2753013E-02	-0.1996082E-02	0.8321902E-06	-0.8768574E-04	0.1752138E-03

MODE SHAPE 8 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	0.1045950E-06	-0.4505161E-02	0.7448763E-02	-0.5571323E-08	-0.1171566E-03	-0.7080479E-04
2	0.1029421E-06	-0.1526318E-03	0.2478261E-03	-0.5207784E-08	-0.1168848E-03	-0.7064070E-04
3	0.9387144E-07	0.3083997E-02	-0.5105291E-02	-0.2176049E-08	-0.5212509E-04	-0.3150241E-04
4	0.1586871E-08	0.2334017E-02	-0.3858754E-02	0.3524826E-08	0.7826414E-04	0.4730622E-04
5	-0.1193131E-08	-0.1647489E-02	0.2731669E-02	0.6276384E-08	0.1435803E-03	0.8678754E-04
6	-0.5325033E-09	-0.5902998E-02	0.9771988E-02	0.6210421E-08	0.1307867E-03	0.7905458E-04
7	0.0	-0.9372480E-02	0.1551155E-01	0.5847607E-08	0.1121251E-03	0.6777533E-04
8	0.0	-0.9158898E-02	0.1515563E-01	0.1838894E-08	-0.2442523E-04	-0.1475326E-04
9	0.1629541E-01	-0.1566130E-03	0.2483348E-03	-0.4070119E-07	-0.1277808E-03	-0.7086771E-04
10	0.3297493E-01	-0.1659867E-03	0.2490568E-03	-0.6853406E-07	-0.1368903E-03	-0.7110742E-04

11	0.5029301E-01	-0.1769174E-03	0.2495038E-03	-0.8118241E-07	-0.1413814E-03	-0.7128681E-04
12	0.5769574E-01	-0.1873600E-03	0.2499991E-03	-0.8441054E-07	-0.1426377E-03	-0.7138270E-04
13	-0.1629507E-01	-0.1551144E-03	0.2483320E-03	0.2864311E-07	-0.1277766E-03	-0.7086771E-04
14	-0.2297375E-01	-0.1628437E-03	0.2490496E-03	0.5511701E-07	-0.1368820E-03	-0.7110740E-04
15	-0.5029264E-01	-0.1720239E-03	0.2495935E-03	0.6708154E-07	-0.1413702E-03	-0.7128681E-04
16	-0.5769136E-01	-0.1812133E-03	0.2498862E-03	0.7011971E-07	-0.1426251E-03	-0.7138269E-04
17	-0.2001744E-01	-0.1681496E-02	0.2737551E-02	-0.3675406E-06	0.1569698E-03	0.8706642E-04
18	-0.4050764E-01	-0.1772911E-02	0.2745896E-02	-0.6500848E-06	0.1681639E-03	0.8736094E-04
19	-0.5178494E-01	-0.1880519E-02	0.2752220E-02	-0.7927265E-06	0.1735826E-03	0.8758134E-04
20	-0.9316129E-01	-0.1988276E-02	0.2755624E-02	-0.8264983E-06	0.1752263E-03	0.8769915E-04
21	0.2001722E-01	-0.1683190E-02	0.2737551E-02	0.3805936E-06	0.1569638E-03	0.8706642E-04
22	0.4050620E-01	-0.1776229E-02	0.2745897E-02	0.6735033E-06	0.1681522E-03	0.8736094E-04
23	0.5178173E-01	-0.1985487E-02	0.2752221E-02	0.8063323E-06	0.1736670E-03	0.8758134E-04
24	0.9315597E-01	-0.1994899E-02	0.2755625E-02	0.8401492E-06	0.1752089E-03	0.8769915E-04
25	0.9848472E-02	-0.1529607E-03	0.2524273E-03	0.5199337E-07	-0.1172602E-03	-0.7722725E-04
26	0.1992229E-01	-0.1534275E-03	0.2659108E-03	0.9685459E-07	-0.1176566E-03	-0.8273387E-04
27	0.3039731E-01	-0.1537811E-03	0.2818927E-03	0.1171803E-06	-0.1179533E-03	-0.8544964E-04
28	0.4091409E-01	-0.1539715E-03	0.2972831E-03	0.1223367E-06	-0.1181118E-03	-0.8620803E-04
29	-0.9348131E-02	-0.1529607E-03	0.2538895E-03	-0.5379179E-07	-0.1172602E-03	-0.7722454E-04
30	-0.1992844E-01	-0.1534273E-03	0.2689450E-03	-0.1099075E-06	-0.1176565E-03	-0.8272955E-04
31	-0.3033570E-01	-0.1537808E-03	0.2866241E-03	-0.1309413E-06	-0.1179532E-03	-0.8544156E-04
32	-0.4091153E-01	-0.1539712E-03	0.3043369E-03	-0.1363099E-06	-0.1181117E-03	-0.8620010E-04
33	-0.1209350E-01	-0.1551038E-02	0.2790358E-02	0.6275604E-06	0.1440419E-03	0.9487977E-04
34	-0.2448459E-01	-0.1556073E-02	0.2944291E-02	0.1113896E-05	0.1445293E-03	0.1016452E-03
35	-0.3734539E-01	-0.1659888E-02	0.3125164E-02	0.1334470E-05	0.1448941E-03	0.1049805E-03
36	-0.5025509E-01	-0.1561941E-02	0.3306307E-02	0.1390661E-05	0.1450891E-03	0.1059135E-03
37	0.1209930E-01	-0.1651038E-02	0.2788617E-02	-0.6138093E-06	0.1440419E-03	0.9487652E-04
38	0.2448333E-01	-0.1556073E-02	0.2940766E-02	-0.1099083E-05	0.1445293E-03	0.1016388E-03
39	0.3734371E-01	-0.1659889E-02	0.3119755E-02	-0.1319066E-05	0.1448941E-03	0.1049720E-03
40	0.5026329E-01	-0.1561941E-02	0.3293999E-02	-0.1375070E-05	0.1450891E-03	0.1059039E-03

MODE SHAPE 9 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.3393595E-07	-0.3133778E-01	0.5905144E-02	-0.4072586E-08	0.1254051E-04	0.6656956E-04
2	-0.3298819E-07	-0.3438555E-01	0.6479446E-02	-0.4784901E-08	0.1262573E-04	0.6702689E-04
3	-0.8573075E-07	-0.1827375E-01	0.3442833E-02	-0.2256143E-08	0.5894097E-05	0.3130217E-04
4	0.1839986E-06	0.1806767E-01	-0.3405461E-02	0.2217850E-08	0.5722904E-05	0.3038828E-04
5	-0.1981353E-07	0.3425762E-01	-0.6457694E-02	0.4513012E-08	0.1228372E-04	0.6520496E-04
6	-0.2193304E-07	0.3139968E-01	-0.5915351E-02	0.4313321E-08	0.1228475E-04	0.6520421E-04
7	0.0	0.2751328E-01	-0.5184807E-02	0.4155964E-08	0.1245232E-04	0.6609020E-04
8	0.0	0.1126106E-01	-0.2121038E-02	0.2399955E-08	0.1126576E-04	0.5977240E-04
9	-0.1733638E-02	-0.3533471E-01	0.6497003E-02	-0.1026651E-04	0.1417601E-04	0.6729865E-04
10	-0.3682143E-02	-0.3786350E-01	0.6521918E-02	-0.1832854E-04	0.1547346E-04	0.6758561E-04
11	-0.5666200E-02	-0.4084609E-01	0.6540798E-02	-0.2200354E-04	0.1611399E-04	0.6780037E-04
12	-0.7661913E-02	-0.4383691E-01	0.6550960E-02	-0.2294518E-04	0.1629342E-04	0.6791517E-04
13	0.1789495E-02	-0.3533330E-01	0.6497003E-02	0.1025582E-04	0.1417466E-04	0.6729865E-04
14	0.3681694E-02	-0.3786070E-01	0.6521918E-02	0.1831677E-04	0.1547088E-04	0.6758560E-04
15	0.5565351E-02	-0.4084180E-01	0.6540794E-02	0.2199141E-04	0.1611069E-04	0.6780037E-04
16	0.7660605E-02	-0.4383125E-01	0.6550953E-02	0.2293297E-04	0.1628982E-04	0.6791517E-04
17	-0.1741173E-02	0.3521343E-01	-0.6475240E-02	0.1023024E-04	0.1379243E-04	0.6546934E-04
18	-0.3593513E-02	0.3773332E-01	-0.6500129E-02	0.1826395E-04	0.1505498E-04	0.6574851E-04
19	-0.5512938E-02	0.4070541E-01	-0.6518994E-02	0.2192607E-04	0.1567822E-04	0.6595744E-04
20	-0.7454685E-02	0.4368559E-01	-0.6529145E-02	0.2286436E-04	0.1585277E-04	0.6606911E-04
21	0.1741061E-02	0.3521223E-01	-0.6475240E-02	-0.1022172E-04	0.1379096E-04	0.6546934E-04
22	0.3582079E-02	0.3773117E-01	-0.6500129E-02	-0.1825574E-04	0.1505218E-04	0.6574851E-04
23	0.5512052E-02	0.4070234E-01	-0.6518994E-02	-0.2191818E-04	0.1567464E-04	0.6595744E-04
24	0.7453315E-02	0.4369184E-01	-0.6529145E-02	-0.2285656E-04	0.1584888E-04	0.6606911E-04
25	-0.9493457E-02	-0.3447896E-01	0.6657641E-02	0.1930614E-05	0.1267722E-04	0.7524407E-04

26	-0.1954313E-01	-0.3461147E-01	0.7133920E-02	0.3451272E-05	0.1273159E-04	0.8212125E-04
27	-0.3007222E-01	-0.3471189E-01	0.7695794E-02	0.4144415E-05	0.1277228E-04	0.8551650E-04
28	-0.4066314E-01	-0.3476593E-01	0.8259196E-02	0.4321992E-05	0.1279403E-04	0.8646748E-04
29	0.9499257E-02	-0.3447896E-01	0.6658938E-02	-0.1941140E-05	0.1267716E-04	0.7524059E-04
30	0.1954224E-01	-0.3461147E-01	0.7135572E-02	-0.3462822E-05	0.1273146E-04	0.8211442E-04
31	0.3007034E-01	-0.3471189E-01	0.7699952E-02	-0.4156663E-05	0.1277210E-04	0.8550740E-04
32	0.4055005E-01	-0.3476593E-01	0.8264918E-02	-0.4334467E-05	0.1279383E-04	0.8645731E-04
33	-0.9241227E-02	0.3436070E-01	-0.6635197E-02	-0.1921720E-05	0.1233376E-04	0.7319877E-04
34	-0.1901199E-01	0.3449276E-01	-0.7109240E-02	-0.3434840E-05	0.1238659E-04	0.7989904E-04
35	-0.2925430E-01	0.3459283E-01	-0.7668402E-02	-0.4124473E-05	0.1242614E-04	0.8319199E-04
36	-0.3955736E-01	0.3464669E-01	-0.8229088E-02	-0.4301143E-05	0.1244727E-04	0.8411713E-04
37	0.9241057E-02	0.3436070E-01	-0.6636586E-02	0.1933591E-05	0.1233377E-04	0.7319542E-04
38	0.1901106E-01	0.3449276E-01	-0.7112399E-02	0.3449134E-05	0.1238661E-04	0.7988240E-04
39	0.2925300E-01	0.3459283E-01	-0.7673521E-02	0.4140081E-05	0.1242617E-04	0.8318316E-04
40	0.3955433E-01	0.3464669E-01	-0.8236233E-02	0.4317140E-05	0.1244731E-04	0.8410723E-04

MODE SHAPE 10 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.2217549E-06	0.5905986E-02	0.3133890E-01	-0.1562164E-07	0.6651902E-04	-0.1254152E-04
2	-0.2203315E-06	0.6480299E-02	0.3438566E-01	-0.1497614E-07	0.6597532E-04	-0.1262765E-04
3	-0.1597753E-06	0.3444226E-02	0.1827053E-01	-0.8527291E-08	0.3126511E-04	-0.5899566E-05
4	-0.1930151E-06	-0.3402772E-02	-0.1807243E-01	0.5219309E-08	0.3038190E-04	-0.5734209E-05
5	-0.5305745E-07	-0.6454412E-02	-0.3427022E-01	0.1217459E-07	0.6521244E-04	-0.1229792E-04
6	-0.4345010E-07	-0.5911674E-02	-0.3139223E-01	0.1156836E-07	0.6521192E-04	-0.1229623E-04
7	0.0	-0.5180970E-02	-0.2751562E-01	0.1113097E-07	0.6609834E-04	-0.1246102E-04
8	0.0	-0.2119750E-02	-0.1126117E-01	0.3081941E-08	0.5978579E-04	-0.1125969E-04
9	-0.9493575E-02	0.6656811E-02	0.3447901E-01	0.1915455E-05	0.7520360E-04	-0.1267885E-04
10	-0.1953335E-01	0.7130630E-02	0.3461147E-01	0.3431894E-05	0.8209028E-04	-0.1273292E-04
11	-0.3006015E-01	0.7689767E-02	0.3471183E-01	0.4123053E-05	0.8549032E-04	-0.1277339E-04
12	-0.4064942E-01	0.8250430E-02	0.3476585E-01	0.4300123E-05	0.8644268E-04	-0.1279502E-04
13	0.9492353E-02	0.6661318E-02	0.3447901E-01	-0.1952666E-05	0.7519721E-04	-0.1267885E-04
14	0.1953162E-01	0.7140502E-02	0.3461145E-01	-0.3475232E-05	0.8207814E-04	-0.1273292E-04
15	0.3005503E-01	0.7705454E-02	0.3471182E-01	-0.4169472E-05	0.8547482E-04	-0.1277339E-04
16	0.4064225E-01	0.8272003E-02	0.3476583E-01	-0.4347401E-05	0.8642585E-04	-0.1279502E-04
17	-0.9243701E-02	-0.6630972E-02	-0.3436330E-01	-0.1915581E-05	0.7322409E-04	-0.1234778E-04
18	-0.1901951E-01	-0.7104456E-02	-0.3449537E-01	-0.3430200E-05	0.7992923E-04	-0.1240043E-04
19	-0.2926830E-01	-0.7663216E-02	-0.3459545E-01	-0.4120693E-05	0.8323944E-04	-0.1243984E-04
20	-0.3957826E-01	-0.8223530E-02	-0.3464932E-01	-0.4297633E-05	0.8416660E-04	-0.1246090E-04
21	0.9243142E-02	-0.6634075E-02	-0.3436330E-01	0.1938552E-05	0.7321752E-04	-0.1234778E-04
22	0.1901750E-01	-0.7110149E-02	-0.3449537E-01	0.3451913E-05	0.7991670E-04	-0.1240043E-04
23	0.2926493E-01	-0.7671393E-02	-0.3459545E-01	0.4141795E-05	0.8322336E-04	-0.1243984E-04
24	0.3957212E-01	-0.8234218E-02	-0.3464932E-01	0.4318550E-05	0.8414905E-04	-0.1246090E-04
25	0.1789454E-02	0.6497901E-02	0.3533306E-01	0.1025749E-04	0.6724767E-04	-0.1417595E-04
26	0.3681712E-02	0.6522875E-02	0.3786220E-01	0.1832801E-04	0.6753526E-04	-0.1547179E-04
27	0.5665421E-02	0.6541796E-02	0.4084556E-01	0.2200647E-04	0.6775049E-04	-0.1611155E-04
28	0.7660753E-02	0.6551985E-02	0.4383701E-01	0.2294885E-04	0.6786553E-04	-0.1629075E-04
29	-0.1789930E-02	0.6497901E-02	0.3533709E-01	-0.1029076E-04	0.6724763E-04	-0.1417537E-04
30	-0.3682012E-02	0.6522875E-02	0.3787055E-01	-0.1836475E-04	0.6753516E-04	-0.1547064E-04
31	-0.5665563E-02	0.6541796E-02	0.4085872E-01	-0.2204567E-04	0.6775036E-04	-0.1610997E-04
32	-0.7560591E-02	0.6551985E-02	0.4385527E-01	-0.2298890E-04	0.6786539E-04	-0.1628896E-04
33	0.1742323E-02	-0.6471951E-02	-0.3521357E-01	-0.1020915E-04	0.6547726E-04	-0.1380555E-04
34	0.3555900E-02	-0.6496832E-02	-0.3773042E-01	-0.1823870E-04	0.6575693E-04	-0.1506731E-04
35	0.5517439E-02	-0.6515685E-02	-0.4069908E-01	-0.2189835E-04	0.6596620E-04	-0.1569022E-04
36	0.7460599E-02	-0.6525833E-02	-0.4367579E-01	-0.2283591E-04	0.6607808E-04	-0.1586470E-04
37	-0.1743013E-02	-0.6471951E-02	-0.3521761E-01	0.1024552E-04	0.6547742E-04	-0.1380503E-04
38	-0.3585539E-02	-0.6496832E-02	-0.3774028E-01	0.1828546E-04	0.6575724E-04	-0.1506527E-04
39	-0.5517371E-02	-0.6515685E-02	-0.4071558E-01	0.2195084E-04	0.6596654E-04	-0.1568884E-04
40	-0.7460345E-02	-0.6525833E-02	-0.4369929E-01	0.2289005E-04	0.6607856E-04	-0.1586313E-04

MODE SHAPE 11 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	0.7103935E-01	0.1949720E-06	0.1855413E-05	-0.2919245E-09	0.1091760E-07	0.1275487E-07
2	0.3084973E-01	-0.5216025E-07	0.2588676E-05	-0.1805933E-09	0.1101449E-07	0.1309816E-07
3	0.2679713E-01	-0.3189475E-06	0.2077769E-05	-0.6480119E-09	0.6963337E-08	0.1002605E-07
4	0.1927734E-01	-0.5760239E-07	-0.2371166E-06	-0.1584193E-08	0.3613565E-08	0.5817174E-08
5	0.1387710E-01	0.4012347E-06	-0.1737035E-05	-0.2051796E-08	0.4755464E-08	0.4898535E-08
6	0.7760134E-02	0.5248910E-06	-0.1698155E-05	-0.1996558E-08	0.3978069E-08	0.4119197E-08
7	0.0	0.5280303E-06	-0.1706869E-05	-0.1904665E-08	0.3114229E-08	0.3458158E-08
8	0.0	0.5348049E-06	-0.2140537E-05	-0.9536674E-09	0.3492303E-08	0.1576241E-08
9	0.3477717E-01	-0.2150011E-06	0.2544309E-05	-0.2096358E-08	-0.4607557E-04	0.1325709E-07
10	0.4503670E-01	-0.7062414E-06	0.2481353E-05	-0.3756320E-08	-0.8362571E-04	0.1342775E-07
11	0.5975517E-01	-0.1323187E-05	0.2433414E-05	-0.4561095E-08	-0.1015964E-03	0.1355512E-07
12	0.7367855E-01	-0.1943997E-05	0.2407607E-05	-0.4768307E-08	-0.1064590E-03	0.1362229E-07
13	0.3473093E-01	0.9956563E-07	0.2542108E-05	-0.1631196E-08	0.4610015E-04	0.1326450E-07
14	0.4605437E-01	0.4917599E-06	0.2476043E-05	-0.3010237E-08	0.8365026E-04	0.1343989E-07
15	0.5976603E-01	0.9735677E-06	0.2425919E-05	-0.3692196E-08	0.1016180E-03	0.1357004E-07
16	0.7369173E-01	0.1488342E-05	0.2398930E-05	-0.3915314E-08	0.1064784E-03	0.1364104E-07
17	0.1564357E-01	0.1536173E-06	-0.1765226E-05	-0.1844849E-08	-0.2072551E-04	0.4962594E-08
18	0.2071289E-01	-0.4353938E-07	-0.1805227E-05	-0.1700399E-08	-0.3761600E-04	0.5031509E-08
19	0.2687912E-01	-0.2351197E-06	-0.1835643E-05	-0.1623290E-08	-0.4569958E-04	0.5082931E-08
20	0.3314210E-01	-0.4203074E-06	-0.1852017E-05	-0.1593331E-08	-0.4788692E-04	0.5110003E-08
21	0.1564550E-01	0.6632247E-06	-0.1765216E-05	-0.1789429E-08	0.2073825E-04	0.4965766E-08
22	0.2071701E-01	0.8549921E-06	-0.1805194E-05	-0.1618239E-08	0.3763007E-04	0.5036636E-08
23	0.2689513E-01	0.1024401E-05	-0.1835517E-05	-0.1522168E-08	0.4571270E-04	0.5089177E-08
24	0.3314555E-01	0.1200484E-05	-0.1851943E-05	-0.1508671E-08	0.4789904E-04	0.5117908E-08
25	0.3477721E-01	-0.5242604E-07	0.2475555E-05	0.3439715E-09	0.1222798E-07	-0.4507612E-04
26	0.4604726E-01	-0.5278599E-07	0.2577473E-05	0.1152463E-08	0.1350634E-07	-0.8362795E-04
27	0.5975605E-01	-0.5282749E-07	0.2810968E-05	0.1627827E-08	0.1446346E-07	-0.1015991E-03
28	0.7367930E-01	-0.5284299E-07	0.3040783E-05	0.1749286E-08	0.1497600E-07	-0.1064618E-03
29	0.3473110E-01	-0.5357327E-07	0.1937349E-05	0.7612755E-08	0.1212800E-07	0.4610153E-04
30	0.4605464E-01	-0.5557813E-07	0.9566378E-07	0.1384384E-07	0.1330408E-07	0.8365144E-04
31	0.5975631E-01	-0.5703320E-07	-0.2184753E-05	0.1700544E-07	0.1418535E-07	0.1016193E-03
32	0.7369220E-01	-0.5780586E-07	-0.4541534E-05	0.1791151E-07	0.1465498E-07	0.1064798E-03
33	0.1564339E-01	0.4020600E-06	-0.2166174E-05	-0.2705444E-08	0.5943395E-08	-0.2072808E-04
34	0.2071334E-01	0.4032387E-06	-0.2596585E-05	-0.2843956E-08	0.7196522E-08	-0.3762047E-04
35	0.2689077E-01	0.4042358E-06	-0.2945545E-05	-0.2664088E-08	0.8134489E-08	-0.4570471E-04
36	0.3314444E-01	0.4047757E-06	-0.3242137E-05	-0.2539503E-08	0.8636285E-08	-0.4789216E-04
37	0.1564534E-01	0.4016931E-06	-0.1606940E-05	-0.1192512E-08	0.5904191E-08	0.2073604E-04
38	0.2071615E-01	0.4023436E-06	-0.1570211E-05	-0.8110950E-09	0.7117318E-08	0.3762632E-04
39	0.2683373E-01	0.4028553E-06	-0.1512391E-05	-0.7318737E-09	0.8025690E-08	0.4570853E-04
40	0.3314763E-01	0.4031509E-06	-0.1431453E-05	-0.7490086E-09	0.8510611E-08	0.4789481E-04

MODE SHAPE 12 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.3661206E-02	-0.5383974E-04	-0.3490057E-04	-0.2064315E-07	-0.1916371E-07	-0.4540664E-07
2	-0.3485733E-02	0.1040535E-05	0.4410876E-05	-0.5054165E-08	-0.2384638E-07	-0.1195124E-07
3	-0.6393315E-03	-0.1575627E-04	0.2391789E-05	-0.3635534E-08	-0.1614628E-07	0.3715568E-08
4	0.5116549E-02	-0.1895028E-04	-0.9035791E-06	-0.7886931E-09	-0.3730865E-08	0.1094706E-07
5	0.7749577E-02	0.7751271E-06	0.8561714E-06	0.6461680E-09	0.1455388E-07	0.2595927E-07
6	0.4433401E-02	0.1152522E-05	0.2812003E-05	0.5765282E-09	0.1489499E-07	0.2307262E-07
7	0.0	-0.1033980E-05	0.4176236E-05	0.4950855E-09	0.1373816E-07	0.2281913E-07
8	0.0	-0.3792506E-05	0.4996192E-05	-0.2931902E-10	-0.8307431E-08	0.8136457E-08
9	-0.6397830E-02	-0.6805291E-06	0.4356639E-05	-0.1937918E-07	0.3771889E-04	-0.1220705E-07

10	-0.1554638E-01	-0.4747612E-05	0.4279702E-05	-0.3172024E-07	0.6971153E-04	-0.1247900E-07
11	-0.2795383E-01	-0.9774729E-05	0.4221465E-05	-0.3803949E-07	0.8579377E-04	-0.1268197E-07
12	-0.3392535E-01	-0.1495705E-04	0.4190120E-05	-0.3985786E-07	0.9036891E-04	-0.1279030E-07
13	-0.6403315E-02	0.4687799E-05	0.4313733E-05	-0.4444267E-07	-0.3775449E-04	-0.1220434E-07
14	-0.1555550E-01	0.1481536E-04	0.4175921E-05	-0.7792107E-07	-0.6973454E-04	-0.1247188E-07
15	-0.2707565E-01	0.2747749E-04	0.4071514E-05	-0.9489696E-07	-0.8580722E-04	-0.1257178E-07
16	-0.3393537E-01	0.4051899E-04	0.4015319E-05	-0.9975230E-07	-0.9037726E-04	-0.1277890E-07
17	0.1422931E-01	0.7862232E-06	0.7563050E-06	-0.6218475E-09	-0.8391051E-04	0.2651305E-07
18	0.3457633E-01	0.5588111E-06	0.6146179E-06	-0.1807289E-08	-0.1550510E-03	0.2710190E-07
19	0.6019342E-01	0.2237703E-06	0.5071116E-06	-0.2446634E-08	-0.1908126E-03	0.2754137E-07
20	0.8657239E-01	-0.1317938E-06	0.4492438E-06	-0.2636112E-08	-0.2009850E-03	0.2777589E-07
21	0.1423503E-01	0.1535514E-05	0.7541652E-06	-0.1015939E-07	0.8394997E-04	0.2651996E-07
22	0.3459345E-01	0.4110433E-05	0.6094526E-06	-0.1962341E-07	0.1550928E-03	0.2711270E-07
23	0.6021733E-01	0.7380908E-05	0.4997429E-06	-0.2433981E-07	0.1908483E-03	0.2755554E-07
24	0.9659852E-01	0.1076397E-04	0.4406893E-06	-0.2569946E-07	0.2010149E-03	0.2779287E-07
25	-0.5400934E-02	0.1054953E-05	0.5309195E-05	0.2234616E-07	-0.2408977E-07	0.3775183E-04
26	-0.1555534E-01	0.1075405E-05	0.1115259E-04	0.4805060E-07	-0.2434495E-07	0.6975281E-04
27	-0.2708142E-01	0.1090840E-05	0.1946204E-04	0.6281869E-07	-0.2453547E-07	0.8585451E-04
28	-0.3395107E-01	0.1099145E-05	0.2851049E-04	0.6763582E-07	-0.2463901E-07	0.9043228E-04
29	-0.6404717E-02	0.1059440E-05	0.1877233E-05	0.3187871E-07	-0.2412446E-07	-0.3777457E-04
30	-0.1556279E-01	0.1085264E-05	-0.6594412E-05	0.6184507E-07	-0.2441780E-07	-0.6978174E-04
31	-0.2703122E-01	0.1106568E-05	-0.1697145E-04	0.7578950E-07	-0.2463768E-07	-0.8586822E-04
32	-0.3396359E-01	0.1117493E-05	-0.2737970E-04	0.7935881E-07	-0.2475494E-07	-0.9044222E-04
33	0.1422931E-01	0.7850318E-06	0.6241641E-06	-0.1900246E-08	0.1515095E-07	-0.8391163E-04
34	0.3457756E-01	0.7990911E-06	0.9782570E-07	-0.3804885E-08	0.1577737E-07	-0.1550627E-03
35	0.6015501E-01	0.8098861E-06	-0.5442947E-06	-0.4780368E-08	0.1624737E-07	-0.1908295E-03
36	0.8657873E-01	0.8155997E-06	-0.1226587E-05	-0.5074767E-08	0.1649900E-07	-0.2010045E-03
37	0.1423729E-01	0.7854267E-06	-0.6998619E-06	0.1720303E-07	0.1509803E-07	0.8395784E-04
38	0.3459213E-01	0.8000363E-06	-0.4823411E-05	0.3004999E-07	0.1567198E-07	0.1550978E-03
39	0.6021534E-01	0.8111583E-06	-0.9699028E-05	0.3596620E-07	0.1610226E-07	0.1908518E-03
40	0.8360073E-01	0.8171485E-06	-0.1457162E-04	0.3745898E-07	0.1633165E-07	0.2010181E-03

MODE SHAPE 13 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.9291452E-06	-0.1143950E-04	0.1464499E-04	-0.6368857E-08	-0.1708464E-07	-0.9414745E-08
2	-0.9580299E-06	-0.8843995E-05	0.1201491E-04	-0.6353897E-08	-0.1602291E-07	-0.8118040E-08
3	-0.1417479E-05	-0.7236725E-05	0.1097500E-04	-0.4465480E-08	-0.8153606E-08	-0.1413743E-07
4	-0.2327478E-05	-0.1588020E-05	0.8111394E-05	-0.6890568E-09	0.1159986E-07	-0.2089351E-07
5	-0.2713701E-05	0.2310240E-05	0.6663877E-05	0.1198026E-08	0.2485426E-07	-0.2056099E-07
6	-0.1541332E-05	0.5815840E-05	0.1239567E-04	0.1168377E-08	0.2952191E-07	-0.2301388E-07
7	0.0	0.8719081E-05	0.1696005E-04	-0.1114262E-08	0.3035248E-07	-0.2340092E-07
8	0.0	0.1338107E-04	0.2264747E-04	0.5625076E-09	-0.3626004E-07	0.1769105E-07
9	0.2103034E-02	-0.5280823E-02	0.1200298E-04	-0.7053794E-04	-0.2814854E-04	-0.8566655E-08
10	0.9906834E-02	-0.2233645E-01	0.1198605E-04	-0.1310548E-03	-0.5228877E-04	-0.9038278E-08
11	0.1756540E-01	-0.4404077E-01	0.1197318E-04	-0.1619130E-03	-0.6460107E-04	-0.9392004E-08
12	0.2652030E-01	-0.6643624E-01	0.1196625E-04	-0.1708094E-03	-0.6815259E-04	-0.9581083E-08
13	0.2100928E-02	0.5267527E-02	0.1195751E-04	-0.7062127E-04	0.2813948E-04	-0.8308259E-08
14	0.9307069E-02	0.2234148E-01	0.1187607E-04	-0.1312174E-03	0.5229790E-04	-0.8511918E-08
15	0.1756913E-01	0.4407158E-01	0.1181439E-04	-0.1621239E-03	0.6461734E-04	-0.8663271E-08
16	0.2652722E-01	0.6654561E-01	0.1178120E-04	-0.1710394E-03	0.6816917E-04	-0.8744191E-08
17	0.5108623E-02	0.1388996E-02	0.6670884E-05	0.1855382E-04	-0.6843559E-04	-0.2108143E-07
18	0.2165704E-01	0.5875256E-02	0.6680822E-05	0.3447215E-04	-0.1271828E-03	-0.2162817E-07
19	0.4272130E-01	0.1158430E-01	0.6689319E-05	0.4258910E-04	-0.1571462E-03	-0.2203842E-07
20	0.6450588E-01	0.1748827E-01	0.6692353E-05	0.4492924E-04	-0.1657896E-03	-0.2225770E-07
21	0.5115848E-02	-0.1385421E-02	0.6671919E-05	0.1857456E-04	0.6847456E-04	-0.2107097E-07
22	0.2167024E-01	-0.5876176E-02	0.6683330E-05	0.3451253E-04	0.1272063E-03	-0.2160784E-07
23	0.4273643E-01	-0.1159160E-01	0.6691942E-05	0.4264167E-04	0.1571553E-03	-0.2201023E-07
24	0.6452209E-01	-0.1750269E-01	0.5696579E-05	0.4498666E-04	0.1657896E-03	-0.2222531E-07

25	-0.2101616E-02	-0.8984322E-05	0.5281605E-02	0.7052129E-04	-0.1681579E-07	0.2812326E-04
26	-0.8992203E-02	-0.9183399E-05	0.2233471E-01	0.1310361E-03	-0.1765094E-07	0.5226264E-04
27	-0.1755754E-01	-0.9334297E-05	0.4403671E-01	0.1618940E-03	-0.1827674E-07	0.6457469E-04
28	-0.2650925E-01	-0.9415515E-05	0.6647980E-01	0.1707902E-03	-0.1861124E-07	0.6812620E-04
29	-0.2103744E-02	-0.8985541E-05	-0.5263947E-02	0.7062104E-04	-0.1652415E-07	-0.2813134E-04
30	-0.8905033E-02	-0.9186354E-05	-0.2233949E-01	0.1312267E-03	-0.1705626E-07	-0.5226138E-04
31	-0.1755994E-01	-0.9334989E-05	-0.4407162E-01	0.1621374E-03	-0.1745341E-07	-0.6456587E-04
32	-0.2651042E-01	-0.9420370E-05	-0.6654769E-01	0.1710539E-03	-0.1766571E-07	-0.6811331E-04
33	-0.5117595E-02	0.2345532E-05	-0.1383642E-02	-0.1860695E-04	0.2545753E-07	0.6847728E-04
34	-0.2167650E-01	0.2395601E-05	-0.5882919E-02	-0.3457408E-04	0.2609738E-07	0.1272558E-03
35	-0.4275158E-01	0.2433503E-05	-0.1160904E-01	-0.4271690E-04	0.2657517E-07	0.1572348E-03
36	-0.6454843E-01	0.2453903E-05	-0.1753091E-01	-0.4506476E-04	0.2683058E-07	0.1658826E-03
37	-0.5123742E-02	0.2347651E-05	0.1389390E-02	-0.1951085E-04	0.2518907E-07	-0.6850877E-04
38	-0.2168597E-01	0.2400729E-05	0.5864974E-02	-0.3439681E-04	0.2554427E-07	-0.1272729E-03
39	-0.4276436E-01	0.2440912E-05	0.1156140E-01	-0.4249983E-04	0.2580947E-07	-0.1572378E-03
40	-0.6456149E-01	0.2462541E-05	0.1745295E-01	-0.4483738E-04	0.2595125E-07	-0.1658768E-03

MODE SHAPE 14 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.4896319E-06	0.2812531E-05	0.5066852E-05	0.1701389E-09	-0.2302211E-07	0.2538276E-07
2	-0.3666837E-06	0.6963685E-06	0.1796818E-05	0.1785451E-09	-0.2173953E-07	0.2498287E-07
3	-0.9290704E-07	-0.2043585E-05	0.5944111E-05	0.6323355E-09	-0.7361763E-08	0.1672652E-07
4	0.6526507E-06	-0.4902782E-05	0.1177738E-04	0.1536310E-08	0.8447024E-08	-0.4106109E-08
5	0.1009719E-05	-0.4907601E-05	0.1307601E-04	0.1987578E-08	0.1258894E-07	-0.1610840E-07
6	0.5771061E-06	-0.5600522E-05	0.2236156E-04	0.1937053E-08	0.2286294E-07	-0.1340813E-07
7	0.0	-0.5845976E-05	0.2906195E-04	0.1848999E-08	0.2648141E-07	-0.1145022E-07
8	0.0	-0.5163087E-05	0.3553837E-04	0.9455652E-09	-0.6521719E-07	-0.1403260E-07
9	-0.6097976E-02	0.5514352E-03	0.2045786E-05	0.7369791E-05	0.8163152E-04	0.2593383E-07
10	-0.2583744E-01	0.2333438E-02	0.2398996E-05	0.1369333E-04	0.1516990E-03	0.2693429E-07
11	-0.5096059E-01	0.4601359E-02	0.2666701E-05	0.1691769E-04	0.1874361E-03	0.2768441E-07
12	-0.7694399E-01	0.6946571E-02	0.2810791E-05	0.1784702E-04	0.1977450E-03	0.2808537E-07
13	-0.6105597E-02	-0.5502086E-03	0.2026843E-05	0.7374178E-05	-0.8167827E-04	0.2545732E-07
14	-0.2565313E-01	-0.2333143E-02	0.2353175E-05	0.1370229E-04	-0.1517412E-03	0.2595766E-07
15	-0.5099236E-01	-0.4602339E-02	0.2600482E-05	0.1692973E-04	-0.1874674E-03	0.2633234E-07
16	-0.7597052E-01	-0.6949179E-02	0.2733592E-05	0.1786066E-04	-0.1977671E-03	0.2653263E-07
17	0.3843270E-02	-0.2838634E-02	0.1328789E-04	-0.3791884E-04	-0.5143718E-04	-0.1650621E-07
18	0.1623127E-01	-0.1200783E-01	0.1358566E-04	-0.7045518E-04	-0.9558641E-04	-0.1692356E-07
19	0.3211146E-01	-0.2367633E-01	0.1381125E-04	-0.8704612E-04	-0.1181040E-03	-0.1723692E-07
20	0.4848365E-01	-0.3574338E-01	0.1393268E-04	-0.9182922E-04	-0.1245995E-03	-0.1740442E-07
21	0.3846709E-02	0.2831679E-02	0.1328517E-04	-0.3797063E-04	0.5145039E-04	-0.1650566E-07
22	0.1628611E-01	0.1201241E-01	0.1357908E-04	-0.7055585E-04	0.9558522E-04	-0.1692621E-07
23	0.3211594E-01	0.2369697E-01	0.1380180E-04	-0.8717598E-04	0.1180905E-03	-0.1724053E-07
24	0.4848634E-01	0.3578168E-01	0.1392168E-04	-0.9197035E-04	0.1245788E-03	-0.1740856E-07
25	0.6096445E-02	0.7045618E-06	-0.5507867E-03	-0.7397839E-05	-0.2276371E-07	-0.8162641E-04
26	0.2583504E-01	0.7161856E-06	-0.2339712E-02	-0.1374595E-04	-0.2384891E-07	-0.1516924E-03
27	0.5095727E-01	0.7250487E-06	-0.4616369E-02	-0.1698233E-04	-0.2465965E-07	-0.1874287E-03
28	0.7693976E-01	0.7298198E-06	-0.6970458E-02	-0.1791494E-04	-0.2509304E-07	-0.1977373E-03
29	0.5103351E-02	0.7104350E-06	0.5510272E-03	-0.7346282E-05	-0.2279682E-07	0.8166439E-04
30	0.2584759E-01	0.7303878E-06	0.2327323E-02	-0.1364921E-04	-0.2391391E-07	0.1517129E-03
31	0.5097244E-01	0.7455323E-06	0.4587557E-02	-0.1686339E-04	-0.2474969E-07	0.1874321E-03
32	0.7595532E-01	0.7536827E-06	0.6925184E-02	-0.1779060E-04	-0.2519645E-07	0.1977302E-03
33	-0.3933712E-02	-0.4985220E-05	0.2845391E-02	0.3788978E-04	0.1264955E-07	0.5140741E-04
34	-0.1626998E-01	-0.5095339E-05	0.1200730E-01	0.7039521E-04	0.1271629E-07	0.9553446E-04
35	-0.3209165E-01	-0.5179828E-05	0.2366550E-01	0.8696844E-04	0.1276522E-07	0.1180411E-03
36	-0.4845623E-01	-0.5223768E-05	0.3572142E-01	0.9174606E-04	0.1279138E-07	0.1245334E-03
37	-0.3944078E-02	-0.4985432E-05	-0.2825646E-02	0.3800188E-04	0.1262526E-07	-0.5143999E-04
38	-0.1629051E-01	-0.5095951E-05	-0.1201335E-01	0.7061224E-04	0.1266255E-07	-0.9556298E-04
39	-0.3210650E-01	-0.5179514E-05	-0.2370720E-01	0.8724592E-04	0.1269087E-07	-0.1180624E-03

40	-0.4847206E-01	-0.5224547E-05	-0.3580165E-01	0.9204434E-04	0.1270600E-07	-0.1245490E-03

MODE SHAPE 15 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.6009034E-06	0.4523144E-06	-0.1552537E-04	0.1378902E-08	-0.2774491E-07	0.1578081E-07
2	-0.5820918E-06	-0.5065533E-06	-0.1157236E-04	0.1351792E-08	-0.3142758E-07	0.1573416E-07
3	-0.2747153E-06	0.3443146E-05	-0.2157863E-04	-0.1809672E-10	-0.3280883E-07	0.5834384E-08
4	0.3459839E-06	0.9853305E-05	-0.2876586E-04	-0.2749494E-08	-0.2090916E-07	-0.4165055E-09
5	0.6388370E-06	0.1191347E-04	-0.2583012E-04	-0.4113343E-08	-0.1521515E-07	0.1666424E-08
6	0.3669223E-06	0.1939181E-04	-0.4370503E-04	-0.4010388E-08	-0.2623446E-07	-0.8025026E-08
7	0.0	0.2459419E-04	-0.5656446E-04	-0.3828077E-08	-0.4437821E-07	-0.1226737E-07
8	0.0	0.2929503E-04	-0.6883830E-04	-0.1963158E-08	0.1282322E-06	0.5593041E-07
9	-0.3553559E-02	-0.1507302E-03	-0.1216881E-04	-0.2011515E-05	0.4764675E-04	0.1603705E-07
10	-0.1508243E-01	-0.6372796E-03	-0.1301500E-04	-0.3738652E-05	0.8855917E-04	0.1635481E-07
11	-0.2974372E-01	-0.1256461E-02	-0.1365619E-04	-0.4619635E-05	0.1094255E-03	0.1659340E-07
12	-0.4491916E-01	-0.1896957E-02	-0.1400129E-04	-0.4873858E-05	0.1154446E-03	0.1672093E-07
13	-0.3565114E-02	0.1490767E-03	-0.1221932E-04	-0.2002234E-05	-0.4767468E-04	0.1600911E-07
14	-0.1503317E-01	0.6333527E-03	-0.1313717E-04	-0.3720975E-05	-0.8855373E-04	0.1629878E-07
15	-0.2975362E-01	0.1249589E-02	-0.1383267E-04	-0.4597410E-05	-0.1093990E-03	0.1651581E-07
16	-0.4491891E-01	0.1885893E-02	-0.1420701E-04	-0.4850185E-05	-0.1154089E-03	0.1663182E-07
17	-0.5544096E-03	0.6887589E-02	-0.2643891E-04	0.9200456E-04	0.7440141E-05	0.1669791E-08
18	-0.2355135E-02	0.2913521E-01	-0.2730261E-04	0.1709489E-03	0.1383696E-04	0.1671908E-08
19	-0.4647235E-02	0.5744711E-01	-0.2795704E-04	0.2112037E-03	0.1709929E-04	0.1674018E-08
20	-0.7017877E-02	0.8672577E-01	-0.2830928E-04	0.2228092E-03	0.1804023E-04	0.1675144E-08
21	-0.5551344E-03	-0.6870445E-02	-0.2643571E-04	0.9212698E-04	-0.7426633E-05	0.1666453E-08
22	-0.2349029E-02	-0.2914528E-01	-0.2729484E-04	0.1711869E-03	-0.1378628E-04	0.1670483E-08
23	-0.4631583E-02	-0.5749504E-01	-0.2794592E-04	0.2115110E-03	-0.1702964E-04	0.1671991E-08
24	-0.6992135E-02	-0.8681554E-01	-0.2829636E-04	0.2231432E-03	-0.1796488E-04	0.1672815E-08
25	0.3557415E-02	-0.5118608E-06	0.1439086E-03	0.2092461E-05	-0.3153135E-07	-0.4763617E-04
26	0.1507673E-01	-0.5193907E-06	0.6493155E-03	0.3891091E-05	-0.3164302E-07	-0.8852682E-04
27	0.2973799E-01	-0.5250666E-06	0.1293949E-02	0.4811092E-05	-0.3172580E-07	-0.1093827E-03
28	0.4490130E-01	-0.5281212E-06	0.1961279E-02	0.5077205E-05	-0.3177007E-07	-0.1153988E-03
29	0.3562428E-02	-0.5064074E-06	-0.1567580E-03	0.1922268E-05	-0.3157519E-07	0.4766577E-04
30	0.1508623E-01	-0.5062022E-06	-0.6218469E-03	0.3563780E-05	-0.3173174E-07	0.8855049E-04
31	0.2975097E-01	-0.5060276E-06	-0.1211534E-02	0.4396479E-05	-0.3184867E-07	0.1093985E-03
32	0.4491630E-01	-0.5059341E-06	-0.1820309E-02	0.4635281E-05	-0.3191116E-07	0.1154091E-03
33	0.5571770E-03	0.1210304E-04	-0.6898437E-02	-0.9194564E-04	-0.1481333E-07	-0.7450411E-05
34	0.2359701E-02	0.1237199E-04	-0.2913104E-01	-0.1708289E-03	-0.1439048E-07	-0.1384474E-04
35	0.4651535E-02	0.1257582E-04	-0.5742244E-01	-0.2110503E-03	-0.1407349E-07	-0.1710611E-04
36	0.7022365E-02	0.1268553E-04	-0.8667940E-01	-0.2226455E-03	-0.1390406E-07	-0.1804689E-04
37	0.5580527E-03	0.1210330E-04	0.6860230E-02	-0.9218437E-04	-0.1492453E-07	0.7457433E-05
38	0.2361036E-02	0.1237262E-04	0.2914761E-01	-0.1712910E-03	-0.1461366E-07	0.1385459E-04
39	0.4655544E-02	0.1257664E-04	0.5751453E-01	-0.2116419E-03	-0.1438251E-07	0.1711660E-04
40	0.7028345E-02	0.1268645E-04	0.8685344E-01	-0.2232827E-03	-0.1425894E-07	0.1805702E-04

MODE SHAPE 16 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.1436299E-05	-0.1155558E-04	0.3966961E-05	0.8093743E-08	0.2211262E-08	0.8716384E-08
2	-0.1460653E-05	-0.1001548E-04	0.4113047E-07	0.8115904E-08	0.4909893E-08	0.1004390E-07
3	-0.1844732E-05	-0.9705038E-05	-0.9502299E-05	0.6904671E-08	0.1646422E-07	0.8231116E-08
4	-0.2597482E-05	-0.5950757E-05	0.2083083E-04	0.4472312E-08	0.1758247E-07	0.1144501E-07
5	-0.2903382E-05	-0.2967698E-05	0.2195773E-04	0.3256730E-08	0.1264553E-07	0.1834935E-07
6	-0.1647636E-05	-0.6296322E-05	0.3489241E-04	0.3169321E-08	0.2598320E-07	0.2006680E-07
7	0.0	-0.8833134E-05	0.4368994E-04	0.3022073E-08	0.2925778E-07	0.1935580E-07
8	0.0	-0.1090840E-04	0.4830514E-04	0.1534258E-08	-0.9902845E-07	-0.1922453E-07

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9	-0.2452253E-02	-0.5681360E-02	0.4333436E-06	-0.7589365E-04	0.7280301E-04	0.1008804E-07
10	-0.1039270E-01	-0.2403777E-01	0.9897785E-06	-0.1410185E-03	0.6094847E-04	0.1013412E-07
11	-0.2047592E-01	-0.4738891E-01	0.1411418E-05	-0.1742270E-03	0.7530446E-04	0.1016882E-07
12	-0.3091432E-01	-0.7154179E-01	0.1638360E-05	-0.1838012E-03	0.7944588E-04	0.1018736E-07
13	-0.2453903E-02	0.5566312E-02	0.5133576E-06	-0.7598601E-04	-0.3281653E-04	0.1024261E-07
14	-0.1039334E-01	0.2403911E-01	0.1183324E-05	-0.1411981E-03	-0.6097634E-04	0.1044867E-07
15	-0.2043453E-01	0.4742277E-01	0.1691025E-05	-0.1744590E-03	-0.7533428E-04	0.1060429E-07
16	-0.3093135E-01	0.7160699E-01	0.1964300E-05	-0.1840536E-03	-0.7947326E-04	0.1068747E-07
17	-0.4372927E-02	-0.1747673E-02	0.2252393E-04	-0.2374827E-04	0.5845654E-04	0.1874725E-07
18	-0.1850277E-01	-0.7393792E-02	0.2332720E-04	-0.4338416E-04	0.1086087E-03	0.1916510E-07
19	-0.3649851E-01	-0.1457898E-01	0.2393591E-04	-0.5360063E-04	0.1341888E-03	0.1947868E-07
20	-0.5509225E-01	-0.2200957E-01	0.2426354E-04	-0.5654611E-04	0.1415679E-03	0.1964629E-07
21	-0.4377139E-02	0.1743882E-02	0.2252327E-04	-0.2338544E-04	-0.5848554E-04	0.1875361E-07
22	-0.1951695E-01	0.7398352E-02	0.2332557E-04	-0.4345567E-04	-0.1086769E-03	0.1917875E-07
23	-0.3551599E-01	0.1459499E-01	0.2393358E-04	-0.5369233E-04	-0.1342697E-03	0.1949756E-07
24	-0.5512950E-01	0.2203811E-01	0.2426082E-04	-0.5664531E-04	-0.1416478E-03	0.1966798E-07
25	0.2445563E-02	-0.1017294E-04	0.5674489E-02	0.7591034E-04	0.1981996E-08	-0.3281515E-04
26	0.1038432E-01	-0.1039632E-04	0.2402920E-01	0.1410317E-03	-0.1110269E-08	-0.6098312E-04
27	0.2048442E-01	-0.1055559E-04	0.4738552E-01	0.1742758E-03	-0.3424236E-08	-0.7534998E-04
28	0.3092991E-01	-0.1065670E-04	0.7153893E-01	0.1838079E-03	-0.4661150E-08	-0.7949426E-04
29	0.2452243E-02	-0.1017594E-04	-0.5675577E-02	0.7597671E-04	0.2036532E-08	0.3283593E-04
30	0.1039158E-01	-0.1040368E-04	-0.2404391E-01	0.1411707E-03	-0.1001362E-08	0.6100134E-04
31	0.2049387E-01	-0.1057616E-04	-0.4742254E-01	0.1744244E-03	-0.3273444E-08	0.7536367E-04
32	0.3094122E-01	-0.1066900E-04	-0.7160199E-01	0.1840175E-03	-0.4487987E-08	0.7950442E-04
33	0.4361445E-02	-0.3016008E-05	0.1762085E-02	0.2327669E-04	0.1013310E-07	-0.5841842E-04
34	0.1348702E-01	-0.3084544E-05	0.7391397E-02	0.4324004E-04	0.7477773E-08	-0.1085642E-03
35	0.3645673E-01	-0.3136449E-05	0.1455202E-01	0.5341604E-04	0.5491462E-08	-0.1341405E-03
36	0.5505212E-01	-0.3164384E-05	0.2195639E-01	0.5634878E-04	0.4429687E-08	-0.1415184E-03
37	0.4355202E-02	-0.3014473E-05	-0.1730242E-02	0.2346505E-04	0.9951716E-08	0.5845106E-04
38	0.1341763E-01	-0.3080834E-05	-0.7402934E-02	0.4360192E-04	0.7105438E-08	0.1085880E-03
39	0.3548058E-01	-0.3131085E-05	-0.1462377E-01	0.5387474E-04	0.4975991E-08	0.1341542E-03
40	0.5507787E-01	-0.3158131E-05	-0.2209234E-01	0.5683873E-04	-0.3837705E-08	0.1415250E-03

MODE SHAPE 17 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.1738550E-08	-0.5650899E-04	0.3085395E-02	-0.2339997E-07	-0.2384480E-06	-0.1776055E-07
2	0.7222640E-08	-0.2759580E-04	0.2389643E-02	-0.3325115E-07	0.2328663E-06	0.7476657E-09
3	-0.2854440E-06	-0.9455638E-04	0.7841963E-02	-0.2805222E-07	0.6843989E-05	0.5799863E-07
4	-0.7375555E-06	-0.1368590E-03	0.1366290E-01	-0.2475457E-07	0.7961861E-05	0.5225244E-07
5	-0.1020477E-05	-0.1174797E-03	0.1479964E-01	-0.2300217E-07	0.5410167E-05	0.4343120E-07
6	-0.6053324E-05	-0.4253748E-03	0.5215020E-01	-0.1864125E-07	-0.7416938E-04	0.6082491E-06
7	0.0	-0.6971955E-03	0.8517575E-01	-0.1601864E-07	0.1262643E-03	0.1035283E-05
8	0.0	-0.1370955E-02	0.1676245E 00	0.1611391E-07	-0.1887889E-03	-0.1545232E-05
9	0.7597505E-04	-0.1087180E-04	0.2435712E-02	0.2649351E-06	-0.1217782E-05	0.8881842E-09
10	0.3994235E-03	0.5690726E-04	0.2501071E-02	0.5257235E-06	-0.2466151E-05	0.1036601E-08
11	0.9185034E-03	0.1458510E-03	0.2550597E-02	0.6617007E-06	-0.3105699E-05	0.1147654E-08
12	0.1253598E-02	0.2386113E-03	0.2577255E-02	0.7017060E-06	-0.3291039E-05	0.1207021E-08
13	-0.7397041E-04	-0.1804449E-04	0.2435564E-02	-0.1145272E-06	-0.1202207E-05	0.8490697E-09
14	-0.3947762E-03	0.5355494E-05	0.2500554E-02	-0.1880082E-06	-0.2436269E-05	0.9561096E-09
15	-0.3090355E-03	0.3523640E-04	0.2550429E-02	-0.2277093E-06	-0.3067636E-05	0.1036230E-08
16	-0.1230001E-02	0.6648526E-04	0.2577057E-02	-0.2397708E-06	-0.3250256E-05	0.1079057E-08
17	0.5051432E-03	-0.5478680E-04	0.1509409E-01	0.9185125E-06	-0.1123406E-04	0.4483547E-07
18	0.3872317E-02	0.1689353E-03	0.1551183E-01	0.1745680E-05	-0.2561987E-04	0.4631885E-07
19	0.8370439E-02	0.4603716E-03	0.1582839E-01	0.2179150E-05	-0.3302540E-04	0.4742872E-07
20	0.1305872E-01	0.7644929E-03	0.1599876E-01	0.2307307E-05	-0.3517926E-04	0.4802205E-07
21	-0.5109570E-03	-0.6187351E-04	0.1509409E-01	-0.7867131E-06	-0.1126710E-04	0.4482493E-07
22	-0.3883975E-02	0.1243093E-03	0.1551183E-01	-0.1460616E-05	-0.2568048E-04	0.4629628E-07
23	-0.8393754E-02	0.3664584E-03	0.1582839E-01	-0.1815508E-05	-0.3309904E-04	0.4739755E-07

24	-0.1309271E-01	0.6192247E-03	0.1595876E-01	-0.1920939E-05	-0.3525567E-04	0.4798625E-07
25	0.1212000E-05	-0.2811590E-04	0.1247302E-02	-0.1547837E-04	0.2364427E-06	-0.1695052E-07
26	0.5480934E-05	-0.2885377E-04	-0.2707784E-02	-0.3096953E-04	0.2402191E-06	-0.3219471E-07
27	0.1074892E-04	-0.2941290E-04	-0.7861976E-02	-0.3859168E-04	0.2430452E-06	-0.4010931E-07
28	0.1634319E-04	-0.2971385E-04	-0.1324339E-01	-0.4085388E-04	0.2445560E-06	-0.4244524E-07
29	-0.1223835E-05	-0.2810996E-04	0.1261053E-02	0.1634093E-04	0.2380461E-06	-0.1727595E-07
30	-0.5431960E-05	-0.2883941E-04	-0.2659117E-02	0.3076739E-04	0.2435150E-06	-0.3283630E-07
31	-0.1095734E-04	-0.2939219E-04	-0.7791854E-02	0.3835360E-04	0.2476084E-06	-0.4086542E-07
32	-0.1665117E-04	-0.2968972E-04	-0.1314048E-01	0.4060585E-04	0.2497963E-06	-0.4321791E-07
33	0.4136844E-05	-0.1198197E-03	0.7516917E-02	-0.1050834E-03	0.5570104E-05	-0.1054583E-06
34	0.3479543E-04	-0.1231395E-03	-0.1773476E-01	-0.1975004E-03	0.5739989E-05	-0.2339173E-06
35	0.7559655E-04	-0.1256552E-03	-0.5062820E-01	-0.2461986E-03	0.5865379E-05	-0.3002529E-06
36	0.1181211E-03	-0.1270092E-03	-0.8495265E-01	-0.2605964E-03	0.5932941E-05	-0.3196020E-06
37	-0.4985234E-05	-0.1198187E-03	0.7545665E-02	0.1047741E-03	0.5570833E-05	-0.8862821E-07
39	-0.3164459E-04	-0.1231372E-03	-0.1763315E-01	0.1970795E-03	0.5740484E-05	-0.2027240E-06
39	-0.6727400E-04	-0.1256521E-03	-0.5043993E-01	0.2455851E-03	0.5867451E-05	-0.2613641E-06
40	-0.1043735E-03	-0.1270057E-03	-0.8467865E-01	0.2599668E-03	0.5935319E-05	-0.2783557E-06

MODE SHAPE 18 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	0.5941056E-06	0.2760179E-02	0.6427556E-04	-0.1940317E-07	-0.3440890E-07	-0.1353298E-06
2	0.6111435E-06	0.2154958E-02	0.2145370E-04	-0.1303960E-08	-0.7782205E-08	-0.5664797E-06
3	-0.2580493E-06	0.7614702E-02	0.3410372E-04	0.6837764E-09	0.3949668E-07	-0.7182012E-05
4	0.9313709E-06	0.1348942E-01	0.8086822E-04	-0.1145523E-07	0.6978286E-07	-0.8327470E-05
5	0.1153017E-06	0.1468462E-01	0.1186725E-03	-0.1745475E-07	0.4250493E-07	-0.5759834E-05
6	0.1795255E-07	0.5218606E-01	0.4252174E-03	-0.1421488E-07	0.6143301E-06	-0.7480721E-04
7	0.0	0.8536458E-01	0.6978139E-03	-0.1067761E-07	0.1047098E-05	-0.1271695E-03
8	0.0	0.1683443E 00	0.1390263E-02	0.1745320E-07	-0.1536134E-05	0.1887788E-03
9	0.1774130E-05	0.1092119E-02	0.2198944E-04	-0.1533958E-04	-0.9138059E-08	-0.5837144E-06
10	0.2949301E-05	-0.2594127E-02	0.2274950E-04	-0.2884748E-04	-0.1052472E-07	-0.6019132E-06
11	0.4362909E-05	-0.7396337E-02	0.2332545E-04	-0.3594412E-04	-0.1175932E-07	-0.6155327E-06
12	0.5931545E-05	-0.1240775E-01	0.2363545E-04	-0.3904693E-04	-0.1228359E-07	-0.6228130E-06
13	-0.9391005E-06	0.1093816E-02	0.2190069E-04	0.1532483E-04	-0.1468264E-07	-0.5835044E-06
14	-0.3403024E-05	-0.2588667E-02	0.2253483E-04	0.2882435E-04	-0.2123306E-07	-0.6014814E-06
15	-0.6624929E-05	-0.7386822E-02	0.2301540E-04	0.3591964E-04	-0.2547157E-07	-0.6149352E-06
16	-0.1015223E-04	-0.1239450E-01	0.2327406E-04	0.3802220E-04	-0.2696590E-07	-0.6221267E-06
17	0.4520002E-05	0.7441483E-02	0.1213679E-03	-0.1045363E-03	-0.9437673E-07	-0.5933353E-05
18	0.3240623E-04	-0.1767844E-01	0.1281919E-03	-0.1968845E-03	-0.2125646E-06	-0.6116586E-05
19	0.6963973E-04	-0.5040347E-01	0.1280837E-03	-0.2449441E-03	-0.2740814E-06	-0.6253711E-05
20	0.1036000E-03	-0.8455431E-01	0.1296493E-03	-0.2592739E-03	-0.2921626E-06	-0.6327008E-05
21	-0.4391894E-05	-0.7454470E-02	0.1213736E-03	0.1044241E-03	-0.9477452E-07	-0.5933347E-05
22	-0.3230005E-04	-0.1763916E-01	0.1252055E-03	0.1964183E-03	-0.2138361E-06	-0.6116569E-05
23	-0.6975339E-04	-0.5033570E-01	0.1281095E-03	0.2447632E-03	-0.2758796E-06	-0.6253691E-05
24	-0.1089933E-03	-0.8445026E-01	0.1296725E-03	0.2590986E-03	-0.2941750E-06	-0.6326984E-05
25	-0.4669327E-04	0.2197950E-02	0.1228379E-04	-0.1423830E-06	-0.7244502E-08	0.1099595E-05
26	-0.3306655E-03	0.2258942E-02	-0.2127292E-04	-0.2711420E-06	-0.6676672E-08	0.2540311E-05
27	-0.8290631E-03	0.2305160E-02	-0.6653409E-04	-0.3431482E-06	-0.6251749E-08	0.3282348E-05
28	-0.1294627E-02	0.2330037E-02	-0.1150449E-03	-0.3661133E-06	-0.6024599E-08	0.3498249E-05
29	0.4737347E-04	0.2197951E-02	0.1187812E-04	0.1446584E-06	-0.7192465E-08	0.1091076E-05
30	0.3793377E-03	0.2258946E-02	-0.2292251E-04	0.2751797E-06	-0.6569774E-08	0.2524111E-05
31	0.8240583E-03	0.2305166E-02	-0.6867830E-04	0.3459710E-06	-0.6103743E-08	0.3261935E-05
32	0.1287809E-02	0.2330044E-02	-0.1173072E-03	0.3679763E-06	-0.5854631E-08	0.3476476E-05
33	-0.4807677E-03	0.1497765E-01	-0.6124651E-04	-0.8127543E-06	0.4406975E-07	0.1117471E-04
34	-0.3875009E-02	0.1539339E-01	-0.1321688E-03	-0.1512143E-05	0.4570417E-07	0.2581794E-04
35	-0.8422140E-02	0.1570841E-01	-0.3829461E-03	-0.1878479E-05	0.4693378E-07	0.3335971E-04
36	-0.1316339E-01	0.1587798E-01	-0.5443528E-03	-0.1986822E-05	0.4759113E-07	0.3555398E-04
37	0.4822772E-03	0.1497765E-01	0.5837895E-04	0.8831087E-06	0.4408261E-07	0.1118788E-04
38	0.3880210E-02	0.1539339E-01	-0.1560923E-03	0.1674752E-05	0.4574819E-07	0.2584080E-04

39	0.8431430E-02	0.1570841E-01	-0.4354601E-03	0.2089852E-05	0.4699432E-07	0.3338576E-04
40	0.1317701E-01	0.1587798E-01	-0.7270479E-03	0.2212901E-05	0.4766123E-07	0.3557971E-04

MODE SHAPE 19 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	0.5270435E-05	-0.4166433E-03	-0.4638566E-01	0.7543190E-07	0.1033159E-04	-0.1084784E-06
2	0.5212046E-05	-0.2803325E-03	-0.3477316E-01	0.1073075E-07	0.3202576E-05	-0.1992852E-07
3	0.5355931E-05	-0.2906303E-03	-0.3450591E-01	0.4576620E-08	0.1293398E-04	-0.9946376E-07
4	0.6751000E-05	-0.1725163E-03	-0.2033570E-01	0.4137092E-08	0.1845216E-04	-0.1451724E-06
5	0.6562470E-05	-0.5724483E-04	-0.5619856E-02	0.5398583E-08	0.6070219E-05	-0.3870353E-07
6	0.3816459E-05	0.3636927E-04	0.4740674E-02	-0.4252524E-08	0.3324419E-04	-0.2477465E-06
7	0.0	0.1309287E-03	0.1689802E-01	-0.9181658E-08	0.5883319E-04	-0.4455031E-06
8	0.0	0.4674844E-03	0.6089112E-01	-0.6265162E-07	-0.3265220E-04	0.2487397E-06
9	-0.6079143E-04	-0.1978294E-03	-0.3556138E-01	0.1263449E-05	-0.1711559E-05	-0.2061191E-07
10	0.7397754E-03	0.1029315E-03	-0.3667963E-01	0.2390503E-05	-0.5977472E-05	-0.2133303E-07
11	0.1875603E-02	0.5020653E-03	-0.3752699E-01	0.2996639E-05	-0.8186640E-05	-0.2187293E-07
12	0.3077977E-02	0.9215910E-03	-0.3798308E-01	0.3179942E-05	-0.8832902E-05	-0.2216148E-07
13	0.7392047E-04	-0.1930447E-03	-0.3555123E-01	-0.1345516E-05	-0.1685171E-05	-0.2050221E-07
14	-0.7193654E-03	0.1300812E-03	-0.3667928E-01	-0.2561988E-05	-0.5931633E-05	-0.2110773E-07
15	-0.1851921E-02	0.5585765E-03	-0.3752648E-01	-0.3214273E-05	-0.8133235E-05	-0.2156098E-07
16	-0.3044097E-02	0.1008696E-02	-0.3798249E-01	-0.3411156E-05	-0.8777353E-05	-0.2180326E-07
17	-0.3117557E-04	-0.4183894E-04	-0.6766267E-02	0.1789427E-06	-0.4473686E-05	-0.4013116E-07
18	0.1780519E-02	0.1582821E-06	-0.6973986E-02	0.3372782E-06	-0.1363449E-04	-0.4163822E-07
19	0.4324146E-02	0.5644544E-04	-0.7131387E-02	0.4236423E-06	-0.1838198E-04	-0.4276631E-07
20	0.6955303E-02	0.1158426E-03	-0.7216107E-02	0.4500593E-06	-0.1977103E-04	-0.4336925E-07
21	0.4782791E-04	-0.3469549E-04	-0.6766267E-02	-0.2840630E-06	-0.4427457E-05	-0.4012942E-07
22	-0.1752996E-02	0.3396760E-04	-0.6973989E-02	-0.5423526E-06	-0.1354835E-04	-0.4163516E-07
23	-0.4282631E-02	0.1247256E-03	-0.7131390E-02	-0.6801947E-06	-0.1827440E-04	-0.4276202E-07
24	-0.6939512E-02	0.2199556E-03	-0.7216111E-02	-0.7216547E-06	-0.1965642E-04	-0.4336433E-07
25	0.3454759E-05	-0.2867884E-03	-0.2429594E-01	0.1607475E-03	0.3278350E-05	0.4272449E-07
26	-0.9129370E-05	-0.2959478E-03	0.1414955E-01	0.3050664E-03	0.3358367E-05	0.9726705E-07
27	-0.2622380E-04	-0.3023882E-03	0.6512797E-01	0.3825205E-03	0.3418253E-05	0.1261238E-06
28	-0.4421023E-04	-0.3066238E-03	0.1186863E 00	0.4059051E-03	0.3450250E-05	0.1347423E-06
29	0.3975294E-05	-0.2867791E-03	-0.2430687E-01	-0.1506506E-03	0.3276090E-05	-0.2630105E-08
30	0.5799910E-05	-0.2959250E-03	0.1411337E-01	-0.3049124E-03	0.3353721E-05	0.1179696E-07
31	0.8647452E-05	-0.3028547E-03	0.6506109E-01	-0.3823484E-03	0.3411815E-05	0.1880505E-07
32	0.1159337E-04	-0.3065846E-03	0.1185905E 00	-0.4057426E-03	0.3442870E-05	0.2068562E-07
33	0.3919014E-05	-0.5444523E-04	-0.4642259E-02	0.3025559E-04	0.6249047E-05	0.7149032E-07
34	-0.1790039E-04	-0.5614826E-04	0.2595545E-02	0.5739112E-04	0.6437880E-05	0.1680328E-06
35	-0.4765049E-04	-0.5743871E-04	0.1218467E-01	0.7193501E-04	0.6579203E-05	0.2186635E-06
36	-0.7887273E-04	-0.5913329E-04	0.2225357E-01	0.7631912E-04	0.6654743E-05	0.2336517E-06
37	0.5164025E-05	-0.5444764E-04	-0.4658893E-02	-0.3006200E-04	0.6247037E-05	0.9644662E-08
38	0.1222080E-04	-0.5615405E-04	0.2531778E-02	-0.5704904E-04	0.6433754E-05	0.5080776E-07
39	0.2234730E-04	-0.5744700E-04	0.1206393E-01	-0.7152600E-04	0.6573485E-05	0.7163101E-07
40	0.3301442E-04	-0.5814290E-04	0.2207638E-01	-0.7589615E-04	0.6648181E-05	0.7757171E-07

MODE SHAPE 20 OF THE COUPLED SYSTEM IN GLOBAL COORDINATES NORMALIZED TO THE UNIT MODAL MASS

MASS NO.	X(1)	X(2)	X(3)	THETA(1)	THETA(2)	THETA(3)
1	-0.1163508E-05	-0.4648757E-01	0.2215831E-03	-0.3101482E-07	-0.1433701E-07	-0.9410257E-05
2	-0.1253957E-05	-0.3486240E-01	0.2773816E-03	0.2722057E-07	-0.1695956E-07	-0.2267737E-05
3	-0.3236634E-06	-0.3466530E-01	0.3687798E-03	0.2160227E-07	-0.7258853E-07	-0.1212877E-04
4	0.2403973E-06	-0.2040437E-01	0.2536159E-03	0.8685848E-08	-0.1743122E-06	-0.1768550E-04
5	0.4220619E-05	-0.6563056E-02	0.6156421E-04	0.4764942E-08	-0.5698158E-07	-0.5104494E-05
6	0.2561453E-05	0.4344650E-02	-0.5095685E-04	-0.6582617E-08	-0.3452963E-06	-0.3150853E-04
7	0.0	0.1607108E-01	-0.1742188E-03	-0.1891974E-07	-0.5082448E-06	-0.5650012E-04

8	0.0	0.5890786E-01	-0.6478280E-03	-0.6883414E-07	0.2669002E-06	0.3085230E-04
9	-0.4197505E-06	-0.2436819E-01	0.2836401E-03	0.1613441E-03	0.2068884E-08	-0.2346908E-05
10	-0.2914751E-05	0.1421203E-01	0.2925191E-03	0.3062785E-03	0.1792256E-07	-0.2430515E-05
11	-0.6590102E-05	0.6539899E-01	0.2992472E-03	0.3841151E-03	0.2643532E-07	-0.2493085E-05
12	-0.1053421E-04	0.1191874E 00	0.3028684E-03	0.4075280E-03	0.2914985E-07	-0.2526528E-05
13	-0.1285735E-05	-0.2438617E-01	0.2836124E-03	-0.1612082E-03	0.1580245E-07	-0.2346922E-05
14	0.4569591E-05	0.1416143E-01	0.2924521E-03	-0.3060962E-03	0.4473025E-07	-0.2430542E-05
15	0.1276255E-04	0.6531609E-01	0.2991499E-03	-0.3839326E-03	0.5999948E-07	-0.2493117E-05
16	0.2147515E-04	0.1190764E 00	0.3027550E-03	-0.4074634E-03	0.6463955E-07	-0.2526568E-05
17	0.3315059E-05	-0.4587609E-02	0.6280573E-04	0.3037206E-04	0.6355788E-07	-0.5282714E-05
18	-0.1830054E-04	0.2574916E-02	0.6456717E-04	0.5765543E-04	0.1693662E-06	-0.5470907E-05
19	-0.4357594E-04	0.1231061E-01	0.6590186E-04	0.7230778E-04	0.2251012E-06	-0.5611748E-05
20	-0.8209813E-04	0.2243604E-01	0.6662028E-04	0.7673398E-04	0.2417817E-06	-0.5687036E-05
21	0.2489334E-05	-0.4590958E-02	0.6280450E-04	-0.3034648E-04	0.2304047E-07	-0.5282714E-05
22	0.1493744E-04	0.2665356E-02	0.6456439E-04	-0.5762052E-04	0.9252921E-07	-0.5470911E-05
23	0.3287576E-04	0.1229483E-01	0.6589782E-04	-0.7227255E-04	0.1286747E-06	-0.5611751E-05
24	0.5188396E-04	0.2241483E-01	0.6661545E-04	-0.7670205E-04	0.1394051E-06	-0.5687036E-05
25	-0.1497965E-04	-0.3566682E-01	0.1941328E-03	-0.1298939E-05	-0.1755859E-07	0.2068563E-05
26	-0.7971902E-03	-0.3680809E-01	-0.1199829E-03	-0.2487522E-05	-0.1819065E-07	0.5840303E-05
27	-0.1861819E-02	-0.3767289E-01	-0.5367820E-03	-0.3123926E-05	-0.1866390E-07	0.7797415E-05
28	-0.2985578E-02	-0.3813336E-01	-0.9745047E-03	-0.3315687E-05	-0.1891682E-07	0.8370543E-05
29	0.1343997E-04	-0.3566682E-01	0.1948172E-03	0.1245724E-05	-0.1749535E-07	0.2082012E-05
30	0.7899593E-03	-0.3580809E-01	-0.9982476E-04	0.2341140E-05	-0.1806087E-07	0.5865299E-05
31	0.1857883E-02	-0.3767289E-01	-0.4897844E-03	0.2929609E-05	-0.1848417E-07	0.7828092E-05
32	0.2999333E-02	-0.3813836E-01	-0.8994443E-03	0.3107538E-05	-0.1871044E-07	0.8402590E-05
33	-0.2875179E-04	-0.6714489E-02	0.4398878E-04	-0.2746431E-06	-0.5920365E-07	0.4688478E-05
34	-0.1774663E-02	-0.6929334E-02	-0.2225589E-04	-0.5255266E-06	-0.6154960E-07	0.1320738E-04
35	-0.4203304E-02	-0.7092133E-02	-0.1103008E-03	-0.6602169E-06	-0.6330549E-07	0.1762825E-04
36	-0.6753042E-02	-0.7179759E-02	-0.2028455E-03	-0.7009183E-06	-0.6424403E-07	0.1892302E-04
37	0.3527632E-04	-0.6714489E-02	0.4433481E-04	0.2614727E-06	-0.5906407E-07	0.4654997E-05
38	0.1773479E-02	-0.6929334E-02	-0.1758737E-04	0.4924704E-06	-0.6126311E-07	0.1314259E-04
39	0.4191965E-02	-0.7092133E-02	-0.9967973E-04	0.6168086E-06	-0.6290884E-07	0.1754546E-04
40	0.5729726E-02	-0.7179759E-02	-0.1859864E-03	0.6544718E-06	-0.6378849E-07	0.1883402E-04

APPENDIX A3

BRIEF DESCRIPTION OF EACH SUBROUTINE

CONFIG - Checks to see that the program limitations are met

LOGLO - (For each module) Reads the mass point locations in local coordinates and transforms them to global coordinates

AIJMOD - (For each module) Forms the $[A_{ij}]$ matrix

MASS - (For each module) Reads the physical mass matrix in local coordinates and transforms to global coordinates

MODE - (For each module) Sets up T-matrix constraints, reads mode shapes in local coordinates and transforms to global coordinates

TDEF - Sets up each T-matrix

FILE - Rewrites the file containing the physical mass matrix in global coordinates for use in later processing

JOINT - Creats a file of mode shape partitions and one of $[A_{ij}]$ matrix partitions at junction points for use in forming the B-matrix

FORMB - Forms the B-matrix

BTMB - Forms B^TMB

RTDS - Used by BTMB to form R^TDS where D is a partition of the block diagonal mass matrix and R and S are partitions of the B-matrix

MXI - Reads in modal mass and eigenvalue matrix, stores B^TMB partitions into M_ξ matrix and writes it out. MXI then stores the stiffness matrix in the proper form (compressed) for FUTILE. MXI will call CHEAP to perform free-free conversion of problem if needed

INCH - Used by CHEAP to invert a symmetric matrix

DIAG - Used by MXI to set up partitions of M_ξ matrix lying along diagonal

OFF - Used by MXI to set up partitions of M_ξ matrix lying below the diagonal

LATE - Solves the eigenvalue problem and orthonormalizes the vectors

FREE - Back transformation of vectors for free-free systems

EIGOUT - Transform the eigenvectors back to the physical global coordinate system

MPRD - Multiply two matrices

TPRD - Multiply the transpose of a matrix by another matrix

MCPY - Copy one matrix into another

LOC810 - Locate member of file 10 - B partition

LOC811 - Locate member of file 11 - global mass partition

ZERO - Zeroes out a matrix

ADD - Obtains the sum of two matrices

APPENDIX A4

SEQUENCE OF OPERATIONS IN SUBROUTINE LATE

Subroutine LATE requires additional discussion. This subroutine solves the coupled-structure eigenvalue problem which is in the following form:

$AX = \lambda BX$ where A is symmetric
and B is symmetric, positive definite

CALL FUTILE to find the Cholesky Decomposition of B

$$B = L\,L^T$$

CALL DAGGER repeatedly to form $L^{-1}\,A\,L^{-T}$

the eigenvalue problem to be solved is

$$(L^{-1}\,A\,L^{-T})(L^T X) = \lambda\,(L^T X)$$

CALL SWITCH to store the matrix $L^{-1}\,A\,L^{-T}$ in a form acceptable to SYMEIG

CALL SYMEIG to solve the eigenvalue problem giving the λ's

CALL SYMVEC (An entry point of SYMEIG) to give the eigenvectors $Y = L^T X$

CALL ORTHON to orthonormalize the set of eigenvectors Y

CALL TRIEQ to find X given $Y = L^T X$

For this program

A is the M_ξ matrix, and

B is the k_ξ matrix except for nonsingular systems (those with rigid-body modes) where

$$A = ([M_{22}]_\xi - [M_{12}]_\xi^T\,[M_{11}]_\xi^{-1}\,[M_{12}]_\xi), \text{ and}$$

$$B = [k_{22}]_\xi$$

APPENDIX A5

INPUT, OUTPUT, AND INTERMEDIATE FILES

FILES 1, 2, 3, 4, 7, 8, 9, 10 - intermediate files

These files are used to temporarily hold matrix partitions to be used later in the program. All files are unformatted. Details are indicated in the program flow charts.

FILE 11 - output file

File 11 is the output file to the Phase II program corresponding to run number 1 (usually the Laboratory run). Write statements are in CONFIG, LOGLO, FILE, and EIGOUT.

FILE 12 - output file

File 12 is the output file to the Phase II program corresponding to run number 2 (usually the Counterweight run). The write statements are the same write statements as those used in FILE 11.

APPENDIX A6

PROGRAM FLOW CHARTS

Symbols Used in the Flow Charts

MODID - The array used to denote absence or presence of each module.

NMO - The array used to keep the number of modes for each module

NMPO - The array used to keep the number of mass points for each module

IXYZ - The array used to store mass point numbers of the attachment points for each attached module

G - Constant G

NIX - Error return indicator from INCH and FUTILE

NUMEIG - Number of eigenvectors to be found by SYMVEC

NUMVAL - Number of eigenvalues to be found by SYMEIG

NZERO - Number of rigid body modes

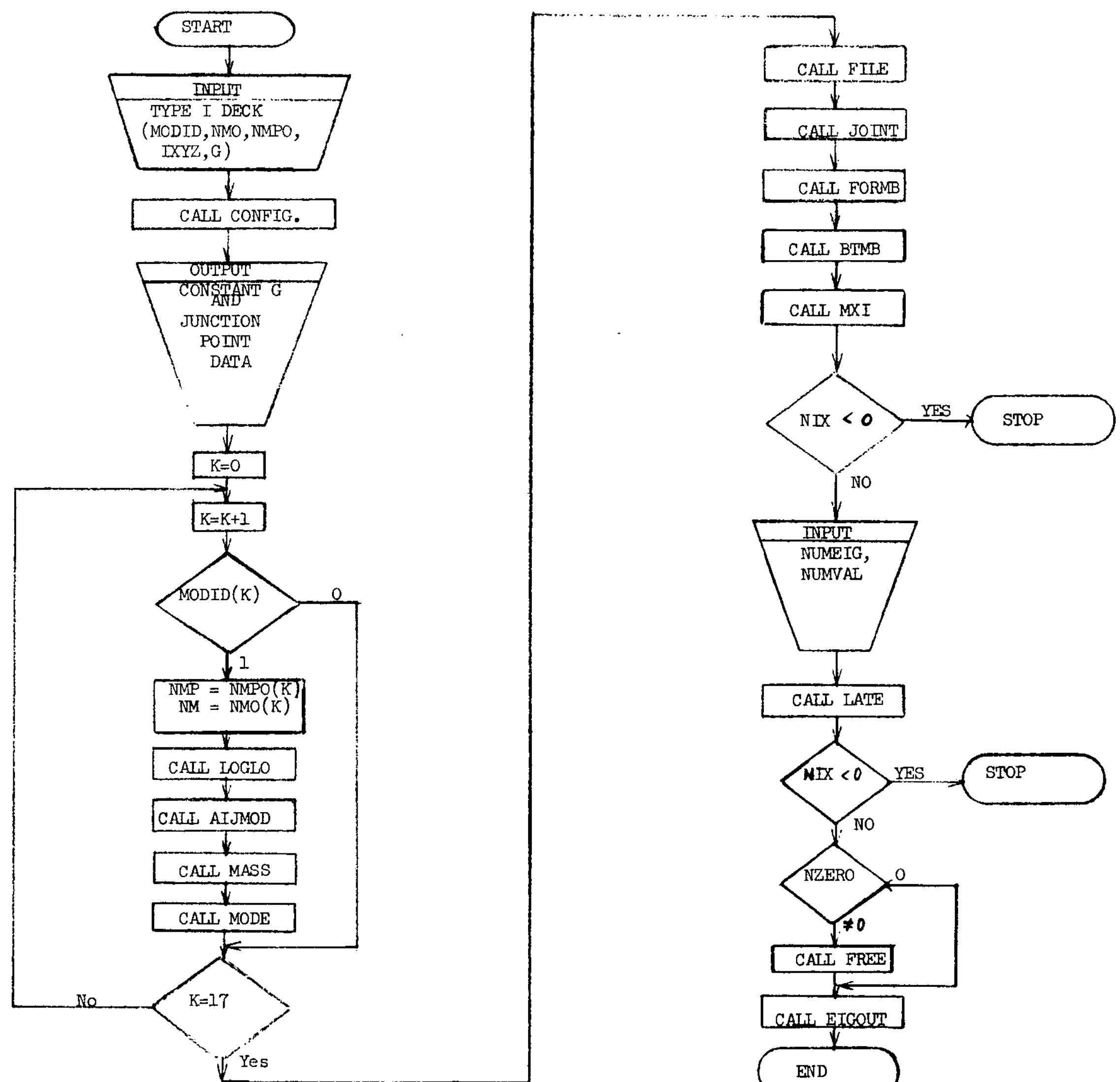
XYZ - Array containing X_0, X_A, X_B, and mass point locations when read in, then later holding mass point locations in absolute global coordinates

XYZBAR - Array containing mass point locations in relative global coordinates when computed

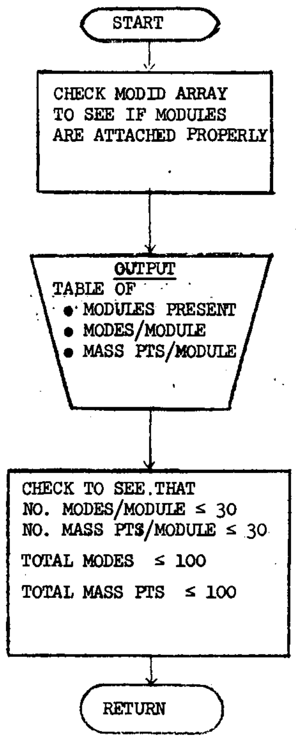
MPN - Current mass point number for a module

NMP - Number of mass points for a module

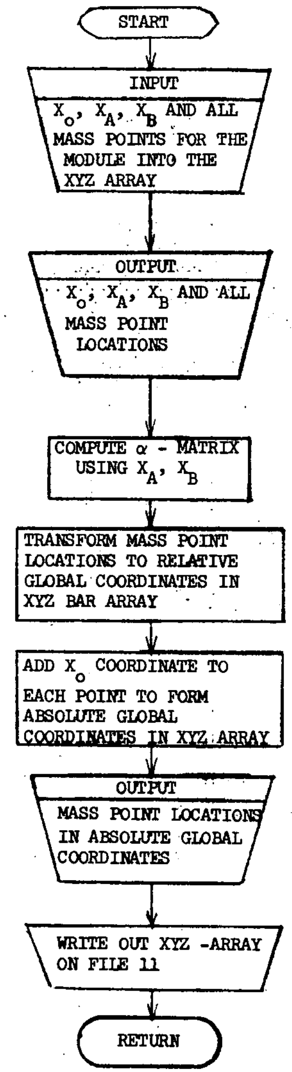
MAIN PROGRAM



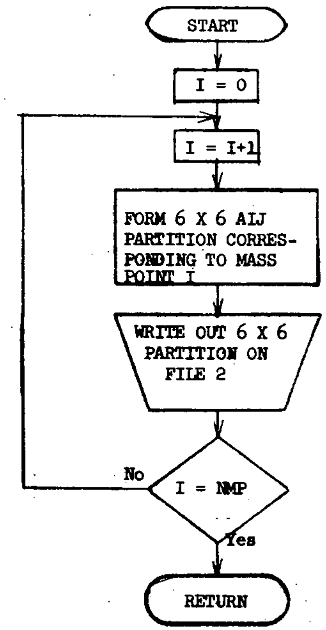
SUBROUTINE CONFIG.



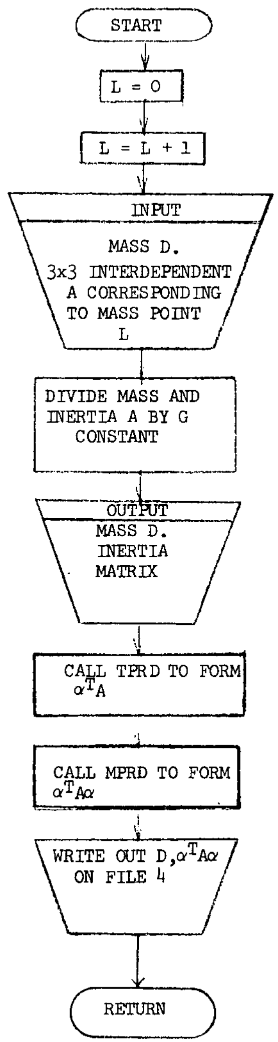
SUBROUTINE LOGLO



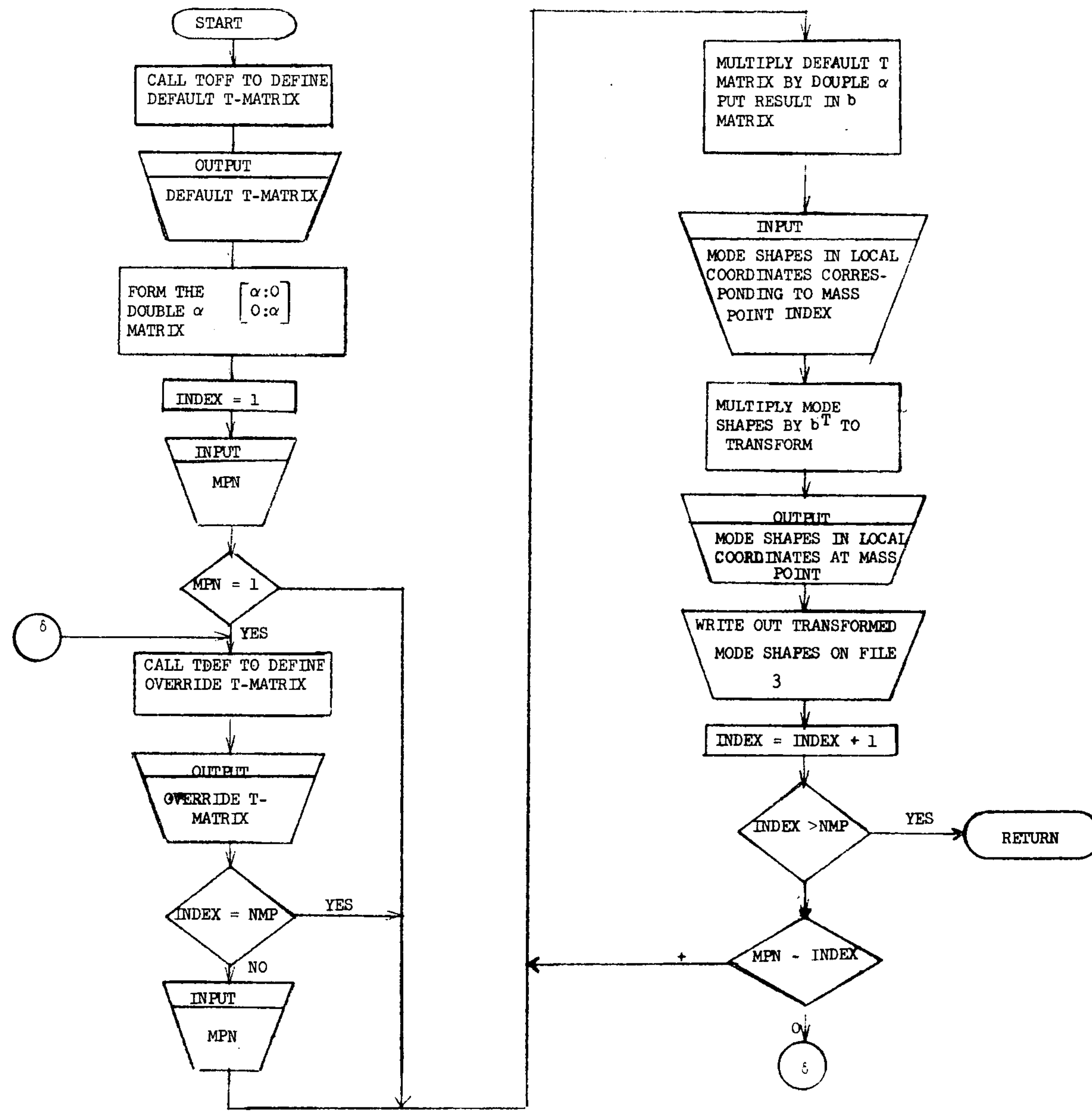
SUBROUTINE AIJMOD



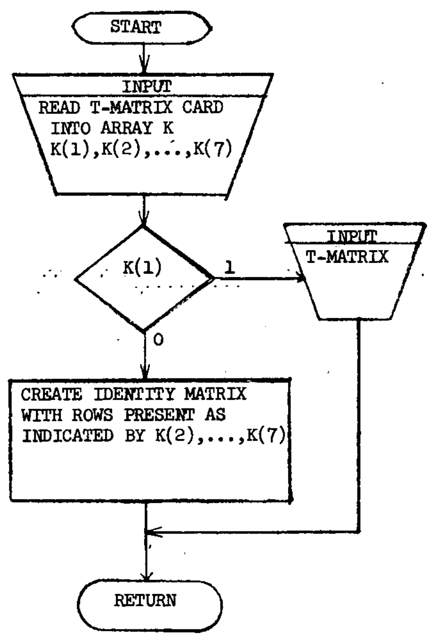
SUBROUTINE MASS



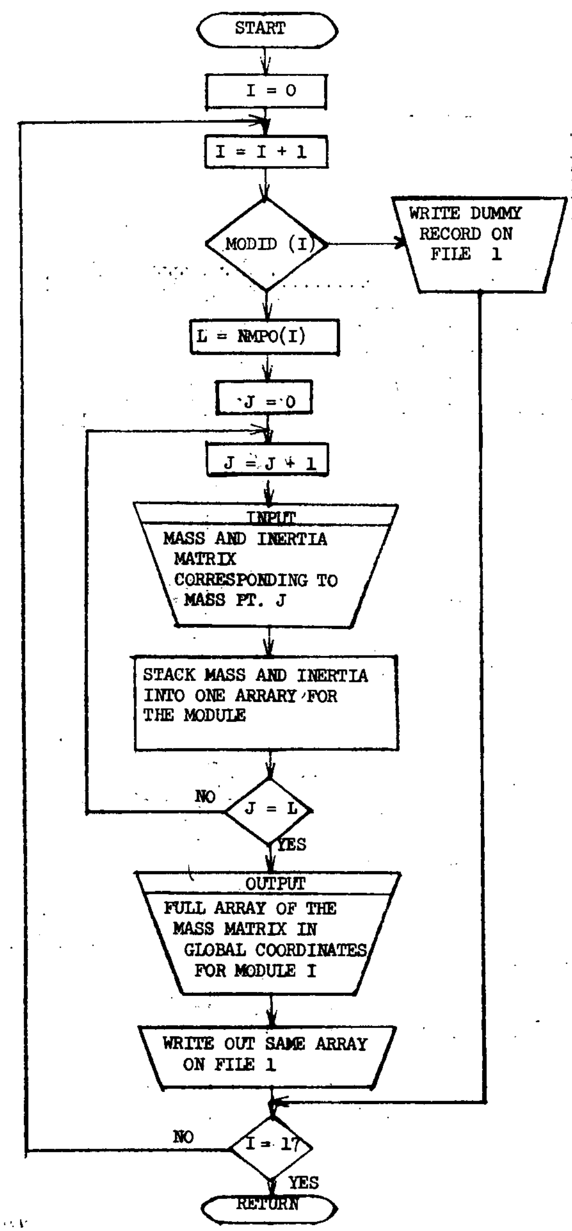
SUBROUTINE MODE



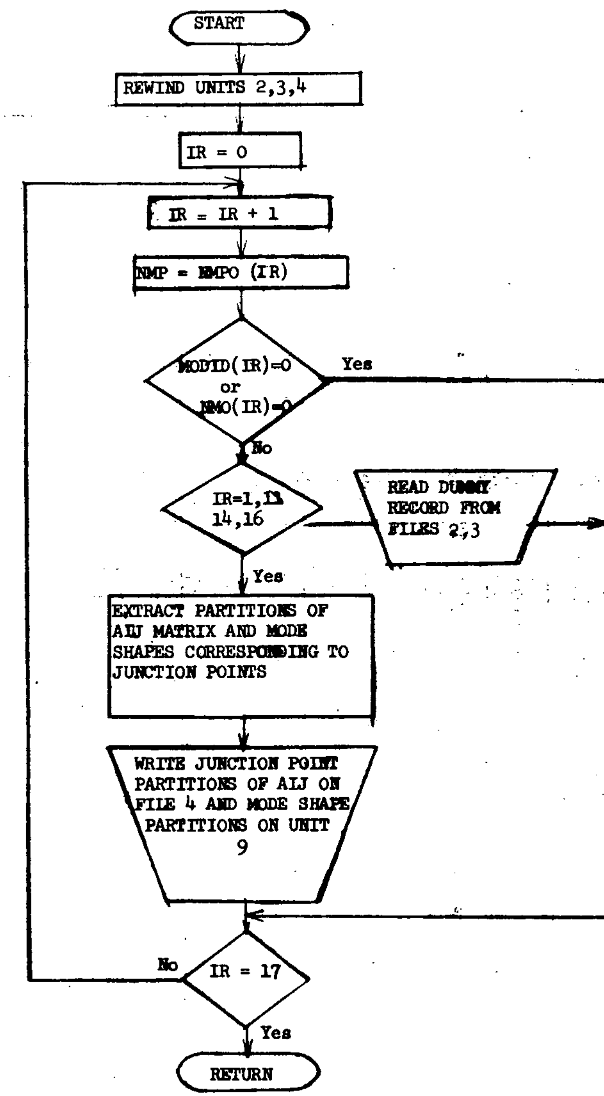
SUBROUTINE TDEF



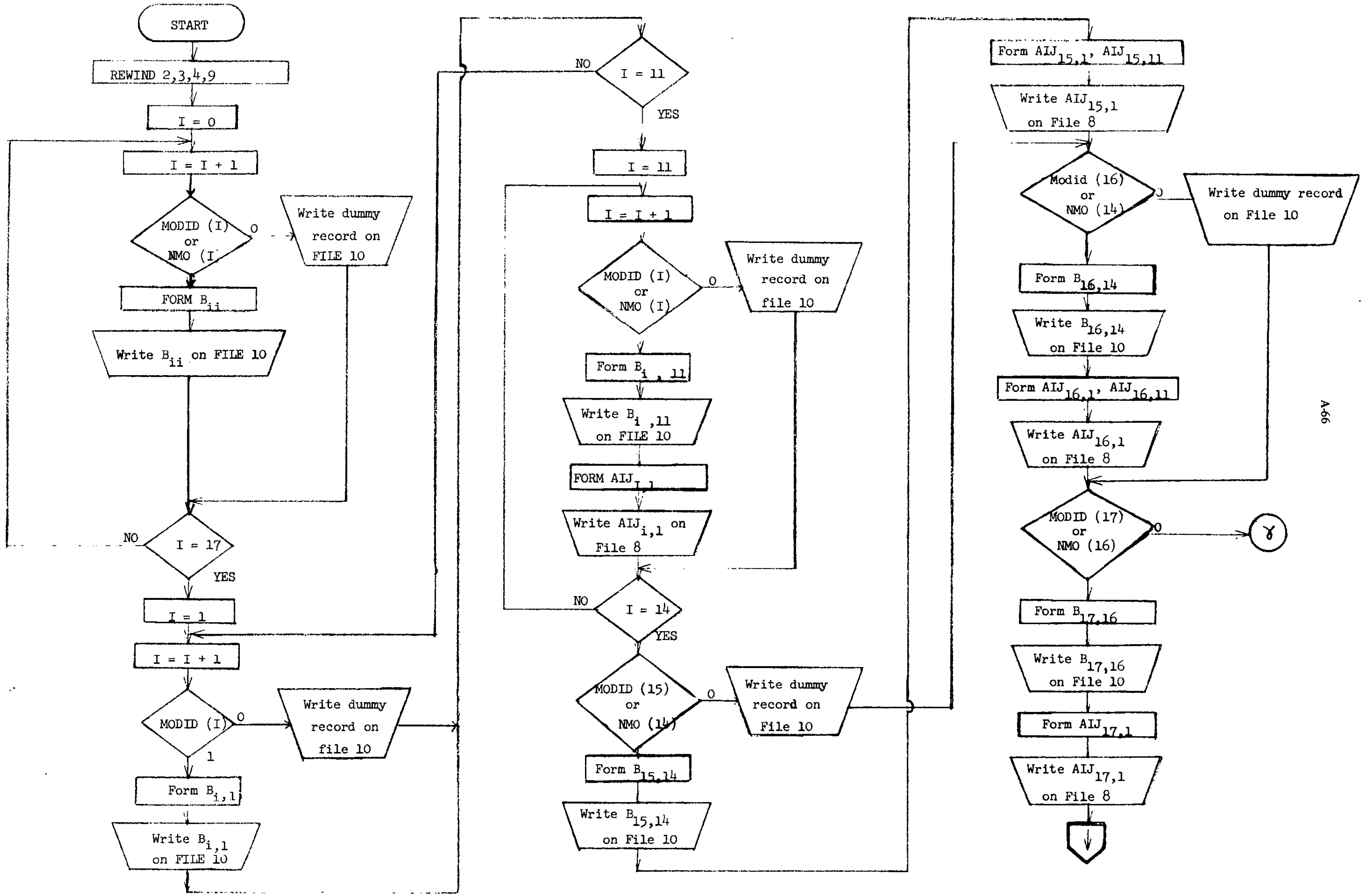
SUBROUTINE FILE

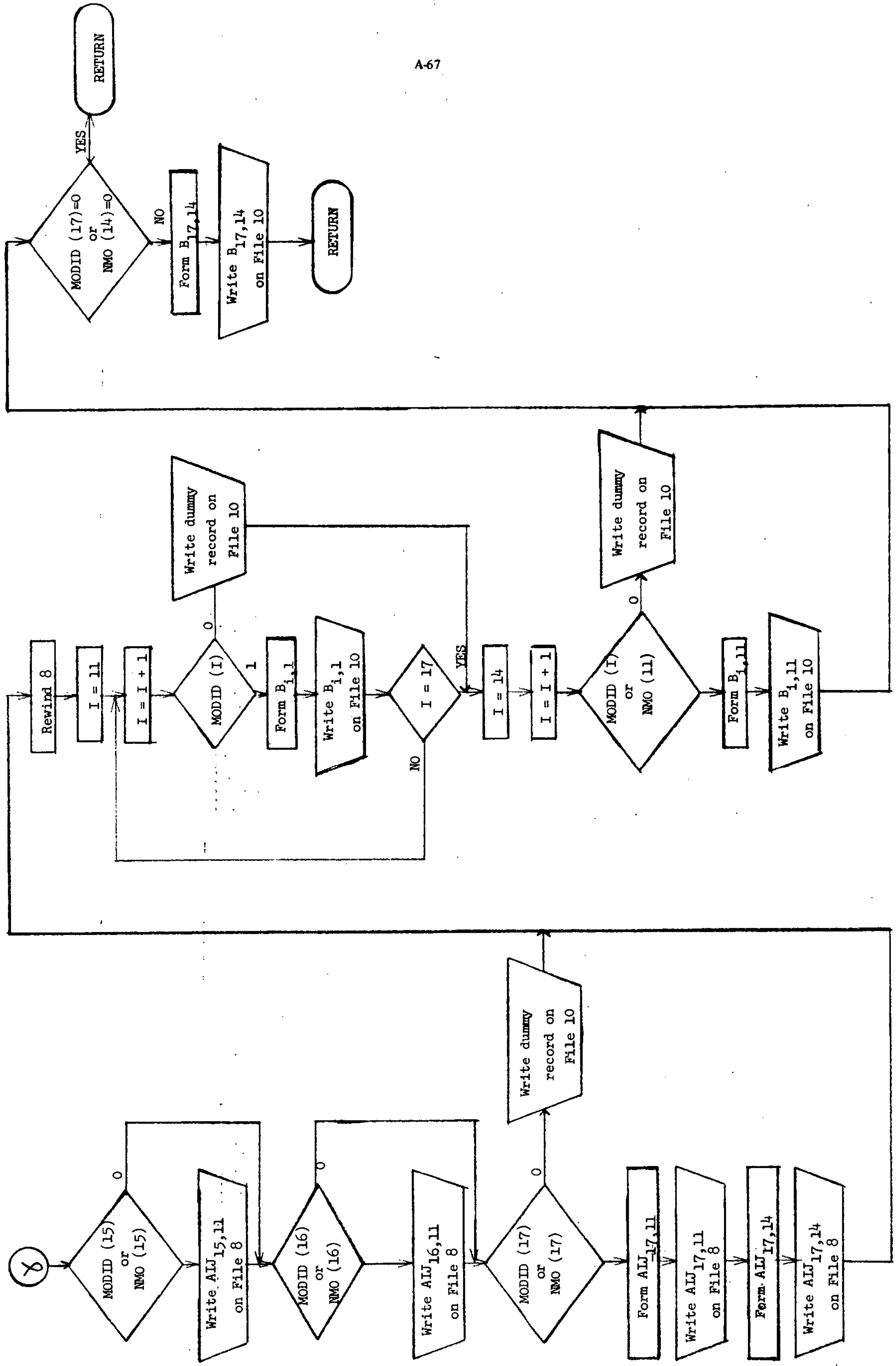


SUBROUTINE JOINT



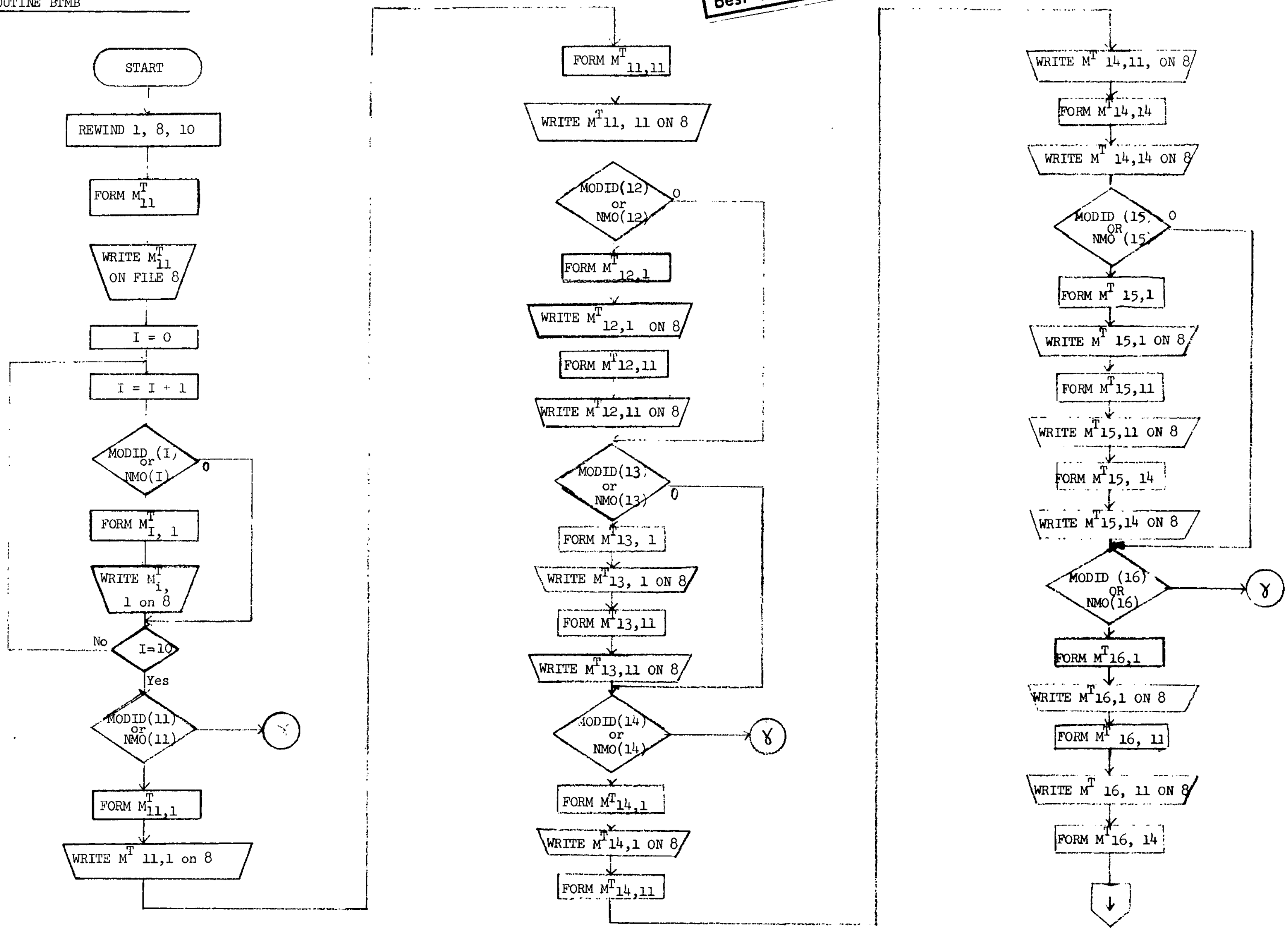
SUBROUTINE FORM B

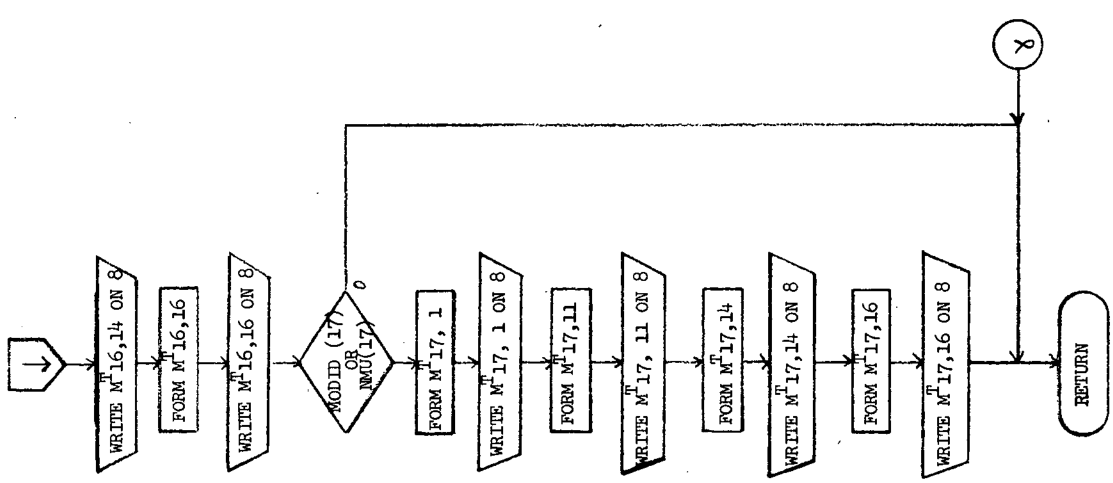




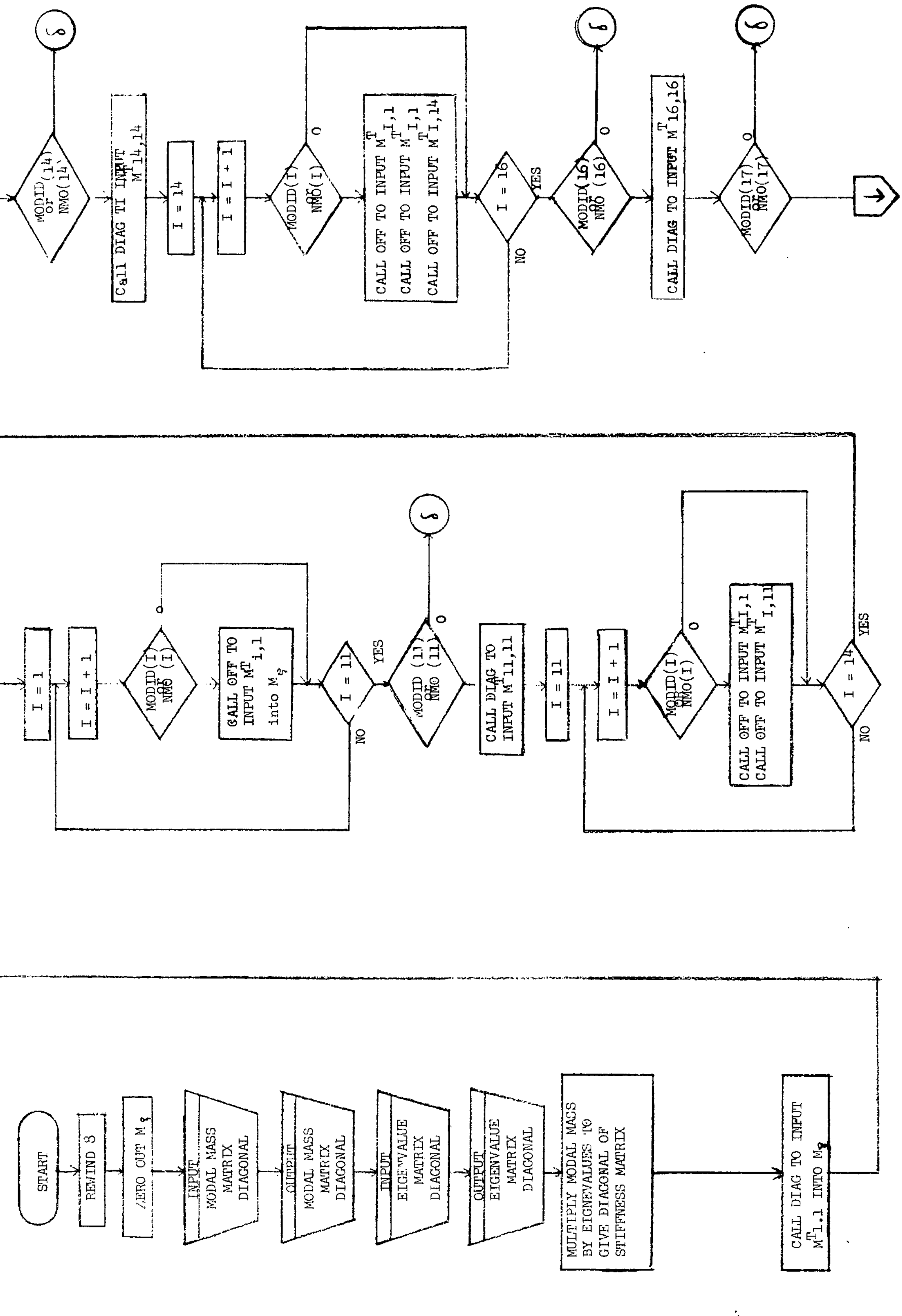
MODID (15) or NMO (15)
0
Write ALJ15,11 on File 8
MODID (16) or NMO (16)
0
Write ALJ16,11 on File 8
MODID (17) or NMO (17)
0
Write dummy record on File 10
Form ALJ17,11
Write ALJ17,11 on File 8
Form ALJ17,14
Write ALJ17,14 on File 8
Rewind 8
I = 11
I = I + 1
MODID (I)
0
1
Write dummy record on File 10
Form Bi,1
Write Bi,1 on File 10
I = 17
YES
NO
I = 14
I = I + 1
MODID (I) or NMO (11)
0
Write dummy record on File 10
Form Bi,11
Write Bi,11 on File 10
MODID (17)=0 or NMO (14)=0
YES
RETURN
NO
Form B17,14
Write B17,14 on File 10
RETURN

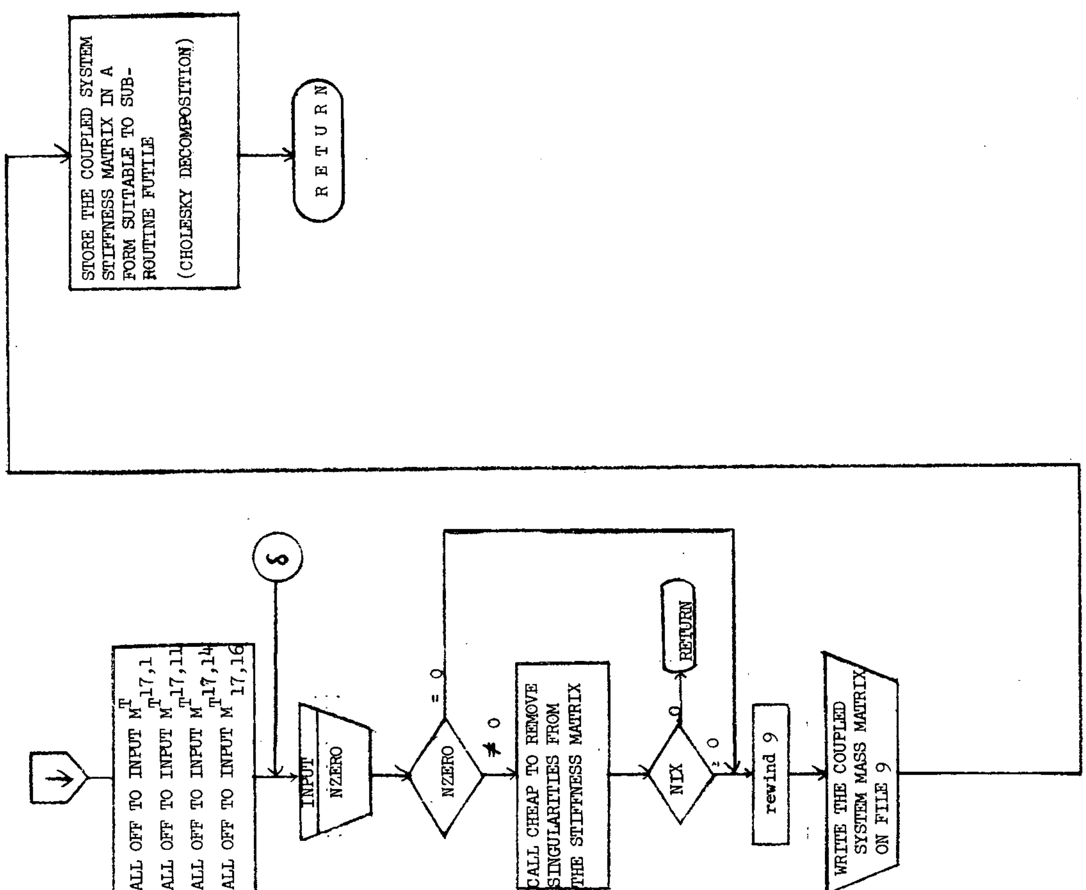
SUBROUTINE BTMB



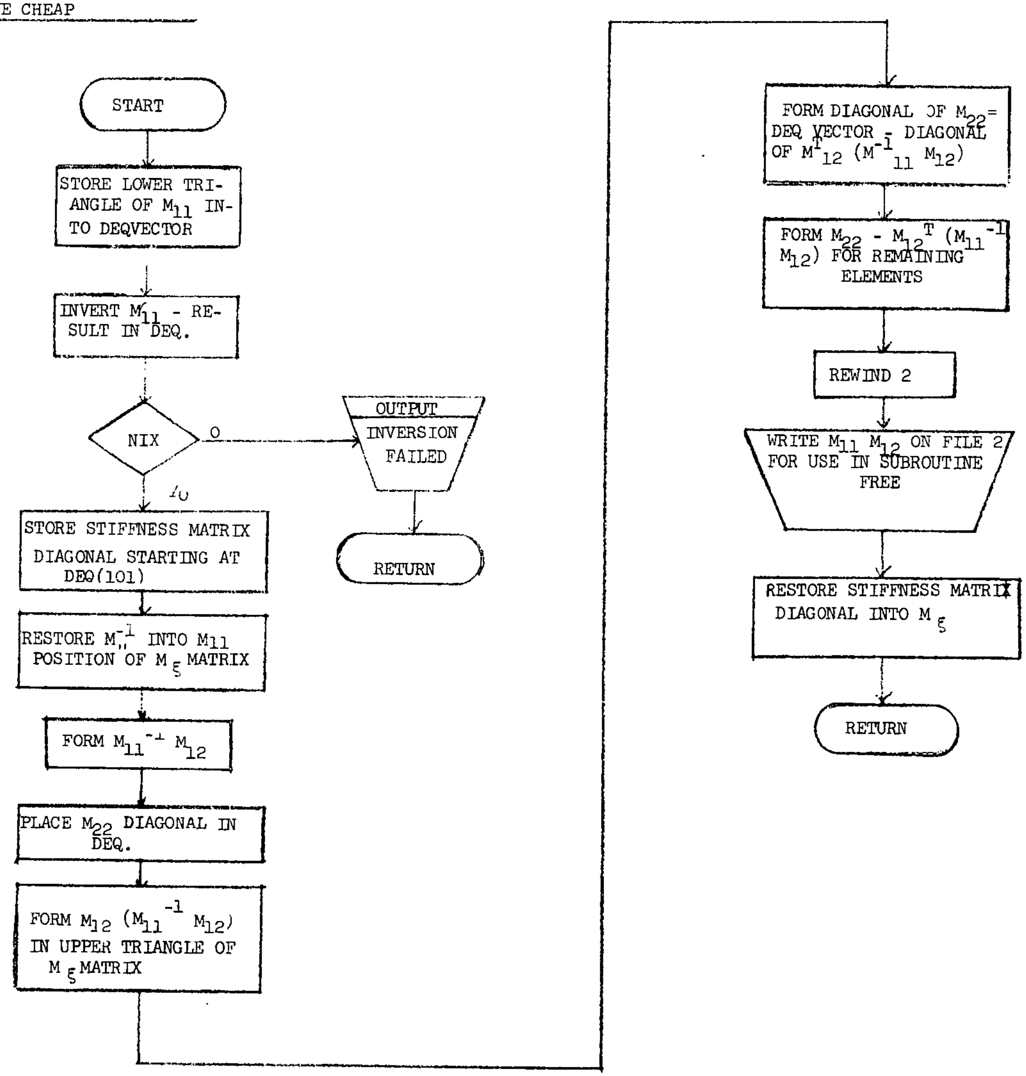

WRITE M^T16,14 ON 8
FORM M^T16,16
WRITE M^T16,16 ON 8
MODID (17) OR NMU(17)
0
FORM M^T17, 1
WRITE M^T17, 1 ON 8
FORM M^T17,11
WRITE M^T17, 11 ON 8
FORM M^T17,14
WRITE M^T17,14 ON 8
FORM M^T17,16
WRITE M^T17,16 ON 8
RETURN

SUBROUTINE MXI

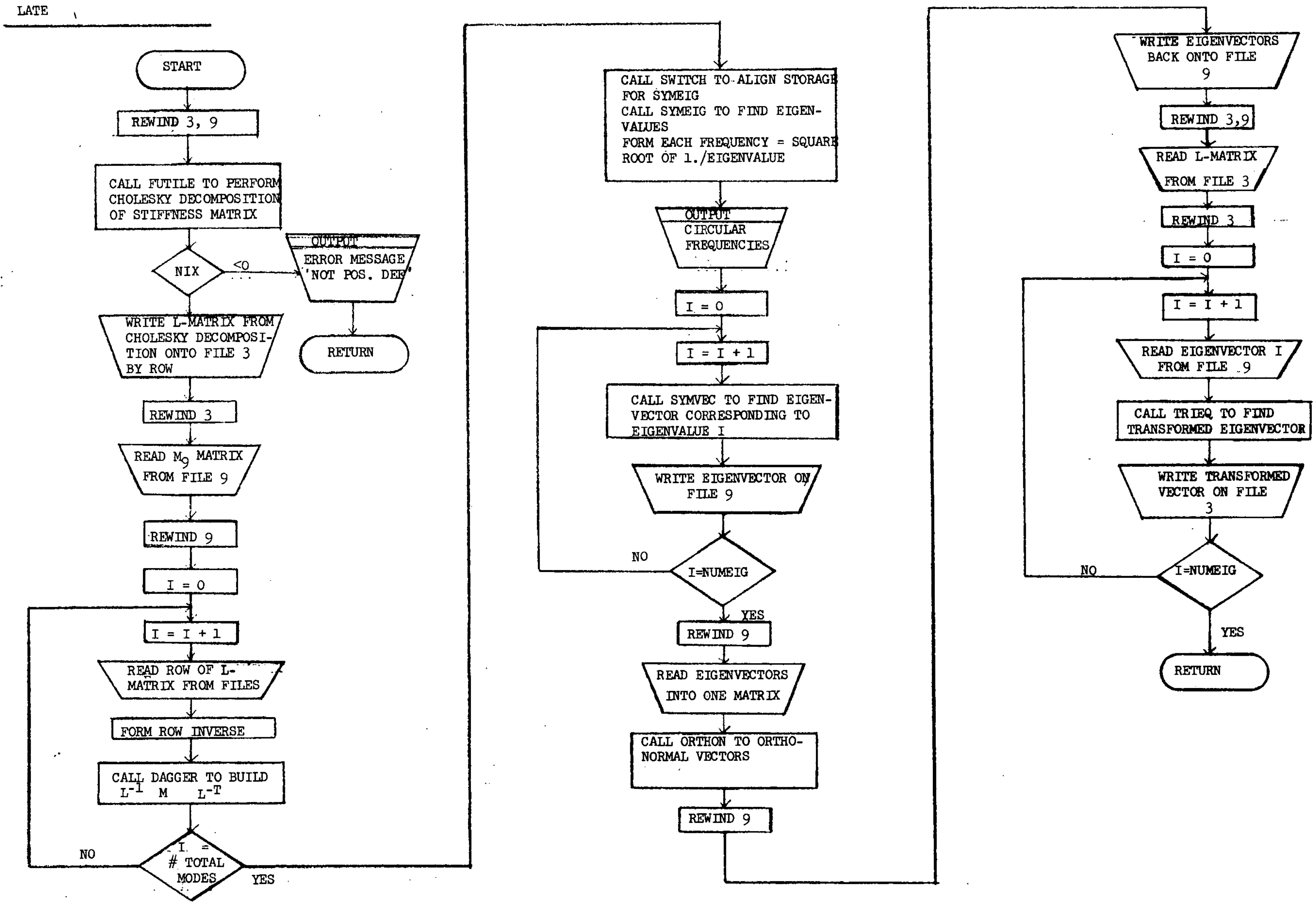



CALL OFF TO INPUT M^T 17,1
CALL OFF TO INPUT M^T 17,11
CALL OFF TO INPUT M^T 17,14
CALL OFF TO INPUT M^T 17,16
8
INPUT
NZERO
NZERO
= 0
≠ 0
CALL CHEAP TO REMOVE SINGULARITIES FROM THE STIFFNESS MATRIX
NIX
0
≥ 0
RETURN
rewind 9
WRITE THE COUPLED SYSTEM MASS MATRIX ON FILE 9
STORE THE COUPLED SYSTEM STIFFNESS MATRIX IN A FORM SUITABLE TO SUB-ROUTINE FUTILE
(CHOLESKY DECOMPOSITION)
R E T U R N

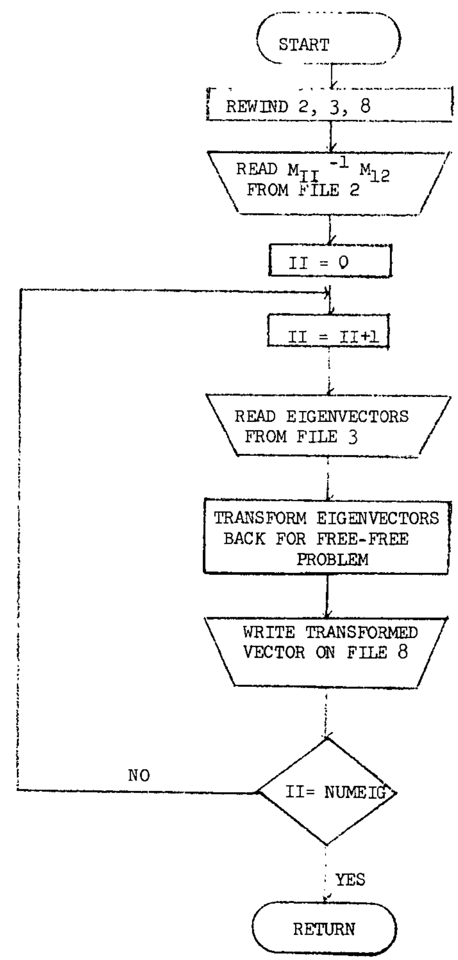
SUBROUTINE CHEAP



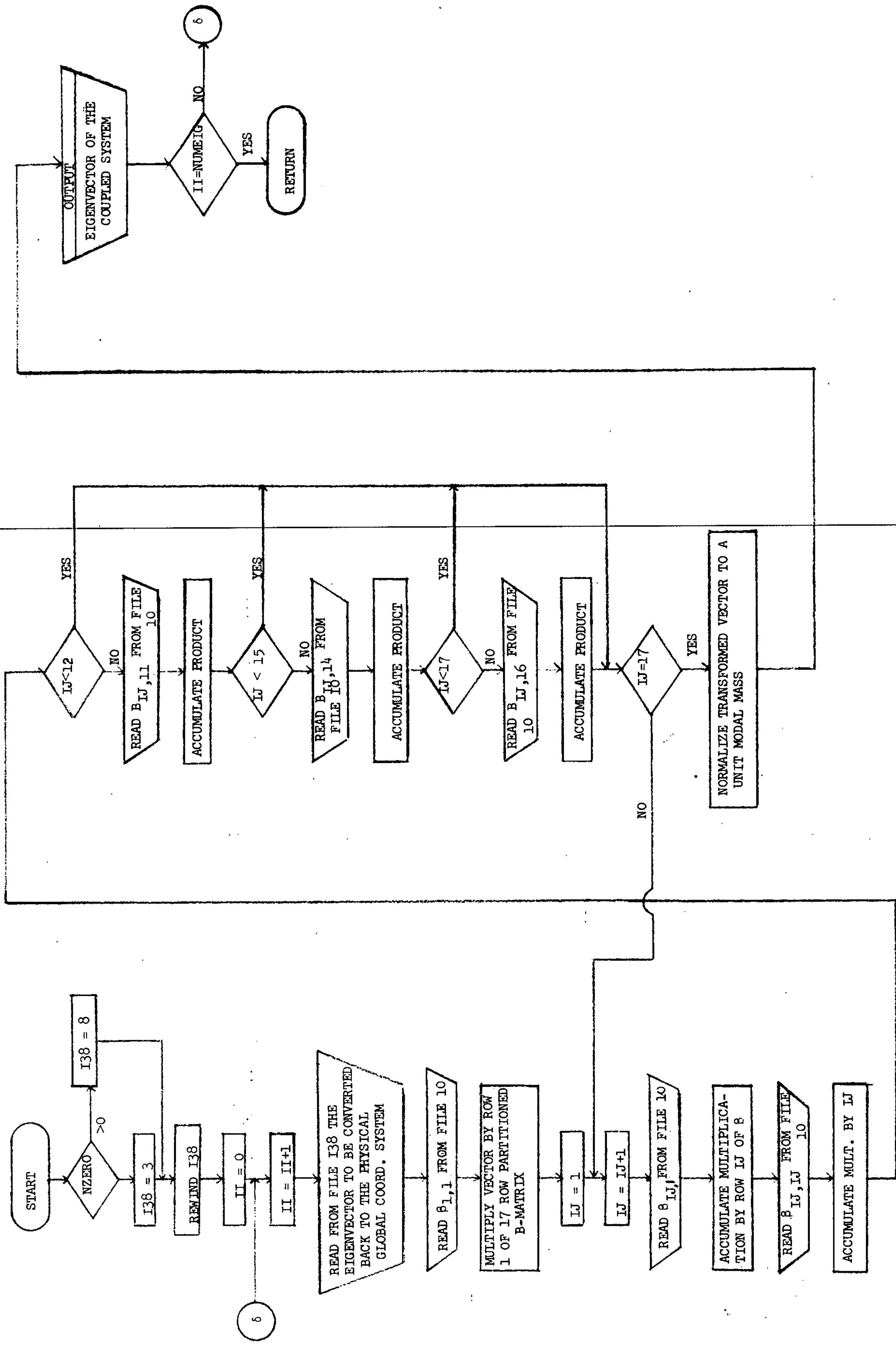
SUBROUTINE LATE



SUBROUTINE FREE



SUBROUTINE EIGOUT



APPENDIX A7

FORTRAN SOURCE DECK LISTING

The fortran source deck listing appears on the following pages. This listing shows the LRC CDC version of the program.

```
      PROGRAM SPACE(INPUT=201,OUTPUT=201,TAPE5=INPUT,TAPE6=OUTPUT,
     *   TAPE1=401,TAPE2=401,TAPE3=401,TAPE4=401,
     *   TAPE8,TAPE9=401,TAPE10,TAPE11=401,TAPE12=201)
      COMMON A
C
C  DYNAMICS OF ROTATING SPACE STATIONS
C            PHASE I , MODAL COUPLING
C
      DIMENSION MODID(17),NMO(17),NMPO(17),A(11300),B(900),IXYZ(16)
      COMMON /A1/MODID,NMO,NMPO /A2/B /INOUT/I05,I06,IOFF,LL
      COMMON /WINTER/Q1
      COMMON /BOND/Q2(2)
      COMMON /INFO/Q3(5)
      COMMON /OPT2/Q4
      I05=5
      I06=6
      LL=11
      IOFF=0
      DO 99 II=1,2
      WRITE(I06,400)
  400 FORMAT(1H1,20(/),47X,*DYNAMICS OF ROTATING SPACE STATIONS*////
     *      61X,*PHASE I*///57X,*MODAL COUPLING*)
      CALL SET10
      CALL SET11
      READ(I05,1       )MODID,NMO,NMPO,IXYZ
      IF(EOF,I05)99,199
  199 CONTINUE
      READ(I05,5)G
C
C* CHECK FOR REASONABLE CONFIGURATION
C
      CALL CONFIG(IER,NTNM,NTNMP,MODHI)
      IF(IER.NE.0)STOP
      IF(IOFF.GE.20)GO TO 101
      WRITE(I06,6)G
      WRITE(I06,2)(I,I=2,17),(IXYZ(I),I=1,16)
C
C* FOR EACH MODULE OR APPENDAGE...
C
  101 DO 10 K=1,17
      IF(MODID(K).EQ.0)GO TO 10
      IF(IOFF.GE.5)GO TO 102
```

```
      WRITE(I06 ,22)K
  102 NMP=NMPO(K)
      NM=NMO(K)
C
C* CHANGE LOCAL TO GLOBAL COORDINATES  +  COMPUTE ALPHA
C
   21 CALL LOGLO (NMP,A,A(310),A(160))
C
C* CONSTRUCT AIJ,STORE K,NMP,AIJ ON DISK
C
      CALL AIJMOD(A(160),NMP,K,A(320))
C
C* READ MASS MATRIX,TRANSFORM,STORE ON DISK
C
      CALL MASS(A(310),NMP,A,G)
C
C* READ IN T-MATRIX DATA,READ IN PHI-X,CHANGE PHI-X TO GLOBAL
C    COORDINATES,COMPUTE NDOF,STORE NDOF,PHI-X ON DISK
C
      IF(NM.EQ.0)GO TO 10
      CALL MODE(A(310),NM,NDOF,NMP,K,A(5000),A(6000))
   10 CONTINUE
      CALL FILE
      CALL JOINT(A,IXYZ,A(5000),A(9000),A(9500))
C
C* READ JUNCTION POINT DATA,FORM ADDITIONAL AIJ*S,STORE THEM ON DISK,
C    COMPUTE B-MATRIX PARTITIONS,STORE THEM ON DISK
C
      CALL FORMB(A,A(1081),A(6481),A(7561),A(8641),A(8321),A(9001),
     *           A(9181),A(9361),A(9637),A(9673),A(9709))
      CALL BTMB(A,A(301),A(5701),B)
C
C* CHANGE M-XI TO STORE FOR LATENT , ALSO STORE K-XI
C
      CALL MXI(A,A,NTNM,B,NIX,NZERO)
      IF(NIX.LT.0)STOP
      TOL=.1E-9
      READ(I05,3)NUMEIG,NUMVAL
C
C* SOLVE THE EIGENVALUE PROGRAM
C          (M-XI)(PHI)=(LAMBDA)(K-XI)(PHI)
C
      N=NTNM
```

```
      CALL LATE(N,A,NUMEIG,TOL,A(9000),NIX,B,NUMVAL)
      IF(NIX.LT.0)STOP
C
C* TRANSFORM EIGENVECTORS TO PHYSICAL GLOBAL COORDINATES
C
      IF(NZERO.NE.0)CALL FREE(A,N,NZERO,NUMEIG,B(101))
      CALL EIGOUT(N,NZERO,NUMEIG,A,A(5401),A(5501),A(6101),NTNMP,B)
      REWIND 1
      REWIND 2
      REWIND 3
      REWIND 4
      REWIND 8
      REWIND 9
      REWIND 10
      LL=LL+1
   99 CONTINUE
      STOP
    1 FORMAT(17I2)
    2 FORMAT(/* JUNCTION POINT DATA*/* MODULE          *,16I3/* JUNCTION
     *POINT *,16I3)
    3 FORMAT(2I3)
    5 FORMAT(E15.8)
    6 FORMAT(/* CONSTANT G FOR THE PROGRAM =*,E16.8)
   22 FORMAT(//11H ** MODULE ,I2,3H **///)
      END
```

```
      SUBROUTINE CONFIG(IER,NM,NMP,MODHI)
      COMMON /A1/MODID(17),NMO(17),NMPO(17)
      COMMCN /INOUT/IO5,IO6,IOFF,LL
      IER=0
      J=0
      NM=0
      NMP=0
      MODHI=0
      IF(MODID(1).EQ.0)IER=1
      K=MODID(12)+MODID(13)+MODID(14)
      IF(K.NE.0 .AND. MODID(11).EQ.0)IER=11
      K=MODID(15)+MODID(16)
      IF(K.NE.0 .AND. MODID(14).EQ.0)IER=14
      IF(MODID(17).NE.0 .AND. MODID(16).EQ.0)IER=16
      IF(IOFF.GE.20.)GO TO 101
      WRITE(IO6,1)
  101 DO 5 I=1,17
      IF(MODID(I).EQ.0)GO TO 5
      IF(IOFF.GE.20.)GO TO 102
      WRITE(IO6,2)I,NMO(I),NMPO(I)
  102 NM=NM+NMO(I)
      NMP=NMP+NMPO(I)
      J=J+1
      IF(NMO(I).GT.30)IER=I
      IF(NMPO(I).GT.30)IER=I
      MODHI=I
    5 CONTINUE
      WRITE(LL)J
      IF(NM.LE.100 .AND. NMP.LE.100)GO TO 20
      IER=20
      WRITE(IO6,4)NM,NMP
      RETURN
   20 IF(IER.NE.0)WRITE(IO6,3)IER
      RETURN
    1 FORMAT(*1CONFIGURATION SPECIFIED*//
     *  45H MODULE NO.  *  NO. MODES  *  NO. MASS POINTS  )
    2 FORMAT(5X,I2,13X,I2,14X,I2)
    3 FORMAT(*1IMPROPER CONFIGURATION AT MODULE*,I3)
    4 FORMAT(*1TOO MANY TOTAL MODES OR MASS POINTS*/* MODES =*,I3/
     *       * MASS POINTS =*,I4)
      END
```

```
      SUBROUTINE LOGLO(NMP,XYZ,ALPHA,XYZBAR)
      DIMENSION XYZ(53,3),ALPHA(3,3),XYZBAR(50,3)
      COMMCN /INOUT/I05,I06,IOFF,LL
C
C* FIRST 3 POINTS IN XYZ ARE POINTS O,A,AND B
C
      NMPP3=NMP+3
      READ(I05,2)((XYZ(I,J),J=1,3),I=1,NMPP3)
      IF(IOFF.GE.5)GO TO 201
      WRITE(I06,24)
      DO 20 I=4,NMPP3
      I1=I-3
   20 WRITE(I06,21)I1,(XYZ(I,J),J=1,3)
      WRITE(I06 ,22)((XYZ(I,J),J=1,3),I=1,3)
C
C* SET UP ALPHA
C
  201 CK=SQRT(XYZ(2,1)*XYZ(2,1)+XYZ(2,2)*XYZ(2,2)+XYZ(2,3)*XYZ(2,3))
      DO 10 I=1,3
   10 ALPHA(3,I)=XYZ(2,I)/CK
      A21=XYZ(2,2)*XYZ(3,3)-XYZ(3,2)*XYZ(2,3)
      A22=XYZ(3,1)*XYZ(2,3)-XYZ(2,1)*XYZ(3,3)
      A23=XYZ(2,1)*XYZ(3,2)-XYZ(3,1)*XYZ(2,2)
      CK=SQRT(A21*A21+A22*A22+A23*A23)
      ALPHA(2,1)=A21/CK
      ALPHA(2,2)=A22/CK
      ALPHA(2,3)=A23/CK
      ALPHA(1,1)=ALPHA(3,3)*ALPHA(2,2)-ALPHA(3,2)*ALPHA(2,3)
      ALPHA(1,2)=ALPHA(3,1)*ALPHA(2,3)-ALPHA(3,3)*ALPHA(2,1)
      ALPHA(1,3)=ALPHA(3,2)*ALPHA(2,1)-ALPHA(3,1)*ALPHA(2,2)
C
C    FORM XYZBAR
C
  202 DO 12 I=1,NMP
      DO 12 J=1,3
      XYZBAR(I,J)=0.
      DO 12 K=1,3
   12 XYZBAR(I,J)=XYZBAR(I,J)+ALPHA(K,J)*XYZ(I+3,K)
      DO 11 I=1,NMP
      DO 11 J=1,3
      I1=I+3
   11 XYZ(I1,J)=XYZBAR(I,J)+XYZ(1,J)
```

```
      IF(ICFF.GE.5)GO TO 30                                             L0001910  19400000
      WRITE(I06,26)                                                     L0001920  19500000
      DO 40 I=4,NMPP3                                                   L0001930  19600000
      I1=I-3                                                            L0001940  19700000
   40 WRITE(I06,21)I1,(XYZ(I,J),J=1,3)                                  L0001950  19800000
C                                                                       L0001960  19900000
C     WRITE TRANSFORMED MASS POINTS ON TAPE 11 FOR LATER JOB PHASE      L0001970  20000000
C                                                                       L0001980  20100000
   30 WRITE(LL)NMP                                                      L0001990  20200000
      WRITE(LL)((XYZ(I,J),J=1,3),I=4,NMPP3)                             L0002000  20300000
      RETURN                                                            L0002010  20400000
    2 FORMAT(3E15.8)                                                    L0002020  20500000
   21 FORMAT(3X,I3,3X,3E16.7)                                           L0002030  20600000
   22 FORMAT(*0COORDINATES OF POINT 0*/ 9X , 3E16.7 /                   L0002040  20700000
     *       * COORDINATES OF POINT A*/ 9X , 3E16.7 /                   L0002050  20800000
     *       * COORDINATES OF POINT B*/ 9X , 3E16.7 )                   L0002060  20900000
   24 FORMAT(//* MASS POINT LOCATIONS IN LOCAL COORDINATES*/*0MASS NO.* L0002070  21000000
     *,19X,*COORDINATES*/)                                              L0002080  21100000
   26 FORMAT(//* MASS POINT LOCATIONS IN ABSOLUTE GLOBAL COORDINATES*// L0002090  21200000
     * * MASS NO.*,19X,*COORDINATES*/)                                  L0002100  21300000
      END                                                               L0002110  21400000
```

```
      SUBROUTINE MASS(ALPHA,NMP,A,G)
      DIMENSION ALPHA(3,3),A(1)
      COMMON/INOUT/I05,I06,IOFF
      IF(IOFF.GE.5)GO TO 201
      WRITE(I06 ,2)
  201 DO 10 L=1,NMP
C
C     READ MATRIX COLUMN BY COLUMN
C
      READ(I05,1)D,(A(I),I=1,9)
      D=D/G
      DO 7 I=1,9
    7 A(I)=A(I)/G
      IF(IOFF.GE.5)GO TO 202
      WRITE(I06,3)L,D,(A(I),I=1,9)
  202 CALL TPRD(ALPHA,A,A(10),3,3,3,3,3)
      CALL MPRD(A(10),ALPHA,A,3,3,3,3,3)
   10 WRITE(4)D,(A(J),J=1,9)
      RETURN
    1 FORMAT(E15.8/(3E15.8))
    2 FORMAT(//* MASSES AND MOMENTS OF INERTIA IN LOCAL COORDINATES*//
     * * MASS NO.*,7X,*MASS*,25X,*INERTIA MATRIX*/)
    3 FORMAT(3X,I3,3X,E16.7,5X,3E16.7/30X,3E16.7/30X,3E16.7/)
      END
```

```
      SUBROUTINE AIJMOD(XYZ,NMP,K,AIJ)                                  L0002360   23900000
      DIMENSION XYZ(50,3),AIJ(180,6)                                    L0002370   24000000
      NMPT6=NMP*6                                                       L0002380   24100000
      IF(K.GT.1)GO TO 2                                                 L0002390   24200000
      DO 1 I=1,180                                                      L0002400   24300000
      DO 1 J=1,6                                                        L0002410   24400000
    1 AIJ(I,J)=0.                                                       L0002420   24500000
      RETURN                                                            L0002430   24600000
    2 DO 10 I=1,NMP                                                     L0002440   24700000
      L=I                                                               L0002450   24800000
      M=6*(I-1)                                                         L0002460   24900000
      AIJ(M+1,5)=XYZ(L,3)                                               L0002470   25000000
      AIJ(M+1,6)=-XYZ(L,2)                                              L0002480   25100000
      AIJ(M+2,4)=-XYZ(L,3)                                              L0002490   25200000
      AIJ(M+2,6)=XYZ(L,1)                                               L0002500   25300000
      AIJ(M+3,4)=XYZ(L,2)                                               L0002510   25400000
      AIJ(M+3,5)=-XYZ(L,1)                                              L0002520   25500000
      DO 10 J=1,6                                                       L0002530   25600000
   10 AIJ(M+J,J)=1.0                                                    L0002540   25700000
      DO 20 L=1,NMP                                                     L0002550   25800000
      M=6*L-5                                                           L0002560   25900000
      MP5=M+5                                                           L0002570   26000000
   20 WRITE(2)((AIJ(I,J),J=1,6),I=M,MP5)                                L0002580   26100000
      RETURN                                                            L0002590   26200000
      END                                                               L0002600   26300000
```

```
      SUBROUTINE MODE(ALPHA,NM,NDOF,NMP,K,E,F)
      DIMENSION ALPHA(3,3),B(6,6)     ,C(6,6),D(6,6),E(6,30),F(6,30)
      COMMON /A2/A(408)
      COMMON /INOUT/IO5,IO6,IOFF
      EQUIVALENCE (B(1,1),A(1)),(C(1,1),A(37)),(D(1,1),A(73))
C
C   READ DEFAULT T-MATRIX FOR MODULE
C
      NDOF=0
      CALL TDEF(KK,D)
      IF(IOFF.GE.5)GO TO 201
      WRITE(IO6 ,26)K,KK,((D(I,J),J=1,6),I=1,KK)
C
C   CREATE DOUBLE ALPHA MATRIX
C
  201 DO 10 I=1,3
      DO 10 J=1,3
      C(I,J)=ALPHA(I,J)
      C(I+3,J+3)=C(I,J)
      C(I+3,J)=0.
   10 C(I,J+3)=0.
C
C   READ MODE SHAPES,TRANSFORM,WRITE ON DISK
C
      INDEX=1
      READ(IO5,2)MPN
      IF(MPN.NE.1)GO TO 50
   70 CALL TDEF(KR,E)
      IF(IOFF.GE.5)GO TO 202
      WRITE(IO6 ,27)MPN,KR,((E(I,J),J=1,6),I=1,KR)
  202 IF(INDEX.EQ.NMP)GO TO 60
      READ(IO5,2)MPN
      GO TO 60
   50 CALL MCPY(D,E,KK,6,6)
      KR=KK
   60 CALL MPRD(E,C,B,KR,6,6,6,6)
      DO 61 I=1,KR
   61 READ(IO5,4)(E(I,J),J=1,NM)
      CALL TPRD(B,E,F,KR,6,NM,6,6)
      IF(IOFF.GE.5)GO TO 25
      IF(INDEX.GT.1)GO TO 40
      WRITE(IO6,28)
```

```
      KOUNT=0                                                           L0003030  30600000
   40 WRITE(I06,29)INDEX                                                L0003040  30700000
      DO 110 I=1,KR                                                     L0003050  30800000
      KOUNT=KOUNT+1                                                     L0003060  30900000
  110 WRITE(I06,30)KOUNT,(E(I,J),J=1,NM)                                L0003070  31000000
   25 WRITE(3)((F(I,J),J=1,NM),I=1,6)                                   L0003080  31100000
      NDOF=NDCF+KR                                                      L0003090  31200000
      INDEX=INDEX+1                                                     L0003100  31300000
      IF(INDEX.GT.NMP)GO TO 100                                         L0003110  31400000
      IF(MPN-INDEX)70,70,50                                             L0003120  31500000
  100 RETURN                                                            L0003130  31600000
    2 FORMAT(I2)                                                        L0003140  31700000
    4 FORMAT(8X,E15.8,9X,E15.8,9X,E15.8)                                L0003150  31800000
   26 FORMAT(//* DEFAULT T-MATRIX FOR MODULE*,I3/I3,* ROWS, 6 COLUMNS*  L0003160  31900000
     */(6E15.6))                                                        L0003170  32000000
   27 FORMAT(//* T-MATRIX FOR MASS POINT*,I3/I3,* ROWS, 6 COLUMNS* /(6E1L0003180  32100000
     *5.6))                                                             L0003190  32200000
   28 FORMAT(///* SUBSTRUCTURE MODAL MATRIX*//* ROW NO.*)               L0003200  32300000
   29 FORMAT(/15X,*COORDINATES OF MASS POINT *,I3)                      L0003210  32400000
   30 FORMAT(/3X,I3,2X,6E17.7/(3X,6E17.7))                              L0003220  32500000
      END                                                               L0003230  32600000
```

```
      SUBROUTINE TDEF(N,A)
      DIMENSION A(6,6),K(7)
      COMMON /INOUT/IO5,IO6,IOFF
      READ(IO5,1)K
      IF(K(1).EQ.1)GO TO 10
      N=0
      DO 5 I=1,6
      IF(K(I+1).EQ.0)GO TO 5
      N=N+1
      DO 15 J=1,6
      A(N,J)=0.
      IF(I.EQ.J)A(N,J)=1.
   15 CONTINUE
    5 CONTINUE
      RETURN
   10 READ(IO5,2)N,((A(I,J),J=1,6),I=1,N)
      RETURN
    1 FORMAT(7I1)
    2 FORMAT(I2/(4E15.8))
      END
```

```
      SUBROUTINE FILE                                                   L0003440  34700000
      COMMON /A1/MODID(17),NM(17),NMP(17)                               L0003450  34800000
      COMMON /A2/A                                                      L0003460  34900000
      COMMCN /INOUT/I05,I06,IOFF,LL                                     L0003470  35000000
      DIMENSION B(10,40)                                                L0003480  35100000
      DIMENSION A(400)                                                  L0003490  35200000
      EQUIVALENCE(A(1),B(1,1))                                          L0003500  35300000
      INTEGER TENL                                                      L0003510  35400000
      REWIND 4                                                          L0003520  35500000
      INDEX=0                                                           L0003530  35600000
      DO 10 I=1,17                                                      L0003540  35700000
      INDEX=INDEX+1                                                     L0003550  35800000
      IF(MODID(I).EQ.0)GO TO 110                                        L0003560  35900000
      L=NMP(I)                                                          L0003570  36000000
      DO 20 J=1,L                                                       L0003580  36100000
      K= J*10-9                                                         L0003590  36200000
      KP9=K+9                                                           L0003600  36300000
   20 READ(4)(A(IJ),IJ=K,KP9)                                           L0003610  36400000
      TENL=10*L                                                         L0003620  36500000
      WRITE(1)(A(J),J=1,TENL)                                           L0003630  36600000
      WRITE(LL)TENL,(A(J),J=1,TENL)                                     L0003640  36700000
      IF(IOFF.GE.10)GO TO 10                                            L0003650  36800000
      WRITE(I06,1)I,(J,(B(M,J),M=1,10),J=1,L)                           L0003660  36900000
      GO TO 10                                                          L0003670  37000000
  110 WRITE(1)MODID                                                     L0003680  37100000
   10 CONTINUE                                                          L0003690  37200000
      RETURN                                                            L0003700  37300000
    1 FORMAT(//* MASSES AND MOMENTS OF INERTIA IN GLOBAL COORDINATES FORL0003710  37400000
     * MODULE *,I2/*0MASS NO.*,7X,*MASS*,25X,*INERTIA MATRIX* //        L0003720  37500000
     *  (3X,I3,3X,E16.7,5X,3E16.7/30X,3E15.7/30X,3E16.7/))                        37600000
      END                                                               L0003740  37700000
```

```
      SUBROUTINE JOINT(A,IXYZ,B,AX,BX)                                  L0003750  37800000
      COMMON/A1/MODID(17),NMO(17),NMPO(17)                              L0003760  37900000
      DIMENSION A(60,6),B(60,30),IXYZ(16),AX(6,6),BX(6,30)              L0003770  38000000
      REWIND 2                                                          L0003780  38100000
      REWIND 3                                                          L0003790  38200000
      REWIND 4                                                          L0003800  38300000
      REWIND 9                                                          L0003810  38400000
      JNEW=0                                                            L0003820  38500000
      IRR=0                                                             L0003830  38600000
      DO 1 IR=1,17                                                      L0003840  38700000
      IF(MODID(IR).EQ.0 .OR. NMO(IR).EQ.0)GO TO 1                       L0003850  38800000
      JOLD=JNEW+1                                                       L0003860  38900000
      IF(IR.EQ.1 .OR.IR.EQ.11 .OR. IR.EQ.14 .OR. IR.EQ.16)GO TO 70      L0003870  39000000
      NMP=NMPO(IR)                                                      L0003880  39100000
      DO 80 I=1,NMP                                                     L0003890  39200000
      READ(2)                                                           L0003900  39300000
   80 IF(NMO(IR).GT.0)READ(3)                                           L0003910  39400000
      GO TO 1                                                           L0003920  39500000
   70 IRR=IRR+1                                                         L0003930  39600000
      IF(NMO(IR).EQ.0)RETURN                                            L0003940  39700000
      NUMB=5-IRR                                                        L0003950  39800000
      IF(IRR.EQ.1)NUMB=10                                               L0003960  39900000
      NMP=NMPO(IR)                                                      L0003970  40000000
      NM=NMO(IR)                                                        L0003980  40100000
      JNEW=JOLD-1+NUMB                                                  L0003990  40200000
      DO 10 I=1,NMP                                                     L0004000  40300000
      IFLAG=0                                                           L0004010  40400000
      JDEX=0                                                            L0004020  40500000
      DO 20 J=JOLD,JNEW                                                 L0004030  40600000
      JDEX=JDEX+1                                                       L0004040  40700000
      IF(I.NE.IXYZ(J))GO TO 20                                          L0004050  40800000
      IF(IFLAG.EQ.1)GO TO 32                                            L0004060  40900000
      IF(IR.NE.1)READ(2)((AX(L1,L2),L2=1,6),L1=1,6)                     L0004070  41000000
      READ(3)((BX(L1,L2),L2=1,NM),L1=1,6)                               L0004080  41100000
      IFLAG=1                                                           L0004090  41200000
   32 JT=(JDEX-1)*6                                                     L0004100  41300000
      DO 30 K=1,6                                                       L0004110  41400000
      IF(IR.EQ.1)GO TO 33                                               L0004120  41500000
      DO 31 K1=1,6                                                      L0004130  41600000
   31 A(JT+K,K1)=AX(K,K1)                                               L0004140  41700000
   33 DO 30 K2=1,NM                                                     L0004150  41800000
   30 B(JT+K,K2)=BX(K,K2)                                               L0004160  41900000
```

```
20 CONTINUE
   IF(IFLAG.EQ.1)GO TO 10
   IF(IR.NE.1)READ(2)
   READ(3)
10 CONTINUE
   JDEX=0
   DO 11 J=JOLD,JNEW
   JDEX=JDEX+1
   IF(IXYZ(J).EQ.0)GO TO 11
   JT=(JDEX-1)*6
   J1=JT+1
   J2=JT+6
   IF(IR.NE.1)WRITE(4)((A(L1,L2),L2=1,5),L1=J1,J2)
   WRITE(9)NM,((B(L1,L2),L2=1,NM),L1=J1,J2)
11 CONTINUE
 1 CONTINUE
   RETURN
   END
```

```
      SUBROUTINE FORMB(C,D,E,F,U,V,W,X,R,S,T,T1)
      DIMENSION C(180,6),D(180,30),E(180,6),F(180,6),
     *          U(6,30),V(6,30),W(6,30),X(6,30),
     *          R(6,6),S(6,6),T(6,6),T1(6,6)
      COMMON /A1/MODID(17),NMO(17),NMPO(17)
      COMMON /INOUT/IO5,IO6,IOFF
      REWIND 2
      REWIND 3
      REWIND 9
      REWIND 4
      INDEX=0
C
C* STEP 1     B(I,I),I=1,17
C
      DO 10 I=1,17
      INDEX=INDEX+1
      IF(MODID(I).EQ.0 .OR. NMO(I).EQ.0)GO TO 110
      NM=NMO(I)
      NMP=NMPO(I)
      DO 11 J=1,NMP
      J6=J*6-5
      J6P5=J6+5
   11 READ(3)((D(J1,J2),J2=1,NM),J1=J6,J6P5)
      NMP6=NMP*6
      WRITE(10)NMP6,NM,((D(J1,J2),J2=1,NM),J1=1,NMP6)
      GO TO 10
  110 WRITE(10)MODID
   10 CONTINUE
C
C* STEP 2     B(I,1),I=2,11
C
      DO 20 I=2,11
      INDEX=INDEX+1
      IF(MODID(I).EQ.0 )GO TO 120
      READ(9)NM1,((X(J1,J2),J2=1,NM1),J1=1,6)
      IF(I.EQ.11)CALL MCPY(X,U,6,NM1,6)
      NMP=NMPO(I)
      CALL CXD(C,X,D,NM1,INDEX,NMP)
      GO TO 20
  120 WRITE(10)MODID
   20 CONTINUE
C
```

```
C* STEP 3     B(I,11),I=12,14
C
      DO 30 I=12,14
      INDEX=INDEX+1
      IF(MODID(I).EQ.0 .OR. NMO(11).EQ.0)GO TO 130
      READ(4)((R(J1,J2),J2=1,6),J1=1,6)
      READ(9)NM2,((X(J1,J2),J2=1,NM2),J1=1,6)
      IF(I.EQ.14)CALL MCPY(X,V,6,NM2,6)
      NMP=NMPO(I)
      CALL CXD(C,X,D,NM2,INDEX,NMP)
      NMP6 =NMP*6
      CALL MPRD(C,R,D,NMP6,6,6,180,6)
      WRITE(8)NMP6,((D(J1,J2),J2=1,6),J1=1,NMP6)
      GO TO 30
  130 WRITE(10)MODID
   30 CONTINUE
C
C* STEP 4     B(15,14)
C
      INDEX=INDEX+1
      IF(MODID(15).EQ.0 .OR. NMO(14).EQ.0)GO TO 140
      READ(4)((S(J1,J2),J2=1,6),J1=1,6)
      CALL MPRD(S,R,T,6,6,6,6,6)
      READ(9)NM,((X(J1,J2),J2=1,NM),J1=1,6)
      NMP=NMPO(15)
      CALL CXD(C,X,D,NM ,INDEX,NMP)
      NMP61=NMP*6
      CALL MPRD(C,T,D,NMP61,6,6,180,6)
      WRITE(8)NMP61,((D(J1,J2),J2=1,6),J1=1,NMP61)
      CALL MPRD(C,S,E,NMP61,6,6,180,6)
      GO TO 40
  140 WRITE(10)MODID
C
C* STEP 5     B(16,14)
C
   40 INDEX=INDEX+1
      IF(MODID(16).EQ.0 .OR. NMO(14).EQ.0)GO TO 180
      READ(4)((S(J1,J2),J2=1,6),J1=1,6)
      CALL MPRD(S,R,T,6,6,6,6,6)
      READ(9)NM3,((W(J1,J2),J2=1,NM3),J1=1,6)
      NMP=NMPO(16)
      CALL CXD(C,W,D,NM3,INDEX,NMP)
      NMP62=NMP*6
```

```
      CALL MPRD(C,T,D,NMP62,6,6,180,6)
      WRITE(8)NMP62,((D(J1,J2),J2=1,6),J1=1,NMP62)
      CALL MPRD(C,S,F,NMP62,6,6,180,6)
      GO TO 50
  180 WRITE(10)MODID
C
C* STEP 6     B(17,16)
C
   50 INDEX=INDEX+1
      IF(MODID(17).EQ.0 .OR. NMO(16).EQ.0)GO TO 360
      READ(4)((T1(J1,J2),J2=1,6),J1=1,6)
      CALL MPRD(T1,T,R,6,6,6,6,6)
      READ(9)NM,((X(J1,J2),J2=1,NM),J1=1,6)
      NMF=NMPO(17)
      CALL CXD(C,X,D,NM ,INDEX,NMP)
      NMP6 =NMP*6
      CALL MPRD(C,R,D,NMP6,6,6,180,6)
      WRITE(8)NMP6 ,((D(J1,J2),J2=1,6),J1=1,NMP6)
  360 IF(MODID(15).EQ.0 .OR. NMO(15).EQ.0)GO TO 361
      WRITE(8)NMP61,((E(J1,J2),J2=1,6),J1=1,NMP61)
  361 IF(MODID(16).EQ.0 .OR. NMO(16).EQ.0)GO TO 160
      WRITE(8)NMP62,((F(J1,J2),J2=1,6),J1=1,NMP62)
      IF(MODID(17).EQ.0 .OR. NMO(17).EQ.0)GO TO 160
      CALL MPRD(T1,S,T,6,6,6,6,6)
      CALL MPRD(C,T,D,NMP6,6,6,180,6)
      WRITE(8)NMP6,((D(J1,J2),J2=1,6),J1=1,NMP6)
      CALL MPRD(C,T1,D,NMP6,6,6,180,6)
      WRITE(8)NMP6,((D(J1,J2),J2=1,6),J1=1,NMP6)
      GO TO 60
  160 WRITE(10)MODID
C
C* STEP 7     B(I,1),I=12,17
C
   60 REWIND 8
      DO 61 I=12,17
      INDEX=INDEX+1
      IF(MODID(I).EQ.0 )GO TO 161
      CALL Q(C,U,D,NM1,INDEX)
      GO TO 61
  161 WRITE(10)MODID
   61 CONTINUE
C
C* STEP 8     B(I,11),I=15,17
```

```
C
      DO 70 I=15,17
      INDEX=INDEX+1
      IF(MODID(I).EQ.0 .OR. NMO(11).EQ.0)GO TO 170
      CALL Q(C,V,D,NM2,INDEX)
      GO TO 70
  170 WRITE(10)MODID
   70 CONTINUE
C
C* STEP 9     B(17,14)
C
      IF(MODID(17).EQ.0 .OR. NMO(14).EQ.0)RETURN
      INDEX=INDEX+1
      CALL Q(C,W,D,NM3,INDEX)
      RETURN
      END
```

```
SUBROUTINE Q(A,B,C,N,M)                                         L0005790   58200000
DIMENSION A(180,6),B(6,30),C(180,30)                            L0005800   58300000
READ(8)NMP6,((A(I,J),J=1,6),I=1,NMP6)                           L0005810   58400000
CALL MPRD(A,B,C,NMP6,6,N,180,6)                                 L0005820   58500000
WRITE(10)NMP6,N,((C(I,J),J=1,N),I=1,NMP6)                       L0005830   58600000
RETURN                                                          L0005840   58700000
END                                                             L0005850   58800000
```

F

```
      SUBROUTINE CXD(C,X,D,NM,INDEX,NMP)                               L0005860  58900000
      DIMENSION C(180,6),X(6,6),D(180,30)                              L0005870  59000000
      DO 20 J=1,NMP                                                    L0005880  59100000
      J6=J*6-5                                                         L0005890  59200000
      J6P5=J6+5                                                        L0005900  59300000
   20 READ(2)((C(I,K),K=1,6),I=J6,J6P5)                                L0005910  59400000
      NMP6=NMP*6                                                       L0005920  59500000
      CALL MPRD(C,X,D,NMP6,6,NM,180,6)                                 L0005930  59600000
      WRITE(10)NMP6,NM,((D(I,J),J=1,NM),I=1,NMP6)                      L0005940  59700000
      RETURN                                                           L0005950  59800000
      END                                                              L0005960  59900000
```

```
      SUBROUTINE BTMB(D,R,S,SUM)                                          L0005970  60000000
      COMMON  /A1/MODID,NM,NMPO(17)                                       L0005980  60100000
      DIMENSION D(300),R(180,30),S(180,31),SUM(30,30),MODID(17),NM(17)              60200000
C                                                                         L0005990  60300000
C  BTMB CCMPUTES (B-TRANSPOSE)(M)(B) LEAVING THE RESULT ON FILE 8.         L0006000  60400000
C       IT MUST BE RE-ORDERED BEFORE ENTERING *LATE*.                     L0006010  60500000
      REWIND 8                                                            L0006020  60600000
      REWIND 10                                                           L0006030  60700000
      REWIND 1                                                            L0006040  60800000
C* (1,1)                                                                  L0006050  60900000
      K=NM(1)                                                             L0006060  61000000
      CALL ZERO(SUM,K,K)                                                  L0006070  61100000
      DO 10 I=1,17                                                        L0006080  61200000
      IF(MODID(I).EQ.0)GO TO 10                                           L0006090  61300000
      INDEX1=16+I                                                         L0006100  61400000
      IF(I.EQ.1)INDEX1=1                                                  L0006110  61500000
      IF(I.GT.11)INDEX1=INDEX1+6                                          L0006120  61600000
      CALL RTDS(K,K,INDEX1,INDEX1,D,R,S(1,2),S,I)                         L0006130  61700000
      CALL ADD(SUM,S,K,K)                                                 L0006140  61800000
   10 CONTINUE                                                            L0006150  61900000
      WRITE(8)K,K,((SUM(I,J),I=1,K),J=1,K)                                L0006160  62000000
C* (2-10,1)                                                               L0006170  62100000
      DO 20 I=2,10                                                        L0006180  62200000
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 20                           L0006190  62300000
      INDEX1=16+I                                                         L0006200  62400000
      L=NM(I)                                                             L0006210  62500000
      CALL RTDS(L,K,INDEX1,I,D,R,S(1,2),S,I)                              L0006220  62600000
      WRITE(8)L,K,((S(I1,J),I1=1,L),J=1,K)                                L0006230  62700000
   20 CONTINUE                                                            L0006240  62800000
C* (11,1)                                                                 L0006250  62900000
      L=NM(11)                                                            L0006260  63000000
      CALL ZERO(SUM,L,K)                                                  L0006270  63100000
      IF(MODID(11).EQ.0 .OR. NM(11).EQ.0)GO TO 200                        L0006280  63200000
      CALL RTDS(L,K,27,11,D,R,S(1,2),S,11)                                L0006290  63300000
      CALL ADD(SUM,S,L,K)                                                 L0006300  63400000
      DO 30 I=12,17                                                       L0006310  63500000
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 30                           L0006320  63600000
      INDEX1=22+I                                                         L0006330  63700000
      INDEX2=16+I                                                         L0006340  63800000
      IF(I.GT.14)INDEX2=INDEX2+9                                          L0006350  63900000
      CALL RTDS(L,K,INDEX1,INDEX2,D,R,S(1,2),S,I)                         L0006360  64000000
      CALL ADD(SUM,S,L,K)                                                 L0006370  64100000
```

```
   30 CONTINUE
      WRITE(8)L,K,((SUM(I,J),I=1,L),J=1,K)
C* (11,11)
      CALL  ZERO(SUM,L,L)
      CALL RTDS(L,L,11,11,D,R,S(1,2),S,11)
      CALL ADD(SUM,S,L,L)
      DO 35 I=12,17
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 35
      INDEX2=16+I
      IF(I.GT.14)INDEX2=INDEX2+9
      CALL RTDS(L,L,INDEX2,INDEX2,D,R,S(1,2),S,I)
      CALL ADD(SUM,S,L,L)
   35 CONTINUE
      WRITE(8)L,L,((SUM(I,J),I=1,L),J=1,L)
C* (12,1)
      M=NM(11)
      IF(MODID(12).EQ.0 .OR. NM(12).EQ.0)GO TO 41
      L=NM(12)
      CALL RTDS(L,K,34,12,D,R,S(1,2),S,12)
      WRITE(8)L,K,((S(I,J),I=1,L),J=1,K)
C* (12,11)
      CALL RTDS(L,M,28,12,D,R,S(1,2),S,12)
      WRITE(8)L,M,((S(I,J),I=1,L),J=1,M)
C* (13,1)
   41 IF(MODID(13).EQ.0 .OR. NM(13).EQ.0)GO TO 42
      L=NM(13)
      CALL RTDS(L,K,35,13,D,R,S(1,2),S,13)
      WRITE(8)L,K,((S(I,J),I=1,L),J=1,K)
C* (13,11)
      CALL RTDS(L,M,29,13,D,R,S(1,2),S,13)
      WRITE(8)L,M,((S(I,J),I=1,L),J=1,M)
C* (14,1)
   42 IF(MODID(14).EQ.0 .OR. NM(14).EQ.0)GO TO 200
      L=NM(14)
      CALL  ZERO(SUM,L,K)
      CALL RTDS(L,K,36,14,D,R,S(1,2),S,14)
      CALL ADD(SUM,S,L,K)
      DO 45 I=15,17
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 45
      INDEX1=22+I
      INDEX2=16+I
      IF(I.EQ.17)INDEX2=INDEX2+10
      CALL RTDS(L,K,INDEX1,INDEX2,D,R,S(1,2),S,I)
```

```
      CALL ADD(SUM,S,L,K)
   45 CONTINUE
      WRITE(8)L,K,((SUM(I,J),I=1,L),J=1,K)
C* (14,11)
      CALL ZERO(SUM,L,M)
      CALL RTDS(L,M,30,14,D,R,S(1,2),S,14)
      CALL ADD(SUM,S,L,M)
      DO 48 I=15,17
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 48
      INDEX1=25+I
      INDEX2=16+I
      IF(I.EQ.17)INDEX2=43
      CALL RTDS(L,M,INDEX1,INDEX2,D,R,S(1,2),S,I)
      CALL ADD(SUM,S,L,M)
   48 CONTINUE
      WRITE(8)L,M,((SUM(I,J),I=1,L),J=1,M)
C* (14,14)
      CALL ZERO(SUM,L,L)
      DO 49 I=14,17
      INDEX1=16+I
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 49
      IF(I.EQ.14)INDEX1=14
      IF(I.EQ.17)INDEX1=43
      CALL RTDS(L,L,INDEX1,INDEX1,D,R,S(1,2),S,I)
      CALL ADD(SUM,S,L,L)
   49 CONTINUE
      WRITE(8)L,L,((SUM(I,J),I=1,L),J=1,L)
C* (15,1)
      N=NM(14)
   50 IF(MODID(15).EQ.0 .OR. NM(15).EQ.0)GO TO 60
      L=NM(15)
      CALL RTDS(L,K,37,15,D,R,S(1,2),S,15)
      WRITE(8)L,K,((S(I,J),I=1,L),J=1,K)
C* (15,11)
      CALL RTDS(L,M,40,15,D,R,S(1,2),S,15)
      WRITE(8)L,M,((S(I,J),I=1,L),J=1,M)
C* (15,14)
      CALL RTDS(L,N,31,15,D,R,S(1,2),S,15)
      WRITE(8)L,N,((S(I,J),I=1,L),J=1,N)
C* (16,1)
   60 IF(MODID(16).EQ.0 .OR. NM(16).EQ.0)GO TO 200
      L=NM(16)
      CALL ZERO(SUM,L,K)
```

```
      CALL RTDS(L,K,38,16,D,R,S(1,2),S,16)
      CALL ADD(SUM,S,L,K)
      IF(MODID(17).EQ.0 .OR. NM(17).EQ.0)GO TO 62
      CALL RTDS(L,K,39,33,D,R,S(1,2),S,17)
      CALL ADD(SUM,S,L,K)
   62 WRITE(8)L,K,((SUM(I,J),I=1,L),J=1,K)
C* (16,11)
      CALL ZERO(SUM,L,M)
      CALL RTDS(L,M,41,16,D,R,S(1,2),S,16)
      CALL ADD(SUM,S,L,M)
      IF(MODID(17).EQ.0 .OR. NM(17).EQ.0)GO TO 64
      CALL RTDS(L,M,42,33,D,R,S(1,2),S,17)
      CALL ADD(SUM,S,L,M)
   64 WRITE(8)L,M,((SUM(I,J),I=1,L),J=1,M)
C* (16,14)
      CALL ZERO(SUM,L,N)
      CALL RTDS(L,N,32,16,D,R,S(1,2),S,16)
      CALL ADD(SUM,S,L,N)
      IF(MODID(17).EQ.0 .OR. NM(17).EQ.0)GO TO 66
      CALL RTDS(L,N,43,33,D,R,S(1,2),S,17)
      CALL ADD(SUM,S,L,N)
   66 WRITE(8)L,N,((SUM(I,J),I=1,L),J=1,N)
C* (16,16)
      CALL ZERO(SUM,L,L)
      CALL RTDS(L,L,16,16,D,R,S(1,2),S,16)
      CALL ADD(SUM,S,L,L)
      IF(MODID(17).EQ.0 .OR. NM(17).EQ.0)GO TO 68
      CALL RTDS(L,L,33,33,D,R,S(1,2),S,17)
      CALL ADD(SUM,S,L,L)
   68 WRITE(8)L,L,((SUM(I,J),I=1,L),J=1,L)
C* (17,1)
      IF(MODID(17).EQ.0 .OR. NM(17).EQ.0)GO TO 200
      L=NM(17)
      CALL RTDS(L,K,39,17,D,R,S(1,2),S,17)
      WRITE(8)L,K,((S(I,J),I=1,L),J=1,K)
C* (17,11)
      CALL RTDS(L,M,42,17,D,R,S(1,2),S,17)
      WRITE(8)L,M,((S(I,J),I=1,L),J=1,M)
C* (17,14)
      CALL RTDS(L,N,43,17,D,R,S(1,2),S,17)
      WRITE(8)L,N,((S(I,J),I=1,L),J=1,N)
C* (17,16)
      M=NM(16)
```

```
      CALL RTDS(L,M,33,17,D,R,S(1,2),S,17)                              L0007670  77100000
      WRITE(8)L,M,((S(I,J),I=1,L),J=1,M)                                L0007680  77200000
  200 RETURN                                                            L0007690  77300000
      END                                                               L0007700  77400000
```

```
      SUBROUTINE ZERO(SUM,N,M)                                     L0007710   77500000
      DIMENSION SUM(30,30)                                         L0007720   77600000
      DO 10 I=1,N                                                  L0007730   77700000
      DO 10 J=1,M                                                  L0007740   77800000
   10 SUM(I,J)=0.                                                  L0007750   77900000
      RETURN                                                       L0007760   78000000
      END                                                          L0007770   78100000
```

```
      SUBROUTINE RTDS(NM2,NM1,INDEX1,INDEX2,D,R,S,RPREV,INDEX)          L0007780   78200000
      DIMENSION D(300),A(3,30),R(180,30),S(180,30),RPREV(180,31)        L0007790   78300000
      CALL LOC810(INDEX2)                                               L0007800   78400000
      READ(10)NMP6,NM2,((S(I,J),J=1,NM2),I=1,NMP6)                      L0007810   78500000
      NMP=NMP6/6                                                        L0007820   78600000
      NMP10=NMP*10                                                      L0007830   78700000
      CALL LOC811(INDEX)                                                L0007840   78800000
      READ(1)(D(I),I=1,NMP10)                                           L0007850   78900000
      DO 10 I1=1,NMP                                                    L0007860   79000000
      I4=10*I1-9                                                        L0007870   79100000
      I7=(I1-1)*6+1                                                     L0007880   79200000
      I8=I7+2                                                           L0007890   79300000
      DO 20 I5=I7,I8                                                    L0007900   79400000
      DO 20 I3=1,NM2                                                    L0007910   79500000
   20 R(I5,I3)=S(I5,I3)*D(I4)                                           L0007920   79600000
      I6=I8+1                                                           L0007930   79700000
      CALL MPRD(D(I4+1),S(I6,1),A,3,3,NM2,3,180)                        L0007940   79800000
      DO 10 LMN=1,3                                                     L0007950   79900000
      IND=I6+LMN-1                                                      L0007960   80000000
      DO 10 LNM=1,NM2                                                   L0007970   80100000
   10 R(IND,LNM)=A(LMN,LNM)                                             L0007980   80200000
      CALL LOC810(INDEX1)                                               L0007990   80300000
      READ(10)NMP6,NM1,((S(I,J),J=1,NM1),I=1,NMP6)                      L0008000   80400000
      DO 40 I=1,NM1                                                     L0008010   80500000
      DO 40 J=1,NM2                                                     L0008020   80600000
      RPREV(J,I)=0.                                                     L0008030   80700000
      DO 40 K=1,NMP6                                                    L0008040   80800000
   40 RPREV(J,I)=RPREV(J,I)+S(K,I)*R(K,J)                               L0008050   80900000
      RETURN                                                            L0008060   81000000
      END                                                               L0008070   81100000
```

```
      SUBROUTINE MXI(A,B,NMTS,D,NIX,NZERO)                              L0008080  81200000
      DIMENSION A(100,1),B(1),MODID(17),NM(17),D(30,20),NMPO(17)        L0008090  81300000
      COMMCN /A1/MCDID,NM,NMPO                                          L0008100  81400000
      COMMCN/INOUT/IO5,IO6,IOFF                                         L0008110  81500000
C                                                                       L0008120  81600000
C  READ IN DIAGONAL MATRIX OF MODAL MASS FOLLOWED BY                     L0008130  81700000
C           DIAGONAL MATRIX OF EIGENVALUES                              L0008140  81800000
C                                                                       L0008150  81900000
      REWIND 8                                                          L0008160  82000000
      DO 4 I=1,NMTS                                                     L0008170  82100000
      DO 4 J=1,NMTS                                                     L0008180  82200000
    4 A(I,J)=0.                                                         L0008190  82300000
      INMST=1                                                           L0008200  82400000
      DO 60 I=1,17                                                      L0008210  82500000
      INM=NM(I)                                                         L0008220  82600000
      IF(INM.EQ.0)GO TO 60                                              L0008230  82700000
      INMF=INMST+INM -1                                                 L0008240  82800000
      READ(IO5,1)(A(J,J),J=INMST,INMF)                                  L0008250  82900000
      INMST=INMF +1                                                     L0008260  83000000
   60 CONTINUE                                                          L0008270  83100000
  201 INM=NM(1)                                                         L0008280  83200000
      READ(IO5,1)C,(A(I-1,I),I=2,INM)                                   L0008290  83300000
      INMST=INM+1                                                       L0008300  83400000
      DO 80 I=2,17                                                      L0008310  83500000
      INM=NM(I)                                                         L0008320  83600000
      IF(INM.EQ.0)GO TO 80                                              L0008330  83700000
      INMF=INMST+INM-1                                                  L0008340  83800000
      READ(IO5,1)(A(J-1,J),J=INMST,INMF)                                L0008350  83900000
      INMST=INMF+1                                                      L0008360  84000000
   80 CONTINUE                                                          L0008370  84100000
      IF(IOFF.GE.20)GO TO 202                                           L0008380  84200000
      I=1                                                               L0008390  84300000
      INM=NM(1)                                                         L0008400  84400000
      IF(INM.EQ.0)GO TO 75                                              L0008410  84500000
      WRITE(IO6,71)I, I,A(1,1),C                                        L0008420  84600000
      IF(INM.LT.2)GO TO 75                                              L0008430  84700000
      WRITE(IO6,72)  (J,A(J,J),A(J-1,J),J=2,INM)                        L0008440  84800000
      INMST=INM+1                                                       L0008450  84900000
   75 DO 70 I=2,17                                                      L0008460  85000000
      INM=NM(I)                                                         L0008470  85100000
      IF(INM.EQ.0)GO TO 70                                              L0008480  85200000
      INMF=INMST+INM-1                                                  L0008490  85300000
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      WRITE(IO6,73) I,(J,A(J,J),A(J-1,J),J=INMST,INMF)              L0008500  85400000
      INMST=INMF+1                                                  L0008510  85500000
   70 CONTINUE                                                      L0008520  85600000
  202 C=A(1,1)*C                                                    L0008530  85700000
      DO 10 I=2,NMTS                                                L0008540  85800000
   10 A(1,I)=A(I,I)*A(I-1,I)                                        L0008550  85900000
  203 KSUM=0                                                        L0008560  86000000
      L=NM(1)                                                       L0008570  86100000
      CALL DIAG(A,D,L,KSUM,NMTS)                                    L0008580  86200000
      DO 12 I=2,11                                                  L0008590  86300000
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 12                     L0008600  86400000
      L=NM(I)                                                       L0008610  86500000
      CALL OFF(A,L,KSUM,NM(1),0,NMTS)                               L0008620  86600000
      KSUM=KSUM+L                                                   L0008630  86700000
   12 CONTINUE                                                      L0008640  86800000
      IF(MODID(11).EQ.0 .OR. NM(11).EQ.0)GO TO 200                  L0008650  86900000
      KSUM=KSUM-L                                                   L0008660  87000000
      KSUM11=KSUM                                                   L0008670  87100000
      CALL DIAG(A,D,L,KSUM,NMTS)                                    L0008680  87200000
      DO 20 I=12,14                                                 L0008690  87300000
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 20                     L0008700  87400000
      L=NM(I)                                                       L0008710  87500000
      CALL OFF(A,L,KSUM,NM(1),0,NMTS)                               L0008720  87600000
      CALL OFF(A,L,KSUM,NM(11),KSUM11,NMTS)                         L0008730  87700000
      KSUM=KSUM+L                                                   L0008740  87800000
   20 CONTINUE                                                      L0008750  87900000
      IF(MODID(14).EQ.0 .OR. NM(14).EQ.0)GO TO 200                  L0008760  88000000
      KSUM14=KSUM-L                                                 L0008770  88100000
      KSUM=KSUM14                                                   L0008780  88200000
      CALL DIAG(A,D,L,KSUM,NMTS)                                    L0008790  88300000
      DO 30 I=15,16                                                 L0008800  88400000
      IF(MODID(I).EQ.0 .OR. NM(I).EQ.0)GO TO 30                     L0008810  88500000
      L=NM(I)                                                       L0008820  88600000
      CALL OFF(A,L,KSUM,NM(1),0,NMTS)                               L0008830  88700000
      CALL OFF(A,L,KSUM,NM(11),KSUM11,NMTS)                         L0008840  88800000
      CALL OFF(A,L,KSUM,NM(14),KSUM14,NMTS)                         L0008850  88900000
      IF(I.EQ.15)KSUM=KSUM+L                                        L0008860  89000000
   30 CONTINUE                                                      L0008870  89100000
      IF(MODID(16).EQ.0 .OR. NM(16).EQ.0)GO TO 200                  L0008880  89200000
      KSUM16=KSUM                                                   L0008890  89300000
      CALL DIAG(A,D,L,KSUM,NMTS)                                    L0008900  89400000
      IF(MODID(17).EQ.0 .OR. NM(17).EQ.0)GO TO 200                  L0008910  89500000
      L=NM(17)                                                      L0008920  89600000
```

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      CALL OFF(A,L,KSUM,NM(1),0,NMTS)                                   L0008930  89700000
      CALL OFF(A,L,KSUM,NM(11),KSUM11,NMTS)                             L0008940  89800000
      CALL OFF(A,L,KSUM,NM(14),KSUM14,NMTS)                             L0008950  89900000
      CALL OFF(A,L,KSUM,NM(16),KSUM16,NMTS)                             L0008960  90000000
  200 NIX=0                                                             L0008970  90100000
      READ(IU5,52)NZERO                                                 L0008980  90200000
      IF(NZERO.EQ.0)GO TO 987                                           L0008990  90300000
      CALL CHEAP(A,NMTS,NZERO,C,D,NIX)                                  L0009000  90400000
      IF(NIX.LT.0)RETURN                                                MXI00010  90500000
  987 REWIND 9                                                          MXI00020  90600000
      WRITE(9)((A(I,J),J=1,I),I=1,NMTS)                                 MXI00030  90700000
  204 A(1,1)=C                                                          MXI00040  90800000
      L=1                                                               MXI00050  90900000
      DO 50 I=2,NMTS                                                    MXI00060  91000000
      L=L+1                                                             MXI00070  91100000
      K=(I*(I+1))/2                                                     MXI00080  91200000
      KM=K-1                                                            MXI00090  91300000
      DO 7 J=L,KM                                                       MXI00100  91400000
    7 B(J)=0.                                                           MXI00110  91500000
      B(K)=A(1,I)                                                       MXI00120  91600000
   50 L=K                                                               MXI00130  91700000
      RETURN                                                            MXI00140  91800000
    1 FORMAT(3(8X,E15.8,1X))                                            MXI00150  91900000
   71 FORMAT(//* MODULE  FREQ NO.    MODAL MASS      EIGENVALUE*/33X,   MXI00160  92000000
     * *FREQUENCY SQUARED*//3X,I2,6X,I3,3X,2E16.7)                      MXI00170  92100000
   72 FORMAT(11X,I3,3X,2E16.7)                                                    92200000
   73 FORMAT(/ I5,6X,I3,3X,2E16.7/(11X,I3,3X,2E16.7))                             92300000
   52 FORMAT(I1)                                                        MXI00200  92400000
      END                                                               MXI00210  92500000
```

```
      SUBROUTINE DIAG(A,D,N,M,NMTS)                                     MXI00220  92600000
      DIMENSION A(100,1),D(30,1)                                        MXI00230  92700000
      READ(8)N,N,((D(I,J),I=1,N),J=1,N)                                 MXI00240  92800000
      DO 10 I=1,N                                                       MXI00250  92900000
      DO 10 J=1,I                                                       MXI00260  93000000
      I1=M+I                                                            MXI00270  93100000
      I2=M+J                                                            MXI00280  93200000
   10 A(I1,I2)=D(I,J)                                                   MXI00290  93300000
      M=M+N                                                             MXI00300  93400000
      RETURN                                                            MXI00310  93500000
      END                                                               MXI00320  93600000
```

```
      SUBROUTINE OFF(A,L,LSUM,M,MSUM,NMTS)                              MXI00330  93700000
      DIMENSION A(100,1)                                                MXI00340  93800000
      LK=L+LSUM                                                         MXI00350  93900000
      MK=M+MSUM                                                         MXI00360  94000000
      LSUMP1=LSUM+1                                                     MXI00370  94100000
      MSUMP1=MSUM+1                                                     MXI00380  94200000
      READ(8)L,M,((A(I,J),I=LSUMP1,LK),J=MSUMP1,MK)                     MXI00390  94300000
      RETURN                                                            MXI00400  94400000
      END                                                               MXI00410  94500000
```

```
      SUBROUTINE CHEAP(A,NMTS,NZERO,C,DEQ,NIX)                          MXI00420  94600000
      DIMENSION A(100,1),DEQ(400)                                       MXI00430  94700000
      COMMON/INOUT/IO5,IO6,IOFF                                         MXI00440  94800000
      IJ=0                                                              MXI00450  94900000
      DO 53 I=1,NZERO                                                   MXI00460  95000000
      DO 53 J=1,I                                                       MXI00470  95100000
      IJ=IJ+1                                                           MXI00480  95200000
   53 DEQ(IJ)=A(I,J)                                                    MXI00490  95300000
      IF(NZERO-1)9,2,3                                                  MXI00500  95400000
    9 NIX=-8                                                            MXI00510  95500000
      GO TO 4                                                           MXI00520  95600000
    2 DEQ(1)=1./DEQ(1)                                                  MXI00530  95700000
      GO TO 54                                                          MXI00540  95800000
    3 CALL INCH(DEQ,NZERO,DEQ(50),NIX)                                  MXI00550  95900000
      IF(NIX.EQ.0)GO TO 54                                              MXI00560  96000000
    4 WRITE(IO6,1)NIX                                                   MXI00570  96100000
      RETURN                                                            MXI00580  96200000
   54 NMTS1=NMTS-NZERO                                                  MXI00590  96300000
      DEQ(101)=C                                                        MXI00600  96400000
      DO 56 I=2,NMTS                                                    MXI00610  96500000
   56 DEQ(I+100)=A(1,I)                                                 MXI00620  96600000
      IJ=0                                                              MXI00630  96700000
      DO 57 I=1,NZERO                                                   MXI00640  96800000
      DO 57 J=1,I                                                       MXI00650  96900000
      IJ=IJ+1                                                           MXI00660  97000000
      A(I,J)=DEQ(IJ)                                                    MXI00670  97100000
      A(J,I)=A(I,J)                                                     MXI00680  97200000
   57 CONTINUE                                                          MXI00690  97300000
      NZER1=NZERO+1                                                     MXI00700  97400000
      DO 58 I=NZER1,NMTS                                                MXI00710  97500000
      DO 58 J=1,NZERO                                                   MXI00720  97600000
      A(J,I)=0.                                                         MXI00730  97700000
      DO 58 K=1,NZERO                                                   MXI00740  97800000
   58 A(J,I)=A(J,I)+A(J,K)*A(I,K)                                       MXI00750  97900000
      DO 61 I=NZER1,NMTS                                                MXI00760  98000000
   61 DEQ(I)=A(I,I)                                                     MXI00770  98100000
      DO 59 J=NZER1,NMTS                                                MXI00780  98200000
      DO 59 I=J,NMTS                                                    MXI00790  98300000
      A(J,I)=0.                                                         MXI00800  98400000
      DO 59 K=1,NZERO                                                   MXI00810  98500000
   59 A(J,I)=A(J,I)+A(J,K)*A(K,I)                                       MXI00820  98600000
      DO 62 I=1,NMTS1                                                   MXI00830  98700000
```

```
62 A(I,I)=DEQ(I+NZERO)-A(I+NZERO,I+NZERO)                    MXI00840  98800000
   DO 63 I=2,NMTS1                                            MXI00850  98900000
   IM1=I-1                                                    MXI00860  99000000
   DO 63 J=1,IM1                                              MXI00870  99100000
63 A(I,J)=A(I+NZERO,J+NZERO)-A(J+NZERO,I+NZERO)              MXI00880  99200000
   REWIND 2                                                   MXI00890  99300000
   WRITE(2)NZERO,((A(I,J),I=1,NZERO),J=NZER1,NMTS)            MXI00900  99400000
   C=DEQ(101+NZERO)                                           MXI00910  99500000
   DO 64 I=NZER1,NMTS                                         MXI00920  99600000
   INZ=I-NZERO +1                                             MXI00930  99700000
   IJ=I+101                                                   MXI00940  99800000
64 A(1,INZ)=DEQ(IJ)                                          MXI00950  99900000
   NMTS=NMTS1                                                 MXI00960 100000000
   RETURN                                                     MXI00970 100100000
 1 FORMAT(/* INVERSION FAILED*/* NIX = *,I2)                  MXI00980 100200000
   END                                                        MXI00990 100300000
```

```
      SUBROUTINE LATE (N,A,NUMEIG,TOL,Q,NIX,B,NUMVAL)                   MXI01000 100400000
C                                                                       MXI01010 100500000
C  SOLVE THE EIGENVALUE PROBLEM:                                        MXI01020 100600000
C        (A)(X)=(LAMBDA)(B)(X)                                          MXI01030 100700000
C        WHERE A IS THE NXN MASS MATRIX                                 MXI01040 100800000
C         AND  B IS THE NXN STIFFNESS MATRIX                            MXI01050 100900000
C                                                                       MXI01060 101000000
C   THE STIFFNESS MATRIX IS PASSED VIA THE CALLING SEQUENCE             MXI01070 101100000
C   THE MASS  MATRIX IS STORED ON DISK FILE NO. 9                       MXI01080 101200000
C                                                                       MXI01090 101300000
      DIMENSION A(1),Q(1),B(1)                                          MXI01100 101400000
      COMMCN /WINTER/INDIC8                                             MXI01110 101500000
      COMMCN /BOND/M,L                                                  MXI01120 101600000
      COMMON /INOUT/IO5,IO6,IOFFC                                       MXI01130 101700000
      REWIND 3                                                          MXI01140 101800000
      REWIND 9                                                          MXI01150 101900000
      INDIC8=-1                                                         MXI01160 102000000
      M=N                                                               MXI01170 102100000
      L=1                                                               MXI01180 102200000
      INDEX=(N*N+N)/2+1                                                 MXI01190 102300000
      INDEX1=INDEX-1                                                    MXI01200 102400000
    6 NIX=0                                                             MXI01210 102500000
C                                                                       MXI01220 102600000
C   FORM CHOLESKY DECOMPOSITICN OF B MATRIX                             MXI01230 102700000
C                                                                       MXI01240 102800000
      CALL FUTILE(A,N,NIX)                                              MXI01250 102900000
      IF(NIX)2,3,3                                                      MXI01260 103000000
    2 WRITE(IO6,41)                                                     MXI01270 103100000
      RETURN                                                            MXI01280 103200000
C                                                                       MXI01290 103300000
C   WRITE OUT L-MATRIX TO DISK FILE NO. 3                               MXI01300 103400000
C                                                                       MXI01310 103500000
    3 IOFF=1                                                            MXI01320 103600000
      DO 1 I=1,N                                                        MXI01330 103700000
      J2=IOFF+I-1                                                       MXI01340 103800000
      WRITE(3)(A(J),J=IOFF,J2)                                          MXI01350 103900000
    1 IOFF=IOFF+I                                                       MXI01360 104000000
      REWIND 3                                                          MXI01370 104100000
C                                                                       MXI01380 104200000
C   READ IN A-MATRIX                                                    MXI01390 104300000
C                                                                       MXI01400 104400000
      READ(9)(A(I),I=1,INDEX1)                                          MXI01410 104500000
```

```
      REWIND 9                                                          MXI01420 104600000
C                                                                       MXI01430 104700000
C     FORM A-MATRIX COLUMN INVERSES - STORE IN Q                        MXI01440 104800000
C                                                                       MXI01450 104900000
    7 DO 10 I=1,N                                                       MXI01460 105000000
      READ(3)(Q(J),J=1,I)                                               MXI01470 105100000
      X=-Q(I)                                                           MXI01480 105200000
      Q(I)=-1.                                                          MXI01490 105300000
      DO 20 J=1,I                                                       MXI01500 105400000
   20 Q(J)=Q(J)/X                                                       MXI01510 105500000
   10 CALL DAGGER(A,N,Q,I,A(INDEX))                                     MXI01520 105600000
C                                                                       MXI01530 105700000
C     STORE (L)(A)(L-TRANSPOSE) IN A FORM SUITABLE FOR SYMEIG           MXI01540 105800000
C        WHERE L IS THE INVERSE OF THE CHOLESKY MATRIX                  MXI01550 105900000
C                                                                       MXI01560 106000000
      CALL SWITCH(A,N)                                                  MXI01570 106100000
      CALL SYMEIG(A,N,1,NUMVAL,Q,TOL,A(INDEX),I,1,N)                    MXI01580 106200000
      DO 58 I=1,NUMVAL                                                  MXI01590 106300000
   58 B(I)=SQRT(1./ABS(Q(I)))                                           MXI01600 106400000
      IF(IOFFC.GE.25)GO TO 201                                          MXI01610 106500000
      WRITE(IO6,56)(B(I),I=1,NUMVAL)                                    MXI01620 106600000
C                                                                       MXI01630 106700000
C     EIGENVALUES ARE IN Q                                              MXI01640 106800000
C                                                                       MXI01650 106900000
  201 DO 30 I=1,NUMEIG                                                  MXI01660 107000000
      CALL SYMVEC(A,N,1,NUMVAL,Q,TOL,A(INDEX),I,1,N)                    MXI01670 107100000
      IN=INDEX1+N                                                       MXI01680 107200000
   30 WRITE(9)(A(IND),IND=INDEX,IN)                                     MXI01690 107300000
      REWIND 9                                                          MXI01700 107400000
      NAP=0                                                             MXI01710 107500000
      DO 27 I=1,NUMEIG                                                  MXI01720 107600000
      J1=NAP+1                                                          MXI01730 107700000
      J2=NAP+N                                                          MXI01740 107800000
      READ(9)(A(IND),IND=J1,J2)                                         MXI01750 107900000
   27 NAP=NAP+N                                                         MXI01760 108000000
      CALL ORTHON(A,N,N,NUMEIG)                                         MXI01770 108100000
      REWIND 9                                                          MXI01780 108200000
      NAP=0                                                             MXI01790 108300000
      DO 28 I=1,NUMEIG                                                  MXI01800 108400000
      J1=NAP+1                                                          MXI01810 108500000
      J2=NAP+N                                                          MXI01820 108600000
      WRITE(9)(A(IND),IND=J1,J2)                                                 108700000
   28 NAP=NAP+N                                                         MXI01840 108800000
```

```
      REWIND 9                                                          MXI01850 108900000
      REWIND 3                                                          MXI01860 109000000
      IOFF=1                                                            MXI01870 109100000
      DO 40 I=1,N                                                       MXI01880 109200000
      J2=IOFF+I-1                                                       MXI01890 109300000
      READ(3)(A(J),J=IOFF,J2)                                           MXI01900 109400000
   40 IOFF=IOFF+I                                                       MXI01910 109500000
      REWIND 3                                                          MXI01920 109600000
      DO 50 I=1,NUMEIG                                                  MXI01930 109700000
      READ(9)(Q(J),J=1,N)                                               MXI01940 109800000
      CALL TRIEQ(A,Q)                                                   MXI01950 109900000
   50 WRITE(3)(Q(J),J=1,N)                                              MXI01960 110000000
      RETURN                                                            MXI01970 110100000
   41 FORMAT(50H1REDUCED STIFFNESS MATRIX IS NOT POSITIVE DEFINITE )             110200000
   56 FORMAT(//* CIRCULAR FREQUENCIES OF THE COUPLED SYSTEM*/(6E14.6))  MXI01990 110300000
      END                                                               MXI02000 110400000
```

```
      SUBROUTINE ORTHON(Y,L,N,K)                                       MXI02010 110500000
      DIMENSION Y(L,1)                                                 MXI02020 110600000
      DOUBLE PRECISION DSUM,DSOM,DSAM                                  MXI02030 110700000
      DO 1 I=1,K                                                       MXI02040 110800000
      IF(I.EQ.1) GO TO 2                                               MXI02050 110900000
      DO 3 J=I,K                                                       MXI02060 111000000
      DSOM =0.D0                                                       MXI02070 111100000
      DO 5 II=1,N                                                      MXI02080 111200000
      DSUM=Y(II,J)                                                     MXI02090 111300000
      DSAM=Y(II,I-1)                                                   MXI02100 111400000
    5 DSOM=DSOM+DSUM*DSAM                                              MXI02110 111500000
      DO 6 II=1,N                                                      MXI02120 111600000
    6 Y(II,J)=Y(II,J)-DSOM*Y(II,I-1)                                   MXI02130 111700000
    3 CONTINUE                                                         MXI02140 111800000
    2 DSUM=0.D0                                                        MXI02150 111900000
      DO 7 II=1,N                                                      MXI02160 112000000
      DSAM=Y(II,I)                                                     MXI02170 112100000
    7 DSUM=DSUM+DSAM*DSAM                                              MXI02180 112200000
      DSUM=DSQRT(DSUM)                                                 MXI02190 112300000
      DO 8 II=1,N                                                      MXI02200 112400000
    8 Y(II,I)=Y(II,I)/DSUM                                             MXI02210 112500000
    1 CONTINUE                                                         MXI02220 112600000
      RETURN                                                           MXI02230 112700000
      END                                                              MXI02240 112800000
```

```
      SUBROUTINE FREE(A,N,NZERO,NUMEIG,B)                               MXI02250 112900000
      DIMENSION A(NZERO,1),B(1)                                         MXI02260 113000000
      NZER1=NZERO+1                                                     MXI02270 113100000
      NMTS=N+NZERO                                                      MXI02280 113200000
      REWIND 2                                                          MXI02290 113300000
      REWIND 8                                                          MXI02300 113400000
      READ(2)NZERO,((A(I,J),I=1,NZERO),J=1,N)                           MXI02310 113500000
      REWIND 3                                                          MXI02320 113600000
      DO 10 II=1,NUMEIG                                                 MXI02330 113700000
      READ(3)(B(I),I=NZER1,NMTS)                                        MXI02340 113800000
      CALL MPRD(A,B(NZER1),B,NZERO,N,1,NZERO,1)                         MXI02350 113900000
      DO 20 I=1,NZERO                                                   MXI02360 114000000
   20 B(I)=-B(I)                                                        MXI02370 114100000
   10 WRITE(8)(B(I),I=1,NMTS)                                           MXI02380 114200000
      N=NMTS                                                            MXI02390 114300000
      RETURN                                                            MXI02400 114400000
      END                                                               MXI02410 114500000
```

```
      SUBROUTINE EIGOUT(N,NZERO,NUMEIG,A,V,R,S,NTNMP,B)
      COMMCN  /A1/MODID(17),NMO(17),NMPO(17)
      COMMCN /INOUT/I05,I06,IOFF,LL
      DIMENSION A(180,30),V(100),R(600),S(600),B(1)
      I38=3
      IF(NZERO.GT.0)I38=8
      REWIND I38
      WRITE(LL)NUMEIG,(B(I),I=1,NUMEIG)
      DO 1 II=1,NUMEIG
      READ(I38)(V(I),I=1,N)
      CALL LOC810(1)
      READ(10)NMP6,NM,((A(I,J),J=1,NM),I=1,NMP6)
      NTNMP6=NTNMP*6
      DO 2 I=NMP6,NTNMP6
    2 S(I)=0.
      CALL MPRD(A,V,S,NMP6,NM,1,180,100)
      IPOINT=1
      IOLD=NMO(1)
      JOLD=NMPO(1)*6
      JPOINT=1
      DO 10 IJ=2,17
      IF(MODID(IJ).EQ.0 .OR. NMO(IJ).EQ.0)GO TO 10
      IPOINT=IPOINT+IOLD
      JPOINT=JPOINT+JOLD
      INDEX=IJ+16
      IF(IJ.GE.12)INDEX=INDEX+6
      CALL LOC810(INDEX)
      READ(10)NMP6,NM,((A(I,J),J=1,NM),I=1,NMP6)
      CALL MPRD(A,V,R(JPOINT),NMP6,NM,1,180,100)
      CALL ADD(S(JPOINT),R(JPOINT),NMP6,1)
      CALL LOC810(IJ)
      READ(10)NMP6,NM,((A(I,J),J=1,NM),I=1,NMP6)
      CALL MPRD(A,V(IPOINT),R(JPOINT),NMP6,NM,1,180,100)
      CALL ADD(S(JPOINT),R(JPOINT),NMP6,1)
      IF(IJ.EQ.11)I11=IPOINT
      IF(IJ.LT.12)GO TO 100
      INDEX=IJ+16
      IF(IJ.GT.14)INDEX=INDEX+9
      CALL LOC810(INDEX)
      READ(10)NMP6,NM,((A(I,J),J=1,NM),I=1,NMP6)
      CALL MPRD(A,V(I11),R(JPOINT),NMP6,NM,1,180,100)
      CALL ADD(S(JPOINT),R(JPOINT),NMP6,1)
```

```
      IF(IJ.EQ.14)I14=IPOINT                                            MXI02840 118800000
      IF(IJ.LT.15)GO TO 100                                             MXI02850 118900000
      INDEX=IJ+16                                                       MXI02860 119000000
      IF(IJ.EQ.17)INDEX=INDEX+10                                        MXI02870 119100000
      CALL LOC810(INDEX)                                                MXI02880 119200000
      READ(10)NMP6,NM,((A(I,J),J=1,NM),I=1,NMP6)                        MXI02890 119300000
      CALL MPRD(A,V(I14),R(JPOINT),NMP6,NM,1,180,100)                   MXI02900 119400000
      CALL ADD(S(JPOINT),R(JPOINT),NMP6,1)                              MXI02910 119500000
      IF(IJ.EQ.16)I16=IPOINT                                            MXI02920 119600000
      IF(IJ.LT.17)GO TO 100                                             MXI02930 119700000
      CALL LOC810(33)                                                   MXI02940 119800000
      READ(10)NMP6,NM,((A(I,J),J=1,NM),I=1,NMP6)                        MXI02950 119900000
      CALL MPRD(A,V(I16),R(JPOINT),NMP6,NM,1,180,100)                   MXI02960 120000000
      CALL ADD(S(JPOINT),R(JPOINT),NMP6,1)                              MXI02970 120100000
  100 JOLD=NMPO(IJ)*6                                                   MXI02980 120200000
      IOLD=NMO(IJ)                                                      MXI02990 120300000
   10 CONTINUE                                                          MXI03000 120400000
      JPOINT=NTNMP*6                                                    MXI03010 120500000
C                                                                       MXI03020 120600000
C  WRITE EIGENVECTOR PHI-X                                              MXI03030 120700000
C                                                                       MXI03040 120800000
      DO 75 IR=1,JPOINT                                                 MXI03050 120900000
   75 S(IR)=S(IR)*B(II)                                                 MXI03060 121000000
      WRITE(LL)JPOINT,(S(I),I=1,JPOINT)                                 MXI03070 121100000
      IF(IOFF.GE.30)GO TO 1                                             MXI03080 121200000
      WRITE(IO6,21)II                                                   MXI03090 121300000
      DO 50 I=1,JPOINT,6                                                MXI03100 121400000
      IM1=I-1                                                           MXI03110 121500000
      IP=IM1/6+1                                                        MXI03120 121600000
   50 WRITE(IO6,22)IP,(S(IM1+IR),IR=1,6)                                MXI03130 121700000
    1 CONTINUE                                                          MXI03140 121800000
      RETURN                                                            MXI03150 121900000
   21 FORMAT(//* MODE SHAPE *,I2,* OF THE COUPLED SYSTEM IN GLOBAL COORDMXI03160 122000000
     *INATES NORMALIZED TO THE UNIT MODAL MASS*//                       MXI03170 122100000
     *  * MASS NO.*,9X,*X(1)*,14X,*X(2)*,14X,*X(3)*,12X,                MXI03180 122200000
     *      *THETA(1)*,10X,*THETA(2)*,10X,*THETA(3)*/)                  MXI03190 122300000
   22 FORMAT(3X,I3,3X,6E18.7)                                           MXI03200 122400000
      END                                                               MXI03210 122500000
```

```
      SUBROUTINE MCPY(A,B,N,M,NDIM)                                     MXI03220 122600000
      DIMENSION A(NDIM,1),B(NDIM,1)                                     MXI03230 122700000
      DO 10 I=1,N                                                       MXI03240 122800000
      DO 10 J=1,M                                                       MXI03250 122900000
   10 B(I,J)=A(I,J)                                                     MXI03260 123000000
      RETURN                                                            MXI03270 123100000
      END                                                               MXI03280 123200000
```

```
      SUBROUTINE MPRD(A,B,C,N,M,K,NDIM1,NDIM2)                          MXI03290 123300000
      DIMENSION A(NDIM1,1),B(NDIM2,1),C(NDIM1,1)                        MXI03300 123400000
      DO 10  I=1,N                                                      MXI03310 123500000
      DO 10  J=1,K                                                      MXI03320 123600000
      C(I,J)=0.                                                         MXI03330 123700000
      DO 10  L=1,M                                                      MXI03340 123800000
   10 C(I,J)=C(I,J)+A(I,L)*B(L,J)                                       MXI03350 123900000
      RETURN                                                            MXI03360 124000000
      END                                                               MXI03370 124100000
```

```
      SUBROUTINE TPRD(A,B,C,N,M,K,IDIM1,IDIM2)                          MXI03380 124200000
      DIMENSION A(IDIM1,1),B(IDIM1 ,1),C(IDIM2,1)                       MXI03390 124300000
      DO 10 I=1,M                                                       MXI03400 124400000
      DO 10 J=1,K                                                       MXI03410 124500000
      C(I,J)=0.                                                         MXI03420 124600000
      DO 10 L=1,N                                                       MXI03430 124700000
   10 C(I,J)=C(I,J)+A(L,I)*B(L,J)                                       MXI03440 124800000
      RETURN                                                            MXI03450 124900000
      END                                                               MXI03460 125000000
```

```
      SUBROUTINE ADD(SUM,S,N,M)                                         MXI03470 125100000
      DIMENSION S(180,31),SUM(30,30)                                    MXI03480 125200000
      DO 10 I=1,N                                                       MXI03490 125300000
      DO 10 J=1,M                                                       MXI03500 125400000
   10 SUM(I,J)=SUM(I,J)+S(I,J)                                          MXI03510 125500000
      RETURN                                                            MXI03520 125600000
      END                                                               MXI03530 125700000
```

```
      SUBROUTINE LOC810(INDNEW)                                         MXI03540 125800000
      I=INDOLD-INDNEW+1                                                 MXI03550 125900000
      IF(I)1,2,3                                                        MXI03560 126000000
    2 INDOLD=INDNEW                                                     MXI03570 126100000
      RETURN                                                            MXI03580 126200000
    1 I=-I                                                              MXI03590 126300000
      DO 21 K=1,I                                                       MXI03600 126400000
   21 READ(10)                                                          MXI03610 126500000
      GO TO 2                                                           MXI03620 126600000
    3 REWIND 10                                                         MXI03630 126700000
      I=INDNEW-1                                                        MXI03640 126800000
      IF(I.EQ.0)GO TO 2                                                 MXI03650 126900000
      DO 22 K=1,I                                                       MXI03660 127000000
   22 READ(10)                                                          MXI03670 127100000
      GO TO 2                                                           MXI03680 127200000
      ENTRY SET10                                                       MXI03690 127300000
      INDOLD=0                                                          MXI03700 127400000
      RETURN                                                            MXI03710 127500000
      END                                                               MXI03720 127600000
```

```
      SUBROUTINE LOC811(INDNEW)                                         MXI03730 127700000
      I=INDOLD-INDNEW+1                                                 MXI03740 127800000
      IF(I)1,2,3                                                        MXI03750 127900000
    2 INDOLD=INDNEW                                                     MXI03760 128000000
      RETURN                                                            MXI03770 128100000
    1 I=-I                                                              MXI03780 128200000
      DO 21 K=1,I                                                       MXI03790 128300000
   21 READ(1)                                                           MXI03800 128400000
      GO TO 2                                                           MXI03810 128500000
    3 REWIND 1                                                          MXI03820 128600000
      I=INDNEW-1                                                        MXI03830 128700000
      IF(I.EQ.0)GO TO 2                                                 MXI03840 128800000
      DO 22 K=1,I                                                       MXI03850 128900000
   22 READ(1)                                                           MXI03860 129000000
      GO TO 2                                                           MXI03870 129100000
      ENTRY SET11                                                       MXI03880 129200000
      INDOLD=0                                                          MXI03890 129300000
      RETURN                                                            MXI03900 129400000
      END                                                               MXI03910 129500000
```

C3

```
      FUNCTION AND(X,Y)                                   MXI03920 129600000
      LOGICAL UND,JA,NEIN                                 MXI03930 129700000
      REAL NO                                             MXI03940 129800000
      EQUIVALENCE(UND,E),(JA,SI),(NEIN,NO)                MXI03950 129900000
      IFLAG=0                                             MXI03960 130000000
      GO TO 1                                             MXI03970 130100000
      ENTRY OR                                                     130200000
      IFLAG=1                                             MXI03990 130300000
    1 SI=X                                                MXI04000 130400000
      NO=Y                                                MXI04010 130500000
      UND=JA.AND.NEIN                                     MXI04020 130600000
      IF(IFLAG.EQ.1)UND=JA.OR.NEIN                        MXI04030 130700000
      AND=E                                               MXI04040 130800000
      IF(IFLAG.EQ.1)OR=E                                  MXI04050 130900000
      RETURN                                              MXI04060 131000000
      END                                                 MXI04070 131100000
```

```
      SUBROUTINE SYMEIG(A,M,INDEX,NUMBR,R,TOL,X,LOW,KOUNT,MID)          MXI04080 131200000
C  MASTER ROUTINE FOR EIGENVALUES AND (OPTIONALLY) EIGENVECTORS OF A    MXI04090 131300000
C    REAL SYMMETRIC MATRIX STORED TRIANGULARLY IN CORE. THE HOUSEHOLDER MXI04100 131400000
C    REDUCTION TO TRIDIAGONAL FORM (SUBROUTINE TFORM) IS FOLLOWED BY A  MXI04110 131500000
C    BISECTION TECHNIQUE (SUBROUTINE STURM) FOR THE ROOTS AND THEN IN-  MXI04120 131600000
C    VERSE ITERATION (SUBROUTINE TRIVEC) FOR THE VECTORS.               MXI04130 131700000
C                                                                       MXI04140 131800000
C                                                                       MXI04150 131900000
C  MEANING OF THE PARAMETERS.                                           MXI04160 132000000
C    A        - THE TRIANGULAR ARRAY CONTAINING THE MATRIX. DURING EXEC-MXI04170 132100000
C                CUTION THE ARRAY IS CHANGED.                           MXI04180 132200000
C                                                                       MXI04190 132300000
C    M        - ORDER OF A.                                             MXI04200 132400000
C                                                                       MXI04210 132500000
C    INDEX    - INDEX OF FIRST EIGENVALUE REQUIRED.                     MXI04220 132600000
C                                                                       MXI04230 132700000
C    NUMBR    - NUMBER OF EIGENVALUES REQUIRED.                         MXI04240 132800000
C                                                                       MXI04250 132900000
C    R        - REAL ARRAY FOR THE ROOTS AND WORKING STORAGE. R MUST CON-MXI04260 133000000
C               TAIN AT LEAST 8*M WORDS AND START ON A D.P. BOUNDARY.   MXI04270 133100000
C                                                                       MXI04280 133200000
C    TOL      - TOLERANCE. IF B IS THE MAG. OF LARGEST ROOT, THE ROOTS  MXI04290 133300000
C               WILL USUALLY HAVE ERRORS AS LARGE AS B*TOL.             MXI04300 133400000
C                                                                       MXI04310 133500000
      DIMENSION A(1),R(1)                                               MXI04320 133600000
      DIMENSION X(MID,1)                                                MXI04330 133700000
      LD = 1 + M                                                        MXI04340 133800000
      LO = LD + M                                                       MXI04350 133900000
      LS = LO + M                                                       MXI04360 134000000
      LP = LS + M                                                       MXI04370 134100000
      LQ = LP + M                                                       MXI04380 134200000
      LR = LQ + M                                                       MXI04390 134300000
      CALL TFORM(A,M,R(LD),R(LO),R(LS),R(LP))                           MXI04400 134400000
      EPS = AMIN1(TOL,1.E-3)                                            MXI04410 134500000
      CALL STURM(M,INDEX,NUMBR,R(LD),R(LO),R(LS),R(LP),R,EPS)           MXI04420 134600000
      RETURN                                                            MXI04430 134700000
      ENTRY SYMVEC                                                               134800000
      CALL  QSVEC(A,R(LD),R(LO),R(LP),R(LQ),R(LR),R(LS),M,ROOT,X(1,I))  MXI04450 134900000
      ROOT = R(LS-1)                                                    MXI04460 135000000
      EPS = ROOT * 3.E-7                                                MXI04470 135100000
      K = LOW                                                           MXI04480 135200000
      DO 200  I = 1,KOUNT                                               MXI04490 135300000
```

```
      ROOT = AMIN1(ROOT-EPS,R(K))                                       MXI04500 135400000
      CALL QWIEL(A,R(LD),R(LO),R(LP),R(LQ),R(LR),R(LS),M,ROUT,X(1,I))   MXI04510 135500000
  200 K = K + 1                                                         MXI04520 135600000
      RETURN                                                            MXI04530 135700000
      END                                                               MXI04540 135800000
```

```
      SUBROUTINE TFORM(A,N,D,O,S,P)                                     MXI04550 135900000
      DIMENSION A(1),D(1),O(1),S(1)                                     MXI04560 136000000
      BL = 0.                                                           MXI04570 136100000
      BU = 0.                                                           MXI04580 136200000
      OLD = 0.                                                          MXI04590 136300000
      D(1) = A(1)                                                       MXI04600 136400000
      K1K1 = 1                                                          MXI04610 136500000
      N1 = N - 1                                                        MXI04620 136600000
      DO 230  K = 1,N1                                                  MXI04630 136700000
      KP1 = K + 1                                                       MXI04640 136800000
      KK = K1K1                                                         MXI04650 136900000
      KKP1 = KK + 1                                                     MXI04660 137000000
      NK = N - K                                                        MXI04670 137100000
      KN = KK + NK                                                      MXI04680 137200000
      K1K1 = KN + 1                                                     MXI04690 137300000
      SUM = 0.                                                          MXI04700 137400000
      DO 100  KJ = KKP1,KN                                              MXI04710 137500000
  100 SUM = SUM + A(KJ)*A(KJ)                                           MXI04720 137600000
      S(K) = SUM                                                        MXI04730 137700000
      RHO = SQRT(SUM)                                                   MXI04740 137800000
      RAD = OLD + RHO                                                   MXI04750 137900000
      BL = AMIN1(BL,D(K)-RAD)                                           MXI04760 138000000
      BU = AMAX1(BU,D(K)+RAD)                                           MXI04770 138100000
      IF (K - N1) 120,230,230                                           MXI04780 138200000
  120 OLD = RHO                                                         MXI04790 138300000
      IF (A(KKP1)) 140,140,130                                          MXI04800 138400000
  130 RHO = -RHO                                                        MXI04810 138500000
  140 O(K) = RHO                                                        MXI04820 138600000
      IF (SUM) 150,230,150                                              MXI04830 138700000
  150 A(KKP1) = A(KKP1) - RHO                                           MXI04840 138800000
      RHO =  1. / (RHO*A(KKP1))                                         MXI04850 138900000
      A(KK) = RHO                                                       MXI04860 139000000
      IJ = KK                                                           MXI04870 139100000
      DO 160  J = KP1,N                                                 MXI04880 139200000
      IJ = IJ + 1                                                       MXI04890 139300000
      O(J) = A(IJ)                                                      MXI04900 139400000
  160 D(J) = 0.                                                         MXI04910 139500000
      II = K1K1                                                         MXI04920 139600000
      NI = NK                                                           MXI04930 139700000
      DO 190  I = KP1,N                                                 MXI04940 139800000
      D(I) = D(I) + A(II)*O(I)                                          MXI04950 139900000
      IJ = II                                                           MXI04960 140000000
```

```
      II = II + NI                                       MXI04970 140100000
      NI = NI - 1                                        MXI04980 140200000
      IF (NI) 170,190,170                                MXI04990 140300000
  170 X = D(I)                                           MXI05000 140400000
      DO 180  J = I,N1                                   MXI05010 140500000
      IJ = IJ + 1                                        MXI05020 140600000
      D(J+1) = D(J+1) + A(IJ)*X                          MXI05030 140700000
  180 D(I) = D(I) + A(IJ)*D(J+1)                         MXI05040 140800000
  190 D(I) = D(I) * RHO                                  MXI05050 140900000
      SUM = 0.                                           MXI05060 141000000
      DO 200  I = KP1,N                                  MXI05070 141100000
  200 SUM = SUM + D(I)*D(I)                              MXI05080 141200000
      TAU = RHO * SUM * .5                               MXI05090 141300000
      DO 210  I = KP1,N                                  MXI05100 141400000
  210 D(I) = D(I) + TAU*D(I)                             MXI05110 141500000
      II = K1K1                                          MXI05120 141600000
      NI = NK                                            MXI05130 141700000
      DO 220  I = KP1,N                                  MXI05140 141800000
      RHO = D(I)                                         MXI05150 141900000
      TAU = D(I)                                         MXI05160 142000000
      IJ = II                                            MXI05170 142100000
      II = II + NI                                       MXI05180 142200000
      NI = NI - 1                                        MXI05190 142300000
      DO 220  J = I,N                                    MXI05200 142400000
      A(IJ) = A(IJ) + RHO*D(J) + TAU*D(J)                MXI05210 142500000
  220 IJ = IJ + 1                                        MXI05220 142600000
  230 D(K+1) = A(K1K1)                                   MXI05230 142700000
      D(N1) = A(KKP1)                                    MXI05240 142800000
      D(N) = AMIN1(BL,D(N)-RHO)                          MXI05250 142900000
      S(N) = AMAX1(BU,D(N)+RHO)                          MXI05260 143000000
      RETURN                                             MXI05270 143100000
      END                                                MXI05280 143200000
```

```
      SUBROUTINE STURM (N,LIM1,NUMB,D,OFFD,SEC,PFFD,SIGMA,EPS)          MXI05290 143300000
      DIMENSION D(1),OFFD(1),SEC(1),SIGMA(1),PFFD(1)                    MXI05300 143400000
      DATA HALF / .5/                                                   MXI05310 143500000
      BL = OFFD(N)                                                      MXI05320 143600000
      BU = SEC(N)                                                       MXI05330 143700000
      LIM2 = LIM1 + NUMB - 1                                            MXI05340 143800000
      CALL PREP(N,D,SEC,ROOT,LORD)                                      MXI05350 143900000
      N1 = N - 1                                                        MXI05350 144000000
      IF (N1) 16,200,200                                                MXI05370 144100000
  200 TOL = AMAX1(-BL,BU)                                               MXI05380 144200000
      OFFD(N) = TOL                                                     MXI05390 144300000
      TOL = TOL * AMAX1(1.E-15,EPS)                                     MXI05400 144400000
      DO 2  I = LIM1,LIM2                                               MXI05410 144500000
      SIGMA(I) = BL                                                     MXI05420 144600000
    2 PFFD(I) = BU                                                      MXI05430 144700000
      LORD = 0                                                          MXI05440 144800000
      L = LIM1 - 1                                                      MXI05450 144900000
      RUTE = 1.E20                                                      MXI05460 145000000
      GO TO 3                                                           MXI05470 145100000
  300 DO 400  I = K,L                                                   MXI05480 145200000
  400 SIGMA(I) = ROOT                                                   MXI05490 145300000
    3 K = L + 1                                                         MXI05500 145400000
      IF (K - LIM2) 4,4,16                                              MXI05510 145500000
    4 BU = PFFD(K)                                                      MXI05520 145600000
      ROOT = BU  +  HALF * (SIGMA(K) - BU)                              MXI05530 145700000
      IF (K - L) 5,7,5                                                  MXI05540 145800000
    5 DO 6  I = K,LIM2                                                  MXI05550 145900000
      IF (BU - PFFD(I)) 7,6,7                                           MXI05560 146000000
    6 L = I                                                             MXI05570 146100000
    7 IF (ABS(ROOT - RUTE) - TOL) 300,300,8                             MXI05580 146200000
    8 CALL DET(N,D,SEC,ROOT,LORD)                                       MXI05590 146300000
      DO 11  I = K,L                                                    MXI05600 146400000
      IF(I -LORD) 9,9,10                                                MXI05610 146500000
    9 SIGMA(I) = ROOT                                                   MXI05620 146600000
      GO TO 11                                                          MXI05630 146700000
   10 PFFD(I) = ROOT                                                    MXI05640 146800000
   11 CONTINUE                                                          MXI05650 146900000
      RUTE = ROOT                                                       MXI05660 147000000
      GO TO 4                                                           MXI05670 147100000
   16 RETURN                                                            MXI05680 147200000
      END                                                               MXI05690 147300000
```

```
      SUBROUTINE PREP(N,D,SEC,ROOT,LORD)                                MXI05700 147400000
      DIMENSICN D(1),SEC(1)                                             MXI05710 147500000
      EQUIVALENCE (RD2,RE2),(RD4,RE4)                                   MXI05720 147600000
      N1 = N - 1                                                        MXI05730 147700000
      RETURN                                                            MXI05740 147800000
      ENTRY DET                                                                  147900000
      RDO = ROOT                                                        MXI05760 148000000
      LOW = 0                                                           MXI05770 148100000
      LAWD = 0                                                          MXI05780 148200000
  100 RD2 = 0.D0                                                        MXI05790 148300000
      RD4 = 1.D0                                                        MXI05800 148400000
      DO 120  I = LOW,N1                                                MXI05810 148500000
      RD4 = D(I+1) - RDO - RD2                                          MXI05820 148600000
      IF (RD4) 120,140,110                                              MXI05830 148700000
  110 LAWD = LAWD + 1                                                   MXI05840 148800000
  120 RE2 = SEC(I+1) / RE4                                              MXI05850 148900000
  130 LORD = LAWD                                                       MXI05860 149000000
      GO TO 200                                                         MXI05870 149100000
  140 LAWD = LAWD + 1                                                   MXI05880 149200000
      IF (RE2) 150,160,150                                              MXI05890 149300000
  150 I = I + 1                                                         MXI05900 149400000
  160 LOW = I + 1                                                       MXI05910 149500000
      IF (LOW - N1) 100,100,130                                         MXI05920 149600000
  200 RETURN                                                            MXI05930 149700000
      END                                                               MXI05940 149800000
```

```
      SUBROUTINE   QSVEC(A,D,OFFD,P,Q,R,S,N,ROOT,X)                      MXI05950 149900000
C  SYMMETRIC MATRIX EIGENVECTOR CALCULATION.                             MXI05960 150000000
C  GIVEN THE ENTRIES (D AND OFFD) OF THE HOUSEHOLDER TRI-DIAGONAL FORM BMXI05970 150100000
C    OF A REAL SYMMETRIC MATRIX A, AND GIVEN A GOOD APPROXIMATE ROOT OF MXI05980 150200000
C    B (AND A) THIS FORTRAN 4 SUBROUTINE COMPUTES A UNIT EIGENVECTOR X  MXI05990 150300000
C    OF B, THEN TRANSFORMS IT TO A UNIT VECTOR OF A, USING THE VECTORS WMXI06000 150400000
C    STORED IN THE A ARRAY.                                             MXI06010 150500000
      DIMENSION A(1),D(1),OFFD(1),P(1),Q(1),R(1),S(1),X(1)               MXI06020 150600000
      DOUBLE PRECISION SUM                                               MXI06030 150700000
      COMMON /INFO/ SUM,M,IX,IA                                          MXI06040 150800000
      DATA MINUS2/07777777777777777776/                                  MXI06050 150900000
C                                                                        MXI06060 151000000
C  PART 1.  PRELIMINARIES.                                               MXI06070 151100000
C                                                                        MXI06080 151200000
      IX = 1                                                             MXI06090 151300000
      IA = 1                                                             MXI06100 151400000
      N1 = N - 1                                                         MXI06110 151500000
      N2 = N - 2                                                         MXI06120 151600000
      RETURN                                                             MXI06130 151700000
      ENTRY QWIEL                                                                 151800000
      ASSIGN 170 TO KOUNT                                                MXI06150 151900000
      TOL = 0.                                                           MXI06160 152000000
      DO 100  I = 1,N                                                    MXI06170 152100000
      P(I) = D(I) - ROOT                                                 MXI06180 152200000
      Q(I) = OFFD(I)                                                     MXI06190 152300000
      R(I) = 0.                                                          MXI06200 152400000
      TOL = AMAX1(TOL,ABS(D(I)))                                         MXI06210 152500000
  100 X(I) = RDM(X) + .1                                                 MXI06220 152600000
      TOL = (TOL + 1.E-15) * 1.E-15                                      MXI06230 152700000
C                                                                        MXI06240 152800000
C  PART 2.  MATRIX DECOMPOSITION.                                        MXI06250 152900000
C                                                                        MXI06260 153000000
      DO 150  I = 1,N1                                                   MXI06270 153100000
      T = ABS (P(I))                                                     MXI06280 153200000
      U = ABS (OFFD(I))                                                  MXI06290 153300000
      IF (T + U - TOL) 110,120,120                                       MXI06300 153400000
  110 P(I) = TOL                                                         MXI06310 153500000
      T = P(I)                                                           MXI06320 153600000
  120 IF (T - U) 130,140,140                                             MXI06330 153700000
  130 S(I) = P(I)/OFFD(I)                                                MXI06340 153800000
      S(I) = OR(S(I), 1)                                                 MXI06350 153900000
      TEMP = Q(I)                                                        MXI06360 154000000
```

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      P(I) = OFFD(I)                                                  MXI06370 154100000
      Q(I) = P(I+1)                                                   MXI06380 154200000
      R(I) = Q(I+1)                                                   MXI06390 154300000
      P(I+1) = TEMP - S(I)*Q(I)                                       MXI06400 154400000
      Q(I+1) = -S(I)*R(I)                                             MXI06410 154500000
      GO TO 150                                                       MXI06420 154600000
  140 S(I) = OFFD(I)/P(I)                                             MXI06430 154700000
      S(I) = AND(S(I),MINUS2)                                         MXI06440 154800000
      P(I+1) = P(I+1) - S(I)*Q(I)                                     MXI06450 154900000
  150 CONTINUE                                                        MXI06460 155000000
      IF (ABS(P(N)) .LT. TOL)  P(N) = TOL                             MXI06470 155100000
      GO TO 210                                                       MXI06480 155200000
C                                                                     MXI06490 155300000
C  PART 3.  RIGHT SIDE MODIFICATION.                                  MXI06500 155400000
C                                                                     MXI06510 155500000
  170 ASSIGN 330 TO KOUNT                                             MXI06520 155600000
      DO 200  I = 1,N1                                                MXI06530 155700000
      TEMP = AND(S(I), 1)                                             MXI06540 155800000
      IF (TEMP) 180,190,180                                           MXI06550 155900000
  180 T = X(I)                                                        MXI06560 156000000
      X(I) = X(I+1)                                                   MXI06570 156100000
      X(I+1) = T - S(I)*X(I)                                          MXI06580 156200000
      GO TO 200                                                       MXI06590 156300000
  190 X(I+1) = X(I+1) - S(I)*X(I)                                     MXI06600 156400000
  200 CONTINUE                                                        MXI06610 156500000
C                                                                     MXI06620 156600000
C  PART 4.  TRIANGULAR SYSTEM SOLUTION.                               MXI06630 156700000
C                                                                     MXI06640 156800000
  210 X(N) = X(N)/P(N)                                                MXI06650 156900000
      X(N1) = (X(N1) - Q(N1)*X(N)) / P(N1)                            MXI06660 157000000
      DO 220  I = 2,N1                                                MXI06670 157100000
      K = N - I                                                       MXI06680 157200000
  220 X(K) = (X(K) - Q(K)*X(K+1) - R(K)*X(K+2)) / P(K)                MXI06690 157300000
C                                                                     MXI06700 157400000
C  PART 5. SCALING TO UNIT VECTOR.                                    MXI06710 157500000
C                                                                     MXI06720 157600000
  230 SUM = 0.D0                                                      MXI06730 157700000
      M = N                                                           MXI06740 157800000
      SCALAR = SQRT(DOTPRO(X,X))                                      MXI06750 157900000
      DO 250  I = 1,N                                                 MXI06760 158000000
  250 X(I) = X(I)/SCALAR                                              MXI06770 158100000
      GO TO KOUNT, (170,330,370)                                      MXI06780 158200000
C                                                                     MXI06790 158300000
```

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C  PART 6.  TRANSFORMATION BY ORTHOGONAL MATRICES.                   MXI06800 158400000
C                                                                     MXI06810 158500000
  330 L = (N*(N+1))/2 - 4                                             MXI06820 158600000
      DO 360  I = 1,N2                                                MXI06830 158700000
      NI = N - I                                                      MXI06840 158800000
      SUM = 0.D0                                                      MXI06850 158900000
      M = I + 1                                                       MXI06860 159000000
      SCALAR =  A(L-1) * DOTPRO(X(NI),A(L))                           MXI06870 159100000
      IJ = L                                                          MXI06880 159200000
      DO 350  J = NI,N                                                MXI06890 159300000
      X(J) = X(J) + SCALAR*A(IJ)                                      MXI06900 159400000
  350 IJ = IJ + 1                                                     MXI06910 159500000
  360 L = L - I - 3                                                   MXI06920 159600000
      ASSIGN 370 TO KOUNT                                             MXI06930 159700000
      GO TO 230                                                       MXI06940 159800000
  370 RETURN                                                          MXI06950 159900000
      END                                                             MXI06960 160000000
```

```
      SUBROUTINE DAGGER(A,M,P,KO,Q)                                     MXI06970 160100000
      DIMENSION A(1),P(1),Q(1)                                          MXI06980 160200000
      EQUIVALENCE (SUN,SUM)                                             MXI06990 160300000
      K = KO                                                            MXI07000 160400000
      K1 = K + 1                                                        MXI07010 160500000
      L=1                                                               MXI07020 160600000
      LL = 0                                                            MXI07030 160700000
      INDEX = 1                                                         MXI07040 160800000
      DO 130  I = 2,K1                                                  MXI07050 160900000
      LJ = INDEX                                                        MXI07060 161000000
      SUM = 0.                                                          MXI07070 161100000
      DO 90  J = 1,L                                                    MXI07080 161200000
      SUM = SUM + A(LJ)*P(J)                                            MXI07090 161300000
   90 LJ = LJ + 1                                                       MXI07100 161400000
      IF (K - L) 100,120,100                                            MXI07110 161500000
  100 LL = LL + L                                                       MXI07120 161600000
      LJ = LL + L                                                       MXI07130 161700000
      DO 110  J = I,K                                                   MXI07140 161800000
      SUM = SUM + A(LJ)*P(J)                                            MXI07150 161900000
  110 LJ = LJ + J                                                       MXI07160 162000000
  120 Q(I-1) = SUN                                                      MXI07170 162100000
      INDEX = INDEX + L                                                 MXI07180 162200000
  130 L = I                                                             MXI07190 162300000
      SUM = 0.                                                          MXI07200 162400000
      DO 140  I = 1,K                                                   MXI07210 162500000
      SUM = SUM + P(I)*Q(I)                                             MXI07220 162600000
      A(LL+1) = Q(I)                                                    MXI07230 162700000
  140 LL = LL + 1                                                       MXI07240 162800000
      A(LL) = SUN                                                       MXI07250 162900000
      IF (M - K)  150, 200, 150                                         MXI07260 163000000
  150 DO 190  L = K1,M                                                  MXI07270 163100000
      JL = LL+L-K                                                       MXI07280 163200000
      SUM = 0.                                                          MXI07290 163300000
      DO 180  J = 1,K                                                   MXI07300 163400000
      SUM = SUM + P(J)*A(JL)                                            MXI07310 163500000
  180 JL = JL + 1                                                       MXI07320 163600000
      LL = LL + L - 1                                                   MXI07330 163700000
  190 A(LL) = SUM                                                       MXI07340 163800000
  200 CONTINUE                                                          MXI07350 163900000
      RETURN                                                            MXI07360 164000000
      END                                                               MXI07370 164100000
```

```
      SUBROUTINE SWITCH(A,M)                                            MXI07380 164200000
      DIMENSION A(1)                                                    MXI07390 164300000
      N = IABS(M)                                                       MXI07400 164400000
      IF (N - 2) 190,190,90                                             MXI07410 164500000
   90 L = (N*(N+1)) / 2                                                 MXI07420 164600000
      KEY = 1                                                           MXI07430 164700000
      LOCK = N/2 + 1                                                    MXI07440 164800000
      IF (M) 100,190,160                                                MXI07450 164900000
  100 IF (N - 3) 110,140,110                                            MXI07460 165000000
  110 KKT = 3                                                           MXI07470 165100000
      NKF = N - 1                                                       MXI07480 165200000
      IMAGE = L                                                         MXI07490 165300000
      INTO = L - 3                                                      MXI07500 165400000
      I = 3                                                             MXI07510 165500000
      DO 130  K = 2,LOCK                                                MXI07520 165600000
      DO 120  IK = KKT,NKF                                              MXI07530 165700000
      X = A(IK)                                                         MXI07540 165800000
      A(IK) = A(INTO)                                                   MXI07550 165900000
      A(INTO) = X                                                       MXI07560 166000000
      INTO = INTO - I                                                   MXI07570 166100000
  120 I = I + 1                                                         MXI07580 166200000
      KKT = NKF + K                                                     MXI07590 166300000
      NKF = NKF + N - K                                                 MXI07600 166400000
      IMAGE = IMAGE - K                                                 MXI07610 166500000
      INTO = IMAGE                                                      MXI07620 166600000
  130 I = K                                                             MXI07630 166700000
  140 IF (KEY) 150,190,150                                              MXI07640 166800000
  150 KEY = 0                                                           MXI07650 166900000
  160 LOV2 = L / 2                                                      MXI07660 167000000
      K = L - 2                                                         MXI07670 167100000
      DO 170  I = 3,LOV2                                                MXI07680 167200000
      X = A(I)                                                          MXI07690 167300000
      A(I) = A(K)                                                       MXI07700 167400000
      A(K) = X                                                          MXI07710 167500000
  170 K = K - 1                                                         MXI07720 167600000
      IF (KEY) 180,190,180                                              MXI07730 167700000
  180 KEY = 0                                                           MXI07740 167800000
      GO TO 100                                                         MXI07750 167900000
  190 RETURN                                                            MXI07760 168000000
      END                                                               MXI07770 168100000
```

```
      FUNCTION DOTPRO(X,Y)                                  MXI07780 168200000
      DIMENSION X(1),Y(1)                                   MXI07790 168300000
      DOUBLE PRECISION S                                    MXI07800 168400000
      COMMCN /INFO/ S,N,IX,IY                               MXI07810 168500000
      IF (N) 120,120,100                                    MXI07820 158600000
  100 JX = 1                                                MXI07830 168700000
      JY = 1                                                MXI07840 168800000
      DO 110  J = 1,N                                       MXI07850 168900000
      S = S + X(JX)*Y(JY)                                   MXI07860 169000000
      JX = JX + IX                                          MXI07870 169100000
  110 JY = JY + IY                                          MXI07880 169200000
  120 DOTPRO = S                                            MXI07890 169300000
      RETURN                                                MXI07900 169400000
      END                                                   MXI07910 169500000
```

B

```
      SUBROUTINE INCH (A,MO,Y,NIX)                                      MXI08090 169600000
C                                                                       MXI08100 169700000
C  INVERSION OF POSITIVE DEFINITE REAL SYMMETRIC MATRIX A.  A IS ASSUMEDMXI08110 169800000
C  TO BE STORED BY ROWS IN LOWER TRIANGULAR FORM. THE INVERSE IS STORED MXI08120 169900000
C  OVER A.                                                              MXI08130 170000000
      COMMON /BOND/ M,K  /WINTER/ KOLD                                  MXI08140 170100000
      COMMCN /OPT2/ PRINT                                               MXI08150 170200000
      REAL A(1),Y(1)                                                    MXI08160 170300000
      KOLD = 0                                                          MXI08170 170400000
      M = IABS(MO)                                                      MXI08180 170500000
      CALL FUTILE(A,M,NIX)                                              MXI08190 170600000
      IF (NIX) 120,100,100                                              MXI08200 170700000
  100 KK = 0                                                            MXI08210 170800000
      K1 = 1                                                            MXI08220 170900000
      DO 115  K = 1,M                                                   MXI08230 171000000
      KK = KK + K                                                       MXI08240 171100000
      DO 105  I = K,M                                                   MXI08250 171200000
  105 Y(I) = 0.                                                         MXI08260 171300000
      Y(K) = 1.                                                         MXI08270 171400000
      CALL TRIEQ(A(K1),Y)                                               MXI08280 171500000
      IK = KK                                                           MXI08290 171600000
      DO 110  I = K,M                                                   MXI08300 171700000
      A(IK) = Y(I)                                                      MXI08310 171800000
      IK = IK + I                                                       MXI08320 171900000
  110 CONTINUE                                                          MXI08330 172000000
  115 K1 = K1 + K                                                       MXI08340 172100000
  120 CONTINUE                                                          MXI08350 172200000
      RETURN                                                            MXI08360 172300000
      END                                                               MXI08370 172400000
```

```
      SUBROUTINE TRIEQ(A,Y)                                              MXI08380 172500000
      REAL A(1),Y(1)                                                     MXI08390 172600000
      COMMON /WINTER/INDIC8                                              MXI08400 172700000
      COMMON /BOND/ M,L                                                  MXI08410 172800000
      EQUIVALENCE (SUN,SUM)                                              MXI08420 172900000
      L1 = L                                                             MXI08430 173000000
      MML=M-L1                                                           MXI08440 173100000
      MM1 = M - 1                                                        MXI08450 173200000
      IF (INDIC8) 130,100,100                                            MXI08460 173300000
  100 Y(L1) = Y(L1) / A(L1)                                              MXI08470 173400000
      I1 = L1                                                            MXI08480 173500000
      II=I1                                                              MXI08490 173600000
      IF(MML)105,125,105                                                 MXI08500 173700000
  105 DO 120  I = L1,MM1                                                 MXI08510 173800000
      I1 = I1 + I                                                        MXI08520 173900000
      SUM = -Y(I+1)                                                      MXI08530 174000000
      IJ = I1                                                            MXI08540 174100000
      DO 110  J = L1,I                                                   MXI08550 174200000
      SUM = SUM + A(IJ)*Y(J)                                             MXI08560 174300000
  110 IJ = IJ + 1                                                        MXI08570 174400000
      II = IJ                                                            MXI08580 174500000
  120 Y(I+1) = -SUM / A(II)                                              MXI08590 174600000
  125 IF (INDIC8) 170,140,170                                            MXI08600 174700000
  130 II=((MML+1)*(M+L1))/2                                              MXI08610 174800000
  140 I = M                                                              MXI08620 174900000
  145 Y(I) = Y(I) / A(II)                                                MXI08630 175000000
      II = II - I                                                        MXI08640 175100000
      I = I - 1                                                          MXI08650 175200000
      IF (I - L1) 170,150,150                                            MXI08660 175300000
  150 SUN = -Y(I+1)                                                      MXI08670 175400000
      IJ = II + L1                                                       MXI08680 175500000
      DO 160  J = L1,I                                                   MXI08690 175600000
      Y(J) = Y(J) + SUN*A(IJ)                                            MXI08700 175700000
  160 IJ = IJ + 1                                                        MXI08710 175800000
      GO TO 145                                                          MXI08720 175900000
  170 RETURN                                                             MXI08730 176000000
       END                                                               MXI08740 176100000
```

```
      SUBROUTINE FUTILE(A,N,NIX)                                        MXI08750 176200000
      DIMENSION A(1)                                                    MXI08760 176300000
      DOUBLE PRECISION SUM                                              MXI08770 176400000
      EQUIVALENCE (SUN,SUM)                                             MXI08780 176500000
      K1 = 1                                                            MXI08790 176600000
      KK = 0                                                            MXI08800 176700000
      DO 210  K = 1,N                                                   MXI08810 176800000
      KK = KK + K                                                       MXI08820 176900000
      IK = KK                                                           MXI08830 177000000
      KK1 = KK - 1                                                      MXI08840 177100000
      IF (KK1) 60,50,60                                                 MXI08850 177200000
   50 ASSIGN 100 TO LEAP                                                MXI08860 177300000
      GO TO 70                                                          MXI08870 177400000
   60 ASSIGN  80 TO LEAP                                                MXI08880 177500000
   70 I1 = K1                                                           MXI08890 177600000
      DO 140  I = K,N                                                   MXI08900 177700000
      SUM = -A(IK)                                                      MXI08910 177800000
      GO TO LEAP, (80,100)                                              MXI08920 177900000
   80 IJ = I1                                                           MXI08930 178000000
      DO 90 KJ = K1,KK1                                                 MXI08940 178100000
      SUM = SUM + A(IJ)*A(KJ)                                           MXI08950 178200000
   90 IJ = IJ + 1                                                       MXI08960 178300000
  100 I1 = I1 + I                                                       MXI08970 178400000
      IF (I - K) 120,105,120                                            MXI08980 178500000
  105 DENOM = -SUM                                                      MXI08990 178600000
      IF (DENOM) 980,980,110                                            MXI09000 178700000
  110 DENOM = -SQRT(DENOM)                                              MXI09010 178800000
      A(IK) = -DENOM                                                    MXI09020 178900000
      GO TO 130                                                         MXI09030 179000000
  120 A(IK) = SUM / DENOM                                               MXI09040 179100000
  130 IK = IK + I                                                       MXI09050 179200000
  140 CONTINUE                                                          MXI09060 179300000
      K1 = K1 + K                                                       MXI09070 179400000
  210 CONTINUE                                                          MXI09080 179500000
      NIX = 0                                                           MXI09090 179600000
  220 RETURN                                                            MXI09100 179700000
  980 NIX = -K                                                          MXI09110 179800000
      GO TO 220                                                         MXI09120 179900000
       END                                                              MXI09130 180000000
*FOLLOWING VARIABLES EQUIVALENCED BUT NOT REFERENCED
SUN
```

```
      FUNCTION ARSIN(X)                                                 MXI09140 180100000
      ARSIN=ASIN(X)                                                     MXI09150 180200000
      RETURN                                                            MXI09160 180300000
      ENTRY ARCOS                                                       MXI09170 180400000
      ARCOS=ACOS(X)                                                     MXI09180 180500000
      RETURN                                                            MXI09190 180600000
      END                                                               MXI09200 180700000
```

```
FUNCTION RDM(X)                                    MXI09210 180800000
RDM=RANF(X)                                        MXI09220 180900000
RETURN                                             MXI09230 181000000
END                                                MXI09240 181100000
```

APPENDIX B

DETAILED PROGRAMMING INFORMATION FOR THE PHASE II COMPUTER PROGRAM

This appendix contains detailed programming information for the Phase II computer program. In addition, samples of input and output data are presented.

APPENDIX B1

EXAMPLES OF INPUT DATA

The following two examples illustrate the method of setting up the input data deck. The configuration for both examples is that discussed in Section 6 of Volume I. Computer output for these examples is presented in Appendix B2.

Example 1

This example shows input data for a 40 second rigid body run with plotting. This run has fluids present, no deployment, no controls, no supplementary forces, no moving masses and no structural loads computed. Although flexible-body data is present, the constraint option has been used to rigidize the entire Space Station. The JUMP clue to set all $\{q_i\}$, $\{\dot{q}_i\}$, $\{\theta_i\}$ and $\{\dot{\theta}_i\}$ to zero is used. Fixed-step numerical integration with a step size of .05 is indicated together with a plotting output interval of .09997436 so that plotting will occur the first time a multiple of .05 exceeds each multiple of .0997436. The time-history printer output interval is 2* .0997436.

	final time, pilot scale	40.	5.		
	plot clue, fluid clue, no. pipes	1 1 5			
	reservoir mass points	8 2			
	pipes mass points	3 4 5 6 7			
	plotting groups	1			
		4 4 8 8 17 42 42			
	KLUE, IFLAB, IFCW, IFCN	4 1 1			
	IFDEPL, IFCON, IFSUPP				
	STRUCTURAL LOADS				
	IPHSI, JUMP	1 1			
	percentage damping	.02	.02	.02	
		.02	.02	.02	
	$\{R\}$				528.
	$\{\dot{R}\}$				
	$\{Y\}$				
	$\{\omega^x\}$	.4189			
input for emptying reservoir	ρ, A	.9346 E-4	15.		
	m_i^e	.070095			
	$[I_i^e]$	521.12317			
			521.12317		
	$\{s_i^f\}$			.16733949	
	$\{e_i^R\}$			5.958075	
	$\{u_i^R\}$			1.	
	$\{u_i^B\}$			60.	
	$\{e_i^B\}$			110.	
				1.	
	$[J_i^B]$	181517.9			
			181517.9		
				35.809862	
	$b_i, h_{i0}, h_{i\,max}, h_{i\,min}$	25.	30.	60.	0.
input for filling reservoir	$\{G_i^f\}$	.014019			
		9.6104029			
			9.6104029		
				.033467897	
				-.364494	
				-1.	
				-21.	
				-31.	
				-1.	
		14432.905			
			14432.905		
				35.809862	
		25.	20.	60.	0.
input for pipe at mass point 3	m_i^f	.126171			
	$\{s_i\}$			-2.018736	
	$\{\Delta u_i\}$			90.	
	$\{\Delta e_i\}$ $\{G_i\}$ $\{\Delta H_i\}$				
	$[\Delta J_i]$	-43200.			
			-43200.		
	$[I_i^f]$	117.61581			
			117.61581		
				.30121108	
start of input for pipe at mass point 4		.168228			
				-.168228	
				120.	

input for pipe at mass point 4 (continued)	- 3600.			
		-3600.		
	202.24264			
		202.24264		
			.40161477	
input for pipe at mass point 5	.126171			
			1.766394	
			90.	
	37800.			
		37800.		
	110.04555			
		110.04555		
			.30121108	
input for pipe at mass point 6	.196266			
			-8.046906	
			140.	
	-172200.			
		-172200.		
	650.72522			
		650.72522		
			.46845507	
input for pipe at mass point 7	.308418			
			-.154209	
			220.	
	-3300.			
		-3300.		
	1244.3979			
		1244.3979		
			.73629374	
IPHS1, JUMP				
NO. Counterweight mass points	1			
			320.	
mass	194.09938			
Inertia Matrix	.17259834 E8			
		.23447205 E7		
			.15489648 E8	
i, q	8 1			
{A}				
{Ā}			-320.	
{S}				
{Ṡ}				
{ø*}				
{ø̇*}				
{Y±'} (a)			-1.	
{Y^a'} (b)	1.			
{λ_0}			1685.9158	
v, V_u, t_{tu}, acc_{MAG}	0.	120.	2.	60.
DELTA, EPSIL, STEP			.05	
DTAU, NTIME	.09997436	2		

Example 2

This example shows input data for a 10 second run with with KLUE = 3 (flexible Laboratory and rigid Counterweight). The quiescent-state initial conditions are used for the deformations (see Section 3.4.10). The complete quiescent-state initial conditions are presented in the output shown in Appendix B2. Plotting will be done, and moving masses 1 and 2 are present indicating elevator motion and mass balancing. Controls are present, and loads will be printed. The integration step-size is fized.

final time, plot scale	10. 5.
plot clue, no. moving masses	1 2
moving masses present	1 1
plotting groups	111 11 1 1
plotting group mass points	4 4 8 8 17 42 42
KLUE, IFLAB, IFCW, IFCN	3 1 1
IFDEPL, IFCON, IFSUPP	1
controls input: i_a, t_{JET}	4 50.
controls input: Counterweight command	1685.9158 950. 1.2 2.4
controls input: Spin command	.4189 950. -.4189 .04
controls input: Spin control	.0002094
controls input: Attitude control	.0001745 .001745 72.
controls input: wobble control	0. -.4189 2880. 360.
	360. 2400. 180.
input for structural loads: KLUCS, KLULAB, KLUCW, N, NB	1 1 2
input for load-computation point ℓ' =4: ℓ', no. masses	411
input for load-computation point ℓ' =4: $\{x_{\ell'}\}$	60.
input for load-computation point ℓ' =4: index numbers for free body	1 2 3 9101112131415
	16
input for load - computation point ℓ' = 42	4227
	0. 0. 0.
	1718192021222324252 7
	282930313233334353637
	38394041264344
IPHSI, JUMP	1
start of input for $\{q_i\}$: $\{q_1\}$	-0.83869551E-08 0.16612466E-06-0.23666996E 00
$\{q_2\}$	0.46313410E-07 0.58134901E-07-0.23666465E 00
$\{q_3\}$	0.92101516E-07-0.11938391E-06-0.23661751E 00
⋮	-0.11785437E-06-0.13196950E-06-0.23651844E 00
	-0.14846518E-06-0.39202860E-06-0.23642588E 00
	-0.11989164E-0[illegible]3185E-06-0.23637813E 00
	-0.26651[illegible]06-0.23637813E 00
	-0.[illegible] 23637813E 00
	[illegible]72992E 00

•
•
•

...

input for $\{\phi_i\}$ (cont.)

```
    ...35E-05 0.7...
 .40029327E-05-0.12095406...
-0.27557019E-06-0.57446596E-06-0.23637801E 00
-0.25430393E-06 0.28183858E-05-0.22518796E 00
 0.13012841E-05 0.58819816E-04 0.25090857E 01
-0.29180126E-06-0.89184323E-06-0.23637795E 00
 0.19956877E-06 0.21486398E-04 0.33776373E 00
 0.77020582E-06 0.40153798E-04 0.14100447E 01
```

start of input for $\{\dot{\phi}_i\}$: $\{\dot{\phi}_1\}$, $\{\dot{\phi}_2\}$, $\{\dot{\phi}_3\}$, ...

...

input for $\{\dot{\phi}_i\}$ (cont.)

start of input for $\{\theta_i\}$: $\{\theta_1\}$, $\{\theta_2\}$, $\{\theta_3\}$, ...

```
-0.15526211E-08 0.49180837E-09 0.87560570E-10
-0.15418777E-08 0.48350324E-09 0.87815380E-10
-0.14736088E-08 0.53686455E-09 0.21095706E-09
-0.14289299E-08 0.56446758E-09 0.40990500E-09
-0.14726993E-08 0.45360271E-09 0.48821147E-09
-0.1429...         ...369E-09 0.43942361E-09
-0...                 ...E-08-0.22493392E-09
                              0.73632905E-10
```

...

input for $\{\theta_i\}$ (cont.)

```
       ...E-02-0....
   ...89750E-03-0.14274...
 ..45169843E-03 0.28689275E-...
 0.55216905E-03-0.59020735E-08-0.12744292E-08
 0.38333496E-02-0.44284395E-07-0.19368720E-08
-0.86043883E-09 0.53627505E-10 0.73632905E-10
 0.35762596E-02-0.18696209E-07-0.21672610E-08
 0.46098903E-02-0.31490277E-07-0.22528703E-08
```

input for $\{\dot{\theta}_i\}$: $\{\dot{\theta}_1\}$, $\{\dot{\theta}_2\}$, $\{\dot{\theta}_3\}$, ...

...

•
•
•

	input for $\{\dot{\theta}_i\}$ (cont.)					
	percentage damping	.02	.02	.02		
		.02	.02	.02		
	$\{R\}$			436.4843		
	$\{\dot{R}\}$					
	$\{\gamma\}$					
	$\{\omega^x\}$	.4189				
	μ_1	25.879917				
	μ_2	12.939959				
	IPHS1, JUMP					
	NO. Counterweight mass points	1				
	$\{\bar{r}_1\}$			320.		
	mass	194.09938				
	Inertia Matrix	.17259834 E8				
			.23447205 E7			
				.15489648 E8		
	i, $\underset{\sim}{a}$	8 1				
	$\{A\}$					
	$\{\bar{A}\}$			-320.		
	$\{\delta\}$			3.009434		
	$\{\dot{\delta}\}$					
	$\{\phi^*\}$					
	$\{\dot{\phi}^*\}$					
	$\{Y^{e'}\}$@			-1.		
	$\{Y^{e'}\}$⊕	1.				
	$\{\lambda_0\}$			1685.9158		
MUCOM input for j=1	axes of motion	1				
	$\{U_1(0)\}$			762.1295		
	$U_0, x_0, acc_{MAG}, vel_{MAX}$	742.	2.	20.	40.	
	$\{U_2(0)\}$			348.5181		
	$\{\dot{U}_2(0)\}$					
Balance Mass control input	$\mu_{1EST}, K_{EXSE}, K_{DESE}, \tau_{BAL}, \omega_{ICBAL}$	12.939959	10.	.364	0.	.4
	$\{X_A^{i_e}\}$			1057.289		
	$\{X^{CMND}_{SENS(CH)}\}$	194.099	248.954	17.2560 E6		
	beam subroutine input	38.6025 E6	15.4855 E5	18.2943 E6		
		624.258	320.	3. E7		
		13.57 E10	10.86 E10	300.		
		.05	.05	.05		
	DELTA, EPSIL, STEP			.05		
	DTAU, NTIME	.09997436	2			
	KLOUTL, KLOUTC	13				
	printout at mass points	1 4 8 12 16 17 18 29 30 45 46 57 58				

APPENDIX B2

EXAMPLES OF PROGRAM OUTPUT

This appendix shows the output for the two problems described in Appendix B1. The key to reading the titles of the time-history print out is given at time = 0 in these examples.

Example 1

The first portion of the output consists of the input data. The input modes were truncated; however, they are shown in their entirety in Appendix I of Volume I.

The second portion of the print out is the time history. Auxiliary results presented in this portion include the location of the center of mass and the total-system angular momentum.

INPUT DATA

```
    FINAL TIME , PLOTTING CODE , PLOT INTERVAL
 0.40000000E 02      1            0.10000000E 01
FLUID CODE , NO. PIPES
   1
RESERVOIR MASS POINTS
  8   2
NO. MOVING MASSES ,         MOVING MASSES PRESENT
     0                  0    0    0    0    0    0    0    0
PIPES ON MASS POINTS
  3   4   5   6   7
CODES FOR THIS RUN
PROBLEM CODE , DEPLOYMENT , CONTROLS , SUPP. FORCES
     4             0             0            0
```

LAD INPUT
NO. MASSES = 72
MASS POINT LOCATIONS

NO.	X(1)	X(2)	X(3)
1	0.0	0.0	0.86100000E 03
2	0.0	0.0	0.80100000E 03
3	0.0	0.0	0.74100000E 03
4	0.0	0.0	0.62100000E 03
5	0.0	0.0	0.50100000E 03
6	0.0	0.0	0.44100000E 03
7	0.0	0.0	0.22050000E 03
8	0.0	0.0	0.0
9	0.0	-0.13200000E 03	0.80100000E 03
10	0.0	-0.25200000E 03	0.80100000E 03
11	0.0	-0.37200000E 03	0.80100000E 03
12	0.0	-0.49200000E 03	0.80100000E 03
13	0.0	0.13200000E 03	0.80100000E 03
14	0.0	0.25200000E 03	0.80100000E 03
15	0.0	0.37200000E 03	0.80100000E 03
16	0.0	0.49200000E 03	0.80100000E 03
17	0.0	-0.56400000E 03	-0.13050000E 03
18	0.0	-0.56400000E 03	0.13050000E 03
19	0.0	-0.56400000E 03	-0.58500000E 02
20	0.0	-0.56400000E 03	0.58500000E 02
21	0.0	-0.81600000E 03	-0.13050000E 03
22	0.0	-0.81600000E 03	0.13050000E 03
23	0.0	-0.81600000E 03	-0.58500000E 02
24	0.0	-0.81600000E 03	0.58500000E 02
25	0.0	-0.31200000E 03	-0.13050000E 03
26	0.0	-0.31200000E 03	0.13050000E 03
27	0.0	-0.31200000E 03	-0.58500000E 02
28	0.0	-0.31200000E 03	0.58500000E 02
29	0.0	-0.10680000E 04	-0.13050000E 03
30	0.0	-0.10680000E 04	0.13050000E 03
31	0.0	-0.10680000E 04	-0.58500000E 02
32	0.0	-0.10680000E 04	0.58500000E 02
33	0.0	-0.60000000E 02	-0.13050000E 03
34	0.0	-0.60000000E 02	0.13050000E 03
35	0.0	-0.60000000E 02	-0.58500000E 02
36	0.0	-0.60000000E 02	0.58500000E 02
37	0.0	-0.10680000E 04	0.0
38	0.0	-0.60000000E 02	-0.36900000E 03
39	0.0	-0.60000000E 02	0.36900000E 03
40	0.0	-0.60000000E 02	0.0

41	0.0	-0.81600000E 03	0.0
42	0.0	-0.12000000E 02	0.0
43	0.0	-0.31200000E 03	0.0
44	0.0	-0.56400000E 03	0.0
45	0.0	0.56400000E 03	-0.13050000E 03
46	0.0	0.56400000E 03	0.13050000E 03
47	0.0	0.56400000E 03	-0.58500000E 02
48	0.0	0.56400000E 03	0.58500000E 02
49	0.0	0.81600000E 03	-0.13050000E 03
50	0.0	0.81600000E 03	0.13050000E 03
51	0.0	0.81600000E 03	-0.58500000E 02
52	0.0	0.81600000E 03	0.58500000E 02
53	0.0	0.31200000E 03	-0.13050000E 03
54	0.0	0.31200000E 03	0.13050000E 03
55	0.0	0.31200000E 03	-0.58500000E 02
56	0.0	0.31200000E 03	0.58500000E 02
57	0.0	0.10680000E 04	-0.13050000E 03
58	0.0	0.10680000E 04	0.13050000E 03
59	0.0	0.10680000E 04	-0.58500000E 02
60	0.0	0.10680000E 04	0.58500000E 02
61	0.0	0.60000000E 02	-0.13050000E 03
62	0.0	0.60000000E 02	0.13050000E 03
63	0.0	0.60000000E 02	-0.58500000E 02
64	0.0	0.60000000E 02	0.58500000E 02
65	0.0	0.10680000E 04	0.0
66	0.0	0.60000000E 02	-0.36900000E 03
67	0.0	0.60000000E 02	0.36900000E 03
68	0.0	0.60000000E 02	0.0
69	0.0	0.81600000E 03	0.0
70	0.0	0.12000000E 02	0.0
71	0.0	0.31200000E 03	0.0
72	0.0	0.56400000E 03	0.0

NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4037268E 05	0.0	0.0
		0.0	0.3985508E 05	0.0
		0.0	0.0	0.4373707E 05
2	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
3	0.1617494E 02	0.4037268E 05	0.0	0.0
		0.0	0.3985508E 05	0.0
		0.0	0.0	0.4373707E 05
4	0.1617494E 02	0.4037268E 05	0.0	0.0
		0.0	0.3985508E 05	0.0
		0.0	0.0	0.4373707E 05
5	0.1617494E 02	0.4037268E 05	0.0	0.0
		0.0	0.3985508E 05	0.0
		0.0	0.0	0.4373707E 05
6	0.8734474E 01	0.1275880E 05	0.0	0.0
		0.0	0.1262940E 05	0.0
		0.0	0.0	0.8152176E 04
7	0.1746895E 02	0.7893375E 05	0.0	0.0
		0.0	0.7815731E 05	0.0
		0.0	0.0	0.1630435E 05

8	[illegible]	[illegible]	0.0	0.0
		0.0	0.1702540E 05	0.0
		0.0	0.0	[illegible]
9	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
10	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
11	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
12	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
13	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
14	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
15	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
16	0.1617494E 02	0.4868425E 05	0.0	0.0
		0.0	0.4994825E 05	0.0
		0.0	0.0	0.4813666E 05
17	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
18	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
19	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
20	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
21	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
22	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
23	0.1252000E 00	0.0	0.0	0.0

		0.0	0.0	0.0
		0.0	0.0	0.0
24	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
25	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
26	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
27	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
28	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
29	0.1394000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
30	0.1394000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
31	0.8969998E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
32	0.8969998E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
33	0.3608998E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
34	0.3608998E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
35	0.8219999E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
36	0.8219999E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
37	0.1418000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
38	0.7873000E 00	0.0	0.0	0.0
		0.0	0.0	0.0

		0.0	0.0	0.0
39	0.7578000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
40	0.3959996E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
41	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
42	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
43	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
44	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
45	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
46	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
47	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
48	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
49	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
50	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
51	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
52	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
53	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0

54	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
55	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
56	0.1252000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
57	0.1394000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
58	0.1394000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
59	0.8969998E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
60	0.8969998E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
61	0.8608998E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
62	0.8608998E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
63	0.8219999E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
64	0.8219999E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
65	0.1418000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
66	0.7873000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
67	0.7873000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
68	0.9959996E-01	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0

69	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
70	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
71	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
72	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0

NO. MODES = 6

MODAL MASSES

0.1300000E 01 0.1300000E 01 0.1300000E 01 0.1000000E 01 0.1000000E 01 0.1000000E 01

FREQUENCIES

0.1249565E 01 0.1250221E 01 0.1346283E 01 0.1362402E 01 0.2394008E 01 0.2397097E 01

MODE 1

MASS NO.	U(1)	U(2)	U(3)	THETA(1)	THETA(2)	THETA(3)
1	0.1121169E-05	0.1954213E-09	0.4337425E-12	0.7004969E-15	0.3147705E-08	0.9416044E-06
2	0.9322054E-06	0.2018765E-09	0.4339812E-12	0.3386863E-13	0.3147599E-08	0.9415951E-06
3	0.7426529E-06	0.2130753E-09	0.5264435E-12	-0.4956326E-13	0.3147065E-08	0.9379352E-06
4	0.3637018E-06	0.2323329E-09	-0.5973097E-13	-0.4635154E-12	0.3143456E-08	0.9335915E-06
5	-0.1478269E-07	0.1208256E-09	0.1350842E-11	-0.8471206E-12	0.3135952E-08	0.9232268E-06
6	-0.2036735E-06	0.1190724E-10	0.2783560E-12	-0.1100793E-11	0.3127211E-08	0.9171530E-06
7	-0.8817460E-06	-0.6813434E-09	0.2783560E-12	-0.1513308E-11	0.2969368E-08	0.8546469E-06
8	-0.1515587E-05	-0.7928840E-09	0.2783560E-12	0.3852099E-11	0.2727572E-08	0.7920815E-06
9	0.1252471E-03	0.2318723E-09	-0.3595260E-11	0.3035956E-13	0.3147638E-08	0.9418990E-06
10	0.2383125E-03	0.2018663E-09	-0.7601153E-11	0.2641633E-13	0.3147679E-08	0.9421519E-06
11	0.3513941E-03	0.2018615E-09	-0.9462971E-11	0.2465237E-13	0.3147710E-08	0.9422759E-06
12	0.4644787E-03	0.2018589E-09	-0.1237754E-10	0.2407537E-13	0.3147727E-08	0.9423104E-06
13	-0.1233825E-03	0.2018735E-09	0.4433393E-11	0.3001926E-13	0.3147638E-08	0.9418974E-06
14	-0.2364476E-03	0.2018694E-09	0.9545364E-11	0.2766902E-13	0.3147679E-08	0.9421493E-
15	-0.3495289E-03	0.201[illegible]	0.1042751E-10	0.2623732E-13	0.3147710E-08	0.94227
16	-0.462613[illegible]		[illegible]67E-12	0.2589607E-13	0.3147727E-08	0.[illegible]
17	-0			0.3852099E-11	0.2727572E-08	
				[illegible]852099E-11	0.2727[illegible]	

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MASS NO.	U(1)	U(2)	U(3)	THETA(1)	THETA(2)	THETA(3)
		[illegible]1900553E-01				[illegible]E-10
	[illegible]94E-06	-0.1732840E-01	-0.46[illegible]			[illegible]1449E-10
						[illegible]1551449E-10
	0.4469644E-06	-0.1711935E-01	-0.6253163E-03		[illegible]10	-0.1551449E-10
63	-0.3160054E-08	-0.1697503E-01	-0.4895884E-03	-0.73[illegible]	[illegible]230558E-10	-0.1551449E-10
64	0.2580129E-06	-0.1725150E-01	-0.5605407E-03	0.2362654E-05	0.4459513E-10	-0.1551449E-10
65	-0.1121239E-06	-0.1707523E-01	0.9283549E-01	0.3617496E-04	0.1824555E-08	0.1463672E-09
66	-0.2791745E-07	-0.2236763E-01	-0.4176642E-03	-0.2701022E-04	0.5811110E-10	-0.1551449E-10
67	0.5314973E-08	-0.1172557E-01	-0.8051293E-03	-0.3023889E-04	-0.4024672E-11	-0.1551449E-10
68	0.1299967E-09	-0.1705910E-01	-0.5140959E-03	0.2838043E-03	0.4913193E-10	0.9366517E-11
69	-0.7489916E-07	-0.1707127E-01	0.7408297E-01	0.1060527E-03	0.1380699E-06	0.1450980E-09
70	0.1390774E-10	-0.1705060E-01	-0.1716029E-03	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
71	-0.1251788E-07	-0.1706319E-01	0.1340017E-01	0.9711327E-04	0.4929692E-09	0.6478306E-10
72	-0.3998930E-07	-0.1706725E-01	0.4325656E-01	0.1298130E-03	0.9365435E-09	0.1279185E-09

BEGINNING OF MODE 1

END OF MODE 6

INITIAL CONDITIONS FOR DEFORMATION COORDINATES

MASS	Q(1)	Q(2)	Q(3)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0		
8			
…	…	…	…
		0.0	0.0
	0.0	0.0	0.0
70	0.0	0.0	0.0
71	0.0	0.0	0.0
72	0.0	0.0	0.0

MASS	QDOT(1)	QDOT(2)	QDOT(3)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
…	…	…	…
72	0.0	0.0	0.0

MASS	THETA(1)	THETA(2)	THETA(3)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	
9	0.0		
…	…	…	…
			0.0
		0.0	0.0
6.		0.0	0.0
68	0.0	0.0	0.0
69	0.0	0.0	0.0
70	0.0	0.0	0.0
71	0.0	0.0	0.0
72	0.0	0.0	0.0

MASS	THETADOT(1)	THETADOT(2)	THETADOT(3)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
		0.0	0.0
			0.0
•	•	•	•
65	0.0	0.0	
66	0.0	0.0	
67	0.0	0.0	0.0
68	0.0	0.0	0.0
69	0.0	0.0	0.0
70	0.0	0.0	0.0
71	0.0	0.0	0.0
72	0.0	0.0	0.0

MODAL DAMPING RATIOS

0.2000000E-01 0.2000000E-01 0.2000000E-01 0.2000000E-01 0.2000000E-01 0.2000000E-01

INITIAL CONDITION FOR MAIN LABORATORY COORDINATES

R =	0.0	0.0	0.5280000E 03
RDOT =	0.0	0.0	0.0
GAMMA=	0.0	0.0	0.0
WX =	0.4169000E 03	0.0	0.0

FLUID DATA

RHO	A
0.9346000E-04	0.1500000E 02

EMPTYING RESERVOIR

FLUID IN RESERVOIR PIPE

MASS	INERTIA MATRIX		
0.7009494E-01	0.5211230E 03	0.0	0.0
	0.0	0.5211230E 03	0.0
	0.0	0.0	0.1673394E 03

SIP=	0.0	0.0	0.5956075E 01
EIR=	0.0	0.0	0.1000000E 01
UIR=	0.0	0.0	0.6000000E 02
UIB=	0.0	0.0	0.1100000E 03
EIB=	0.0	0.0	0.1000000E 01

JIB

0.1815179E 06	0.0	0.0
0.0	0.1815179E 06	0.0
0.0	0.0	0.3580986E 02

```
        BI               HIG              HIMAX            HIMIN
   0.2500000E 02    0.3000000E 02    0.6000000E 02    0.0
GTP=    0.0              0.0              0.0
FILLING RESERVOIR
            FLUID IN RESERVOIR PIPE
       MASS                               INERTIA MATRIX
   0.1401900E-01         0.9610402E 01    0.0              0.0
                         0.0              0.9610402E 01    0.0
                         0.0              0.0              0.3346790E-01

SIP=    0.0              0.0              -0.3644940E 00
EIR=    0.0              0.0              -0.1000000E 01
UIR=    0.0              0.0              -0.2100000E 02
UIB=    0.0              0.0              -0.3100000E 02
EIB=    0.0              0.0              -0.1000000E 01
JIB
   0.1443290E 05    0.0              0.0
   0.0              0.1443290E 05    0.0
   0.0              0.0              0.3580986E 02

        BI               HIG              HIMAX            HIMIN
   0.2500000E 02    0.2000000E 02    0.6000000E 02    0.0
GTP=    0.0              0.0              0.0
FLUID IN PIPE ON MASS NO.   3
MASS =  0.1261710E 00
S   =    0.0              0.0              -0.2018736E 01
DELU=    0.0              0.0               0.9000000E 02
DELE=    0.0              0.0               0.0
G   =    0.0              0.0               0.0
DELH=    0.0              0.0               0.0
DELJ
  -0.4320000E 05    0.0              0.0
   0.0             -0.4320000E 05    0.0
   0.0              0.0              0.0
INERTIA MATRIX
   0.1176158E 03    0.0              0.0
   0.0              0.1176158E 03    0.0
   0.0              0.0              0.3012111E 00
FLUID IN PIPE ON MASS NO.   4
MASS =  0.1632280E 00
S   =    0.0              0.0              -0.1632280E 00
DELU=    0.0              0.0               0.1200000E 03
DELE=    0.0              0.0               0.0
G   =    0.0              0.0               0.0
DELH=    0.0              0.0               0.0
DELJ
  -0.3600000E 04    0.0              0.0
   0.0             -0.3600000E 04    0.0
   0.0              0.0              0.0
INERTIA MATRIX
   0.2022426E 03    0.0              0.0
   0.0              0.2022426E 03    0.0
   0.0              0.0              0.4016147E 00
FLUID IN PIPE ON MASS NO.   5
MASS =  0.1261710E 00
S   =    0.0              0.0               0.1766394E 01
DELU=    0.0              0.0               0.9000000E 02
DELE=    0.0              0.0               0.0
G   =    0.0              0.0               0.0
```

```
DELH=     0.0                0.0                0.0
DELJ
    0.3720000E 03     0.0               0.0
    0.0               0.3720000E 03     0.0
    0.0               0.0               0.0
INERTIA MATRIX
    0.1100455E 03     0.0               0.0
    0.0               0.1100455E 03     0.0
    0.0               0.0               0.5012111E 00
FLUID IN PIPE ON MASS NO.    6
MASS =  0.1962660E 00
S    =    0.0                0.0                -0.8046906E 01
DELU=     0.0                0.0                 0.1430000E 03
DELE=     0.0                0.0                 0.0
G    =    0.0                0.0                 0.0
DELH=     0.0                0.0                 0.0
DELJ
   -0.1722000E 06     0.0               0.0
    0.0              -0.1722000E 06     0.0
    0.0               0.0               0.0
INERTIA MATRIX
    0.6507251E 03     0.0               0.0
    0.0               0.6507251E 03     0.0
    0.0               0.0               0.4684550E 00
FLUID IN PIPE ON MASS NO.    7
MASS =  0.3084130E 00
S    =    0.0                0.0                -0.1542090E 00
DELU=     0.0                0.0                 0.2200000E 03
DELE=     0.0                0.0                 0.0
G    =    0.0                0.0                 0.0
DELH=     0.0                0.0                 0.0
DELJ
   -0.3300000E 04     0.0               0.0
    0.0              -0.3300000E 04     0.0
    0.0               0.0               0.0
INERTIA MATRIX
    0.1244398E 04     0.0               0.0
    0.0               0.1244398E 04     0.0
    0.0               0.0               0.7362937E 00

COUNTERWEIGHT INPUT
NO. MASSES =   1
MASS POINT LOCATIONS
NO.          Y(1)                Y(2)                Y(3)
 1      0.0                 0.0                 0.3200000E 03
NO.         MASS                             INERTIA MATRIX
 1      0.1940994E 03       0.1725982E 08    0.0                0.0
                            0.0              0.2344720E 07      0.0
                            0.0              0.0                0.1548965E 06

CONNECTING STRUCTURE INPUT
CONNECTS TO MASSES I=   8 , A=  1
S       =     0.0              0.0              0.0
SBAR    =     0.0              0.0             -0.3200000E 03
DEL     =     0.0              0.0              0.0
DELDOT=       0.0              0.0              0.0
PHISTAR     =    0.0              0.0              0.0
PHISTARDOT=      0.0              0.0              0.0
YA=      0.0              0.0            -0.1000000E 01
YB=      0.1000000E 01    0.0              0.0
```

DEPLOYMENT INPUT - LO

0.0	0.0	0.1685918E 04

PUMP COMMAND INPUT

V	VELCO	TIMCO	ACCMAG
0.0	0.1200000E 03	0.2000000E 01	0.6000000E 02

PLOTTING GROUPS SELECTED FOR THIS RUN

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NUMERICAL INTEGRATION DATA

DELTA	EPSIL	STEP	DTAU	NTIME
0.0	0.0	0.5000000E-01	0.9997433E-01	2

```
TIME HISTORY

*****.********************************************************

RIGID PROBLEM OUTPUT AT TIME T= 0.0            STEP= 0.49999997E-01
   RDOT ({Ṙ})         WX ({ω^x})        RDDOT ({R̈})        WXDOT ({ω̇^x})       R ({R})           GAM ({γ})         WY ({ω^y})
 0.0                 0.41889995E 00   0.0                0.14339151E-10   0.0               0.0               0.41889995E 00
 0.0                 0.0               0.48292086E-05    0.0               0.0               0.0               0.0
 0.0                 0.0               0.34843728E 01    0.0               0.52800000E 03    0.0               0.0

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
  0.0            0.20031308E-04    0.19738876E 02

ANGULAR MOMENTUM IN Z- COORDINATES
   0.34328934E 09    0.0               0.0

TOTAL KINETIC ENERGY
   0.71901280E 06

FLUID DATA     V= 0.0                VDOT= 0.0
FLUID HEIGHT IN RES(  B)= 0.30000000E 02
FLUID HEIGHT IN RES(  2)= 0.20000000E 02

*************************************************************

RIGID PROBLEM OUTPUT AT TIME T= 0.14999987E 00 STEP= 0.49999997E-01
   RDOT               WX                RDDOT              WXDOT              R                  GAM               WY
 0.0                 0.41889999E 00   0.0               -0.47910853E-09   0.0               0.83779931E-01   0.41889989E 00
 0.57980988E-01      0.0               0.57912809E 00    0.0               0.38672485E-02    0.0               0.0
 0.69043583E 00      0.0               0.34279079E 01    0.0               0.52806909E 03    0.0               0.0

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
  0.0            -0.16837313E 01    0.19739212E 02

ANGULAR MOMENTUM IN Z- COORDINATES
   0.34328909E 09    0.0               0.0

TOTAL KINETIC ENERGY
   0.71901232E 06

FLUID DATA     V= 0.0                VDOT= 0.0
FLUID HEIGHT IN RES(  B)= 0.30000000E 02
FLUID HEIGHT IN RES(  2)= 0.20000000E 02

*************************************************************

RIGID PROBLEM OUTPUT AT TIME T= 0.39999968E 00 STEP= 0.49999997E-01
   RDOT               WX                RDDOT              WXDOT              R                  GAM               WY
 0.0                 0.41889995E 00   0.0               -0.24921003E-08   0.0               0.16755986E 00   0.41889995E 00
 0.23110914E 00      0.0               0.11501245E 01    0.0               0.30872498E-01    0.0               0.0
 0.13663244E 01      0.0               0.33188839E 01    0.0               0.52827515E 03    0.0               0.0

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
```

```
0.0              -0.33075323E 01    0.19739624E 02

ANGULAR MOMENTUM IN Z- COORDINATES
   0.34328934E 09    0.0              0.0

TOTAL KINETIC ENERGY
   0.71901264E 08

FLUID DATA     V= 0.0              VDOT= 0.0
FLUID HEIGHT IN RES(  8)= 0.30000000E 02
FLUID HEIGHT IN RES(  2)= 0.25000000E 02

****************************************************

RIGID PROBLEM OUTPUT AT TIME T= 0.59999949E 00 STEP= 0.49999997E-01
   RDOT             WX              RDDOT            WXDOT            R                GAM              WY
 0.0             0.41889989E 00  0.0            -0.30047496E-08  0.0              0.25133979E 00  0.41889989E 00
 0.51695257E 00  0.0             0.17049513E 01  0.0              0.10382873E 00  0.0             0.0
 0.20132856E 01  0.0             0.31489284E 01  0.0              0.52861353E 03  0.0             0.0

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
  0.0            -0.49611444E 01  0.19738983E 02

ANGULAR MOMENTUM IN Z- COORDINATES
   0.34328939E 09    0.0              0.0

TOTAL KINETIC ENERGY
   0.71901246E 08

FLUID DATA     V= 0.0              VDOT= 0.0
FLUID HEIGHT IN RES(  8)= 0.30000000E 02
FLUID HEIGHT IN RES(  2)= 0.25000000E 02

****************************************************

RIGID PROBLEM OUTPUT AT TIME T= 0.79999930E 00 STEP= 0.49999997E-01
   RDOT             WX              RDDOT            WXDOT            R                GAM              WY
 0.0             0.41889989E 00  0.0            -0.11013324E-08  0.0             0.33511972E 00  0.41889989E 00
 0.91148609E 00                                                   0.24490285E 00  0.0             0.0
 0.261722                                                         0.52907764E 03  0.0             0.0
```

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•
•

```
FLUID HEIGHT IN RE...
FLUID HEIGHT IN RES(  2)= 0.....

**** ************************************************

RIGID PROBLEM OUTPUT AT TIME T= 0.39993912E 02 STEP= 0.49999997E-01
     RDOT              WX              RDDOT            WXDOT             R               GAM              WY
 0.0              0.41466880E 00   0.0             -0.42550863E-06   0.0             0.16673264E 02   0.41466880E 00
-0.11266265E 03   0.0             -0.35165649E 02   0.0             -0.17162120E 03   0.0              0.0
-0.77981659E 02   0.0              0.44911926E 02   0.0              0.21574579E 03   0.0              0.0

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
  0.0            -0.35049902E 03   0.20052719E 02

ANGULAR MOMENTUM IN Z- COORDINATES
   0.34327936E 09    0.0            0.0

TOTAL KINETIC ENERGY
   0.71212658E 08

FLUID DATA    V= 0.0                VDOT= 0.0
FLUID HEIGHT IN RES(  6)= 0.0
FLUID HEIGHT IN RES(  2)= 0.59017685E 02

*****  END OF TIME HISTORY  *****
```

Example 2

The time-history printout for this problem, where the vehicle is flexible, includes the connecting-structure deformations $\{\delta\}$ and $\{\phi^*\}$ as well as the main variables. Elastic deformations are also printed at each mass point requested. In addition, internal structural loads are printed at the requested points. As discussed in Section 4.5 of Volume I, the internal loads are inaccurate at t = 0. These loads have been deleted from the printout at t = 0; however, this modification was done after making the run on the example presented. After completing the time history, a tabulation is printed of the maximum and minimum (or largest negative) elastic motions that occurred during the run at every mass point. Also, the maximum and minimum internal structural loads are printed at only those points where loads were requested in the input data. The maxima and minima for both deformations and loads are obtained by examining the data at every printout time point and not at every numerical-integration time point.

```
INPUT DATA

   FINAL TIME , PLOTTING CLUE , PLOT INTERVAL
  0.10000000E 03      1        0.50000000E-01
FLUID CLUE , NO. PIPES
   0          0
RESERVOIR MASS POINTS
   0   0
NC. MOVING MASSES ,        MOVING MASSES PRESENT
       2               1   1   0   0   0   0   0   0
PIPES ON MASS POINTS
  0
CLUES FOR THIS RUN
PROBLEM CLUE , DEPLOYMENT , CONTROLS , SUPP. FORCES
      3           0            1           0

CONTROLS INPUT , SENSOR ON MASS POINT   4 , FJET= 0.50000000E 02
COUNTERWEIGHT COMMAND
 LENGTH UPDATE    TIME OF UPDATE     ACCEL. MAG       VEL. MAX
  0.16859165 04    0.3500000E 03    0.1200000E 01   0.2400000E 01
SPIN COMMAND
ANG. VEL. COMMAND    ANG. VEL. UPDATE        ACCEL MAG         TIME OF UPDATE
  0.4189000E 00       -0.4189000E 00        0.4000000E-01        0.9500000E 03
SPIN CONTROL
SPIN RATE ERROR DEAD BAND= 0.20939999E-03
ATTITUDE CONTROL
   DEAD BAND         MAX. ANG. VEL.    JET MOMENT ARM
  0.1745000E-03     0.1745000E-02     0.7200000E 02
WOBBLE DAMPING
     BET               DBET               KT                TGLIM              KDBET              MOMCMG             GIMBAL INERTIA
  0.0              -0.1132000E 00    0.2880000E 04     0.3600000E 03     0.3600000E 03     0.2400000E 04     0.1800000E 03

LOADS COMPUTED ON LABORATORY
LOAD TO BE COMPUTED AT MASS POINT    4
LOCATION IN LOCAL COORDINATES     0.0                     0.0                0.6000000E 02
 11 MASS POINT NUMBERS COMPRISING FREE BODY
  1   2   3   5  10  11  12  13  14  15  16
LOAD TO BE COMPUTED AT MASS POINT  42
LOCATION IN LOCAL COORDINATES     0.0                     0.0                0.0
 27 MASS POINT NUMBERS COMPRISING FREE BODY
 17  18  19  20  21  22  23  24  25  27  28  29  30  31  32  33  34  35  36  37
 38  39  40  41  35  43  44

LAB INPUT
NO. MASSES =  72
MASS POINT LOCATIONS
NO.          X(1)                 X(2)                X(3)
  1      0.0              0.0              0.86100000E 03
  2      0.0              0.0              0.80100000E 03
  3      0.0              0.0              0.74100000E 03
  4      0.0              0.0              0.62100000E 03
  5      0.0              0.0              0.50100000E 03
  .      0.0              0.0              0.44...
         .                0.0
                                  .
                                  .
                                  .
```

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•
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59			
60	0.0		
61	0.0		...3050000E 03
62	0.0	0.60000000E 02	0.13050000E 03
63	0.0	0.60000000E 02	-0.58500000E 02
64	0.0	0.60000000E 02	0.58500000E 02
65	0.0	0.10680000E 04	0.0
66	0.0	0.60000000E 02	-0.36900000E 03
67	0.0	0.60000000E 02	0.36900000E 03
68	0.0	0.60000000E 02	0.0
69	0.0	0.81600000E 03	0.0
70	0.0	0.12000000E 02	0.0
71	0.0	0.31200000E 03	0.0
72	0.0	0.56400000E 03	0.0

NO.	MASS	INERTIA MATRIX		
1	0.1617494E 02	0.4037268E 05	0.0	0.0
		0.0	0.3985508E 05	0.0
		0.0	0.0	0.4373707E 05
2	0.0	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
3				0.0

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	0.0	0.0	0.0	
		0.0	0.0	0.0
		0.0	0.0	0.0
71	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0
72	0.1383000E 00	0.0	0.0	0.0
		0.0	0.0	0.0
		0.0	0.0	0.0

NO. MODES = 6

MODAL MASSES

0.1000000E 01 0.1000000E 01 0.1000000E 01 0.1000000E 01 0.1000000E 01 0.1000000E 01

FREQUENCIES

0.1249565E 01 0.1250221E 01 0.1346283E 01 0.1362402E 01 0.2394608E 01 0.2397697E 01

MODE 1

MASS NO.	Q(1)	Q(2)	Q(3)	THETA(1)	THETA(2)	THETA(3)
1	0.1121169E-05	0.1954213E-09	0.4337425E-12	0.7004969E-15	0.3147705E-08	0.9416044E-06
2	0.9322954E-06	0.2018765E-09	0.4339812E-12	0.3386963E-13	0.3147599E-08	0.9415951E-06
3	0.7426523E-06	0.2130753E-09	0.5264435E-12	-0.4956326E-13	0.3147065E-08	0.937[illegible]
4	0.363701[illegible]		[illegible]07E-13	-0.4635154E-12	0.3143456E-08	
5	[illegible]			0.8471206E-12	0.3135952E	

BEGINNING OF MODE 1

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	[illegible]22E-08	-0.1437958E-01	0.527095[illegible]			[illegible]1449E-10
[illegible]	-0.9712095E-07	-0.2014850E-01	0.5264169E 00	-0.1[illegible]		-0.1551449E-10
51	-0.3095351E-07	-0.1566010E-01	0.5269642E 00	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
52	-0.7029564E-07	-0.1960001E-01	0.5266610E 00	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
53	-0.2142737E-05	-0.1639250E-01	0.4632576E 00	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
54	-0.1529976E-05	-0.1818882E-01	0.4624734E 00	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
55	-0.1144465E-06	-0.1655221E-01	0.4631166E 00	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
56	0.5011299E-07	-0.1772273E-01	0.4627649E 00	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
57	-0.3501295E-06	-0.1331243E-01	0.9284961E-01	0.2469415E-04	0.1824961E-08	-0.1551449E-10
58	0.1260770E-05	-0.2104078E-01	0.9284961E-01	0.2713878E-04	0.1824937E-08	-0.1551449E-10
59	-0.2187583E-05	-0.1519410E-01	0.9284228E-01	0.2901509E-04	0.1824721E-08	-0.1551449E-10
60	-0.5306570E-03	-0.1900558E-01	0.9284228E-01	0.3052253E-04	0.1824813E-08	-0.1551449E-10
61	-0.8067104E-08	-0.1732840E-01	-0.4670424E-03	-0.9617907E-05	0.7359133E-10	-0.1551449E-10
62	0.4469644E-08	-0.1711985E-01	-0.6253163E-03	-0.7375049E-05	0.1916231E-10	-0.1551449E-10
63	-0.3160054E-08	-0.1697503E-01	-0.4895884E-03	-0.7379945E-06	0.6230658E-10	-0.1551449E-10
64	0.2580129E-08	-0.1725150E-01	-0.5605407E-03	0.2362654E-05	0.3459513E-10	-0.1551449E-10
65	-0.1121339E-05	-0.1707523E-01	0.9283549E-01	0.3617496E-04	0.1824555E-08	0.1483672E-09
66	-0.2721745E-07	-0.2238763E-01	-0.4176642E-03	-0.2701022E-04	0.8811110E-10	-0.1551449E-10
67	0.5314970E-08	-0.1172557E-01	-0.8651293E-03	-0.3023889E-04	-0.4024672E-11	-0.1551449E-10
68	0.1299967E-09	-0.1705910E-01	-0.5140959E-03	0.2838043E-05	0.4913193E-10	0.9066517E-11
69	-0.7489916E-07	-0.1707127E-01	0.7408297E-01	0.1060527E-03	0.1390699E-08	0.1450980E-09
70	0.1390774E-10	-0.1705660E-01	-0.1716629E-03	-0.1444727E-04	0.1245948E-10	-0.1551449E-10
71	-0.1251738E-07	-0.1706319E-01	0.1340017E-01	0.9711327E-04	0.4929892E-09	0.8478308E-10
72	-0.3998930E-07	-0.1706725E-01	0.4325856E-01	0.1298130E-03	0.9368435E-09	0.1279185E-09

END OF MODE 6

INITIAL CONDITIONS FOR DEFORMATION COORDINATES

MASS	Q(1)	Q(2)	Q(3)
1	-0.8386952E-08	0.1661246E-05	-0.2366700E 00
2	0.4631341E-07	0.5813490E-07	-0.2366646E 00
3	-0.9210152E-07	-0.1193839E-06	-0.2366175E 00
4	-0.1178544E-05	-0.1319694E-06	-0.2365184E 00
5	-0.1484652E-06	-0.3920286E-05	-0.2364259E 00
6	-0.1198516E-06	-0.4576431E-06	-0.2363781E 00
7	-0.2666172E-05	-0.6919755E-05	-0.2363781E 00
8	-0.2909330E-05	-0.8918432E-06	-0.2363781E 00
9	0.5800554E-07	0.5807669E-07	-0.2367299E 00
10	0.7176317E-07	0.5800393E-07	-0.2368985E 00
11	0.8550961E-07	0.5793117E-07	-0.2370944E 00
12	0.9845007E-07	0.5790207E-07	-0.2372898E 00
13	0.3532894E-07	0.5810580E-07	-0.2367302E 00
14	0.2430310E-07	0.5809125E-07	-0.2368993E 00
15	0.1354361E-07	0.5807669E-07	-0.2370956E 00
16	0.3934133E-03	0.5803304E-07	-0.2372914E 00
17	-0.7231311E-05	-0.1202033E 00	0.2135449E 02
18	0.5207304E-05	0.1201248E 00	0.2132310E 02
19	-0.3529372E-05	-0.5963879E-01	0.2134869E 02
20	0.2046365E-05	0.5955520E-01	0.2133461E 02
21	0.1193910E-05	-0.1515666E 00	0.1579842E 02
22	-0.3630429E-05	0.1514618E 00	0.1677711E 02
23	-0.4252640E-06	-0.7359699E-01	0.1679433E 02
24	-0.2591704E-05	0.7347929E-01	0.1678477E 02
25	-0.7333228E-05	-0.8853991E-01	0.1444334E 02
26	0.9333985E-05	0.9853775E-01	0.1441858E 02
27	-0.2743023E-05	-0.4555708E-01	0.1443889E 02
28	0.4720949E-05	0.4550719E-01	0.1442779E 02
29	0.6509129E-05	-0.1826136E 00	0.3220690E 01
30	-0.4596394E-05	0.1824825E 00	0.3220690E 01
31	0.3445967E-05	-0.8740133E-01	0.3220455E 01
32	-0.1572399E-05	0.8724976E-01	0.3220455E 01
33	0.7645373E-06	-0.5679414E-01	-0.2236958E 00
34	-0.6202399E-06	0.5676814E-01	-0.2287396E 00
35	0.1296852E-06	-0.3138164E-01	-0.2244118E 00
36	-0.4913260E-06	0.3136579E-01	-0.2266729E 00
37	0.9570267E-05	-0.7926005E-04	0.3220241E 01
38	0.3625969E-05	-0.1209540E-05	-0.2221182E 00
39	-0.2667364E-06	-0.5744660E-06	-0.2363778E 00
40	-0.2509694E-06	-0.4601184E-05	-0.2251878E 00
41	0.7949726E-06	-0.6059759E-04	0.2509081E 01
42	-0.2900330E-06	-0.8918432E-06	-0.2363780E 00
43	0.1273915E-06	-0.2326749E-04	0.3377636E 00
44	0.5176919E-05	-0.4193319E-04	0.1410043E 01
45	-0.7408883E-05	0.1202018E 00	0.2135454E 02
46	0.6808415E-05	-0.1201266E 00	0.2132318E 02
47	-0.3202865E-05	0.5963711E-01	0.2134871E 02
48	0.3171558E-05	-0.5955705E-01	0.2133467E 02
49	-0.7559096E-06	0.1515652E 00	0.1679851E 02
50	0.5789939E-05	-0.1514639E 00	0.1677719E 02
51	-0.7095795E-06	0.7359523E-01	0.1679439E 02
52	-0.1175994E-06	-0.7348114E-01	0.1678484E 02
53	-0.3427355E-05	0.8858836E-01	0.1444337E 02

54	0.5593115E-05	-0.9853954E-01	0.1441861E 02
~~55~~	~~0.9261995E-04~~	~~-0.4555535E-01~~	~~0.1443893E 02~~
56	0.3118395E-05	-0.4550897E-01	0.1442782E 02
57	0.9205395E-05	0.1826124E 00	0.3220695E 01
~~58~~	~~-0.5693664E-05~~	~~-0.1824848E 00~~	~~0.3220695E 01~~
59	0.5095556E-05	0.8739978E-01	0.3220461E 01
60	-0.1582991E-05	-0.9725178E-01	0.3220461E 01
~~61~~	~~0.8681914E-06~~	~~0.5679235E-01~~	~~-0.2236958E 00~~
62	-0.6679533E-05	-0.5676979E-01	-0.2287397E 00
63	0.1678849E-06	0.3137982E-01	-0.2244118E 00
~~64~~	~~-0.5226066E-06~~	~~-0.3136751E-01~~	~~-0.2266730E 00~~
65	0.1755463E-05	0.7748378E-04	0.3220245E 01
66	0.4002933E-05	-0.1209540E-05	-0.2221183E 00
~~67~~	~~-0.2755702E-06~~	~~-0.5744660E-06~~	~~-0.2363780E 00~~
68	-0.2543039E-06	0.2818385E-05	-0.2251880E 00
69	0.1301283E-05	0.5861980E-04	0.2509086E 01
~~70~~	~~-0.2917013E-06~~	~~-0.8918432E-05~~	~~-0.2363779E 00~~
71	0.1995687E-05	0.2148640E-04	0.3377637E 00
72	0.7702058E-06	0.4015378E-04	0.1410045E 01

MASS	QDOT(1)	QDOT(2)	QDOT(3)
1	0.0	0.0	0.0
~~2~~	~~0.0~~	~~0.0~~	~~0.0~~
3	0.0	0.0	0.0
4	0.0	0.0	0.0
~~5~~	~~0.0~~	~~0.0~~	~~0.0~~
6	0.0	0.0	0.0
7	0.0	0.0	0.0
~~8~~	~~0.0~~	~~0.0~~	~~0.0~~
9	0.0	0.0	0.0
10	0.0	0.0	0.0
~~11~~	~~0.0~~	~~0.0~~	~~0.0~~
12	0.0	0.0	0.0
13	0.0	0.0	0.0
~~14~~	~~0.0~~	~~0.0~~	~~0.0~~
15	0.0	0.0	0.0
16	0.0	0.0	0.0
~~17~~	~~0.0~~	~~0.0~~	~~0.0~~
18	0.0	0.0	0.0
19	0.0	0.0	0.0
~~20~~	~~0.0~~	~~0.0~~	~~0.0~~
	0.0	0.0	0.0
		0.0	0.0
		~~0.0~~	~~0.0~~

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57			
58	0.0		
59	0.0		0.0
60	0.0	0.0	0.0
61	0.0	0.0	0.0
62	0.0	0.0	0.0
63	0.0	0.0	0.0
64	0.0	0.0	0.0
65	0.0	0.0	0.0
66	0.0	0.0	0.0
67	0.0	0.0	0.0
68	0.0	0.0	0.0
69	0.0	0.0	0.0
70	0.0	0.0	0.0
71	0.0	0.0	0.0
72	0.0	0.0	0.0

MASS	THETA(1)	THETA(2)	THETA(3)
1	-0.1552621E-08	0.4918081E-09	0.8756057E-10
2	-0.1541878E-08	0.4835032E-09	0.8781538E-10
3	-0.1473609E-08	0.5368643E-09	0.2109571E-09
4	-0.1428530E-08	0.5644674E-09	0.4099050E-09
5	-0.1472599E-08	0.4536025E-09	0.4882112E-09
6	-0.1429157E-08	0.4521037E-09	0.4394236E-09
7	-0.2916421E-08	0.1712072E-08	-0.2249339E-09
8	-0.8604386E-09	0.5362749E-10	0.7363289E-10
9	0.6815164E-06	0.4833234E-09	0.9860426E-10
10	0.1208326E-05	0.4831870E-09	0.1078449E-09
11	0.1442317E-05	0.4830853E-09	0.1092872E-09
12	0.1500411E-05	0.4830036E-09	0.1085620E-09
13	-0.6846124E-06	0.4836369E-09	0.8788621E-10
14	-0.1211431E-05	0.4837253E-09	0.8836117E-10
15	-0.1445428E-05	0.4837903E-09	0.8545123E-10
16	-0.1503524E-05	0.4838530E-09	0.8307008E-10
17	-0.8604386E-09	0.5362749E-10	0.7363289E-10
18	-0.8604386E-09	0.5362749E-10	0.7363289E-10
19	-0.8604386E-09	0.5362749E-10	0.7363289E-10
20	-0.8604386E-09	0.5362749E-10	0.7363289E-10
21	-0.8604386E-09	0.5362749E-10	0.7363289E-10
22	-0.8604386E-09	0.5362749E-10	0.7363289E-10
23	-0.8604386E-09	0.5362749E-10	0.7363289E-10
24	-0.8604386E-09	0.5362749E-10	0.7363289E-10
25	-0.8604386E-09	0.5362749E-10	0.7363289E-10
26	-0.8604386E-09	0.5362749E-10	0.7363289E-10
27	-0.8604386E-09	0.5362749E-10	0.7363289E-10

28	-0.8604386E-09	0.5362749E-10	0.7363289E-10
29	-0.1281715E-02	-0.4254521E-07	0.7363289E-10
30	-0.1282030E-02	-0.4256263E-07	0.7363289E-10
31	-0.1403743E-02	-0.4254476E-07	0.7363289E-10
32	-0.1403953E-02	-0.4255892E-07	0.7363289E-10
33	-0.1894102E-03	-0.9888488E-09	0.7363289E-10
34	-0.1893227E-03	-0.7001661E-09	0.7363289E-10
35	-0.4864356E-03	-0.7635293E-08	0.7363289E-10
36	-0.4862675E-03	-0.2984175E-08	0.7363289E-10
37	-0.1606659E-02	-0.4254793E-07	0.5509802E-09
38	0.4518939E-03	-0.1365193E-07	0.7363289E-10
39	0.4516961E-03	0.2573689E-08	0.7363289E-10
40	-0.5521697E-03	-0.5304226E-09	0.1223641E-08
41	-0.3833349E-02	-0.3323701E-07	0.8271779E-09
42	-0.8604386E-09	0.5362749E-10	0.7363289E-10
43	-0.3576254E-02	-0.1461517E-07	0.1639233E-08
44	-0.4609873E-02	-0.2392668E-07	0.1370312E-08
45	-0.8604386E-09	0.5362749E-10	0.7363289E-10
46	-0.8604386E-09	0.5362749E-10	0.7363289E-10
47	-0.8604386E-09	0.5362749E-10	0.7363289E-10
48	-0.8604386E-09	0.5362749E-10	0.7363289E-10
49	-0.8604386E-09	0.5362749E-10	0.7363289E-10
50	-0.8604386E-09	0.5362749E-10	0.7363289E-10
51	-0.8604386E-09	0.5362749E-10	0.7363289E-10
52	-0.8604386E-09	0.5362749E-10	0.7363289E-10
53	-0.8604386E-09	0.5362749E-10	0.7363289E-10
54	-0.8604386E-09	0.5362749E-10	0.7363289E-10
55	-0.8604386E-09	0.5362749E-10	0.7363289E-10
56	-0.8604386E-09	0.5362749E-10	0.7363289E-10
57	0.1281718E-02	-0.5708207E-07	0.7363289E-10
58	0.1282033E-02	-0.5709472E-07	0.7363289E-10
59	0.1403747E-02	-0.5707930E-07	0.7363289E-10
60	0.1403958E-02	-0.5708992E-07	0.7363289E-10
61	0.1894094E-03	-0.1088076E-07	0.7363289E-10
62	0.1893211E-03	-0.8017556E-09	0.7363289E-10
63	0.4864361E-03	-0.9446516E-09	0.7363289E-10
64	0.4862666E-03	-0.3345408E-08	0.7363289E-10
65	0.1606661E-02	-0.5707854E-07	-0.1740960E-08
66	-0.4518973E-03	-0.1427479E-07	0.7363289E-10
67	-0.4516982E-03	0.2868927E-08	0.7363289E-10
68	0.5521670E-03	-0.5902073E-08	-0.1274429E-08
69	0.3833350E-02	-0.4428439E-07	-0.1936872E-08
70	-0.8604386E-09	0.5362749E-10	0.7363289E-10
71	0.3576260E-02	-0.1869621E-07	-0.2167261E-08
72	0.4609390E-02	-0.3149027E-07	-0.2252870E-08

MASS	THETADOT(1)	THETADOT(2)	THETADOT(3)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	

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 61   0..
 62   0.0                               ...
 63   0.0             0.0               0.0
 64   0.0             0.0               0.0
 65   0.0             0.0               0.0
 66   0.0             0.0               0.0
 67   0.0             0.0               0.0
 68   0.0             0.0               0.0
 69   0.0             0.0               0.0
 70   0.0             0.0               0.0
 71   0.0             0.0               0.0
 72   0.0             0.0               0.0
MODAL DAMPING RATIOS
  0.2000000E-01  0.2000000E-01  0.2000000E-01  0.2000000E-01  0.2000000E-01  0.2000000E-01


INITIAL CONDITION FOR MAIN LABORATORY COORDINATES

R     =   0.0                0.0              0.4364841E 03
RDOT  =   0.0                0.0              0.0
GAMMA=    0.0                0.0              0.0
WX    =   0.4189000E 00      0.0              0.0

MASS MU(J) OF  EACH MOVING MASS
  0.2587991E 02  0.1233996E 02  0.0        0.0       0.0       0.0       0.0       0.0

COUNTERWEIGHT INPUT
NO. MASSES =   1
MASS POINT LOCATIONS
NO.          Y(1)              Y(2)              Y(3)
 1     0.0              0.0              0.3200000E 03
NO.        MASS                      INERTIA MATRIX
 1     0.1940994E 03       0.1725992E 08   0.0              0.0
                           0.0             0.2344720E 07    0.0
                           0.0             0.0              0.1549965E 08

CONNECTING STRUCTURE INPUT
CONNECTS TO MASSES I=  3 , A=  1
S      =    0.0              0.0              0.0
SBAP   =    0.0              0.0             -0.3200000E 03
DEL    =    0.0              0.0              0.3009434E 01
DELDOT=     0.0              0.0              0.0
PHISTAR    =    0.0               0.0               0.0
PHISTARDOT=     0.0               0.0               0.0
YA=     0.0                0.0              -0.1000000E 01
YB=     0.1000000E 01      0.0               0.0
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DEPLOYMENT INPUT - LD
   0.0               0.0             0.1685916E 04

MUCOM INPUT FOR MOVING MASS    1
 UJ =    0.0              0.0              0.76212939E 03
AXIS =   3
       UU                 TU               ACCMAG           VELMAX
  0.73962939E 03   0.20000000E 01   0.20000000E 02   0.40000000E 02

BALANCE MASS CONTROL INPUT
  EL MASS EST          KEXSF             KDESE       FILTER TIME CONST   OMEGA BAL (MIN)
    0.1293906E 03    0.1000000E 03    0.3640000E 00     0.0                 0.4000000E 00
LOCAL SENSOR COORDS    =    0.0              0.0              0.0
DIST CM TO SENSOR CAND=    0.0              0.0              0.1057289E 04
U2    INITIAL          =    0.0              0.0              0.3485181E 03
U2D   INITIAL          =    0.0              0.0              0.0

BEAM SUBROUTINE INPUT
     CWT MASS           LAB MASS       CWT TRANS INRTA   LAB TRANS INRTA   CWT ROLL INRTA   LAB ROLL INRTA
   0.1940990E 03     0.2489540E 03    0.1725600E 08     0.3860250E 08     0.1549550E 08    0.1829429E 08
        A                  B                AE                EI                GJ
   0.6242578E 03     0.3200000E 03    0.3000000E 08     0.1357000E 12     0.1086000E 12
  AXIAL DAMPING RATIO   BENDING DAMPING RATIO   TORSION DAMPING RATIO
      0.5000000E-01          0.5000000E-01          0.5000000E-01

PLOTTING GROUPS SELECTED FOR THIS RUN
                   2
                   3
                   4   AT MASS NO.   4
                   7   AT MASS NO.   8
                   8   AT MASS NO. 17
                  10
                  12   AT MASS NO. 42

NUMERICAL INTEGRATION DATA
     DELTA              EPSIL             STEP              DTAU             NTIME
      0.0                0.0          0.5000000E-01     0.3997433E-01          2
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TIME HISTORY

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TIME= 0.0 STEP= 0.49999997E-01

R ({R})	RDOT ({Ṙ})	GAMMA {γ}	WX ({ω^x})	DELPR ({ΔR})	DELRRD ({ΔṘ})	ETA-STAR ({η*})	WY ({ω^Y})
0.1861835E-08	0.0	0.1549408E-08	0.4189000E 00	-0.2928215E-06	-0.3585674E-22	-0.2408847E-08	0.4189000E 00
0.1475943E-05	0.0	0.9016567E-13	-0.5304183E-11	0.1691727E-05	-0.2638432E-25	-0.5353730E-10	0.3084480E-10
0.4364941E-03	0.0	0.1266217E-10	0.3777039E-13	0.3245850E-01	-0.2638432E-25	-0.6097070E-10	-0.2246454E-10

RDDOT ({R̈})	WXDOT ({ω̇^x})	DELRRDD ({ΔR̈})	WYDOT ({ω̇^Y})	DEL ({δ})	DELDOT ({δ̇})	PHISTAR ({φ*})	PHISTARDOT ({φ̇*})
0.6256068E-06	0.4991264E-07	-0.3658893E-06	0.9221139E-12	0.0	0.0	0.0	0.0
0.5783366E-04	-0.5941885E-09	0.3531547E-04	0.7135285E-11	0.0	0.0	0.0	0.0
0.1673957E-01	0.1073150E-10	0.8904868E-01	0.1244162E-10	0.3009434E 01	0.0	0.0	0.0

MASS PT.	Q	Q-DOT	QDDOT	THETA	THETA-DOT	THETADDOT
1	-0.10365770E-07	0.0	0.18832793E-07	-0.31010294E-08	0.0	0.16836452E-08
	0.69921572E-06	0.0	-0.20222797E-06	0.49171778E-09	0.0	-0.36992431E-09
	-0.23667169E 00	0.0	0.22627038E 00	0.74898379E-10	0.0	0.12579044E-11
4	-0.11981155E-06	0.0	0.99411352E-07	-0.29773384E-08	0.0	0.15605361E-08
	0.29503951E-07	0.0	0.13052158E-06	0.56437699E-09	0.0	-0.43944604E-09
	-0.23652011E 00	0.0	0.22612548E 00	0.39724268E-09	0.0	-0.30810376E-09
8	-0.29283416E-06	0.0	0.20304645E-06	-0.24088471E-08	0.0	0.90813046E-09
	-0.16919312E-05	0.0	0.95364521E-06	0.53537313E-10	0.0	0.47681206E-10
	-0.23637980E 00	0.0	0.22599137E 00	0.60970701E-10	0.0	-0.14672976E-11
12	0.90246772E-07	0.0	-0.47487621E-07	0.14988618E-05	0.0	-0.14342813E-05
	0.49808921E-06	0.0	-0.86802174E-07	0.49291326E-09	0.0	-0.36150327E-09
	-0.23729080E 00	0.0	0.22686291E 00	0.95899830E-10	0.0	-0.18735555E-10
16	0.81905576E-08	0.0	-0.40796206E-07	-0.15050719E-05	0.0	0.14376565E-05
	0.49822017E-06	0.0	-0.86933142E-07	0.48376259E-09	0.0	-0.36231529E-09
	-0.23729394E 00	0.0	0.22686458E 00	0.70407888E-10	0.0	0.56172593E-11
17	-0.72403418E-05	0.0	0.73594128E-05	-0.24088471E-08	0.0	0.90813046E-09
	-0.12020421E 00	0.0	0.11492145E 00	0.53537313E-10	0.0	0.47681206E-10
	0.21354477E 02	0.0	-0.20416153E 02	0.60970701E-10	0.0	-0.14672976E-11
18	0.51093473E-05	0.0	-0.50008839E-05	-0.24088471E-08	0.0	0.90813046E-09
	0.12012416E 00	0.0	-0.11484629E 00	0.53537313E-10	0.0	0.47681206E-10
	0.21323090E 02	0.0	-0.20386169E 02	0.60970701E-10	0.0	-0.14672976E-11
29	0.64937149E-05	0.0	-0.55211567E-05	-0.12817162E-02	0.0	0.12253944E-02
	-0.18251456E 00	0.0	0.17459946E 00	-0.42545302E-07	0.0	0.38050906E-07
	0.32206889E 01	0.0	-0.30791683E 01	0.60970701E-10	0.0	-0.14672976E-11
30	-0.46122295E-05	0.0	0.44118251E-05	-0.12820312E-02	0.0	0.12256959E-02
	0.18249199E 00	0.0	-0.17446393E 00	-0.42562721E-07	0.0	0.38068450E-07
	0.32206889E 01	0.0	-0.30791683E 01	0.60970701E-10	0.0	-0.14672976E-11
45	-0.74036298E-05	0.0	0.82263377E-05	-0.24088471E-08	0.0	0.90813046E-09
	0.12020069E 00	0.0	-0.11491984E 00	0.53537313E-10	0.0	0.47681206E-10
	0.21354523E 02	0.0	-0.20416214E 02	0.60970701E-10	0.0	-0.14672976E-11

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46   0.68136433E-05   0.0          -0.58284531E-05  -0.24088471E-08   0.0      0.90813046E-09
    -0.12012714E 00   0.0           0.11484826E 00   0.53537313E-10   0.0      0.47681206E-10
     0.21333166E 02   0.0          -0.20386230E 02   0.60970701E-10   0.0     -0.14672976E-11

57   0.92170285E-05   0.0          -0.71661334E-05   0.12817169E-02   0.0     -0.12253982E-02
     0.18261129E 00   0.0          -0.17459808E 00  -0.57082158E-07   0.0      0.51989936E-07
     0.32206917E 01   0.0          -0.30791750E 01   0.60970701E-10   0.0     -0.14672976E-11

58  -0.56820736E-05   0.0           0.64043752E-05   0.12820312E-02   0.0     -0.12256992E-02
    -0.19244534E 00   0.0           0.17446631E 00  -0.57094812E-07   0.0      0.52005689E-07
     0.32206917E 01   0.0          -0.30791750E 01   0.60970701E-10   0.0     -0.14672976E-11

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
 -0.15945665E-05   0.16319279E-04  -0.20995449F-01

ANGULAR MOMENTUM IN Z- COORDINATES
   0.36072269E 09    0.51922421F-03   -0.51476635E-01

TOTAL KINETIC ENERGY
   0.75552880E 03

STRUCTURAL LOADS APPLIED BY CONNECTING STRUCTURE (ON LAB IN X AXES AND ON CWT IN Y AXES)
                        FORCE                                             TORQUE
ON LAB    -0.2866994E-05  -0.1289969E-03  -0.5355132E 05         0.0          0.0          0.0
ON CWT.    0.0             0.0            -0.5355132E 05         0.0          0.0          0.0

STRUCTURAL LOADS ON LAB IN X AXES

MASS POINT = 4
LOCATION =     0.0             0.0             0.6000000E 02
                 FORCE                                              TORQUE
 -0.3657064E-08   0.2441406E-03   0.4055938E 05        0.1000000E 01  -0.5485803E-02  -0.2502690E-03

MASS POINT =42
LOCATION =     0.0             0.0             0.0
                 FORCE                                              TORQUE
 -0.4343558E-08  -0.3396841E 03   0.4704268E 03       -0.1425413E 06  -0.1690800E-03  -0.1444747E-03

MOTION OF MOVING MASS  1
UJ   =    0.0             0.0            0.7621294E 03
UJD  =    0.0             0.0            0.0
UJDD=     0.0             0.0            0.0

BALANCE MASS DATA
U(2,3)= 0.34851907E 03  UDDT(2,3)= 0.0             UDDCT(2,3)=-0.72631836E-01
SENSOR ACCELERATION ERROR =-0.72631836E-02
SENSOR TO CM POS ERROR =

CONTROL SYSTEM DATA
JET THRUST
 F1 = 0.0          F2 = 0.0          F3 = 0.0          F4 = 0.0          F5 = 0.0          F6 = 0.0
 F7 = 0.0          F8 = 0.0          F9 = 0.0          F10= 0.0          F11= 0.0          F12= 0.0
 F13= 0.0          F14= 0.0          F15= 0.0          F16= 0.0
CMG TORQUE =    0.5684342E-13    0.1782918E-07    0.1294721E-07
 NCMG=  0
L03= 0.16859165E 04  L03D= 0.0            L03DD= 0.0
SPIN SPEED COMMAND = 0.4189000E 00
SPIN ACCELERATION COMMAND = 0.0

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TIME= 0.10000000E 00 STEP= 0.40000000E-01

R	RDOT	GAMMA	WX	DELRR	DELRRD	ETA-STAR	WY
-0.1778212E-07	-0.9243424E-07	0.8377880E-01	0.4188849E 00	-0.1045100E-06	-0.8744627E-07	0.1141006E-05	0.4189017E 00
-0.1140891E-02	-0.1544643E-01	0.1749051E-10	0.7538470E-10	-0.5294941E-03	-0.6829616E-02	-0.1228787E-09	0.1086832E-09
0.4364844E 03	-0.1087303E-01	0.1384954E-10	0.2857665E-10	0.3245118E 01	-0.3416534E-01	-0.6037564E-10	-0.6535475E-10

RDDOT	WXDOT	DELRRDD	WYDOT	DEL	DELDOT	PHISTAR	PHISTARDOT
0.8584666E-06	-0.1263072E-03	-0.2233284E-04	0.3414768E-04	-0.1385515E-06	0.1133042E-06	-0.1159348E-05	-0.1711361E-04
-0.1455879E 00	-0.7357567E-09	-0.3793452E-01	0.1083826E-07	-0.5512945E-03	-0.7123329E-02	-0.1257120E-09	0.1846856E-09
-0.2545604E 00	-0.2347700E-09	-0.3488280E 00	-0.1518256E-10	0.3013367E 01	-0.8753851E-02	0.1356165E-10	0.1744664E-10

MASS PT.	Q	Q-DOT	QDDOT	THETA	THETA-DOT	THETADDOT
1	-0.14158122E-07	0.53074238E-08	0.12121834E-07	-0.42290822E-07	-0.57196416E-06	-0.48147303E-05
	0.90428949E-05	0.12461384E-03	0.10488634E-02	0.42609205E-09	-0.53234681E-10	-0.34980552E-09
	-0.23203731E 00	0.42972174E-01	0.19364375E 00	0.88027696E-10	0.43826063E-11	0.50836696E-10
4	-0.10800261E-06	0.16687626E-07	0.90438391E-07	-0.41169480E-07	-0.55822977E-06	-0.46990554E-05
	-0.10196864E-05	-0.12472685E-04	-0.10506333E-03	0.49736393E-09	-0.66385841E-10	-0.40877013E-09
	-0.23188671E 00	0.42944651E-01	0.19351977E 00	0.40400461E-09	-0.54813792E-10	-0.21786009E-09
8	-0.24306997E-06	0.25900075E-07	-0.13988499E-06	-0.18344394E-07	-0.24549342E-06	-0.20666739E-05
	-0.21536078E-04	-0.28985459E-03	-0.24430398E-02	-0.28333906E-11	0.25908192E-10	0.82537024E-11
	-0.23175114E 00	0.42919185E-01	0.19340497E 00	0.73937426E-10	0.27526904E-11	0.36332687E-10
12	0.95017697E-07	-0.63745951E-08	-0.19037547E-07	0.14301613E-05	-0.84623861E-06	-0.60567936E-05
	0.64884225E-05	0.90256883E-04	0.75972360E-03	0.41745940E-09	-0.51617738E-10	-0.34245629E-09
	0.23262495E 00	0.43366883E-01	0.19652557E 00	0.10859315E-09	0.28551716E-12	0.31198658E-10
16	0.22432269E-03	-0.89027914E-08	-0.59942408E-07	-0.15149726E-05	-0.30081401E-06	-0.35989697E-05
	0.64985533E-05	0.90266854E-04	0.75972360E-03	-0.41829207E-09	-0.51771962E-10	-0.34315129E-09
	-0.23266661E 00	0.42802837E-01	0.19177753E 00	0.83611298E-10	0.49198423E-11	0.52150395E-10
17	-0.74980526E-05	0.14951566E-05	0.58420055E-05	-0.18344394E-07	-0.24549342E-06	-0.20666739E-05
	-0.11785302E 00	0.21563306E-01	0.96145511E-01	-0.28333906E-11	0.25908192E-10	0.82537024E-11
	0.20935684E 02	-0.38888626E 01	-0.17569275E 02	0.73937426E-10	0.27526904E-11	0.36332687E-10
18	0.48549446E-05	-0.88791188E-06	-0.46307478E-05	-0.18344394E-07	-0.24549342E-06	-0.20666739E-05
	0.11775017E 00	-0.22137549E-01	-0.10103399E 00	-0.28333906E-11	0.25908192E-10	0.82537024E-11
	0.20994922E 02	-0.38871491E 01	-0.17643457E 02	0.73937426E-10	0.27526904E-11	0.36332687E-10
29	0.57811476E-05	-0.89730412E-06	-0.53283584E-05	-0.12565958E-02	0.23314099E-03	0.10522362E-02
	-0.17905521E 00	0.32930840E-01	0.14760999E 00	-0.40820094E-07	0.69903088E-08	0.32890071E-07
	0.31575336E 01	-0.58635986E 00	-0.26484632E 01	0.73937426E-10	0.27526904E-11	0.36332687E-10
30	-0.48746726E-05	0.92763339E-06	0.32571743E-05	-0.12569020E-02	0.23323983E-03	0.10528439E-02
	0.17888510E 00	-0.33491150E-01	-0.15231866E 00	-0.40838504E-07	0.69939610E-08	0.32903447E-07
	0.31575336E 01	-0.58635986E 00	-0.26484632E 01	0.73937425E-10	0.27526904E-11	0.36332687E-10
45	-0.76520228E-05	0.16964068E-05	0.70169190E-05	-0.18344394E-07	-0.24549342E-06	-0.20666739E-05
	0.11783016E 00	-0.22087038E-01	-0.10055429E 00	-0.28333906E-11	0.25908192E-10	0.82537024E-11
	0.20937379E 02	-0.38658266E 01	-0.17375351E 02	0.73937426E-10	0.27526904E-11	0.36332687E-10
46	0.64403912E-05	-0.10154190E-05	-0.49689306E-05	-0.18344394E-07	-0.24549342E-06	-0.20666739E-05
	-0.11779951E 00	0.21484926E-01	0.95540226E-01	-0.28333906E-11	0.25908192E-10	0.82537024E-11
	0.20906631E 02	-0.38601475E 01	-0.17349838E 02	0.73937426E-10	0.27526904E-11	0.36332687E-10

```
57    0.84510430E-05   -0.11707561E-05   -0.62409345E-05    0.12566594E-02   -0.23230158E-03   -0.10451691E-02
      0.17902172E 00   -0.33383265E-01   -0.15131855E 00   -0.55092087E-07    0.96633883E-08    0.45013650E-07
      0.31577644E 01   -0.58320266E 00   -0.26218882E 01    0.73937426E-10    0.27526904E-11    0.36332687E-10

58   -0.56288133E-05    0.13516647E-05    0.55085839E-05    0.12569709E-02   -0.23231718E-03   -0.10450769E-02
     -0.17893827E 00    0.32775991E-01    0.14629829E 00   -0.55105751E-07    0.96668380E-08    0.45027132E-07
      0.31577644E 01   -0.58320266E 00   -0.26218882E 01    0.73937426E-10    0.27526904E-11    0.36332687E-10

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
 -0.15762788E-06   0.13170404E-02   -0.21347906E-01

ANGULAR MOMENTUM IN Z- COORDINATES
   0.36072269E 09   0.73643238E-03   -0.51305033E-01

TOTAL KINETIC ENERGY
   0.75552768E 03

STRUCTURAL LOADS APPLIED BY CONNECTING STRUCTURE (ON LAB IN X AXES AND ON CWT IN Y AXES)
                                   FORCE                                                TORQUE
ON LAB      0.9331120E-05   0.7229328E 00  -0.5362252E 05          0.7104199E 03   0.6917275E-03  -0.9142247E-03
ON CWT.    -0.1393043E-04   0.6617494E 00  -0.5362252E 05          0.3776658E 03   0.2025202E-01  -0.9142209E-03

STRUCTURAL LOADS ON LAB IN X AXES

MASS POINT = 4
LOCATION =      0.0             0.0              0.6000000E 02
                     FORCE                                                  TORQUE
 0.2533234E-04   0.3015357E 01   0.4056814E 05          0.1682000E 04  -0.1706076E-02  -0.4119348E-02

MASS POINT =42
LOCATION =      0.0             0.0              0.0
                     FORCE                                                  TORQUE
-0.5481359E-06  -0.3434370E 03   0.4946968E 03         -0.1569525E 06  -0.7490823E-03  -0.7497373E-03

MOTION OF MOVING MASS 1
UJ  =     0.0             0.0             0.7621294E 03
UJD =     0.0             0.0             0.0
UJDD=     0.0             0.0             0.0

BALANCE MASS DATA
U(2,3)= 0.34846242E 03  UDOT(2,3)=-0.25701690E 00  UDDOT(2,3)= 0.56276190E 00
SENSOR ACCELERATION ERROR = 0.46920776E-01
SENSOR TO CM POS ERROR = 0.15136719E-01
SENSOR ACCELERATION ERROR (FILTERED) = 0.46920776E-01

CONTROL SYSTEM DATA
JET THRUST
 F1 = 0.0           F2 = 0.0           F3 = 0.0           F4 = 0.0           F5 = 0.0           F6 = 0.0
 F7 = 0.0           F8 = 0.0           F9 = 0.0           F10= 0.0           F11= 0.0           F12= 0.0
 F13= 0.0           F14= 0.0           F15= 0.0           F16= 0.0
CMG TORQUE =     0.1617432E-02    0.4670757E-03    0.5559437E-02
  NCMG=  0
L03= 0.16859165 04  L03D= 0.0          L03DD= 0.0
SPIN SPEED COMMAND = 0.4189000E 00
SPIN ACCELERATION COMMAND = 0.0

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TIME= 0.39999968E 00 STEP= 0.49999997E-01
```

R	RDOT	GAMMA	WX	DELRR	DELRBD	ETA-STAR	WY
-0.3222989E-07	-0.1131180E-06	0.1675532E 00	0.4186604E 00	-0.2608729E-06	0.5744536E-08	0.8523037E-05	0.4189211E 00
-0.7499002E-02	-0.3552833E-01	0.2979962E-10	0.9020888E-10	-0.1433182E-02	0.6743193E-02	-0.2694030E-10	0.7634679E-10
0.4364780E 03	-0.4023401E-01	0.2466109E-10	0.1061770E-09	0.3229571E 01	-0.9642208E-01	-0.5198038E-10	-0.4500243E-10

RDDOT	WXDOT	DELRBDD	WYDOT	DEL	DELDOT	PHISTAR	PHISTARDOT
0.7120456E 05	0.1919806E-03	0.1460046E-04	0.1682892E-03	0.2573375E-07	0.4143594E-07	-0.8632321E-05	-0.6127036E-04
-0.1293970E 00	0.5747107E-09	0.2238345E 00	-0.6988589E-08	-0.1563963E-02	0.5960200E-02	-0.2335773E-10	0.1883040E-09
0.6156620E-01	0.4235943E-09	0.1118805E 00	-0.7962042E-10	0.3009875E 01	-0.2097189E-01	0.2346572E-10	0.8554135E-10

MASS PT.	Q	Q-DOT	QDDOT	THETA	THETA-DOT	THETADDOT
1	0.12764907E-07	0.90553236E-08	0.21117277E-07	-0.25416301E-06	-0.15200148E-05	-0.41004214E-05
	0.55200711E-04	0.33113756E-03	0.89322776E-03	0.41026382E-09	-0.95664990E-10	-0.10478257E-09
	-0.21996683E 00	0.75543284E-01	0.12765545E 00	0.90202040E-10	0.18231500E-10	0.73726608E-10
4	-0.10318803E-05	0.29708229E-07	0.42798913E-07	-0.24797265E-06	-0.14835014E-05	-0.40018931E-05
	-0.56415255E-05	-0.33162622E-04	-0.89491645E-04	0.47784759E-09	-0.11872808E-09	-0.14362195E-09
	0.21992692E 00	0.75494885E-01	0.12757367E 00	0.38960338E-09	-0.84327057E-10	-0.10459049E-09
8	-0.23514502E-05	0.47214346E-07	0.37373958E-07	-0.10928551E-06	-0.65243956E-06	-0.17600951E-05
	-0.12890343E-03	-0.77031646E-03	-0.20780540E-02	0.35821016E-11	0.43520632E-10	0.12984273E-09
	-0.21969557E 00	0.75450122E-01	0.12749803E 00	0.75446316E-10	0.13082138E-10	0.56039617E-10
12	0.93636970E-07	0.62688912E-08	0.13657590E-07	0.11411076E-05	-0.20035832E-05	-0.49217542E-05
	0.39922345E-04	0.23985686E-03	0.64698234E-03	0.40208659E-09	-0.92807206E-10	-0.99905806E-10
	-0.22041827E 00	0.76430879E-01	0.13001204E 00	0.10959011E-09	0.10763739E-10	0.60333516E-10
16	-0.27702691E-08	-0.20826462E-07	-0.53451146E-07	-0.16508220E-05	-0.10447493E-05	-0.33014858E-05
	0.39922976E-04	0.23985682E-03	0.64698211E-03	0.40287595E-09	-0.93078351E-10	-0.10036401E-09
	0.22066891E 00	0.74991941E-01	0.12596840E 00	0.85911278E-10	0.18922226E-10	0.74143053E-10
17	-0.70883616E-05	0.25564986E-05	0.45340639E-05	-0.10928551E-06	-0.65243955E-06	-0.17600951E-05
	-0.11183544E 00	-0.37671845E-01	-0.62957644E-01	0.35821016E-11	0.43520632E-10	0.12984273E-09
	0.19842300E 02	-0.68468256E 01	-0.11600830E 02	0.75446316E-10	0.13082138E-10	0.56039617E-10
18	0.45978556E-05	-0.16110407E-05	-0.26245380E-05	-0.10928551E-06	-0.65243955E-06	-0.17600951E-05
	0.11150271E 00	-0.39210461E-01	-0.67133009E-01	0.35821016E-11	0.43520632E-10	0.12984273E-09
	0.19813156E 02	-0.68367662E 01	-0.11583785E 02	0.75446316E-10	0.13082138E-10	0.56039617E-10
29	0.55149076E-05	-0.16583081E-05	-0.24731498E-05	-0.11910712E-02	0.41022990E-03	0.69434405E-03
	-0.16982549E 00	0.57687581E-01	0.96876323E-01	-0.38844728E-07	0.12325554E-07	0.20168056E-07
	0.29926891E 01	-0.10322161E 01	-0.17484989E 01	0.75446316E-10	0.13082138E-10	0.56039617E-10
30	-0.46252426E-05	0.15592732E-05	0.27918313E-05	-0.11913457E-02	0.41044084E-03	0.69481204E-03
	0.16944569E 00	-0.59197787E-01	-0.10099196E 00	-0.38862144E-07	0.12331750E-07	0.20179129E-07
	0.29926891E 01	-0.10322161E 01	-0.17484989E 01	0.75446316E-10	0.13082138E-10	0.56039617E-10
45	-0.71776731E-05	0.30111296E-05	0.56605149E-05	-0.10928551E-06	-0.65243955E-06	-0.17600951E-05
	0.11160266E 00	-0.39063700E-01	-0.66712379E-01	0.35821016E-11	0.43520632E-10	0.12984273E-09
	0.19852539E 02	-0.67856054E 01	-0.11435682E 02	0.75446316E-10	0.13082138E-10	0.56039617E-10
46	0.61547244E-05	-0.17547662E-05	-0.25399404E-05	-0.10928551E-06	-0.65243955E-06	-0.17600951E-05
	-0.11179280E 00	0.37476078E-01	0.62454257E-01	0.35821016E-11	0.43520632E-10	0.12984273E-09
	0.19823380E 02	-0.67756367E 01	-0.11418883E 02	0.75446316E-10	0.13082138E-10	0.56039617E-10
57	0.81179860E-05	-0.20262951E-05	-0.26184343E-05	0.11914454E-02	-0.40799892E-03	-0.68832515E-03
	0.16962439E 00	-0.58889937E-01	-0.10011989E 00	-0.52364989E-07	0.17027919E-07	0.28023305E-07
	0.29940891E 01	-0.10238256E 01	-0.17258663E 01	0.75446316E-10	0.13082138E-10	0.56039617E-10

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58   -0.55503213E-05    0.24184928E-05    0.46967625E-05    0.11917565E-02   -0.40798914E-03   -0.68819709E-03
     -0.16976380E-03    0.57297170E-01    0.95864773E-01   -0.52377690E-07    0.17034104E-07    0.28035764E-07
      0.29940991E 01   -0.10238256E 01   -0.17258663E 01    0.75446316E-10    0.13082138E-10    0.56039617E-10

LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES
 -0.15757178E-05    0.34936448E-02   -0.20628739E-01

ANGULAR MOMENTUM IN Z- COORDINATES
   0.36072243E 09    0.32783704E-03   -0.49727455E-01

TOTAL KINETIC ENERGY
   0.75553280E 03

STRUCTURAL LOADS APPLIED BY CONNECTING STRUCTURE (ON LAB IN X AXES AND ON CMT IN Y AXES)
                                  FORCE                                                      TORQUE
ON LAB      -0.1731274E-04    0.7822663E 01   -0.5355625E 05         0.3774086E 04    0.1409357E-01   -0.1710371E-02
ON CMT       0.15469815-04    0.3366202E 01   -0.5355625E 05         0.1827414E 04   -0.1134125E-01   -0.1710328E-02

STRUCTURAL LOADS ON LAB IN X AXES

MASS POINT = 4
LOCATION =      0.0              0.0              0.6000000E 02
                      FORCE                                              TORQUE
 -0.4755590E-05    0.5306006E 01    0.4052636E 05           0.9930000E 03   -0.5821675E-02   -0.7712673E-02

MASS POINT =42
LOCATION =      0.0              0.0              0.0
                      FORCE                                              TORQUE
  0.2717969E-05   -0.3453335E 03    0.4849446E 03          -0.1515860E 06   -0.8128798E-03   -0.4564971E-03

MOTION OF MOVING MASS  1
UJ  =     0.0              0.0              0.7621294E 03
UJD =     0.0              0.0              0.0
UJDD=     0.0              0.0              0.0

BALANCE MASS DATA
U(2,3)= 0.34844116E 03  UDOT(2,3)=-0.21686208E 00  UDDOT(2,3)=-0.10976667E 01
SENSOR ACCELERATION ERROR =-0.11766052E 00
SENSOR TO CM POS ERROR = 0.10009766E-01
SENSOR ACCELERATION ERROR (FILTERED) =-0.11766052E 00

CONTROL SYSTEM DATA
JET THRUST
 F1 = 0.0          F2 = 0.0          F3 = 0.0          F4 = 0.0          F5 = 0.0          F6 = 0.0
 F7 = 0.0          F8 = 0.0          F9 = 0.0          F10= 0.0
 F13= 0.0          F14= 0.0          F15= 0.0          F16= 0.0
   TORQUE =      0.5493169E-03     0.1479058E-02     0.8744222E-02

          L03D= 0.0          L07
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                                                    0.3428326E 04   0.4833084E-02   0.9103614E-01
                                                                    0.3029509E-01   0.9103608E-0.
ON CWT.

STRUCTURAL LOADS ON LAB IN X AXES

MASS POINT = 4
LOCATION =    0.0            0.0            0.6960000E 02
                  FORCE                                              TORQUE
 0.4001966E-05  0.5143994E 02  0.4050630E 05         -0.5285000E 04  -0.4298728E-02  -0.7417214E-01

MASS POINT =42
LOCATION =    0.0            0.0            0.0
                  FORCE                                              TORQUE
-0.1508779E-05 -0.3352058E 03  0.4733154E 03         -0.1442003E 06  -0.2416530E-03  -0.1726059E-02

MOTION OF MOVING MASS  1
UJ   =   0.0            0.0            0.7395294E 03
UJD  =   0.0            0.0            0.0
UJDD=    0.0            0.0            0.0

BALANCE MASS DATA
U(2,3)= 0.3719387E-03  UDOT(2,3)= 0.3691504E-01  UDDOT(2,3)= 0.6023988E 00
SENSOR ACCELERATION ERROR = 0.19461060E 00
SENSOR TO CM POS ERROR =-0.57910156E 00
SENSOR ACCELERATION ERROR (FILTERED) = 0.19461069E 00

CONTROL SYSTEM DATA
JET THRUST
 F1 = 0.0          F2 = 0.5000000E 02  F3 = 0.0           F4 = 0.0       F5 =-0.5000000E 02  F6 = 0.0
 F7 = 0.0          F8 = 0.0            F9 =-0.5000000E 02 F10= 0.0       F11= 0.0            F12= 0.0
 F13= 0.0          F14= 0.5000000E 02  F15= 0.0           F16= 0.0
CMG TORQUE =   -0.2553387E-02   -0.2532119E-01   -0.1450825E-01
  NCMG=  0
LC3= 0.1685916E 04  LC3D= 0.0          LC3DD= 0.0
SPIN SPEED COMMAND = 0.4189000E 00
SPIN ACCELERATION COMMAND = 0.0
```

END OF TIME
HISTORY AT
TIME = 10. SEC.

STATISTICS ON RUN

MAXIMUM AND MINIMUM ELASTIC MOTIONS

MASS NO.	QMIN	QMAX	QDOTMIN	QDOTMAX	QDDOTMIN	QDDOTMAX
1	-0.1550792E-07	-0.4019181E-08	-0.1102419E-07	0.1255472E-07	-0.2907037E-07	0.2961636E-07
	-0.1595665E-02	0.2827357E-02	-0.6158024E-02	0.5789861E-02	-0.1482033E-01	0.1576592E-01
	-0.2366717E 00	-0.1583151E 00	-0.8580226E-01	0.9166360E-01	-0.2042857E 00	0.2262704E 00
2	0.3133209E-07	0.4601385E-07	-0.1474709E-07	0.1781392E-07	-0.4162555E-07	0.3809368E-07
	-0.1448113E-02	-0.2047485E-02	-0.4459564E-02	0.4192933E-02	-0.1073269E-01	0.1141747E-01
	-0.2366663E 00	-0.1583115E 00	-0.8580029E-01	0.9166151E-01	-0.2042810E 00	0.2262653E 00
3	0.6159371E-07	0.9110579E-07	-0.3446035E-07	0.3262310E-07	-0.8927918E-07	0.7901747E-07
	-0.3345775E-03	0.1264540E-02	-0.2754533E-02	0.2589834E-02	-0.6629255E-02	0.7052213E-02
	-0.2366192E 00	-0.1582800E 00	-0.8578318E-01	0.9164327E-01	-0.2042403E 00	0.2262202E 00
4	-0.1193115E-06	-0.7961199E-07	-0.4627736E-07	0.3665711E-07	-0.9764523E-07	0.1075160E-06
	-0.2835668E-03	0.2003849E-03	-0.5805050E-03	0.6174082E-03	-0.1580705E-02	0.1485987E-02
	-0.2365201E 00	-0.1582137E 00	-0.8574730E-01	0.9160489E-01	-0.2041548E 00	0.2261255E 00
–	-0.1505369E-05	-0.1006683E-06	-0.5949625E-07	0.4483711E-07	-0. [illegible]	
	[illegible]3035755E-02	0.1275131E-02	-0.3692908E-02	0.39277[illegible]		
		[illegible]1581518E 00	-0.85713[illegible]			

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MASS NO.	QMIN	QMAX	QDOTMIN	QDOTMAX	QDDOTMIN	QDDOTMAX
67					[illegible]2248248E-06	0.2597924E-[illegible]
	-0.4[illegible]			[illegible]E-02	-0.2521819E-01	0.2370564E-01
	-0.2363797E 00			[illegible]9149736E-01	-0.2037382E 00	0.2259913E 00
68	-0.2551593E-06	-0.1550628E-06	-0.1067478E-06	0.8584607E-07	-0.2104129E-06	0.2709836E-06
	-0.6575765E-02	0.4655663E-02	-0.1347300E-01	0.1433000E-01	-0.3668794E-01	0.3448781E-01
	-0.2251897E 00	-0.1506455E 00	-0.8157998E-01	0.8718491E-01	-0.1941990E 00	0.2152929E 00
69	0.5230785E-06	0.1399027E-05	-0.1165135E-05	0.1153413E-05	-0.2970660E-05	0.3252967E-05
	-0.6532945E-02	0.4702207E-02	-0.1347234E-01	0.1433412E-01	-0.3669756E-01	0.3450241E-01
	0.1679966E 01	0.2509082E 01	-0.9672360E 00	0.9010762E 00	-0.2398833E 01	0.2140493E 01
70	-0.3032873E-06	-0.1832236E-06	-0.1217929E-06	0.9488821E-07	-0.2376460E-06	0.3031573E-06
	-0.6579015E-02	0.4652116E-02	-0.1347171E-01	0.1432830E-01	-0.3668366E-01	0.3448342E-01
	-0.2363796E 00	-0.1581235E 00	-0.8567631E-01	0.9153986E-01	-0.2039745E 00	0.2259912E 00
71	0.1146771E-06	0.2016180E-06	-0.1193330E-06	0.1188471E-06	-0.3529888E-06	0.3926633E-06
	-0.6562173E-02	0.4671190E-02	-0.1347281E-01	0.1433140E-01	-0.3669122E-01	0.3449275E-01
	0.2262271E 00	0.3377614E 00	-0.1299953E 00	0.1209032E 00	-0.3229220E 00	0.2869766E 00
72	0.3695845E-06	0.8091014E-06	-0.5490822E-06	0.5601734E-06	-0.1418234E-05	0.1616404E-05
	-0.6547567E-02	0.4686703E-02	-0.1347259E-01	0.1433278E-01	-0.3669444E-01	0.3449762E-01
	0.5441462E 00	0.1410042E 01	-0.5434635E 00	0.5061950E 00	-0.1348085E 01	0.1202351E 01

MASS NO.	THETAMIN	THETAMAX	THETADOTMIN	THETADOTMAX	THETADDOTMIN	THETADDOTMAX
1	-0.1298120E-04	0.9179485E-05	-0.2658163E-04	0.2827185E-04	-0.7238226E-04	0.6804088E-04
	0.3240299E-09	0.5025529E-09	-0.1553495E-09	0.1988203E-09	-0.4851490E-09	0.3922842E-09
	-0.2607209E-10	0.1664165E-09	-0.2609999E-09	0.2777134E-09	-0.7794012E-09	0.7796934E-09
2	-0.1298035E-04	0.9178898E-05	-0.2657992E-04	0.2827001E-04	-0.7237757E-04	0.6803646E-04
	0.3174196E-09	0.4944785E-09	-0.1547215E-09	0.1956943E-09	-0.4783445E-09	0.3856790E-09
	-0.3072734E-10	0.1690155E-09	-0.2727456E-09	0.2866329E-09	-0.8011793E-09	0.8006336E-09
3	-0.1268543E-04	0.9111854E-05	-0.2638563E-04	0.2806338E-04	-0.7184854E-04	0.6753918E-04
	0.3579841E-09	0.5457175E-09	-0.1656947E-09	0.2147721E-09	-0.5210883E-09	0.4261198E-09
	0.8214580E-10	0.2608378E-09	-0.2558838E-09	0.2617380E-09	-0.7454688E-09	0.7435965E-09
4	-0.1266906E-04	0.8958877E-05	-0.2594260E-04	0.2759218E-04	-0.7064217E-04	0.6640516E-04
	0.3792284E-09	0.5722773E-09	-0.1706390E-09	0.2247360E-09	-0.5432645E-09	0.4472358E-09
	0.2636599E-09	0.4244971E-09	-0.2306434E-09	0.2228875E-09	-0.6586307E-09	0.6990033E-09
5	-0.1241598E-04	0.8780523E-05	-0.2542630E-04	0.2704305E-04	-0.6923628E-04	0.6508359E-04
	0.2927218E-09	0.4651872E-09	-0.1544605E-09	0.1841181E-09	-0.4534593E-09	0.3612795E-09
	0.3377101E-09	0.4965914E-09	-0.2178168E-09	0.2064140E-09	-0.6308483E-09	0.6961951E-09
6	-0.1218914E-04	0.8619428E-05	-0.2495978E-04	0.2654686E-04	-0.6796590E-04	0.6388941E-04
	0.2219302E-09	0.4638199E-09	-0.1531275E-09	0.1837123E-09	-0.4523386E-09	0.3604121E-09
	0.2932952E-09	0.4510774E-09	-0.2201196E-09	0.2106011E-09	-0.6311021E-09	0.6881833E-09
7	-0.91107[illegible]			[illegible]E-04	-0.5079301E-04	0.4774635E-04
	[illegible]				[illegible]77493E-08	0.1431540E-08
						0.8428627E-[illegible]

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MASS NO.	THETAMIN	THETAMAX	THETADOTMIN	THETADOTMAX	THETADDOTMIN	THETADDOTMAX
	[illegible]E-02	0.3833348E-02	[illegible]			
	-0.4428449E-07	-0.3002094E-07	-0.1604177E-0[illegible]			
	-0.2295209E-08	-0.3441163E-09	-0.2617349E-08	0.269[illegible]		
70	-0.5572645E-05	0.3940354E-05	-0.1141082E-04	0.1213636E-04	-0.310[illegible]	
	-0.3243235E-10	0.8218324E-10	-0.1103227E-09	0.8902941E-10	-0.1993411E-09	0.2634746E-09
	-0.2460859E-10	0.1398229E-09	-0.2254624E-09	0.2354918E-09	-0.6572851E-09	0.6565037E-09
71	0.2394343E-02	0.3576258E-02	-0.1379145E-02	0.1285305E-02	-0.3419115E-02	0.3053788E-02
	-0.1949629E-07	-0.1267528E-07	-0.6760633E-08	0.6928680E-08	-0.1580262E-07	0.1728956E-07
	-0.2270928E-08	-0.1126453E-08	-0.1332675E-08	0.1217052E-08	-0.3684317E-08	0.2963371E-08
72	0.3096473E-02	0.4609887E-02	-0.1777471E-02	0.1656258E-02	-0.4407328E-02	0.3934834E-02
	-0.3149036E-07	-0.2132809E-07	-0.1140119E-07	0.1151219E-07	-0.2646300E-07	0.2885591E-07
	-0.2450911E-08	-0.8255150E-09	-0.2120643E-08	0.2135380E-08	-0.5844473E-08	0.5349087E-08

MAXIMUM LOADS COMPUTED

STRUCTURAL LOADS APPLIED BY CONNECTING STRUCTURE (ON LAB IN X AXES AND ON CWT IN Y AXES)

	FORCE			TORQUE		
ON LAB	0.3798214E-04	0.2502379E 02	0.0	0.3678963E 05	0.4134485E-01	0.9103609E-01
ON CWT.	0.1366981E-04	0.2240135E 02	0.0	0.1511271E 05	0.2025202E-01	0.9103614E-01

STRUCTURAL LOADS ON LAB IN X AXES

MASS POINT = 4
LOCATION = 0.0 0.0 0.6000000E 02

FORCE			TORQUE		
0.7654646E-04	0.7513794E 02	0.4100304E 05	0.4665000E 04	0.5669385E-02	0.8361536E-01

MASS POINT =43
LOCATION = 0.0 0.0 0.0

FORCE			TORQUE		
0.6132221E-05	0.0	0.4946968E 03	0.0	0.8798135E-03	0.2115173E-02

MINIMUM LOADS COMPUTED

STRUCTURAL LOADS APPLIED BY CONNECTING STRUCTURE (ON LAB IN X AXES AND ON CWT IN Y AXES)

	FORCE			TORQUE		
ON LAB	-0.2877915E-04	-0.9968398E 01	-0.5402790E 05	-0.1847439E 05	-0.5454440E-01	-0.9139854E-01
ON CWT.	-0.1635344E-04	-0.4427664E 01	-0.5402791E 05	-0.1904321E 05	-0.1325284E-01	-0.9139764E-01

STRUCTURAL LOADS ON LAB IN X AXES

MASS POINT = 4
LOCATION = 0.0 0.0 0.6000000E 02

FORCE			TORQUE		
-0.4567247E-04	-0.7563933E 02	0.0	-0.3451600E 05	-0.1073803E-01	-0.7417214E-01

MASS POINT =43
LOCATION = 0.0 0.0 0.0

FORCE			TORQUE		
-0.8002900E-05	-0.3493728E 03	0.0	-0.1569525E 06	-0.9902811E-03	-0.1726059E-02

APPENDIX B3

Description of Numerical-Integration Subroutine (MAGIC) Parameters

The numerical-integration subroutine provides the user with both a fixed-step and variable-step numerical-integration option. Both options use a Runge-Kutta method. For details of this subroutine, the user is referred to the MAGIC documentation manual.*

The parameters needed to control this integration process are DELTA, EPSIL, STEP, DTAU, and ERR.

B3.1 Fixed-Step Runs

For fixed-step runs set DELTA = 0 and set STEP to the time step size of each numerical-integration cycle. A guideline for choosing STEP is to set it to 1/20th of the highest frequency present among the integrated variables. DTAU is the time interval between both the print and plot output cycles. EPSIL and ERR are not used in fixed-step runs.

B3.2 Variable-Step Runs

In variable-step runs, the subroutine tests the accuracy of the integration for each variable and uses this information to set the numerical-integration time step size. As explained in detail below, DELTA and EPSIL are small positive numbers used to test the integration accuracy by comparing a precision parameter with a percentage of each variable. When the absolute value of a variable is very small an ERR parameter (one is supplied for each integrated variable) is used for testing accuracy. One guideline for selecting DELTA and EPSIL is to choose DELTA = 1/3 EPSIL. The approximate tests started below describe the usage of EPSIL, DELTA, and ERR and should be used to determine their values†. MAGIC initially selects a step size of .0078125.

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* Ball, D., Stoodley, G., and Angelillo, R., "A Fortran Program for the Numerical-Integration of Ordinary Differential Equations," Grumman Aerospace Corporation, Data Systems Department Report, CR-61-2, October 1969.

† The precise test is more complicated and is stated in the previously referenced MAGIC documentation manual.

Let y be a typical element of the vector {y} to be integrated. Then y dev is a precision parameter determined by subtracting the values of y obtained by using two somewhat different numerical-integration processes. The tests are as follows:

Dominant test when y is not small:

If $\|y\ dev\| > EPSIL*\|y\|$	for any integrated variable, the step size is halved and the integration is repeated
If $\|y\ dev\| < DELTA*\|y\|$	for each integrated variable, the integration is not repeated and the step size doubles
If $\|DELTA*\|y\| \le \|y\ dev\| \le EPSIL*\|y\|$	integration continues with the current step size

Dominant test when y is small (of order ERR):

If $\|y\ dev\| > ERR$	for any integrated variable, the step size is halved and the integration is repeated
If $\|y\ dev\| < .01 \cdot ERR$	for each integrated variable, the integration is not repeated and the step size doubles
If $.01\ ERR \le \|y\ dev\| \le ERR$	integration continues with the current step size

Discontinuities in the analysis (e.g., pulse-type forces or an elevator moving with constant acceleration) may cause the step size to halve indefinitely. To avoid this difficulty, the user must input a value of STEP which is used as the minimum time interval. STEP has no other use in variable step runs.

DTAU is the time interval between print output cycles.

B3.3 Limitations of variable-Step Option

While the variable time-step option often reduces the computer running time considerably, the following problem limits the use of this option.

Whenever the step size is halved all computations needed to obtain the derivatives are repeated at a value of time which is less than the previous valued used for these computations. Several control-system subroutines use the value of the variables at the previous time step; however the stored value now corresponds to a future time step. This discrepancy leads to errors when these subroutines are used. For this reason the following problems should not be run using the variable-step option:

Moving masses and mass balancing
Fluid motion
Deployment or retraction maneuvers
Spin up or spin down

APPENDIX B4

BRIEF DESCRIPTION OF EACH SUBROUTINE*

ADD	addition of 3 X N matrices
ATTCTR	attitude control subroutine
BMCON	balance mass control interface routine
BMCTR	balance mass control subroutine
CHASE	solution of equations for symmetric positive definite system
COMMIN	major subroutine for data input and initialization of common areas
CONSTR	connecting structure subroutine for circular beam
CONTRL	interface program for controls subroutines
CW	calculates the contributions to [Λ] and { ∇ } from the Counterweight
CWCOM	Counterweight command
DOTP	dot product of vectors
FIRST	computes the realignment of the initial conditions
FUTILE	Cholesky decomposition of symmetric positive definite matrix
GAMMA	compute gamma functions [see Appendix B, Volume I]
INCH	inversion of a real symmetric positive definite matrix
LAB	calculates the portions of [Λ] and { ∇ } corresponding to the Laboratory, not including fluids and moving masses
LAST	compute connecting structure deformations
LOADIN	computations of structural loads
LOOK	look-up subroutine to give the values of k denoting the masses m_k which influence moving mass μ_j
LUMP	calculates the contributions to [Λ] and { ∇ } from the moving masses
MCPY	matrix copy subroutine
MINCY	sets up and performs integration step, prints time - history output and plotting output and computes the transformations to physical coordinates
MINMAX	computation of minimum and maximum displacements, velocities and accelerations

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* For the definition of the analytical symbols, see Section 4 of Volume I.

MPRD	general matrix multiplication
MTRAN	multiplication by transpose of a 3 x 3 matrix
MUCOM	moving mass command subroutine
MULT	multiplication by a 3 x 3 matrix
PIF	computes Π-function [see Appendix B, Volume I]
PIPE	calculates the contributions to [Λ] and { ∇ } from the pipes
PLO3AX	Calcomp plotting program
PMPCOM	pump command subroutine
POSCOM	position command subroutine
POSCTR	position control subroutine
PTLP	compute $[P]^T$ [L] [P] where [P] is a 3 x 3 matrix and L is the 3 x 1 diagonal of a 3 x 3 diagonal matrix
RESVR	calculates the contribution to [Λ] and { ∇ } from the reservoir
SCALR	multiplication of a matrix by a scalar
SETUP (MAGIC)	Runge-Kutta integration program
SPNCOM	spin command subroutine
SPNCTR	spin control subroutine
SSIN	computes S-function or S^{-1} function [see Appendix B, Volume 1]
SUBTR	matrix subtraction subroutine
SUPPLM	supplementary forces subroutine
TPRD	general matrix-transpose multiplication
VELCOM	velocity command subroutine
VELCTR	velocity control subroutine
WBLCTR	wobble control subroutine
XADD	general matrix addition
XMCPY	matrix stacking subroutine
XMPRD	general matrix multiplication
XTPRD	general multiplication by transpose of a matrix
ZCW	calculates portions of $[\Lambda_R]$ and $\{\nabla_R\}$
ZLAB	calculates portions of $[\Lambda_R]$ and $\{\nabla_R\}$

APPENDIX B5

REPLACEABLE SUBROUTINES

The following subroutines may be replaced by the user in order to run different physical problems:

CONSTR - computes structural loads for beam-type connecting structure

CONTRL - main controls interface routine; calls and computes data for CWCOM, SPNCOM, ATTCTR, SPNCTR, and WBLCTR

CWCOM - commands position of Counterweight

SPNCOM - commands Space-Station spin speed

MUCOM - commands motion of moving masses (μ_j's)

PMPCOM - commands velocity of fluid being pumped

POSCOM - position command policy

VELCOM - velocity command policy

ATTCTR - controls Space-Station attitude

SPNCTR - controls Space-Station spin speed

WBLCTR - controls Space-Station wobble

BMCON - interface for BMCTR; calls and computes data for BMCTR

BMCTR - controls motion of balance mass to balance mass shifts along long axis of Space-Station

POSCTR - position control policy

VELCTR - velocity control policy

SUPPLM - contains supplementary external loads as a function of time (these are set to zero in the subroutine supplied)

LOOK - selects structural masses (m_k's) that influence motion of moving masses (μ_j's). In the version of LOOK supplied with the program k = 1, 2, ..., 8 for all μ_j's and the k's remain constant with time

CONTRL and BMCON are interface subroutines for the major control systems (i.e., the control systems required to control the motion of the Space Station). Figure B1 illustrates the hierarchy of the control-system subroutines.

The read and print statements for the replaceable subroutines are located within these subroutines.

The input and output symbols for all replaceable subroutines are tabulated on the following pages. The analytical symbols used in this chart are defined in Section 3.2.

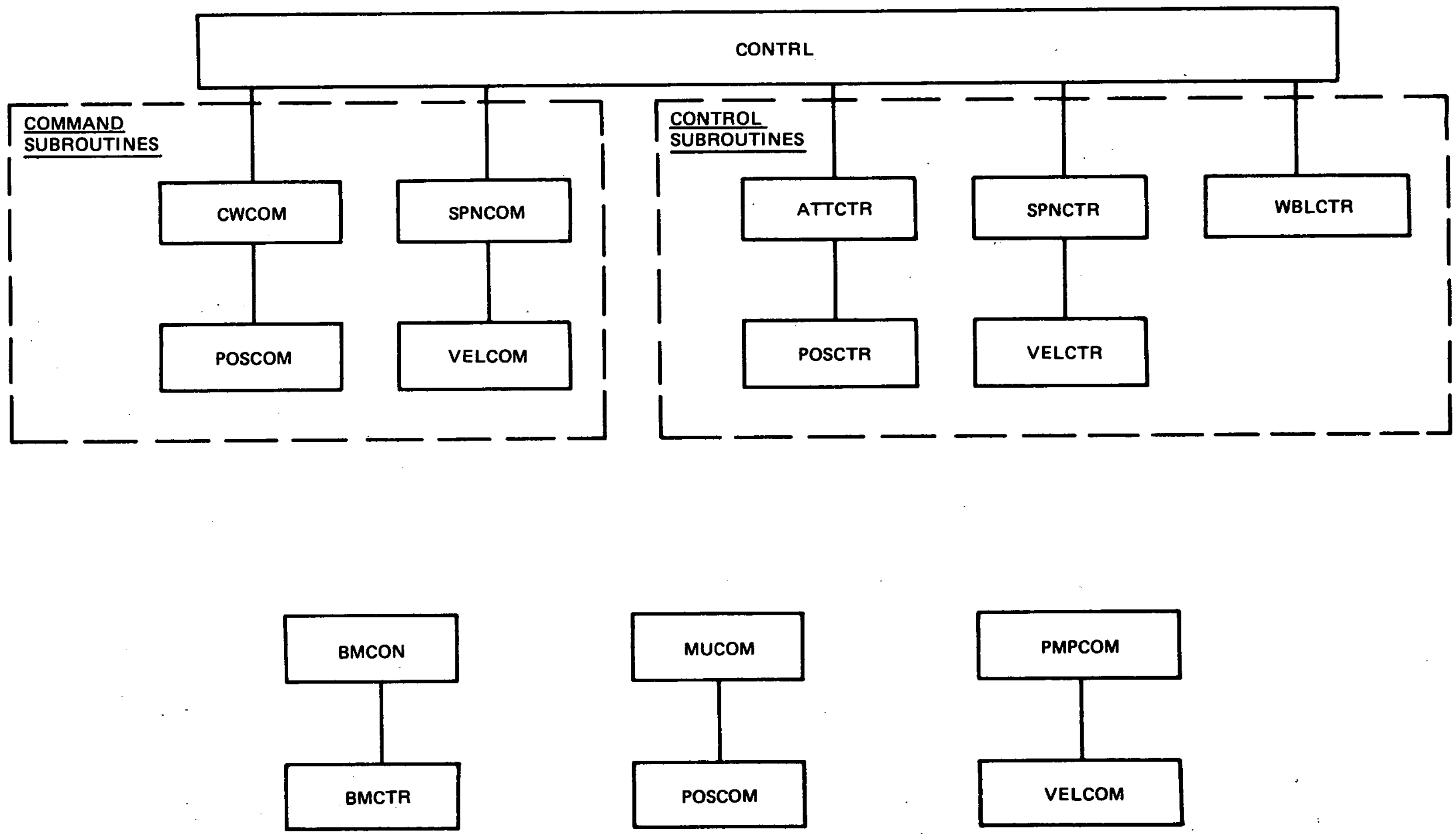


Fig. B1 Hierarchy of Control Subroutines

CONSTR - Called from ZLAB and ZCW

INPUT

Main Program Analytical Symbols	CONSTR Symbols	Comments
$\{\ell_0\}$	EL	
$\{P_{\bar{z}}\}_3$	P	average axial load component in Connecting Structure
$\{\Phi^*\}$	PHIST	
$\{\dot{\Phi}^*\}$	PHISTD	
$\{\delta\}$	DEL	
$\{\dot{\delta}\}$	DELD	
t	T	
	IN	Card Input Unit
	IOUT	Printer Output Unit

OUTPUT

Main Program Analytical Symbols	CONSTR Symbols	Comments
$\{f_E^*\}$	FETEST	Elements 1-3
$\{\tau_E^*\}$	FETEST	Elements 4-6

CONTRL - Called from ZLAB and ZCW

INPUT

Main Program Analytical Symbols	CONTRL Symbols	Comments
	N	Number of mass points on the vehicle
	IFCON	Clue { Set to 1 if controls are present Set to 0 if controls are not present
	LABCW	Clue { Set to 1 if called from ZLAB Set to -1 if called from ZCW
t	T	
$\{\omega^X\}$	WX	
all $\{r_i\}$	RI	$\{r_i\}$ begins at RI $(3 \cdot i - 2)$
all $\{\theta_i\}$	TH	
all $\{\mathring{\theta}_i\}$	THD	
$\{\ddot{R}\}$	RDDOT	
$\{\dot{\omega}^X\}$	WXDOT	
all $\{\ddot{q}_i\}$	XDD	$\{\ddot{q}_i\}$ begins at XDD (1, i)
all $\{\ddot{\theta}_i\}$	XDD	$\{\ddot{\theta}_i\}$ begins at XDD (4, i)
M_C	EMC	mass of Counterweight (see Note 6)
M	TOT	mass of Space Station
M_L	EML	mass of Laboratory (see Note 6)
$\{\gamma\}$	GAM	
$\{\dot{\gamma}\}$	GAMD	
$\{\ell_0\}$	EL	
$\{\dot{\ell}_0\}$	ELD	
$\{\ddot{\ell}_0\}$	ELDD	
	IN	Card Input Unit
	IOUT	Printer Output Unit
$\{\omega^{X^i s}\}$	O	
$[D_L]$	DL	} See Note 6
$[D_C]$	DC	
$[I_L]$	IL	Inertia matrix of Laboratory
$[I_C]$	IC	Inertia matrix of Counterweight
	YPRED	Integrated controls variable (after t = 0)

Continued

CONTRL (Continued)

OUTPUT

Main Program Analytical Symbols	CONTRL Symbols	Comments
all $\{f_c^i\}$ (or $\{\bar{f}_c^i\}$)	A	$\{f_c^i\}$ (or $\{\bar{f}_c^i\}$) begins at A(3i -2)(see Note 1)
all $\{\tau_c^i\}$ (or $\{\bar{\tau}_c^i\}$)	A	$\{\tau_c^i\}$ (or $\{\bar{\tau}_c^i\}$) begins at A(3i +1)(see Note 1)
$\{\dot{\omega}^{X^{i_s}}\}$	DO	Output when entered via EARLY
i_s	IS	
	NEQS	The number of integrated controls variables (at T = 0)
	YICS	Initial conditions of integrated controls variables (at T = 0)
	YDOT	Time-derivative of integrated controls variables

Special Considerations

(1) The forces and torques exerted by the control actuators are computed for the:

Laboratory when LABCW = 1
Counterweight when LABCW = -1

(2) Entry point CONTRD is used to input the controls input data

(3) Entry point EARLY is used to compute the value of

$$\{\dot{\omega}^{X^{i_s}}\}$$

(4) Entry point LLDLDD is used to call CWCOM and then return

(5) The variables currently being integrated are 4 variables from WBLCTR (if controls are present) and 3 variables from BMCTR (if mass balancing is present)

(6) See Equations (A29) and (A36) of Appendix C, Volume I

CWCOM - Called from CONTRL

INPUT

Control - System Analytical Symbols	CWCOM Symbols	Comments
t	TIME	
ℓ_{03u}	XB3CU	Connecting Structure length update
$t_{\ell 03u}$	TXB3CU	Update time
$acc_{\ell 03\ max}$	ACCB3C	Magnitude of acceleration of ℓ_{03}
$vel_{\ell 03\ max}$	VELMBC	Maximum velocity of ℓ_{03}
ℓ_{03}	XB3C	Input at $t = 0$

OUTPUT

Control - System Analytical Symbols	CWCOM Symbols	Comments
$\ddot{\ell}_{03}$	DDXB3C	
$\dot{\ell}_{03}$	DXB3C	
ℓ_{03}	XB3C	Undeformed length of connecting Structure

SPNCOM - Called from CONTRL

INPUT

Control - System Analytical Symbols	SPNCOM Symbols	Comments
time	TIME	
ω_{1CU}	O1CU	
$t_{\omega 1CU}$	TO1CU	
$acc_{\omega 1C}$	ACCO1C	At time = 0
f_{JET}	FJET	These variables are in the argument list but are not currently used.
$\{X^{A_j}\}$	XAJ	
$[M_{11}]$	WM11	
ω_{1C}	O1C	At time = 0

OUTPUT

Control - System Analytical Symbols	SPNCOM Symbols	Comments
$acc_{\omega 1C}$	ACCO1C	
ω_{1C}	O1C	
$\omega_{1C\ mag}$	O1CMAG	

MUCOM - Called from LUMP

INPUT

Main Program Analytical Symbols	CONSTR Symbols	Comments
t	T	
j	L	Moving mass number
	IN	Card input unit
	IOUT	Printer output unit

OUTPUT

Main Program Analytical Symbols	CONSTR Symbols	Comments
$\{U_j\}$	UJ	
$\{\dot{U}_j\}$	UJD	
$\{\ddot{U}_j\}$	UJDD	

PMPCOM - Called from MAIN

INPUT

Main Program Analytical Symbols	PMPCOM Symbols	Comments
t	T	
	IN	Card input unit
	IOUT	Printer output unit

OUTPUT

Main Program Analytical Symbols	PMPCOM Symbols	Comments
V	V	
$\dot{V}$	VDOT	

POSCOM - Called from MUCOM, CWCOM

INPUT

Control - system Analytical Symbols	POSCOM Symbols	Comments
time	TIME	
poscu	POSCU	Position command update
timcu	TIMCU	Time command update
acc_{mag}	ACCMAG	Magnitude of acceleration command
vel_{max}	VELMAX	Maximum velicity command

OUTPUT

Control - system Analytical Symbols	POSCOM Symbols	Comments
out	OUT	Intermediate output to each subroutine that calls POSCOM and returned each time cycle
time0	TIME0	
time1	TIME1	
time2	TIME2	
time3	TIME3	
acc01	ACC01	
acc12	ACC12	
acc23	ACC23	
posc0	POSC0	
posc1	POSC1	
posc2	POSC2	
velc1	VELC1	
velc2	VELC2	
acc_{cmn}	ACCCMN	Acceleration command
vel_{cmn}	VELCMN	Velocity command
pos_{cmn}	POSCMN	Position command

VELCOM - Called from SPNCOM, PMPCOM

INPUT

Control-system Analytical Symbols	VELCOM Symbols	Comments
time	TIME	
velcu	VELCU	Velocity command update
timcu	TIMCU	Time command update
acc_{mag}	ACCMAG	Magnitude of acceleration command

OUTPUT

Control-system Analytical Symbols	VELCOM Symbols	Comments
out	OUT	Intermediate output to be stored in each subroutine that calls, VELCOM and returned each time cycle.
time0	TIME0	
time1	TIME1	
acc01	ACC01	
velc0	VELC0	
acc_{cmn}	ACCCMN	Acceleration command
vel_{cmn}	VELCMN	Velocity command

ATTCTR - Called from CONTRL

INPUT

Control-system Analytical Symbols	ATTCTR Symbols	Comments
$\{\theta\}$	T	
$\{\theta\}$	DT	
$e_{\theta_{DB}}$	ETDB	
$\dot{e}_{\theta_{MAX}}$	DETMAX	
$\{x^{A_j}\}$	XAJ	
$[M_{11}]$	WM11	Inertia matrix of Space Station
f_{jet}	FJET	
ω_{1CMAG}	OICMAG	

OUTPUT

Control-system Analytical Symbols	ATTCTR Symbols	Comments
f^{A_j}	FAJ	CONTRL currently expects values for: FAJ (2, 1)* FAJ (2, 2) FAJ (2, 3) FAJ (1, 4) FAJ (2, 5) FAJ (2, 6) FAJ (2, 7) FAJ (1, 8) FAJ (2, 9) FAJ (2, 10) FAJ (2, 11) FAJ (1, 12) FAJ (2, 13) FAJ (2, 14) FAJ (2, 15) FAJ (1, 16)

---

* The first index designates the axis and the second designates the jet number (1 through 16) indicated in Figure 3.8. FAJ(I,J)=0 when jet is off. Otherwise FAJ(I,J)=$\pm F_{jet}$ depending whether the jet is directed along the positive or negative jth axis.

SPNCTR - Called from CONTRL

INPUT

Control - System Analytical Symbols	SPNCTR Symbols	Comments
ω_{1C}	O1C	
$\{\omega\}$	O	
$e_{\omega 1DB}$	EO1DB	
f_{JET}	FJET	
ω_{1CMAG}	O1CMAG	

OUTPUT

Control-System Analytical	SPNCTR Symbols	Comments
f^{Aj}	FAJ	See Table for ATTCTR on previous page

WBLCTR - Called from CONTRL

INPUT

Control - system Analytical Symbols	WBLCTR Symbols	Comments
$\{\omega\}$	O	
$[M_{11}]$	WM11	
β	BET	equivalenced to YPRED (2)
$\dot{\beta}$	DBET	equivalenced to YPRED (1)
K_T	KT	
t_{qLIM}	TQLIM	
$K_{\dot{\beta}}$	WKDBET	
$\{\dot{\omega}\}$	DO	
time	TIME	
mom_{CMG}	WMOMCM	
$I_{\beta GIM}$	WIBGIM	
err_{KT}	ERRKT	
err_{KTI}	ERRKTI	equivalenced to YPRED (3)
$\ddot{\beta}$	DDBET	
ω_{1CMAG}	OICMAG	
err_{LL}	ERRLL	
err_{LLI}	ERRLLI	equivalenced to YPRED (4)
i_s	IS	
	YICS	initial conditions of integrated controls variables
	YPRED	integrated controls variables (after T=0)
	NEQS	the number of integrated controls variables

Continued

WBLCTR (Continued)

OUTPUT

Control - system Analytical Symbols	WBLCTR Symbols	Comments
	YDOT	time-derivative of integrated controls variables (β, $\dot{\beta}$, err_{KT}, err_{11})
$\{{}_{\tau}A_j\}$	TAJ	
n_{CMG}	NCMG	

BMCON - Called from LUMP

INPUT

Main program Analytical Symbols	BMCON Symbols	Comments
	IN	card input unit
	IOUT	printer output unit
all $\{R_i\}$	RI	
all $\{\dot{R}_i\}$	RID	
all $\{\omega^{X^i}\}$	WXI	
$\{\omega^X\}$	WX	
all $\{r_i\}$	RID	
all $\{\theta_i\}$	TH	
i_s	IS	
$\{\omega^{X^{i_s}}\}$	O	
$\{R\}$	R	
	YICS	initial values of integrated controls variables
	YPRED	gives values $\{\dot{U}_2\}_3$ = YPRED (5); $\{U_2\}_3$ = YPRED (6) for $T>0$
t	T	
$\{U_1\}$	UJ	
$\{\dot{U}_1\}$	UJD	
$\{\ddot{U}_1\}$	UJDD	
$\{\dot{\omega}^{X^{i_s}}\}$	DO	
ω_{1CMAG}	O1CMAG	
$\{\ddot{R}\}$	RDDOT	value computed at previous program cycle
$\{\dot{\omega}^X\}$	WXDOT	value computed at previous program cycle

Continued

G

BMCON (Continued)

Main - program Analytical Symbols	BMCON Symbols	Comments
	QDD	value computed at previous program cycle
$\{ZCM\}$	ZCM	(after T=0) value computed at previous program cycle (Eq. (A27b), App. C, VI)
M_c	EMC	Mass of Counterweight
M	TOT	Mass of Space Station
all μ_i	U	
$\Pi(\eta)$	PIETA	
$\Pi(\gamma)$	PIGAM	
$\{\ell_0\}$	EL	
$\{\ell_0\}$	ELD	

OUTPUT

Main - program Analytical Symbols	BMCON Symbols	Comments
$\{U_2\}$	UJ	
$\{\dot{U}_2\}$	UJD	
$\{\ddot{U}_2\}$	UJDD	
	YDOT	YDOT (5) set to $\{\ddot{U}_2\}_3$; YDOT (6)
	NEQS	Set to $\{\dot{U}_1\}_3$ set to 2 at T=0 only

REMINDER:

UJ, UJD, UJDD contain the values of $\{U_1\}$, $\{\dot{U}_1\}$, $\{\ddot{U}_1\}$ upon entrance but are expected to contain the values of $\{U_2\}$, $\{\dot{U}_2\}$, $\{\ddot{U}_2\}$ upon exit.

BMCTR - Called from BMCON

INPUT

Control-system Analytical Symbols *	BMCTR Sym	Comments
$\{\dot{X}^B\}$	DXB	
$\{\dot{\omega}\}$	DO	
M	WM	
(m_1, m_2)	WMI	
$[\Gamma(\dot{\omega}^{X^{i}s})]$	GDO	
$[\Gamma(\omega^{X^{i}s})]$	GO	
$\{\dot{X}^{(1)}\}$	DXI	first column
$\{\dot{X}^{(2)}\}$	DXI	second column
m_{1EST}	WMLEST	
K_{eXSE}	WKEXSE	
K_{DESE}	WKDESE	
τ_{BAL}	TAUBAL	
ω_{1CMAG}	O1CMAG	
$\{X^{CMND}_{SENS/CM}\}$	XSCM	
$\{\ddot{X}^{SENS}\}_3$	DDXSNS	
$\{\ddot{X}^{(1)}\}$	DDXI	first column
ω_{1CBAL}	O1CBAL	
t	T	first element

OUTPUT

Control-system Analytical Symbols	BMCTR Sym	Comments
$\{\ddot{X}^{(2)}\}$	DDXI	second column

* See Appendix H13 of Volime I.

POSCTR - Called from ATTCTR for each axis

INPUT

Control-system Analytical Symbols	POSCTR Symbols	Comments
e	E	Position error
e_{DB}	EDB	Position error dead band when $\dot{e} = 0$
$\dot{e}$	EDOT	
$\dot{e}_{MAX}$	EDOTMX	
acc_s	ACCS	Nonzero acceleration magnitude used to establish switching curves

OUTPUT

Control-system Analytical Symbols	POSCTR Symbols	Comments
acc_{NOW}	ACCNOW	Multiplier of desired acceleration (+1., 0., or -1.)

VELCTR - Called from BMCTR, SPNCTR

INPUT

Control System Analytical Symbols	VELCTR Symbols	Comments
$\dot{e}$	EDOT	Velocity error
$\dot{e}_{DB}$	EDOTDB	Velocity error dead band

OUTPUT

Control System Analytical Symbols	VELCTR Symbols	Comments
acc_{NOW}	ACCNOW	Multiplier of desired acceleration (+1., 0., or -1.)

SUPPLM - Called from ZLAB and ZCW

INPUT

Main Program Analytical Symbols	SUPPLM Symbols	Comments
	N	number of mass points on the vehicle
	K	clue set to { 1 if called from ZLAB; -1 if called from ZCW }
	IF	clue set to { 1 if supplementary forces are to be computed; 0 if supplementary forces are not to be computed }

OUTPUT

Main Program Analytical Symbols	SUPPLM Symbols	Comments
all $\{f_s^i\}$ (or $\{\bar{f}_s^i\}$)	A	$\{f_c^i\}$ (or $\{\bar{f}_c^i\}$) begins at A (3i-2) (see Note)
all $\{\tau_s^i\}$ (or $\{\bar{\tau}_s^i\}$)	A	$\{\tau_c^i\}$ (or $\{\bar{\tau}_c^i\}$) begins at A (3i+1) (see Note)

NOTE:

Supplementary forces and torques are computed for the

{ Laboratory when K = 1
  Counterweight when K = -1 }

LOOK - Called from LUMP

INPUT

Main program Analytical Symbols	LOOK Symbols	Comments
j	L	moving mass no.

OUTPUT

Main program Analytical Symbols	LOOK Symbols	Comments
	M	no. of influencing values.
k	K	values of k which influence μ,

APPENDIX B6

INPUT, OUTPUT, AND INTERMEDIATE FILES

FILE 1 - intermediate file

File number 1 is used for intermediate data to be used by the plotting program. Write statements are in MAIN and MINCY. Read statements are in PLO3AX.

FILE 11 - input file

Contains Phase I input for the Laboratory. READ statements are in COMMIN.

FILE 12 - input file

Contains Phase I input for the Counterweight. READ statements are in COMMIN.

APPENDIX B7

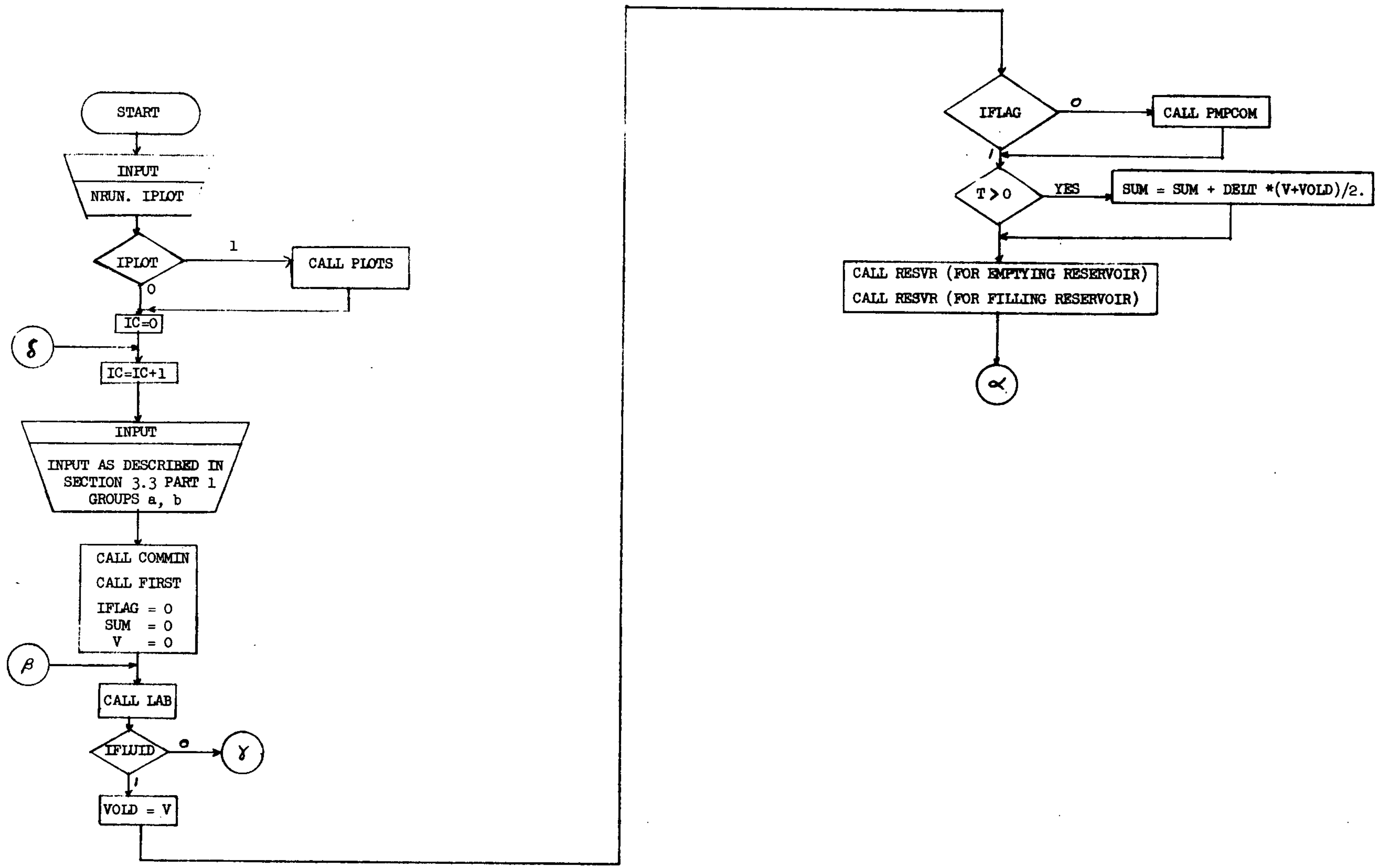
FLOW CHARTS

Fortran Symbols Used in Flow Charts*

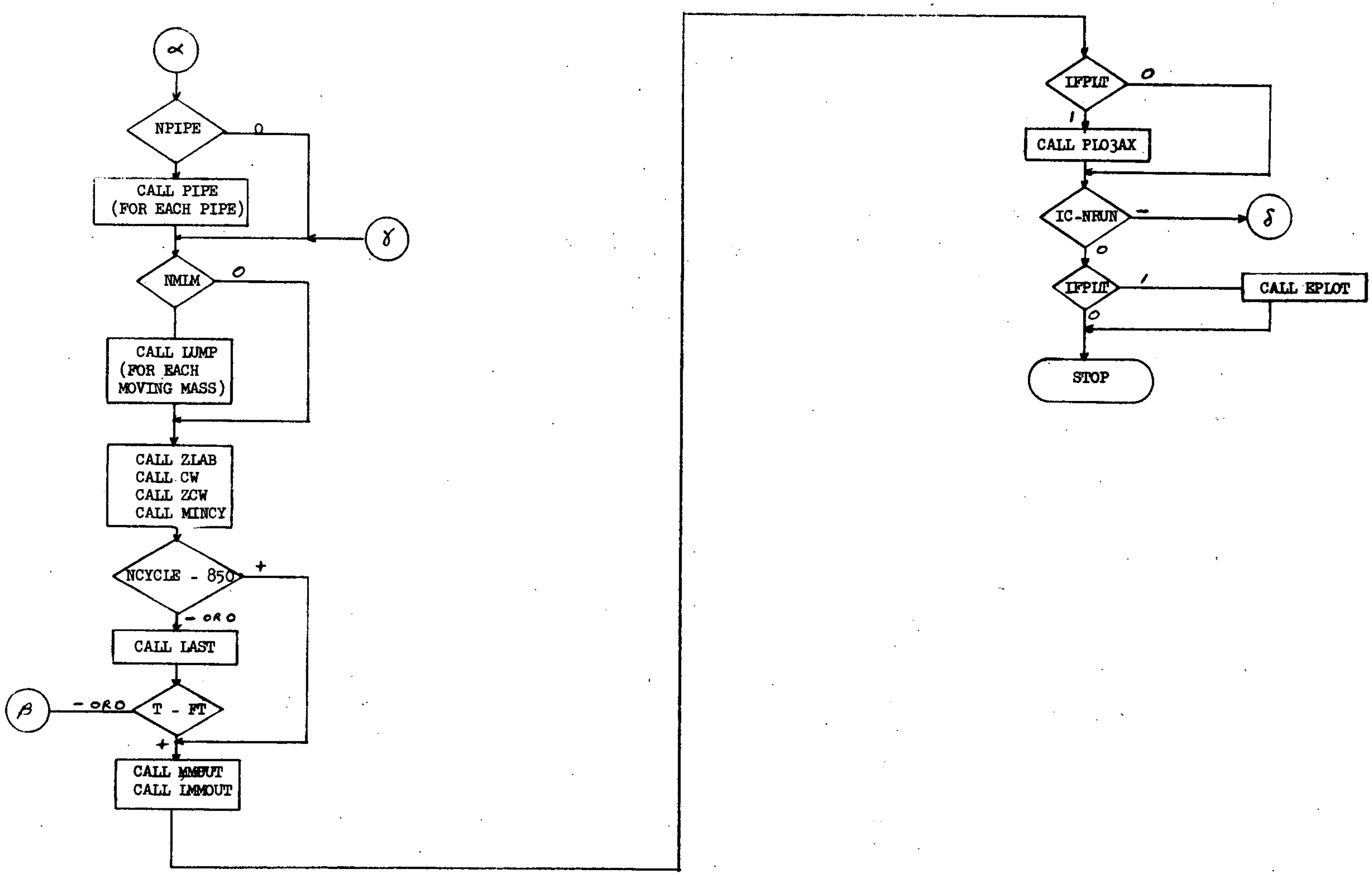
IFLAG	-	set to 1 when emptying reservoir becomes empty or when filling reservoir becomes full
SUM	-	$\int_0^T V\,dt$ where V is fluid velocity in pipe
DELT	-	time increment
IPLOT	-	set to 1 if plotting is present for any run on the job
IFPLT	-	set to 1 if plotting is present for the current run
T	-	Time
IFLUID	-	fluid clue: set to 1 if fluids are present, set to 0 if not
NPIPE	-	number of pipes present
NMLM	-	number of moving lumped masses
NCYCLE	-	number of output cycles
FT	-	final time
KLUE	-	problem clue (see Section 3.3, Part 1, Group c)
LABCW	-	argument of CONTROL subroutine indicating whether subroutine was called from ZLAB (LABCW=1) or from ZCW(LABCW=-1)
YICS	-	vector of initial conditions used in MAGIC integration
YDOT	-	vector of derivatives to be integrated by MAGIC
NTIME	-	} see Section 3.3, Part 10, Group 6
DTAU	-	}
MAGOUT	-	Magic output clue. Magic sets MAGOUT=2 to indicate an output cycle
IFDEPL	-	deployment clue: set to 1 if deployment is present, set to 0 if not
IFCON	-	controls clue: set to 1 if controls are present, set to 0 if not

*For analytical symbols see Volume 1, Section 4.

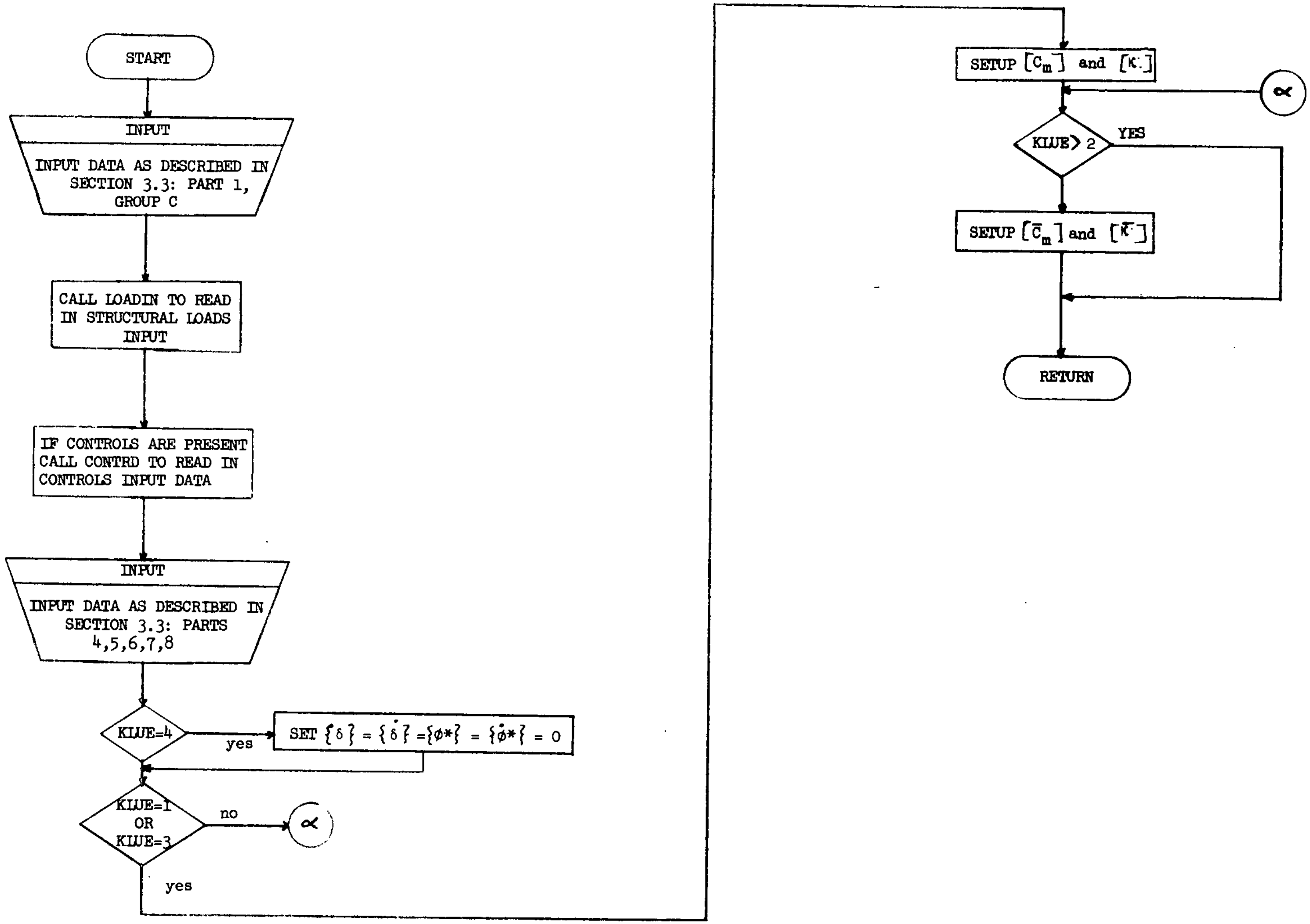
MAIN PROGRAM



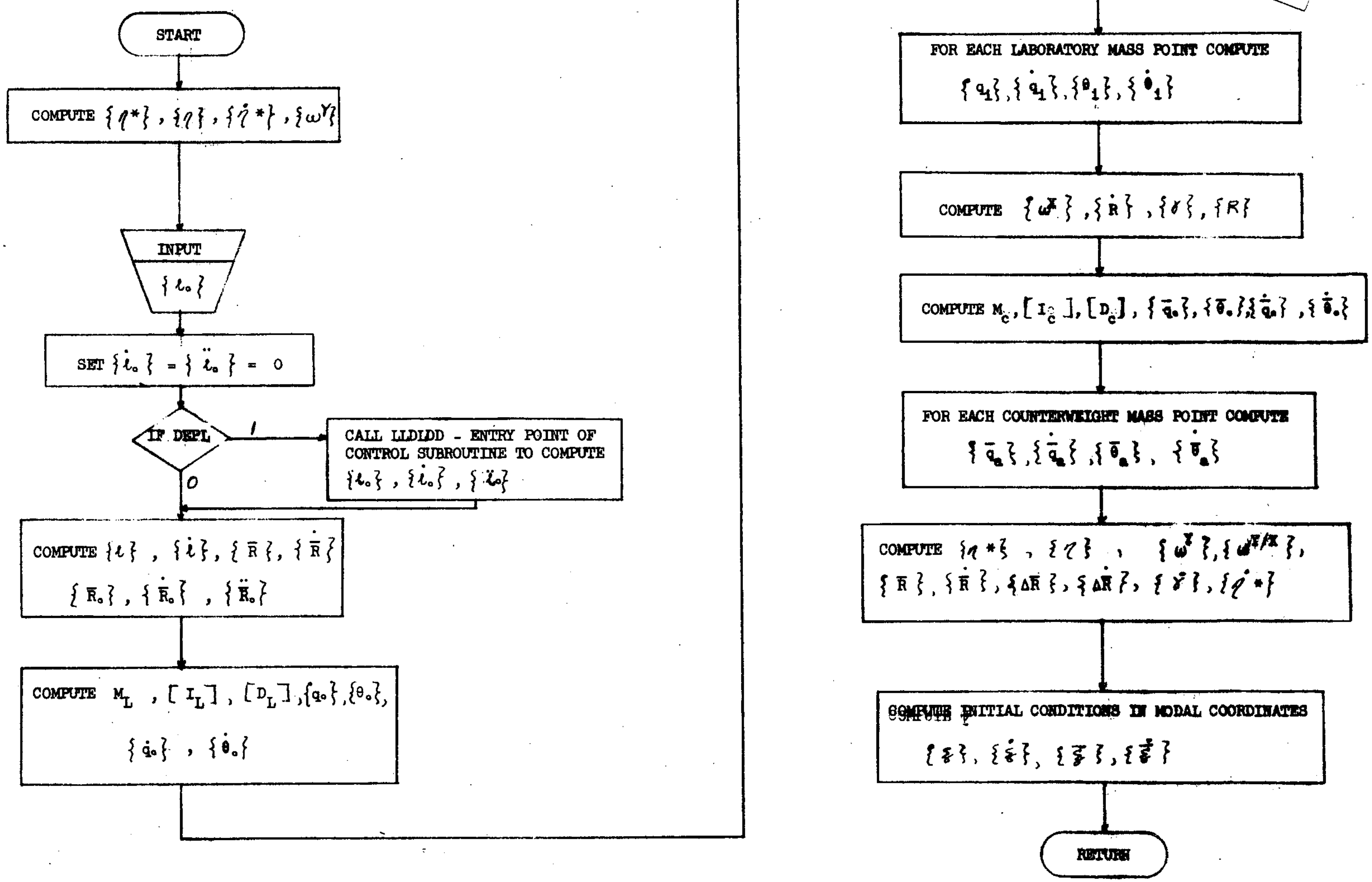
MAIN PROGRAM



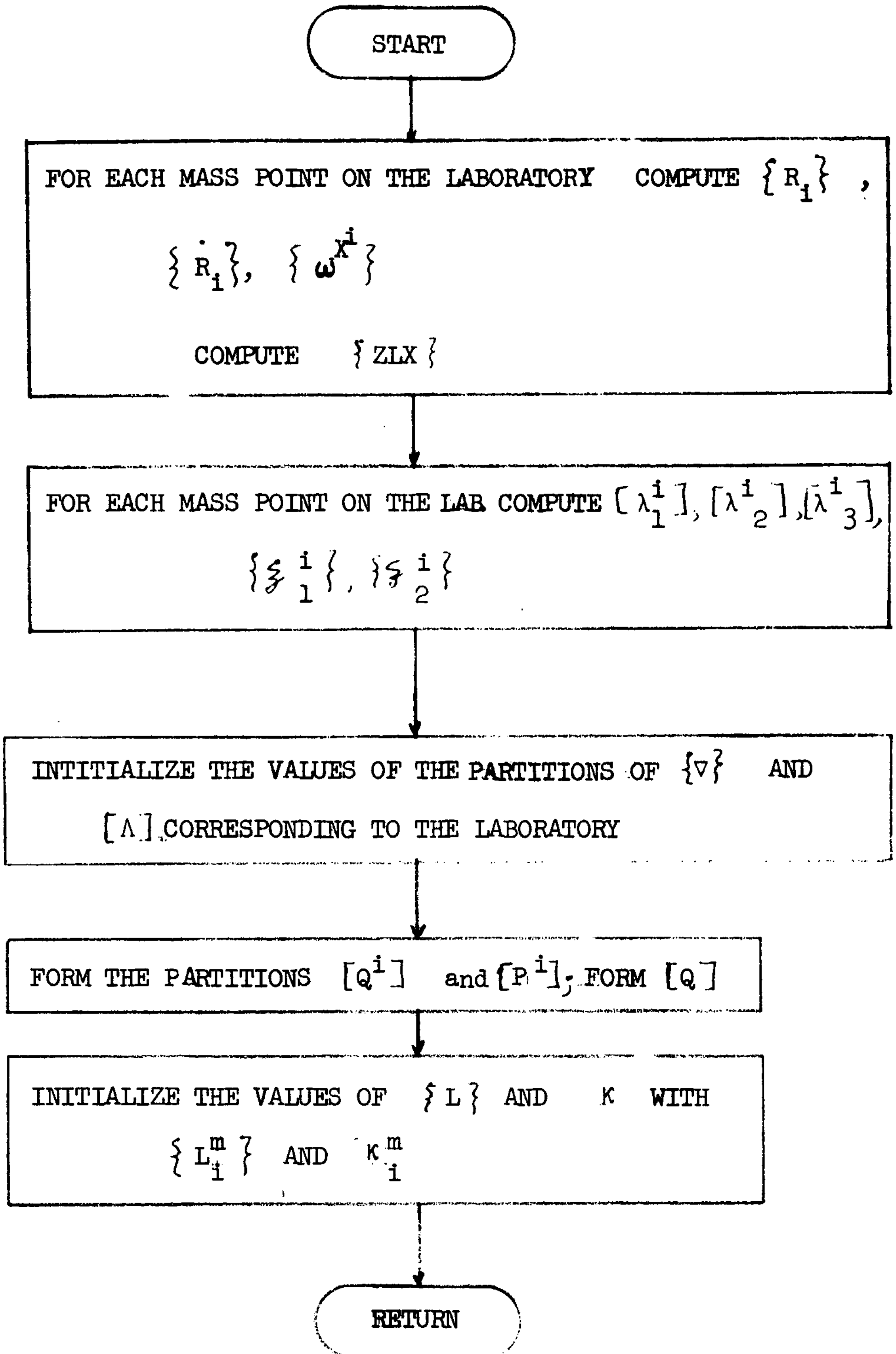
COMMIN


START
INPUT
INPUT DATA AS DESCRIBED IN SECTION 3.3: PART 1, GROUP C
CALL LOADIN TO READ IN STRUCTURAL LOADS INPUT
IF CONTROLS ARE PRESENT CALL CONTRD TO READ IN CONTROLS INPUT DATA
INPUT
INPUT DATA AS DESCRIBED IN SECTION 3.3: PARTS 4,5,6,7,8
KLUE=4
yes
SET {δ} = {δ̇} = {φ*} = {φ̇*} = 0
KLUE=1 OR KLUE=3
no
α
yes
SETUP [Cm] and [K]
α
KLUE > 2
YES
SETUP [C̄m] and [K̄]
RETURN

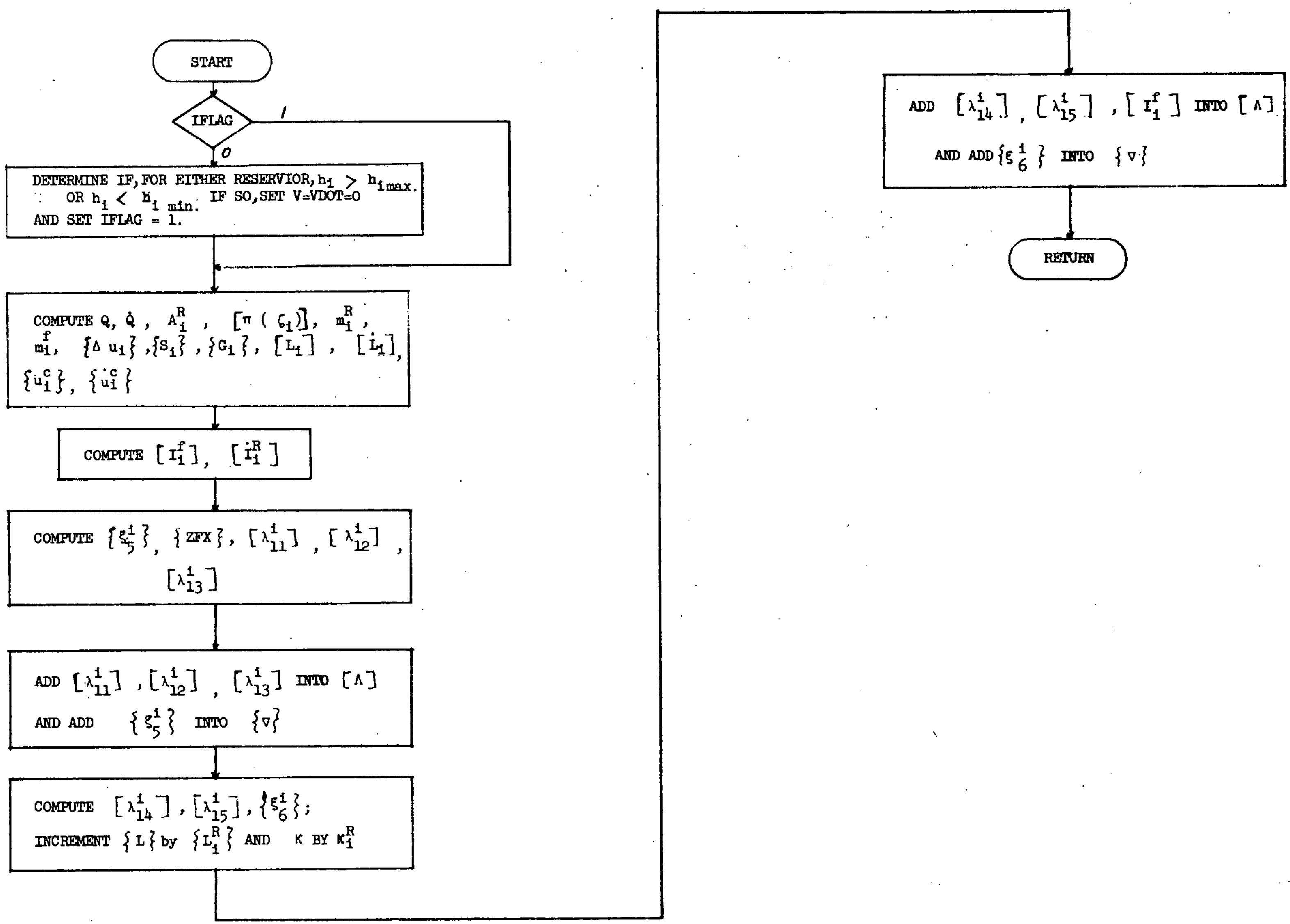
FIRST


START
COMPUTE $\{\eta^*\}$, $\{\eta\}$, $\{\dot{\eta}^*\}$, $\{\omega^Y\}$
INPUT
$\{\ell_o\}$
SET $\{\dot{\ell}_o\} = \{\ddot{\ell}_o\} = 0$
IF DEPL
1
0
CALL LLDLDD - ENTRY POINT OF CONTROL SUBROUTINE TO COMPUTE $\{\ell_o\}$, $\{\dot{\ell}_o\}$, $\{\ddot{\ell}_o\}$
COMPUTE $\{\ell\}$, $\{\dot{\ell}\}$, $\{\bar{R}\}$, $\{\dot{\bar{R}}\}$
$\{\bar{R}_o\}$, $\{\dot{\bar{R}}_o\}$, $\{\ddot{\bar{R}}_o\}$
COMPUTE M_L, $[I_L]$, $[D_L]$, $\{q_o\}$, $\{\theta_o\}$, $\{\dot{q}_o\}$, $\{\dot{\theta}_o\}$
FOR EACH LABORATORY MASS POINT COMPUTE
$\{q_1\}$, $\{\dot{q}_1\}$, $\{\theta_1\}$, $\{\dot{\theta}_1\}$
COMPUTE $\{\omega^X\}$, $\{\dot{R}\}$, $\{\gamma\}$, $\{R\}$
COMPUTE M_c, $[I_c]$, $[D_c]$, $\{\bar{q}_o\}$, $\{\bar{\theta}_o\}$, $\{\dot{\bar{q}}_o\}$, $\{\dot{\bar{\theta}}_o\}$
FOR EACH COUNTERWEIGHT MASS POINT COMPUTE
$\{\bar{q}_a\}$, $\{\dot{\bar{q}}_a\}$, $\{\bar{\theta}_a\}$, $\{\dot{\bar{\theta}}_a\}$
COMPUTE $\{\eta^*\}$, $\{\eta\}$, $\{\omega^Y\}$, $\{\omega^{Y/X}\}$,
$\{\bar{R}\}$, $\{\dot{\bar{R}}\}$, $\{\Delta\bar{R}\}$, $\{\Delta\dot{\bar{R}}\}$, $\{\dot{\gamma}\}$, $\{\dot{\eta}^*\}$
COMPUTE INITIAL CONDITIONS IN MODAL COORDINATES
$\{\xi\}$, $\{\dot{\xi}\}$, $\{\bar{\xi}\}$, $\{\dot{\bar{\xi}}\}$
RETURN

LAB

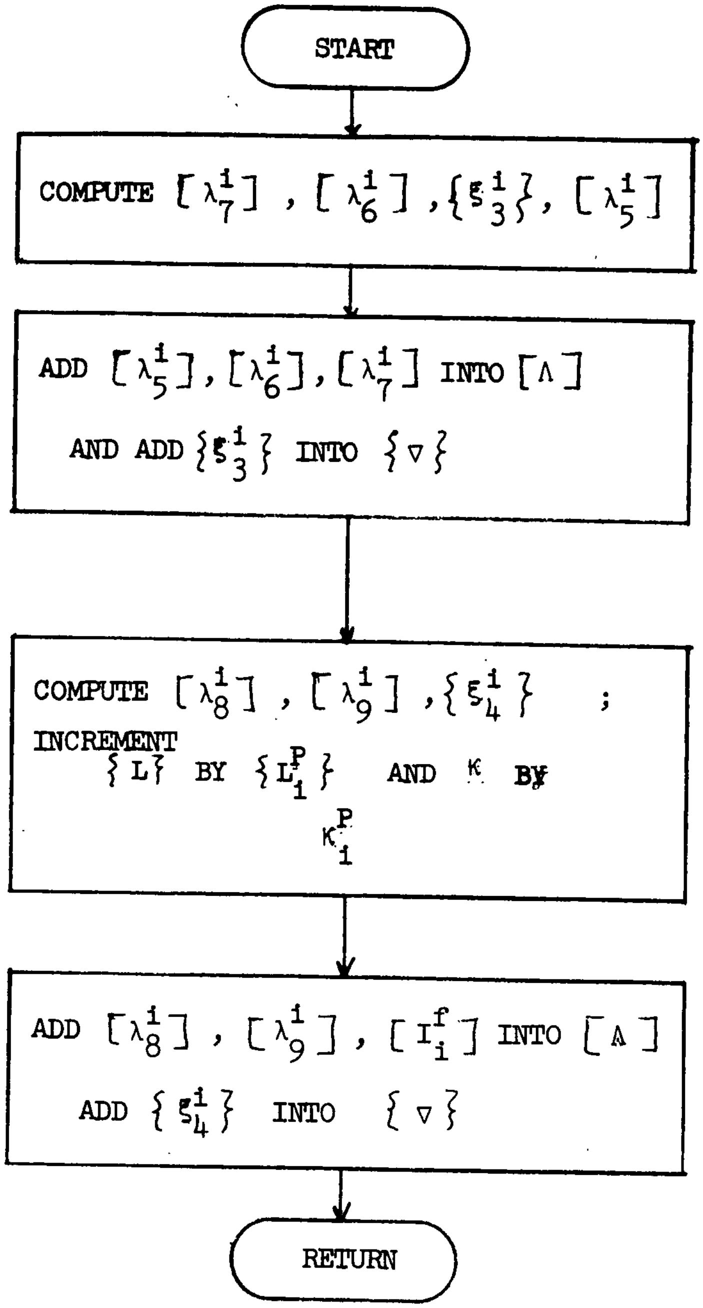

START
FOR EACH MASS POINT ON THE LABORATORY COMPUTE $\{R_i\}$, $\{\dot{R}_i\}$, $\{\omega^{X^i}\}$
COMPUTE $\{ZLX\}$
FOR EACH MASS POINT ON THE LAB COMPUTE $[\lambda_1^i]$, $[\lambda^i_2]$, $[\lambda^i_3]$, $\{\xi^i_1\}$, $\{\xi^i_2\}$
INTITIALIZE THE VALUES OF THE PARTITIONS OF $\{\nabla\}$ AND $[\Lambda]$ CORRESPONDING TO THE LABORATORY
FORM THE PARTITIONS $[Q^i]$ and $[P^i]$; FORM $[Q]$
INITIALIZE THE VALUES OF $\{L\}$ AND κ WITH $\{L_i^m\}$ AND κ_i^m
RETURN

RESVR


START
IFLAG
1
0
DETERMINE IF, FOR EITHER RESERVIOR, $h_i > h_{i\,max}$. OR $h_i < h_{i\,min}$. IF SO, SET V=VDOT=0 AND SET IFLAG = 1.
COMPUTE Q, $\dot{Q}$, A_i^R, $[\pi(\zeta_i)]$, m_i^R, m_i^f, $\{\Delta u_i\}$, $\{S_i\}$, $\{G_i\}$, $[L_i]$, $[\dot{L}_i]$, $\{u_i^c\}$, $\{\dot{u}_i^c\}$
COMPUTE $[I_i^f]$, $[\dot{I}_i^R]$
COMPUTE $\{\xi_5^i\}$, {ZFX}, $[\lambda_{11}^i]$, $[\lambda_{12}^i]$, $[\lambda_{13}^i]$
ADD $[\lambda_{11}^i]$, $[\lambda_{12}^i]$, $[\lambda_{13}^i]$ INTO $[\Lambda]$ AND ADD $\{\xi_5^i\}$ INTO $\{\nabla\}$
COMPUTE $[\lambda_{14}^i]$, $[\lambda_{15}^i]$, $\{\xi_6^i\}$; INCREMENT {L} by $\{L_i^R\}$ AND K BY K_i^R
ADD $[\lambda_{14}^i]$, $[\lambda_{15}^i]$, $[I_i^f]$ INTO $[\Lambda]$ AND ADD $\{\xi_6^i\}$ INTO $\{\nabla\}$
RETURN

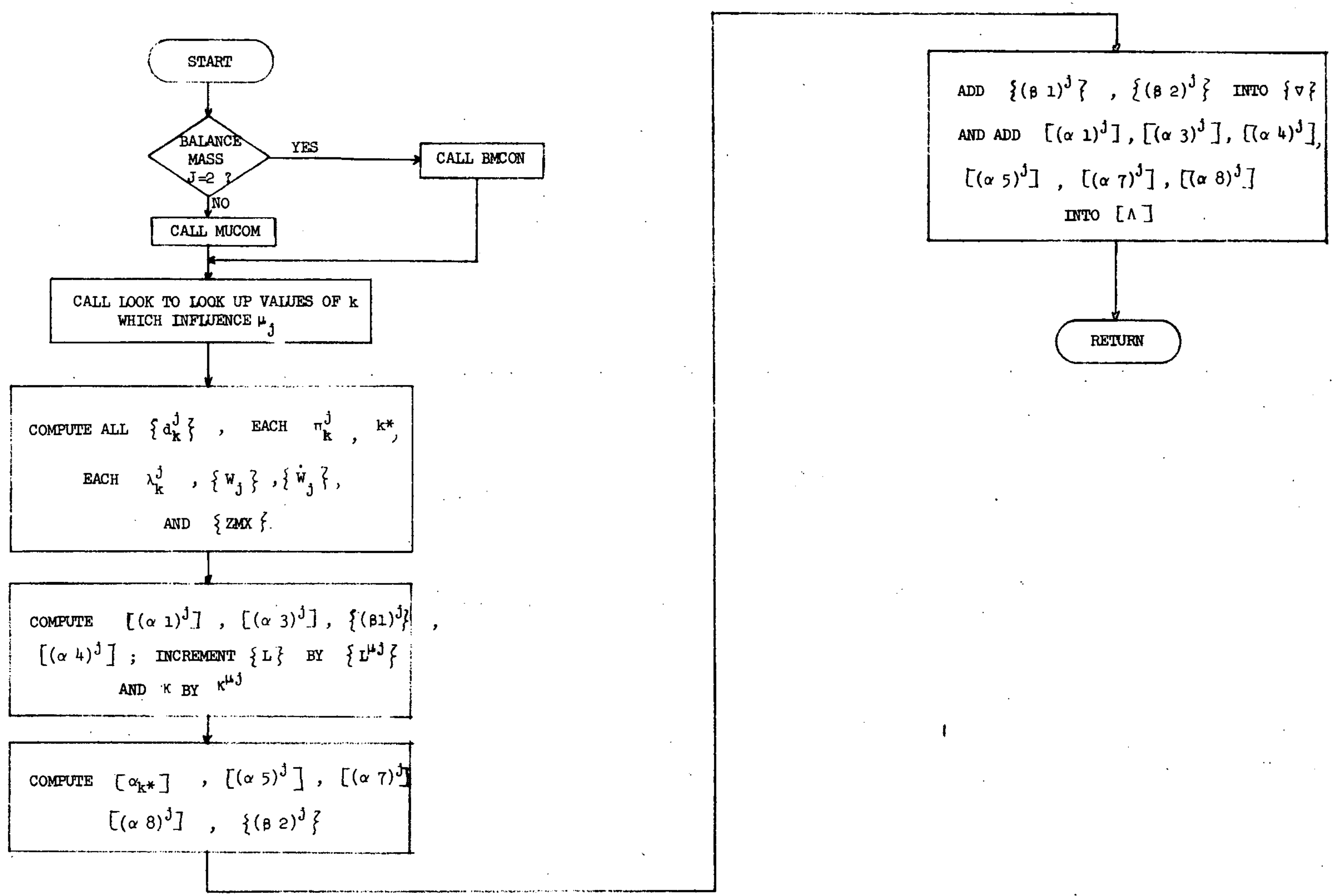
C4

PIPE

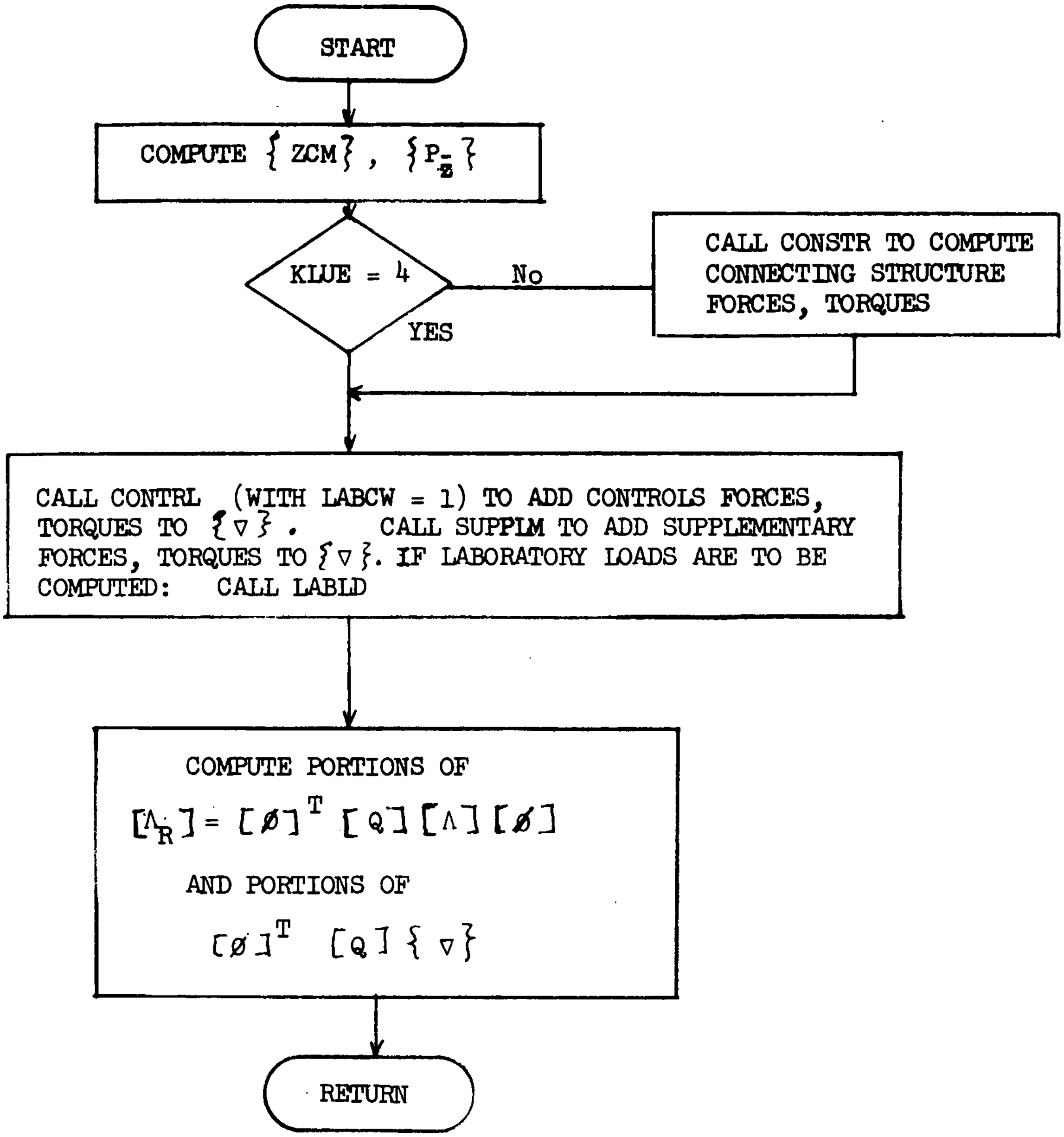


START
COMPUTE [λ_7^i], [λ_6^i], {ξ_3^i}, [λ_5^i]
ADD [λ_5^i], [λ_6^i], [λ_7^i] INTO [Λ]
AND ADD {ξ_3^i} INTO {∇}
COMPUTE [λ_8^i], [λ_9^i], {ξ_4^i} ;
INCREMENT {L} BY {L_i^P} AND κ BY κ_i^P
ADD [λ_8^i], [λ_9^i], [I_i^f] INTO [Λ]
ADD {ξ_4^i} INTO {∇}
RETURN

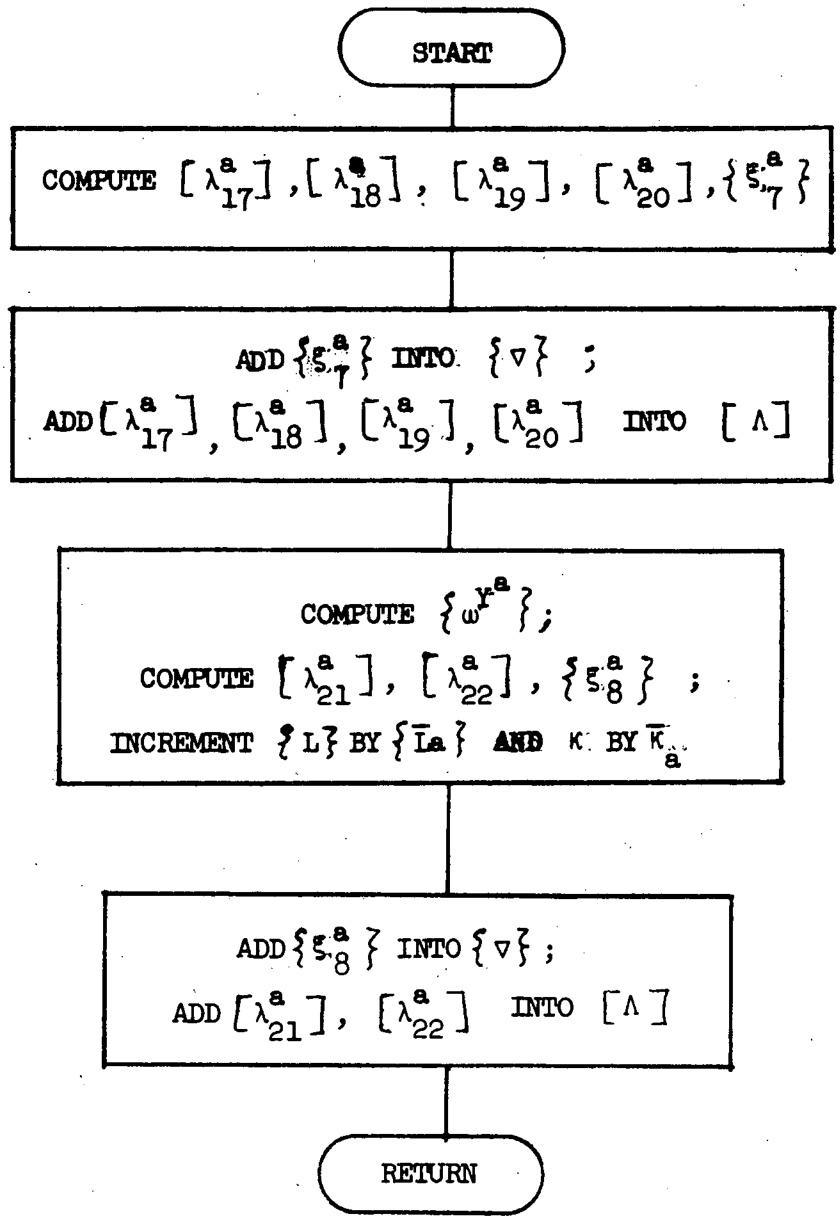
LUMP


START
BALANCE MASS J=2 ?
YES
NO
CALL BMCON
CALL MUCOM
CALL LOOK TO LOOK UP VALUES OF k WHICH INFLUENCE μ_j
COMPUTE ALL $\{d_k^j\}$, EACH π_k^j , k^*, EACH λ_k^j , $\{W_j\}$, $\{\dot{W}_j\}$, AND $\{ZMX\}$.
COMPUTE $[(\alpha\ 1)^j]$, $[(\alpha\ 3)^j]$, $\{(\beta 1)^j\}$, $[(\alpha\ 4)^j]$; INCREMENT $\{L\}$ BY $\{L^{\mu j}\}$ AND κ BY $\kappa^{\mu j}$
COMPUTE $[\alpha_{k*}]$, $[(\alpha\ 5)^j]$, $[(\alpha\ 7)^j]$ $[(\alpha\ 8)^j]$, $\{(\beta\ 2)^j\}$
ADD $\{(\beta\ 1)^j\}$, $\{(\beta\ 2)^j\}$ INTO $\{\nabla\}$ AND ADD $[(\alpha\ 1)^j]$, $[(\alpha\ 3)^j]$, $[(\alpha\ 4)^j]$, $[(\alpha\ 5)^j]$, $[(\alpha\ 7)^j]$, $[(\alpha\ 8)^j]$ INTO $[\Lambda]$
RETURN

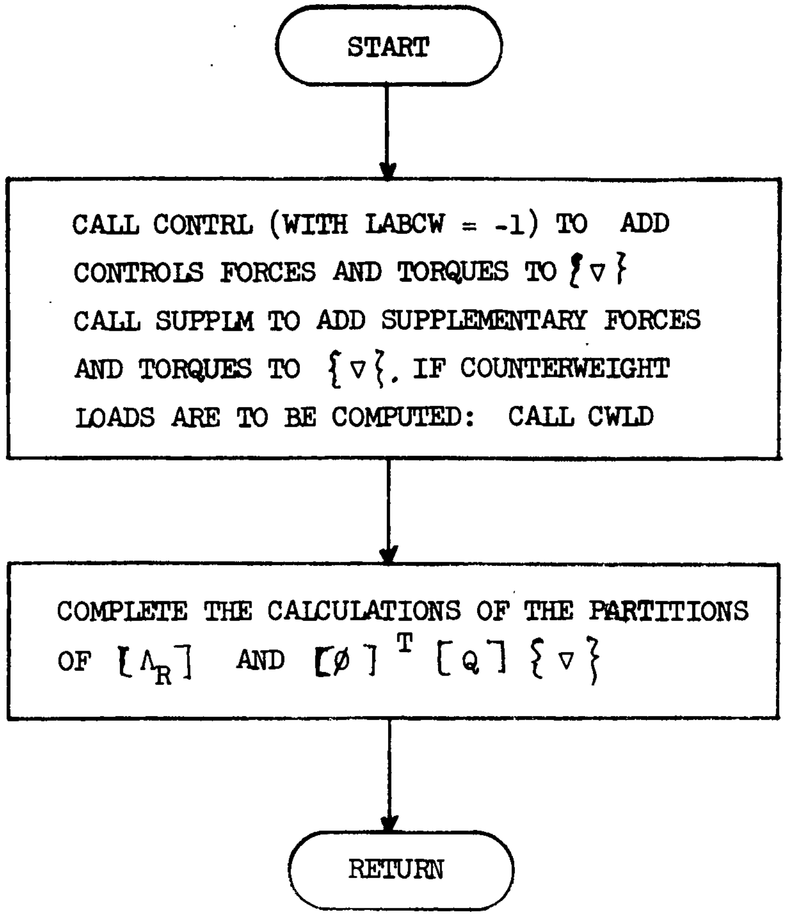
ZLAB


START
COMPUTE {ZCM}, {P_Z}
KLUE = 4
No
YES
CALL CONSTR TO COMPUTE CONNECTING STRUCTURE FORCES, TORQUES
CALL CONTRL (WITH LABCW = 1) TO ADD CONTROLS FORCES, TORQUES TO {∇}. CALL SUPPLM TO ADD SUPPLEMENTARY FORCES, TORQUES TO {∇}. IF LABORATORY LOADS ARE TO BE COMPUTED: CALL LABLD
COMPUTE PORTIONS OF
[Λ_R] = [Ø]^T [Q] [Λ] [Ø]
AND PORTIONS OF
[Ø]^T [Q] {∇}
RETURN

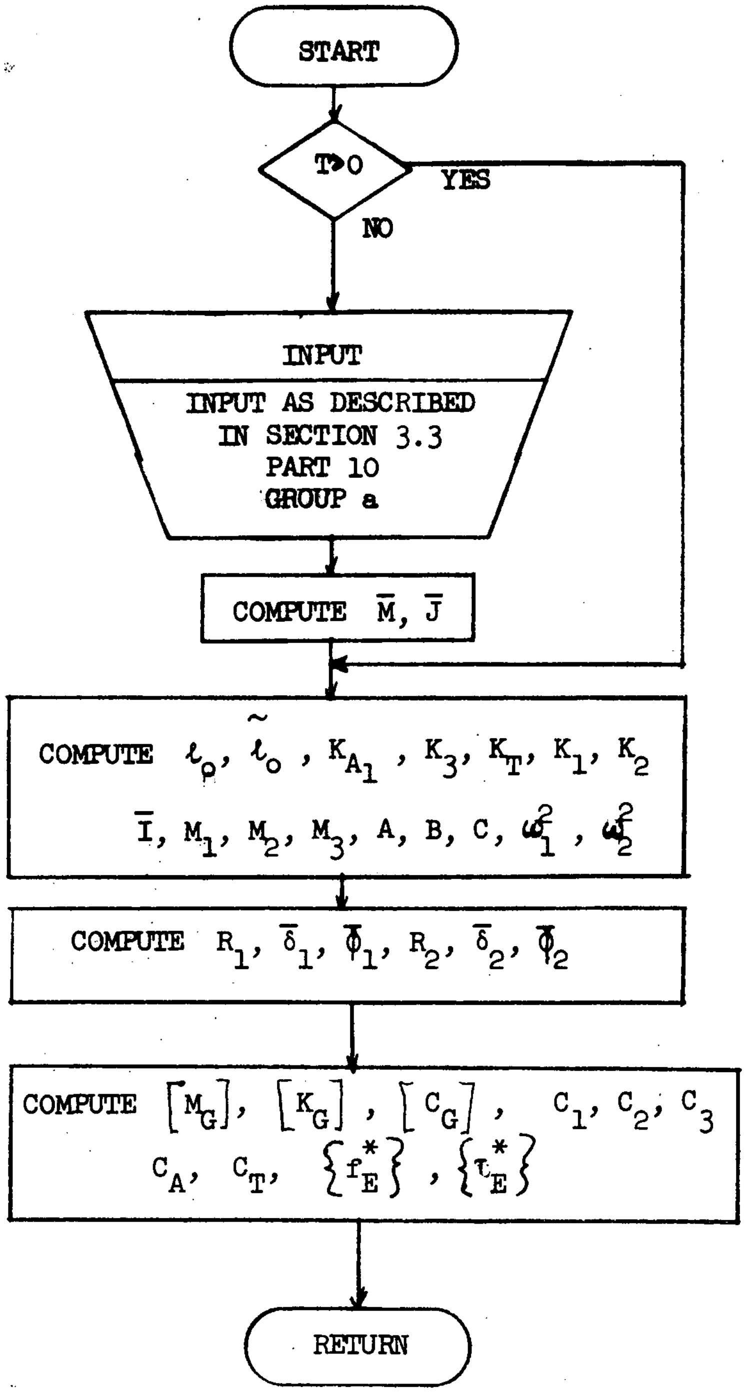
CW


START
COMPUTE $[\lambda^a_{17}]$, $[\lambda^a_{18}]$, $[\lambda^a_{19}]$, $[\lambda^a_{20}]$, $\{\xi^a_7\}$
ADD $\{\xi^a_7\}$ INTO $\{\nabla\}$;
ADD $[\lambda^a_{17}]$, $[\lambda^a_{18}]$, $[\lambda^a_{19}]$, $[\lambda^a_{20}]$ INTO $[\Lambda]$
COMPUTE $\{\omega^{\gamma a}\}$;
COMPUTE $[\lambda^a_{21}]$, $[\lambda^a_{22}]$, $\{\xi^a_8\}$;
INCREMENT $\{L\}$ BY $\{\bar{L}a\}$ AND κ BY $\bar{\kappa}_a$
ADD $\{\xi^a_8\}$ INTO $\{\nabla\}$;
ADD $[\lambda^a_{21}]$, $[\lambda^a_{22}]$ INTO $[\Lambda]$
RETURN

ZCW

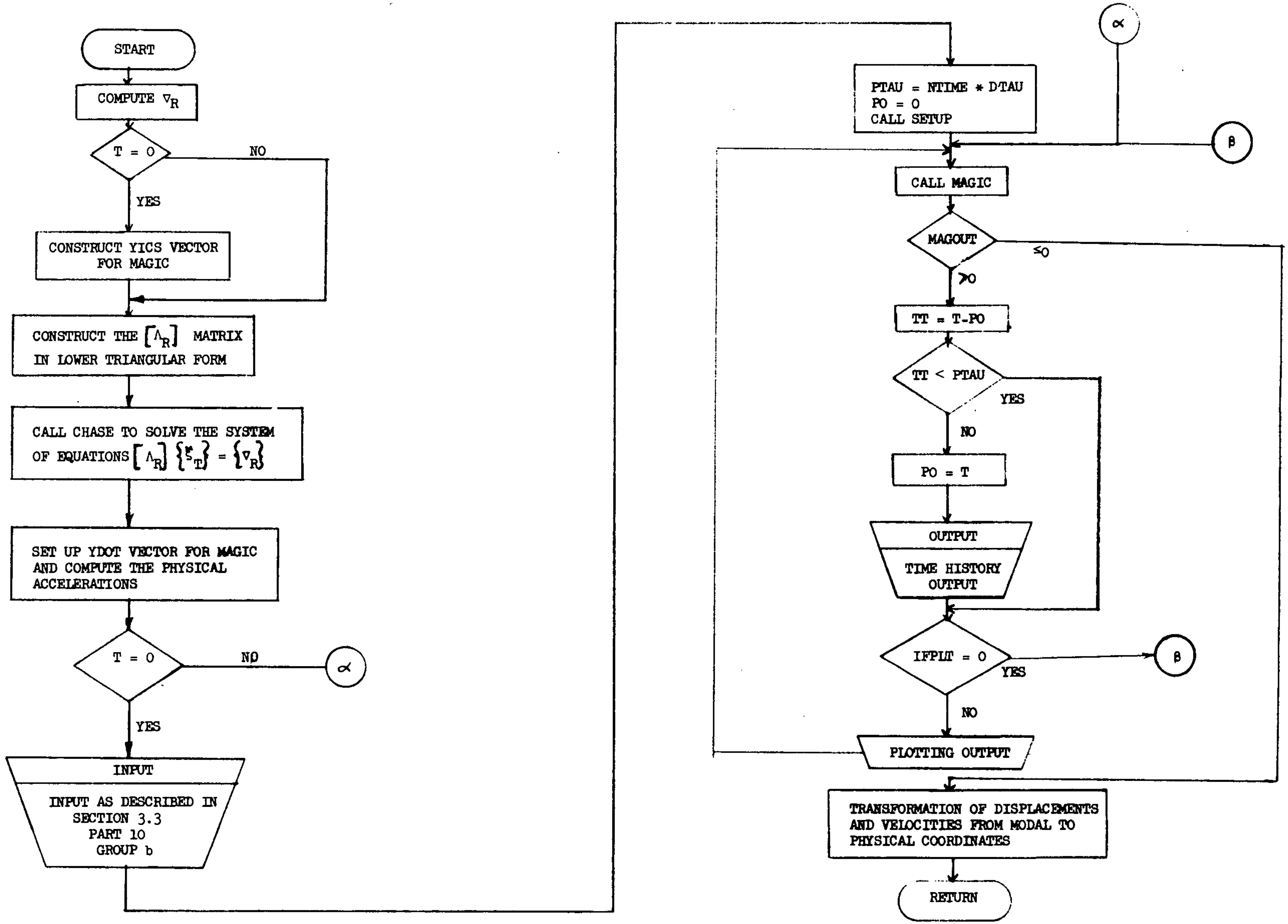

START
CALL CONTRL (WITH LABCW = -1) TO ADD CONTROLS FORCES AND TORQUES TO {∇}
CALL SUPPLM TO ADD SUPPLEMENTARY FORCES AND TORQUES TO {∇}. IF COUNTERWEIGHT LOADS ARE TO BE COMPUTED: CALL CWLD
COMPLETE THE CALCULATIONS OF THE PARTITIONS OF [Λ_R] AND [Ø]^T [Q] {∇}
RETURN

CONSTR

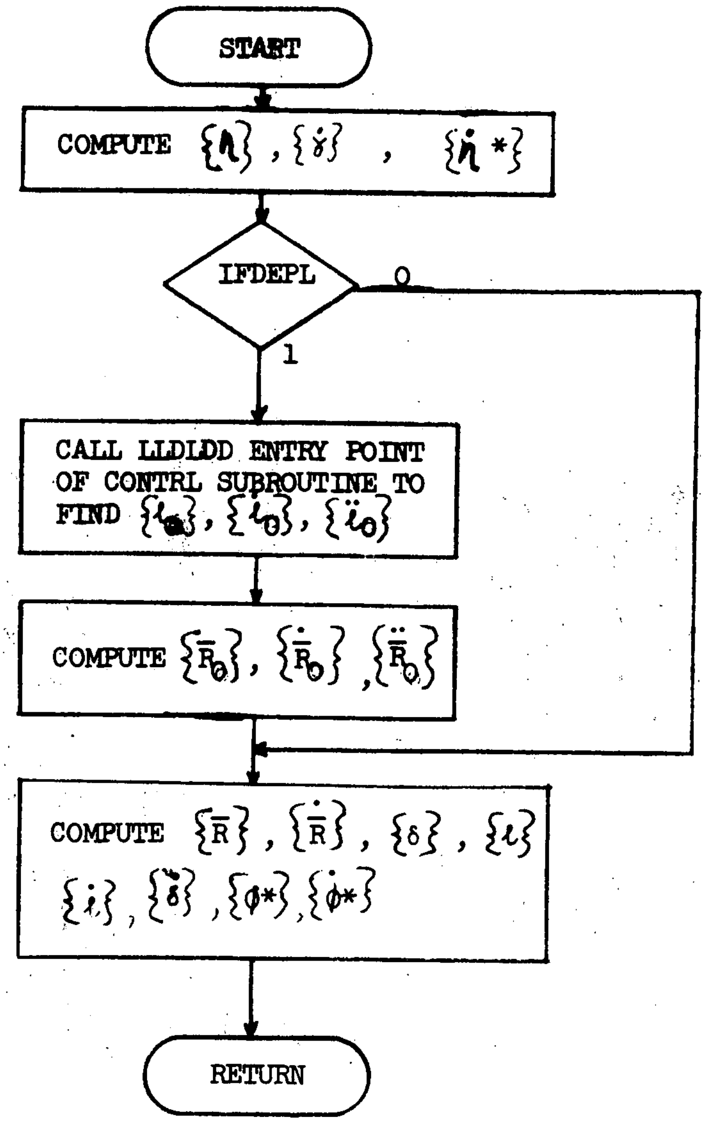


START
T>0
YES
NO
INPUT
INPUT AS DESCRIBED IN SECTION 3.3 PART 10 GROUP a
COMPUTE $\bar{M}$, $\bar{J}$
COMPUTE ℓ_ρ, $\tilde{\ell}_o$, K_{A_1}, K_3, K_T, K_1, K_2, $\bar{I}$, M_1, M_2, M_3, A, B, C, ω_1^2, ω_2^2
COMPUTE R_1, $\bar{\delta}_1$, $\bar{\Phi}_1$, R_2, $\bar{\delta}_2$, $\bar{\Phi}_2$
COMPUTE $[M_G]$, $[K_G]$, $[C_G]$, C_1, C_2, C_3, C_A, C_T, $\{f_E^*\}$, $\{\tau_E^*\}$
RETURN

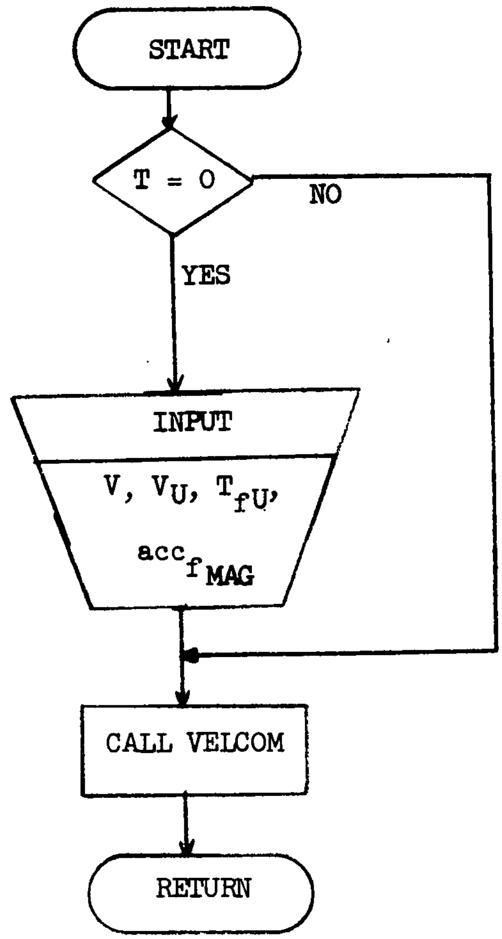
MINCY


START
COMPUTE ∇_R
T = 0
NO
YES
CONSTRUCT YICS VECTOR FOR MAGIC
CONSTRUCT THE $[\Lambda_R]$ MATRIX IN LOWER TRIANGULAR FORM
CALL CHASE TO SOLVE THE SYSTEM OF EQUATIONS $[\Lambda_R]\{\xi_T\} = \{\nabla_R\}$
SET UP YDOT VECTOR FOR MAGIC AND COMPUTE THE PHYSICAL ACCELERATIONS
T = 0
NO
YES
α
INPUT
INPUT AS DESCRIBED IN SECTION 3.3 PART 10 GROUP b
PTAU = NTIME * DTAU
PO = 0
CALL SETUP
α
β
CALL MAGIC
MAGOUT
≤0
>0
TT = T-PO
TT < PTAU
YES
NO
PO = T
OUTPUT
TIME HISTORY OUTPUT
IFPLT = 0
YES
β
NO
PLOTTING OUTPUT
TRANSFORMATION OF DISPLACEMENTS AND VELOCITIES FROM MODAL TO PHYSICAL COORDINATES
RETURN

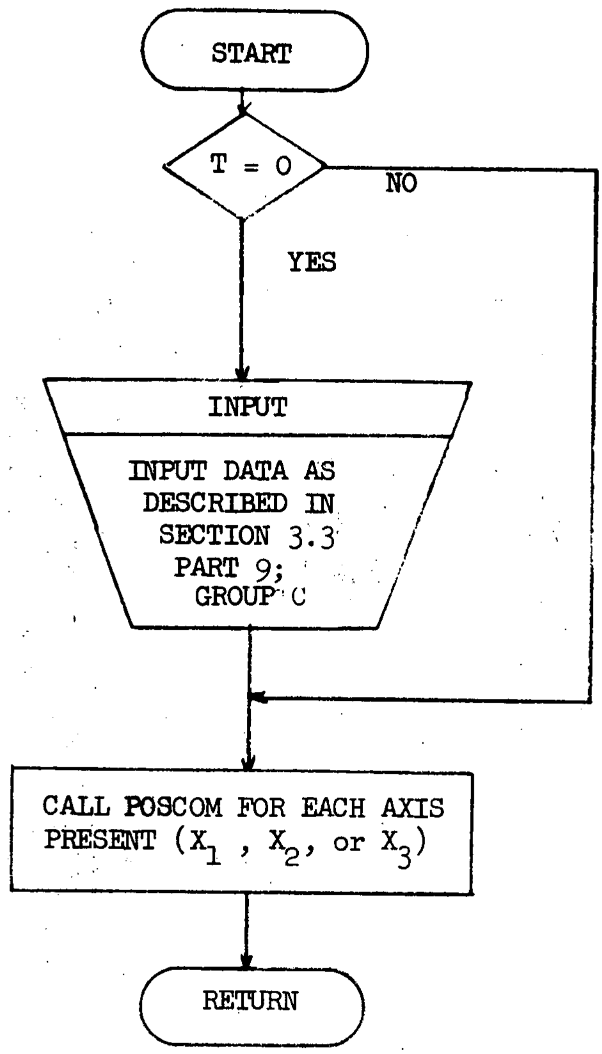
LAST


START
COMPUTE {r}, {ṙ}, {r̈*}
IFDEPL
0
1
CALL LLDLDD ENTRY POINT OF CONTRL SUBROUTINE TO FIND {l0}, {l̇0}, {l̈0}
COMPUTE {R̄0}, {R̄̇0}, {R̄̈0}
COMPUTE {R̄}, {R̄̇}, {δ}, {l}, {i}, {δ̈}, {φ*}, {φ̇*}
RETURN

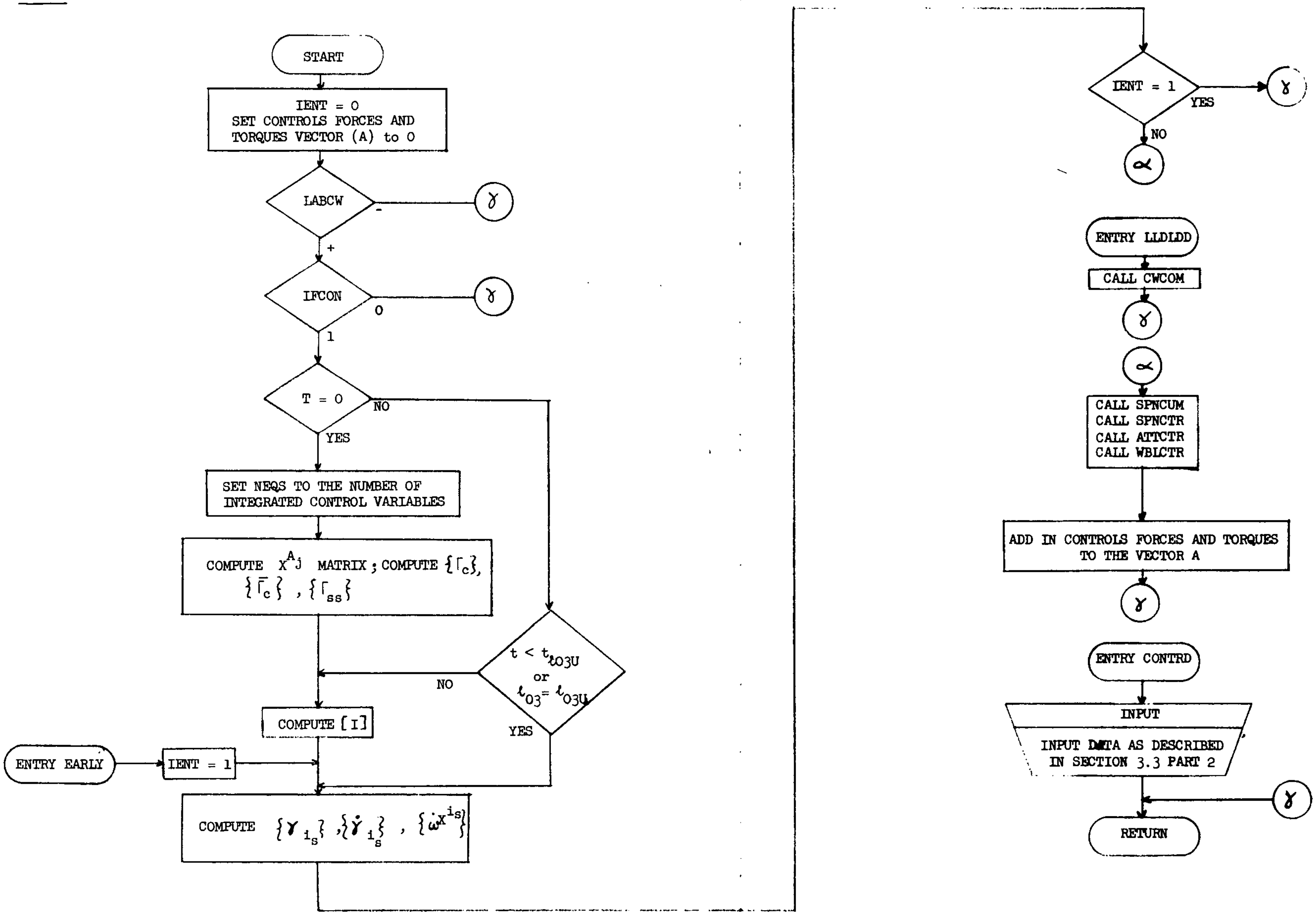
PMPCOM

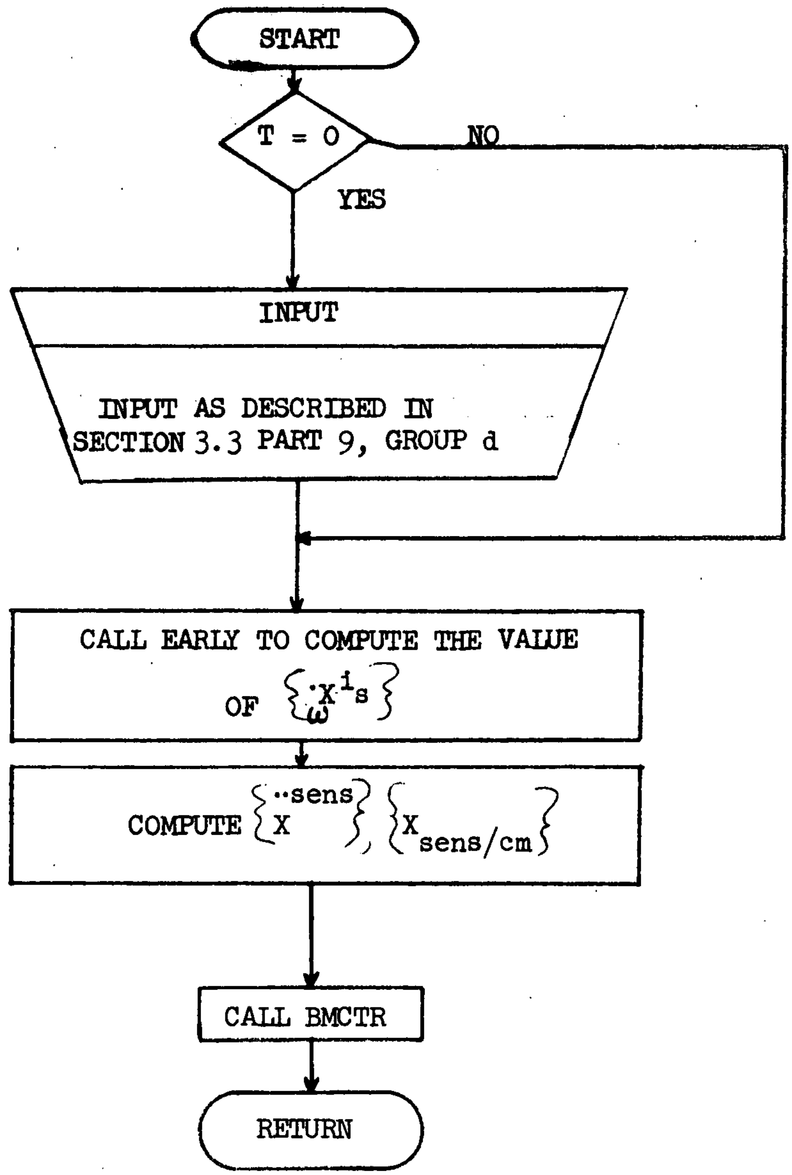


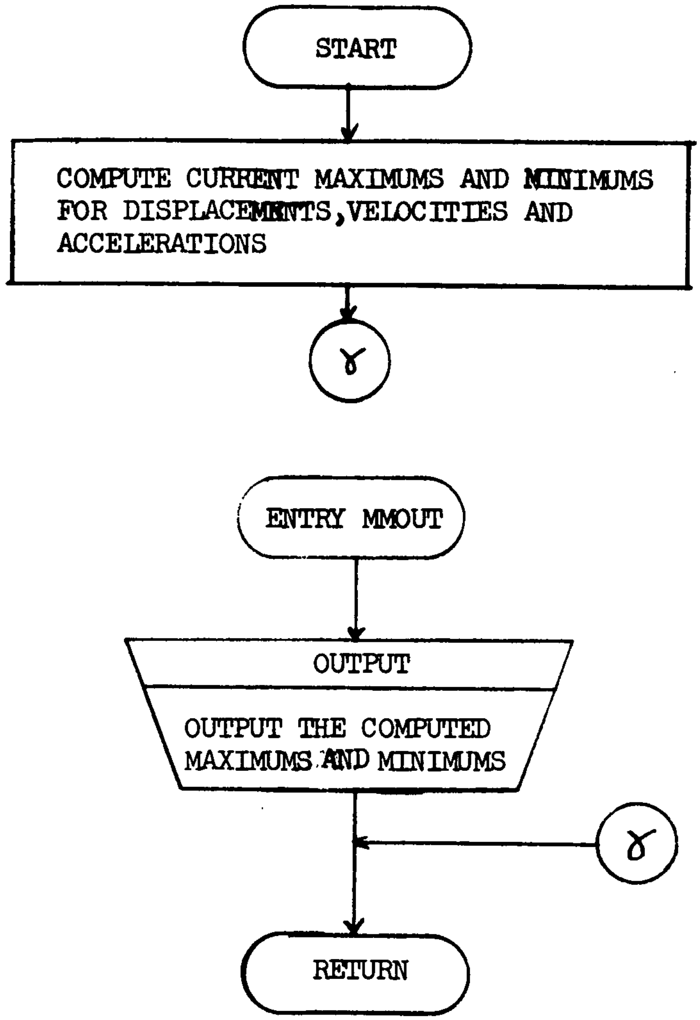
MUCOM


START
T = 0
NO
YES
INPUT
INPUT DATA AS DESCRIBED IN SECTION 3.3 PART 9; GROUP C
CALL POSCOM FOR EACH AXIS PRESENT (X_1 , X_2, or X_3)
RETURN

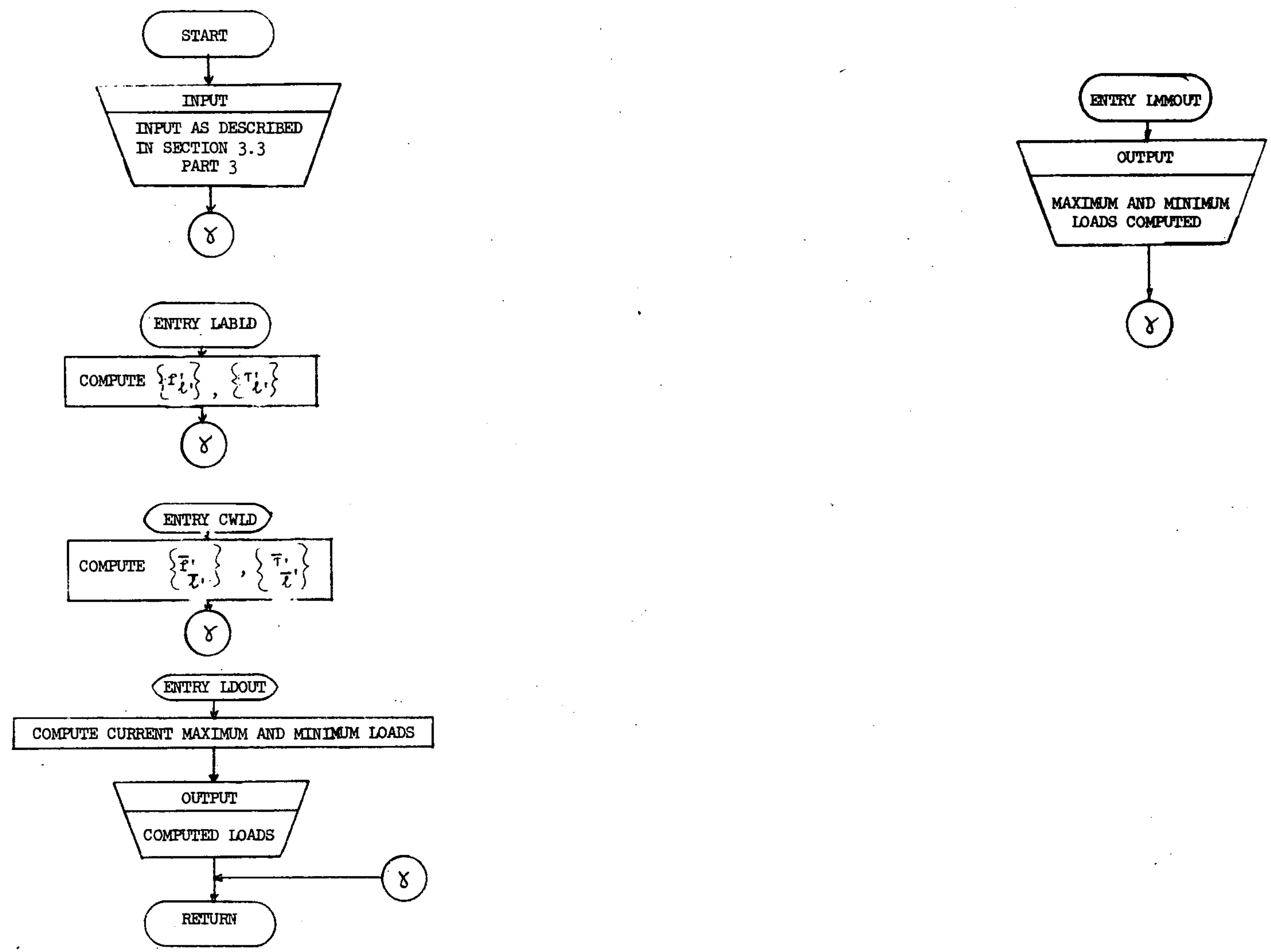
CONTRL


START
IENT = 0
SET CONTROLS FORCES AND TORQUES VECTOR (A) to 0
LABCW
-
+
IFCON
0
1
T = 0
NO
YES
SET NEQS TO THE NUMBER OF INTEGRATED CONTROL VARIABLES
COMPUTE X^{A_J} MATRIX ; COMPUTE $\{\Gamma_c\}$, $\{\bar{\Gamma}_c\}$, $\{\Gamma_{ss}\}$
$t < t_{\ell 03U}$ or $\ell_{03} = \ell_{03U}$
NO
YES
COMPUTE [I]
ENTRY EARLY
IENT = 1
COMPUTE $\{\gamma_{i_s}\}$, $\{\dot{\gamma}_{i_s}\}$, $\{\dot{\omega}^{x^{i_s}}\}$
IENT = 1
YES
NO
ENTRY LLDLDD
CALL CWCOM
CALL SPNCUM
CALL SPNCTR
CALL ATTCTR
CALL WBLCTR
ADD IN CONTROLS FORCES AND TORQUES TO THE VECTOR A
ENTRY CONTRD
INPUT
INPUT DATA AS DESCRIBED IN SECTION 3.3 PART 2
RETURN


START
T = 0
NO
YES
INPUT
INPUT AS DESCRIBED IN SECTION 3.3 PART 9, GROUP d
CALL EARLY TO COMPUTE THE VALUE OF $\{\dot{X}^{i}_{\omega s}\}$
COMPUTE $\{\ddot{X}^{sens}\}$, $\{X_{sens/cm}\}$
CALL BMCTR
RETURN


START
COMPUTE CURRENT MAXIMUMS AND MINIMUMS FOR DISPLACEMENTS, VELOCITIES AND ACCELERATIONS
γ
ENTRY MMOUT
OUTPUT
OUTPUT THE COMPUTED MAXIMUMS AND MINIMUMS
γ
RETURN

LOADIN



START
INPUT
INPUT AS DESCRIBED IN SECTION 3.3 PART 3
γ
ENTRY LABLD
COMPUTE {f'ℓ'}, {T'ℓ'}
γ
ENTRY CWLD
COMPUTE {f̄'ℓ'}, {T̄'ℓ'}
γ
ENTRY LDOUT
COMPUTE CURRENT MAXIMUM AND MINIMUM LOADS
OUTPUT
COMPUTED LOADS
γ
RETURN
ENTRY LMMOUT
OUTPUT
MAXIMUM AND MINIMUM LOADS COMPUTED
γ

APPENDIX B8

FORTRAN SOURCE DECK LISTING

The CDC LRC version of the program appears on the following pages.

```
**** YOUR SEQUENCED PROGRAM FOLLOWS ****

                                                                              ************
                                                                              * SEQUENCE *
                                                                              * FOR MODS *
                                                                              ************
      PROGRAM STATION(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT,         C 00020     100000
     *          TAPE1,TAPE11,TAPE12)                                  C 00030     200000
C                                                                     C 00010     300000
C  DYNAMICS OF ROTATING SPACE STATIONS                                C 00040     400000
C          PHASE II , NUMERICAL INTEGRATION                           C 00050     500000
C                                                                     C 00060     600000
      COMMON/INOUT/ IN,IOUT,IOFF,IC,IPLOUT(14)                        C 00070     700000
     *,N1,N2,N3,N4,N5,N6,N7                                           C 00080     800000
      COMMON /CLUES/IFPLT,IFLUID,NPIPE,NMLM,MLM,IRES,IPIPES           C 00090     900000
      COMMON T,R,RDOT,XIDEN,RHO,A,Z(12009)                            C 00100    1000000
      COMMON /PASS/Q1(3)                                              C 00110    1100000
      COMMON /LABOR/Q2(2503)                                          C 00120    1200000
      COMMON /CWT/Q3(2512)                                            C 00130    1300000
      COMMON /RES/Q4(88)                                              C 00140    1400000
      COMMON /PIPES/Q5(1020)                                          C 00150    1500000
      COMMON /LUMPS/Q6(8)                                             C 00160    1600000
      COMMON /LOADS/Q7(1912)                                          C 00170    1700000
      COMMON /VAROUT/Q8(108)                                          C 00180    1800000
      COMMON /BIG/Q9(34466)                                           C 00190    1900000
      COMMON /CONECT/Q10(47)                                          C 00200    2000000
      COMMON /NEWCOM/Q11(191)                                         C 00210    2100000
      COMMON /EXTRA/Q12(17)                                           C 00220    2200000
      COMMON /OPT2/Q13                                                C 00230    2300000
      COMMON /ALLCNT/Q14(94)                                          C 00240    2400000
      COMMON /WINTER/Q15                                              C 00250    2500000
      COMMON /BOND/Q16(2)                                             C 00260    2600000
      COMMON /LODPAS/Q17(113)                                         C 00270    2700000
      EQUIVALENCE (T,D)                                               C 00280    2800000
      DOUBLE PRECISION D                                              C 00290    2900000
      DIMENSION R(3),RDOT(3),XIDEN(3,3),MLM(8),IRES(2),IPIPES(30)     C 00300    3000000
      IN=5                                                            C 00310    3100000
      IOUT=6                                                          C 00320    3200000
      READ(IN,1)NRUN,IPLOT                                            C 00330    3300000
      IF(IPLOT.EQ.1)CALL CALCOMP                                      C 00340    3400000
      DO 15 IC=1,NRUN                                                 C 00350    3500000
      WRITE(IOUT,400)                                                 C 00360    3600000
  400 FORMAT(1H1,20(/),47X,*DYNAMICS OF ROTATING SPACE STATIONS*////  C 00370    3700000
     *    61X,*PHASE II*///54X,*NUMERICAL INTEGRATION*)               C 00380    3800000
      READ(IN,2)FT,DTPLOT                                             C 00390    3900000
      T=0                                                             C 00400    4000000
C                                                                     C 00410    4100000
```

```
C   TO PLOT RESULTS USE IFPLT=1.
C   NO MORE THAN 850 TIME INTERVALS ARE PLOTTED.
C     DTPLOT =  NO.SECS. / INCH
      READ(IN,4)IFPLT,IFLUID,NPIPE,NMLM,MLM,IRES,
     *          (IPIPES(I),I=1,NPIPE)
      WRITE(IOUT,6)
    6 FORMAT(*1INPUT DATA*//)
      WRITE(IOUT,700)FT,IFPLT,DTPLOT,IFLUID,NPIPE,IRES,NMLM,MLM,
     *                (IPIPES(I),I=1,NPIPE)
  700 FORMAT(5X,*FINAL TIME , PLOTTING CLUE , PLOT INTERVAL*/E16.8,6X,I1
     *,10X,F15.8/* FLUID CLUE , NO. PIPES*/6X,I1,11X,I2/
     ** RESERVOIR MASS POINTS*/1X,2I4/* NO. MOVING MASSES ,          MOVIN
     *G MASSES PRESENT */7X,I2,12X,8I4/* PIPES ON MASS POINTS*/30I4)
      PBLOCK=1.
      IF(IFPLT.GT.0)READ(IN,800)IPLOUT
      IF(IFPLT.GT.0)READ(IN,802)N1,N2,N3,N4,N5,N6,N7
  802 FORMAT(7I3)
  800 FORMAT(14I1)
      DO 900 I=1,13
  900 IF(IPLOUT(I).EQ.1)PBLOCK=PBLOCK+1
      IF(IFPLT.EQ.1)WRITE(1)IC,PBLOCK,FT,DTPLOT
      CALL COMMIN(NLAB,NCW,NPIPE,NMLM,IFLUID,MLM,IPIPES)
      CALL FIRST(NLAB,NCW)
      SUM=0.
      IFLAG=0
      V=0.
   10 CONTINUE
      CALL LAB(NLAB)
      IF(IFLUID.EQ.0)GO TO 100
      VOLD=V
      IF(IFLAG.EQ.0)CALL PMPCOM(V,VDOT)
      IF(T.EQ.0.)GO TO 98
      SUM=SUM+DELT*(V+VOLD)/2.
   98 CONTINUE
      CALL RESVR(1,IRES(1),SUM,V,VDOT,IFLAG)
      CALL RESVR(2,IRES(2),SUM,V,VDOT,IFLAG)
      IF(NPIPE.EQ.0)GO TO 100
      DO 40 I=1,NPIPE
   40 CALL PIPE(I,IPIPES(I),V,VDOT)
  100 IF(NMLM.EQ.0)GO TO 200
      DO 50 I=1,8
      IF(MLM(I).EQ.0)GO TO 50
      CALL LUMP(I,MLM(I))
   50 CONTINUE
  200 CALL ZLAB(NLAB,NCW)
      CALL CW(NCW)
      CALL ZCW(NCW)
      CALL MINCY(NLAB,NCW,DELT,NCYCLE,V,VDOT)
      IF(NCYCLE.GT.850)GO TO 851
      CALL LAST (NLAB,NCW)
      IF(T.LE.FT)GO TO 10
```

```
851 WRITE(IOUT,500)
500 FORMAT(////34H *****  END OF TIME HISTORY  ***** /1H1,20X,
   *  22H STATISTICS DURING RUN /////)
    CALL MMOUT(NLAB,NCW)
    CALL LMMOUT                                              C  00940
    IF(IFPLT.EQ.0)GO TO 15                                   C  00950
    END FILE 1                                               C  00960
    CALL PLO3AX                                              C  00970
 15 CONTINUE                                                 C  00980
    IF(IPLOT.EQ.1)CALL CALPLT(0.,0.,999)
 99 STOP                                                     C  01000
  1 FORMAT(2I2)                                              C  01010
  2 FORMAT(2E15.8)                                           C  01020
  4 FORMAT(4I3/8I3/2I3/(15I3))                               C  01030
    END                                                      C  01040
```

```
      SUBROUTINE COMMIN(NLAB,NCW,NPIPE,NMLM,IFLUID,MLM,IPIPES)
      COMMON T,R,RDOT,XIDEN,RHO,A,YA,YB,NMPO(17),FRQLAB(20),FRQCW(20),
     *       DAMP(20),DAMPB(20)
      COMMON /LABOR/WX,RIO,Q ,QD,TH,THD,XMAS,XINERT
      COMMON /CWT/RB,RBD,ETA,WY,RAO,QB,QBD,THB,THBD,XMBAR,XIBAR
      COMMON /RES/XMIP,XIIP,SIP,UIR,FIR,UIB,EIB,XJIB,BI,HIO,
     *            HIMAX,HIMIN,GIP,XLI
      COMMON /PIPES/XMIF,XIF,S,DELU,DELE,G,DELJ, VEC
      COMMON /LUMPS/U
      COMMON /INOUT/IN,IOUT,IOFF
      COMMON /LOADS/ZZ(585),DD(1212)
      COMMON /VAROUT/ZER1(16),NZER,ZER2(88)
      COMMON /BIG/DM(40),UMASS(20),UMASSB(20),DN(8960)
     *            ,NMLAB,RMODE(600,20),NMCW,SMODE(600,20)
      COMMON /CONECT/IBAR,SS(3),IABAR,SSBAR(3),DEL(3),DELDOT(3),
     *                PHIST(3),PHISTD(3),XX(6),GAMMA(3)
      COMMON /NEWCOM/XXX(107),IFDEPL,KLUE,KCM(20,4),IFCON,IFSUPP
      DIMENSION R(3),RDOT(3),XIDEN(3,3),WX(3),RIO(3,100),Q(3,100),
     *          QD(3,100),TH(3,100),THD(3,100),RB(3),RBD(3),ETA(3),
     *          WY(3),RAO(3,100),QB(3,100),QBD(3,100),THB(3,100),
     *          THBD(3,100),XMAS(100),XINERT(3,3,100)
      DIMENSION XMIP(2),XIIP(3,3,2),SIP(3,2),UIR(3,2),EIR(3,2),UIB(3,2),
     *          EIB(3,2),XJIB(3,3,2),GIP(3,2),XLI(3,2),BI(2),HIO(2),
     *          HIMAX(2),HIMIN(2),YA(3),YB(3)
      DIMENSION XMBAR(100),XIBAR(3,3,100)
      DIMENSION XMIF(30),XIF(3,3,30),S(3,30),DELU(3,30),DELE(3,30),
     *          G(3,30),DELJ(3,3,30),VEC(3,30)
      DIMENSION U(8) ,MLM(8),IPIPES(30)
      REAL KCM
      DO 196 I=1,16
  196 ZER1(I)=0.
      DO 197 I=1,90
  197 ZER2(I)=0.
      NZER=0.
      DO 210 I=1,1212
  210 DD(I)=0.
      NMLAB=0
      NMCW=0
      DO 10 I=1,3
      DO 20 J=1,3
   20 XIDEN(I,J)=0.
   10 XIDEN(I,I)=1.
C
C  READ DEPLOYMENT CLUE AND RIGID PROBLEM CLUE
C
      READ(IN,2)KLUE,IFLAB,IFCW,IFCN
      READ(IN,2)IFDEPL,IFCON,IFSUPP
      WRITE(IOUT,700)KLUE,IFDEPL,IFCON,IFSUPP
  700 FORMAT(* CLUES FOR THIS RUN*/* PROBLEM CLUE , DEPLOYMENT , CONTROL
```

```
     *S , SUPP. FORCES*/6X,I2,12X,I2,10X,I2,10X,I2)
      IF(IFCON.GT.0)CALL CONTRD
      CALL LCADIN
      READ(IN,2)IPHS1,JUMP
      IF(IPHS1.EQ.0)GO TO 5
C
C   PHASE I INPUT FOR LAB
C
      NOLD=0
      REWIND 11
      READ(11)NMODL
      DO 15 II=1,NMODL
      READ(11)NMP
      J1=NOLD+1
      J2=NOLD+NMP
      READ(11)     ((RIO(I,J),I=1,3),J=J1,J2)
      NOLD=NOLD+NMP
   15 NMPO(II)=NMP
      NLAB=NOLD
      NOLD=0
      DO 16 II=1,NMODL
      NMP=NMPO(II)
      J1=1+NCLO
      J2=NMP+NOLD
      READ(11)IX,(XMAS(L),((XINERT(I,J,L),I=1,3),J=1,3),L=J1,J2)
   16 NOLD=NOLD+NMP
      READ(11)NMLAB,(FRQLAB(I),I=1,NMLAB)
      DO 17 J=1,NMLAB
      UMASS(J)=1.
      READ(11)IX,(RMODE(I,J),I=1,IX)
   17 CONTINUE
      GO TO 25
C
C   ALTERNATE CARD INPUT FOR LAB
C
    5 READ(IN,2)NLAB
      READ(IN,1)((RIO(I,J),I=1,3),J=1,NLAB)
      READ(IN,54)(XMAS(L),((XINERT(I,J,L),I=1,3),J=1,3),L=1,NLAB)
      IF(KLUE.EQ.1 .OR. KLUE.EQ.3)GO TO 9
      IF(IFLAB)9,8,9
    9 READ(IN,2)NMLAB
      READ(IN,1)(UMASS(I),I=1,NMLAB)
      READ(IN,1)(FRQLAB(I),I=1,NMLAB)
      IX=6*NLAB
      READ(IN,1)((RMODE(I,J),I=1,IX),J=1,NMLAB)
C
C   REGULAR CARD INPUT FOR LAB
C
   25 CONTINUE
    8 DO 11 J=1,NLAB
      DO 11 I=1,3
```

```
      Q(I,J)=0.                                                           C   02050      20800000
      QD(I,J)=0.                                                          C   02060      20900000
      TH(I,J)=0.                                                          C   02070      21000000
   11 THD(I,J)=0.                                                         C   02080      21100000
      IF(IFLAB.EQ.0)GO TO 6                                               C   02090      21200000
      IF(JUMP.EQ.1)GO TO 604                                              C   02100      21300000
      READ(IN,1)((Q  (I,J),I=1,3),J=1,NLAB),                              C   02110      21400000
     *           ((QD (I,J),I=1,3),J=1,NLAB),                             C   02120      21500000
     *           ((TH (I,J),I=1,3),J=1,NLAB),                             C   02130      21600000
     *           ((THD(I,J),I=1,3),J=1,NLAB)                              C   02140      21700000
  604 IF(NMLAB.EQ.0)GO TO 6                                               C   02150      21800000
      READ(IN,1)(DAMP(I),I=1,NMLAB)                                       C   02160      21900000
    6 READ(IN,1)R,RDOT,GAMMA,WX                                           C   02170      22000000
      WRITE(IOUT,701)NLAB                                                 C   02180      22100000
  701 FORMAT(*OLAP INPUT*/* NO. MASSES =*,I4)                             C   02190      22200000
      WRITE(IOUT,702)(J,(RIO(I,J),I=1,3),J=1,NLAB)                        C   02200      22300000
  702 FORMAT(* MASS POINT LOCATIONS*/* NO.*,9X,*X(1)*,14X,*X(2)*,14X,     C   02210      22400000
     **X(3)*/(I4,3E18.8))                                                 C   02220      22500000
      WRITE(IOUT,703)(L,XMAS(L),((XINERT(I,J,L),I=1,3),J=1,3),L=1,NLAB)  C   02230      22600000
  703 FORMAT(* NO.*,8X,*MASS*,27X,*INERTIA MATRIX*/                       C   02240      22700000
     * (I4,E17.7,5X,3E16.7/2 (26X,3E16.7/)))                              C   02250      22800000
      IF(IFLAB.EQ.0)GO TO 808                                             C   02260      22900000
      WRITE(IOUT,704)NMLAB                                                C   02270      23000000
  704 FORMAT(* NO. MODES =*,I4)                                           C   02280      23100000
      WRITE(IOUT,705)(UMASS(I),I=1,NMLAB)                                 C   02290      23200000
  705 FORMAT(* MODAL MASSES*/(8E16.7))                                    C   02300      23300000
      WRITE(IOUT,706)(FRQLAB(I),I=1,NMLAB)                                C   02310      23400000
  706 FORMAT(* FREQUENCIES*/(8E16.7))                                     C   02320      23500000
      DO 720 J=1,NMLAB                                                    C   02330      23600000
      WRITE(IOUT,721)J                                                    C   02340      23700000
      DO 720 L=1,NLAB                                                     C   02350      23800000
      LS=6*(L-1)                                                          C   02360      23900000
      J1=LS+1                                                             C   02370      24000000
      J2=LS+6                                                             C   02380      24100000
  720 WRITE(IOUT,707)L,(RMODE(I,J),I=J1,J2)                               C   02390      24200000
  707 FORMAT(I5,6E16.7)                                                   C   02400      24300000
  721 FORMAT(* MODE*I4/* MASS NO.   Q(1)*,12X,*Q(2)*,12X,*Q(3)*,10X,*THEC   02410      24400000
     *TA(1)*,8X,*THETA(2)*,8X,*THETA(3)*)                                 C   02420      24500000
      WRITE(IOUT,725)                                                     C   02430      24600000
  725 FORMAT(*OINITIAL CONDITIONS FOR DEFORMATION COORDINATES*/           C   02440      24700000
     *   *OMASS*,8X,*Q(1)*,13X,*Q(2)*,13X,*Q(3)*)                         C   02450      24800000
      WRITE(IOUT,708)(J,(Q  (I,J),I=1,3),J=1,NLAB)                        C   02460      24900000
      WRITE(IOUT,726)                                                     C   02470      25000000
  726 FORMAT(*OMASS*,6X,*QDOT(1)*,10X,*QDOT(2)*,10X,*QDOT(3)*)            C   02480      25100000
      WRITE(IOUT,708)(J,(QD (I,J),I=1,3),J=1,NLAB)                        C   02490      25200000
      WRITE(IOUT,727)                                                     C   02500      25300000
  727 FORMAT(*OMASS*,6X,*THETA(1)*, 9X,*THETA(2)*,9X,*THETA(3)*)          C   02510      25400000
      WRITE(IOUT,708)(J,(TH (I,J),I=1,3),J=1,NLAB)                        C   02520      25500000
      WRITE(IOUT,728)                                                     C   02530      25600000
  728 FORMAT(*OMASS*,4X,*THETADOT(1)*,7X,*THETADOT(2)*,7X,*THETADOT(3)*)C   02540      25700000
      WRITE(IOUT,708)(J,(THD(I,J),I=1,3),J=1,NLAB)                        C   02550      25800000
```

```
708 FORMAT(I4,3E17.7)
    WRITE(IOUT,709)(DAMP(I),I=1,NMLAB)
709 FORMAT(*0MODAL DAMPING RATIOS*/(8E16.7))
808 CONTINUE
    WRITE(IOUT,719)
719 FORMAT(*0INITIAL CONDITION FOR MAIN LABORATORY COORDINATES*/)
    WRITE(IOUT,710)R,RDOT,GAMMA,WX
710 FORMAT(*0R    =*,3E17.7/* RDOT =*,3E17.7/
   *      * GAMMA=*,3E17.7/* WX    =*,3E17.7)
    IF(IFLUID.EQ.0)GO TO 50
C
C   RESERVOIR INPUT
C
    READ(IN,1)RHO,A
    WRITE(IOUT,760)
760 FORMAT(/* FLUID DATA*)
    WRITE(IOUT,729)RHO,A
729 FORMAT(8X,*RHO*,15X,*A*/2E17.7)
    DO 30 L=1,2
    READ(IN,4)XMIP(L),((XIIP(I,J,L),J=1,3),I=1,3),
   *(SIP(I,L),I=1,3),
   *(EIR(I,L),I=1,3),
   *(UIR(I,L),I=1,3),
   *(UIB(I,L),I=1,3),
   *(EIB(I,L),I=1,3),
   *((XJIB(I,J,L),J=1,3),I=1,3),
   * BI(L),HIO(L),HIMAX(L),HIMIN(L),
   *(GIP(I,L),I=1,3)
    IF(L.EQ.1)WRITE(IOUT,730)
730 FORMAT(* EMPTYING RESERVOIR*)
    IF(L.EQ.2)WRITE(IOUT,731)
731 FORMAT(* FILLING RESERVOIR*)
    WRITE(IOUT,733)
733 FORMAT(14X,*FLUID IN RESERVOIR PIPE*)
    WRITE(IOUT,732)XMIP(L),((XIIP(I,J,L),J=1,3),I=1,3),
   *(SIP(I,L),I=1,3),
   *(EIR(I,L),I=1,3),
   *(UIR(I,L),I=1,3),
   *(UIB(I,L),I=1,3),
   *(EIB(I,L),I=1,3),
   *((XJIB(I,J,L),J=1,3),I=1,3),
   * BI(L),HIO(L),HIMAX(L),HIMIN(L),
   *(GIP(I,L),I=1,3)
732 FORMAT(8X,*MASS*,27X,*INERTIA MATRIX*/E17.7,5X,3E16.7/2(22X,
   *3E16.7/)/           * SIP=*,3E17.7/
   *  * EIR=*,3E17.7/* UIR=*,3E17.7/* UIB=*,3E17.7/* EIB=*,3E17.7/
   *  * JIB*/3(3E17.7/)/9X,*BI*,14X,*HIO*,13X,*HIMAX*,12X,*HIMIN*/
   *  4E17.7/* GIP=*,3E17.7)
 30 CONTINUE
  4 FORMAT(E15.8/11(3E15.8/),(4E15.8))
    IF(NPIPE.EQ.0)GO TO 50
```

```
C
C   PIPE INPUT
C
      DO 40 L=1,NPIPE
      READ(IN,7)XMIF(L),(S(I,L),I=1,3),
     *(DELU(I,L),I=1,3),
     *(DELE(I,L),I=1,3),
     *(G   (I,L),I=1,3),
     *(VEC (I,L),I=1,3),
     *((DELJ(I,J,L),J=1,3),I=1,3),
     *((XIF (I,J,L),J=1,3),I=1,3)
      WRITE(IOUT,740)IPIPES(L)
  740 FORMAT(* FLUID IN PIPE ON MASS NO.*,I4)
      WRITE(IOUT,742)XMIF(L),(S(I,L),I=1,3),
     *(DELU(I,L),I=1,3),
     *(DELE(I,L),I=1,3),
     *(G   (I,L),I=1,3),
     *(VEC (I,L),I=1,3),
     *((DELJ(I,J,L),J=1,3),I=1,3),
     *((XIF (I,J,L),J=1,3),I=1,3)
  742 FORMAT(* MASS =*,E15.7/* S    =*3E17.7/* DELU=*3E17.7/
     *  * DELE=*3E17.7/* G    =*3E17.7/  * DELH=*,3E17.7/* DELJ*/3(3E17.7
     */),* INERTIA MATRIX*/(3E17.7 ))
   40 CONTINUE
    7 FORMAT(E15.8/(3E15.8))
   50 IF(NMLM.EQ.0)GO TO 70
C
C   MOVING MASS INPUT
C
      DO 51 I=1,8
      U(I)=0.
      IF(MLM(I).EQ.0)GO TO 51
      READ(IN,1)U(I)
   51 CONTINUE
      WRITE(IOUT,750)(U(I),I=1,8)
  750 FORMAT(*0MASS MU(J) OF  EACH MOVING MASS*/8E16.7)
   70 CONTINUE
      READ(IN,2)IPHS1,JUMP
      IF(IPHS1.EQ.0)GO TO 105
C
C  PHASE I INPUT FOR COUNTERWEIGHT
C
      NOLD=0
      REWIND 12
      READ(12)NMODL
      DO 115 II=1,NMODL
      READ(12)NMP
      J1=NOLD+1
      J2=NOLD+NMP
      READ(12) ((RAO(I,J),I=1,3),J=J1,J2)
      NOLD=NOLD+NMP
```

```
  115 NMPO(II)=NMP                                                       C  03580     36100000
      NCW=NOLD                                                           C  03590     36200000
      NOLD=0                                                             C  03600     36300000
      DO 116 II=1,NMODL                                                  C  03610     36400000
      NMP=NMPO(II)                                                       C  03620     36500000
      J1=NOLD+1                                                          C  03630     36600000
      J2=NOLD+NMP                                                        C  03640     36700000
      READ(12)IX,(XMBAR(L),((XIBAR(I,J,L),I=1,3),J=1,3),L=J1,J2)         C  03650     36800000
  116 NOLD=NOLD+NMP                                                      C  03660     36900000
      READ(12)NMCW,(FRQCW(I),I=1,NMCW)                                   C  03670     37000000
      DO 117 J=1,NMCW                                                    C  03680     37100000
      UMASSB(J)=1.                                                       C  03690     37200000
      READ(12)IX,(SMODE(I,J),I=1,IX)                                     C  03700     37300000
  117 CONTINUE                                                           C  03710     37400000
      GO TO 125                                                          C  03720     37500000
C                                                                        C  03730     37600000
C  ALTERNATE CARD INPUT FOR COUNTERWEIGHT                                C  03740     37700000
C                                                                        C  03750     37800000
  105 READ(IN,2)NCW                                                      C  03760     37900000
      READ(IN,1)((RAO(I,J),I=1,3),J=1,NCW)                               C  03770     38000000
      READ(IN,54)(XMBAR(L),((XIBAR(I,J,L),I=1,3),J=1,3),L=1,NCW)         C  03780     38100000
      IF(KLUE.LT.3)GO TO 29                                              C  03790     38200000
      IF(IFCW)29,28,29                                                   C  03800     38300000
   29 READ(IN,2)NMCW                                                     C  03810     38400000
      READ(IN,1)(UMASSB(I),I=1,NMCW)                                     C  03820     38500000
      READ(IN,1)(FRQCW(I),I=1,NMCW)                                      C  03830     38600000
      IX=6*NCW                                                           C  03840     38700000
      READ(IN,1)((SMODE(I,J),I=1,IX),J=1,NMCW)                           C  03850     38800000
C                                                                        C  03860     38900000
C  REGULAR CARD INPUT FOR COUNTERWEIGHT                                  C  03870     39000000
C                                                                        C  03880     39100000
  125 CONTINUE                                                           C  03890     39200000
   28 DO 12 J=1,NCW                                                      C  03900     39300000
      DO 12 I=1,3                                                        C  03910     39400000
      QB(I,J)=0.                                                         C  03920     39500000
      QBD(I,J)=0.                                                        C  03930     39600000
      THB(I,J)=0.                                                        C  03940     39700000
   12 THBD(I,J)=0.                                                       C  03950     39800000
      IF(IFCW.EQ.0)GO TO 26                                              C  03960     39900000
      IF(JUMP.EQ.1)GO TO 606                                             C  03970     40000000
      READ(IN,1)((QB  (I,J),I=1,3),J=1,NCW),                             C  03980     40100000
     *          ((QBD (I,J),I=1,3),J=1,NCW),                             C  03990     40200000
     *          ((THB (I,J),I=1,3),J=1,NCW),                             C  04000     40300000
     *          ((THBD(I,J),I=1,3),J=1,NCW)                              C  04010     40400000
C                                                                        C  04020     40500000
C  READ CRITICAL DAMPING                                                 C  04030     40600000
C                                                                        C  04040     40700000
  606 IF(NMCW.EQ.0)GO TO 26                                              C  04050     40800000
      READ(IN,1)(DAMPB(I),I=1,NMCW)                                      C  04060     40900000
   26 CONTINUE                                                           C  04070     41000000
      WRITE(IOUT,751)NCW                                                 C  04080     41100000
```

```
  751 FORMAT(*0COUNTERWEIGHT INPUT*/* NO. MASSES =*,I4)                    C    04090    41200000
      WRITE(IOUT,715)(J,(RAD(I,J),I=1,3),J=1,NCW)                          C    04100    41300000
  715 FORMAT(* MASS POINT LOCATIONS*/* NO.*,9X,*Y(1)*,14X,*Y(2)*,14X,      C    04110    41400000
     **Y(3)*/(I4,3E18.8))                                                  C    04120    41500000
      WRITE(IOUT,703)(L,XMBAR(L),((XIBAR(I,J,L),I=1,3),J=1,3),L=1,NCW)     C    04130    41600000
      IF(IFCW.EQ.0)GO TO 858                                               C    04140    41700000
      WRITE(IOUT,704)NMCW                                                  C    04150    41800000
      WRITE(IOUT,705)(UMASSB(I),I=1,NMCW)                                  C    04160    41900000
      WRITE(IOUT,706)(FRQCW(I),I=1,NMCW)                                   C    04170    42000000
      DO 770 J=1,NMCW                                                      C    04180    42100000
      WRITE(IOUT,721)J                                                     C    04190    42200000
      DO 770 L=1,NCW                                                       C    04200    42300000
      LS=6*(L-1)                                                           C    04210    42400000
      J1=LS+1                                                              C    04220    42500000
      J2=LS+6                                                              C    04230    42600000
  770 WRITE(IOUT,707)L,(SMODE(I,J),I=J1,J2)                                C    04240    42700000
      WRITE(IOUT,775)                                                      C    04250    42800000
  775 FORMAT(*0INITIAL CONDITIONS FOR DEFORMATION COORDINATES*/            C    04260    42900000
     *                                *0MASS*,7X,* QBAR(1)*,10X,*QBAR(2)*, C    04270    43000000
     * 10X,*QBAR(3)*)                                                      C    04280    43100000
      WRITE(IOUT,708)(J,(QB   (I,J),I=1,3),J=1,NCW)                        C    04290    43200000
      WRITE(IOUT,776)                                                      C    04300    43300000
  776 FORMAT(*0MASS*,5X,*QBARDOT(1)*,7X,*QBARDOT(2)*,7X,*QBARDOT(3)*)      C    04310    43400000
      WRITE(IOUT,708)(J,(QBD (I,J),I=1,3),J=1,NCW)                         C    04320    43500000
      WRITE(IOUT,777)                                                      C    04330    43600000
  777 FORMAT(*0MASS*,5X,*THETABAR(1)*,6X,*THETABAR(2)*,6X,*THETABAR(3)*)C    04340    43700000
      WRITE(IOUT,708)(J,(THB (I,J),I=1,3),J=1,NCW)                         C    04350    43800000
      WRITE(IOUT,778)                                                      C    04360    43900000
  778 FORMAT(*0MASS*,3X,*THETABARDOT(1)*,4X,*THETABARDOT(2)*,4X,*THETABAC    04370    44000000
     *RDOT(3)*)                                                            C    04380    44100000
      WRITE(IOUT,708)(J,(THBD(I,J),I=1,3),J=1,NCW)                         C    04390    44200000
      WRITE(IOUT,709)(DAMPB  (I),I=1,NMCW)                                 C    04400    44300000
  858 CONTINUE                                                             C    04410    44400000
      IF(KLUE.NE.4)GO TO 39                                                C    04420    44500000
      IF(IFCN )39,38,39                                                    C    04430    44600000
C                                                                          C    04440    44700000
C  READ CONNECTING STRUCTURE DATA                                          C    04450    44800000
C                                                                          C    04460    44900000
   39 READ(IN,2)IBAR,IABAR                                                 C    04470    45000000
      READ(IN,1)SS,SSBAR,DEL,DELDOT,PHIST,PHISTD,YA,YB                     C    04480    45100000
      WRITE(IOUT,780)IBAR,IABAR                                            C    04490    45200000
  780 FORMAT(* CONNECTING STRUCTURE INPUT*/* CONNECTS TO MASSES I=*,I3,    C    04500    45300000
     *  * , A=*,I3)                                                        C    04510    45400000
      WRITE(IOUT,782)SS,SSBAR,DEL,DELDOT                                   C    04520    45500000
  782 FORMAT(* S      =*,3E17.7/* SBAR   =*,3E17.7/* DEL    =*,3E17.7/     C    04530    45600000
     *     * DELDOT=*,3E17.7)                                              C    04540    45700000
      WRITE(IOUT,784)PHIST,PHISTD,YA,YB                                    C    04550    45800000
  784 FORMAT(* PHISTAR     =*,3E17.7/* PHISTARDOT=*,3E17.7/* YA=*,3E17.7/C    04560    45900000
     * * YB=*,3E17.7)                                                      C    04570    46000000
   38 IF(KLUE.NE.4)GO TO 46                                                C    04580    46100000
      DO 13 I=1,3                                                          C    04590    46200000
```

```
      DEL(I)=0.
      DELDOT(I)=0.
      PHIST(I)=0.
   13 PHISTD(I)=0.
   46 IF(KLUE.EQ.2 .OR. KLUE.GT.3)GO TO 59
C
C  TEST FOR ZERO FREQUENCIES AND SET UP CM AND KAPPA MATRICES
C
      DO 81 I=1,NMLAB
      KCM(I,1)=2.*UMASS(I)*DAMP(I)*FRQLAB(I)
   81 KCM(I,3)=FRQLAB(I)*FRQLAB(I)*UMASS(I)
   59 IF(KLUE.GT.2)GO TO 99
      DO 82 I=1,NMCW
      KCM(I,2)=2.*UMASSB(I)*DAMPB(I)*FRQCW(I)
   82 KCM(I,4)=FRQCW(I)*FRQCW(I)*UMASSB(I)
   99 RETURN
    1 FORMAT(3E15.7)
    2 FORMAT(5I4)
   54 FORMAT(E15.8/(3E15.8))
      END
```

```
      SUBROUTINE FIRST(NLAB,NCW)                                         C  04800   48300000
      COMMON T,R,RDOT,XIDEN,RHO,A,YA,YB,R3,R4,R5,R6,H1,H2,HOLD,SAVE,     C  04810   48400000
     *       G1,G2,G3,G4,G5,G6,G7,G8,G9,WORK1,WORK2,WORK,R1,R2,G0(9)     C  04820   48500000
      COMMON /BIG/PIETA(3,3),PIGAM(3,3),SUML(3),SUMT,SGAM(3,3),SETA(3,3)C  04830   48600000
     *,EMU(20),EMUBAR(20),WURK(600,2),ZZ(7760),NMLAB,                    C  04840   48700000
     * RMODE(600,20),NMCW,SMODE(600,20)                                  C  04850   48800000
      COMMON /LABOR/WX,RI,Q,QDOT,TH,THD,XMAS,XINERT                      C  04860   48900000
      COMMON /INOUT/IN,IOUT,IOFF                                         C  04870   49000000
      COMMON /CWT/RB,RBDOT,ETA,WY,RA,QB,QBD,THB,THBD,XMBAR,XIBAR         C  04880   49100000
      COMMON /CONECT/IPT,S,IAPT,SB,DEL,DELD,PHIST,PHISTD,                C  04890   49200000
     *                 DELRB,DELRBD,GAM,GAMD,ETAST,ETASTD                C  04900   49300000
     *,PZB(3),ELL(3),ELLD(3)                                             C  04910   49400000
      COMMON /NEWCOM/EL,ELD,ELDD,ROB,ROBD,ROBDD,VEC(20,2),VECBAR(20,2)   C  04920   49500000
     *                 ,PIBETA(3,3),IFDEPL,KLUE                          C  04930   49600000
      COMMON /EXTRA/ZFX(3),ZLX(3),ZMX(3),ZCY(3),ZCM(3),EMC,TOT           C  04940   49700000
      DIMENSION R(3),RDOT(3),R1(6),R2(6),R3(6),R4(6),R5(6),R6(6),H1(3),  C  04950   49800000
     *          H2(3),WORK2(21),WORK1(6,6),WORK(3,3,100),XMAS(100),      C  04960   49900000
     *          XINERT(3,3,100),RB(3),RBDOT(3),XMBAR(100),XIBAR(3,3,100)C  04970   50000000
       DIMENSION YA(3),YB(3),G1(3,3),G2(9),G3(9),G4(9),G5(9),G6(9),      C  04980   50100000
     *          G7(9),G8(9),G9(9),XIDEN(9),TH(3,100),THD(3,100),         C  04990   50200000
     *          THB(3,100),THBD(3,100),Q(3,100),QDOT(3,100),QB(3,100),   C  05000   50300000
     *          QBD  (3,100),RI(3,100),RA(3,100),ETAST(3),ETASTD(3),     C  05010   50400000
     *          ETA(3),HOLD(3),SAVE(3),PHIST(3),PHISTD(3),WX(3),WY(3),   C  05020   50500000
     *          EL(3),ELD(3),ELDD(3),DEL(3),DELD(3),S(3),SB(3),ROB(3),   C  05030   50600000
     *          ROBD(3),ROBDD(3),DELRB(3),DELRBD(3),GAM(3),GAMD(3)       C  05040   50700000
      COMMON /OPT2/PRINT                                                 C  05050   50800000
      COMMON /ALLCNT/ALL(4),DL(3,3),DC(3,3),EM ,XIL(3,3),XIC(3,3)        C  05060   50900000
      PRINT=0.                                                           C  05070   51000000
  888 CONTINUE                                                           C  05080   51100000
       VAR=SQRT(DOTP(YA,YA))                                             C  05090   51200000
       DO 10 I=1,3                                                       C  05100   51300000
   10 G1 (3,I)=YA(I)/VAR                                                 C  05110   51400000
       G1(2,1)=YA(2)*YB(3)-YB(2)*YA(3)                                   C  05120   51500000
       G1(2,2)=YB(1)*YA(3)-YA(1)*YB(3)                                   C  05130   51600000
       G1(2,3)=YA(1)*YB(2)-YB(1)*YA(2)                                   C  05140   51700000
       VAR=G1(2,1)*G1(2,1)+G1(2,2)*G1(2,2)+G1(2,3)*G1(2,3)               C  05150   51800000
      VAR=SQRT(VAR)                                                      C  05160   51900000
       DO 11 I=1,3                                                       C  05170   52000000
   11 G1(2,I)=G1(2,I)/VAR                                                C  05180   52100000
       G1(1,1)=G1(3,3)*G1(2,2)-G1(3,2)*G1(2,3)                           C  05190   52200000
       G1(1,2)=G1(3,1)*G1(2,3)-G1(3,3)*G1(2,1)                           C  05200   52300000
       G1(1,3)=G1(3,2)*G1(2,1)-G1(3,1)*G1(2,2)                           C  05210   52400000
      CALL SCALR(1.,G1,PIBETA,3)                                         C  05220   52500000
C* A2                                                                    C  05230   52600000
       CALL SCALR(-1.,XIDEN,G2,3)                                        C  05240   52700000
       G2(1  )=1.                                                        C  05250   52800000
       CALL PIF(PHIST,G3)                                                C  05260   52900000
C* A5                                                                    C  05270   53000000
      CALL GAMMA(THB(1,IAPT),G5)                                         C  05280   53100000
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```
C* A6
      CALL PIF(TH(1,IPT),G6)
      CALL PIF(THB(1,IAPT),G5)
      CALL MULT(G2,G6,G7,3)
      CALL MULT(G1,G7,G8,3)
      CALL MTRAN(G3,G8,G7,3)
      CALL MTRAN(G1,G7,G8,3)
      CALL MTRAN(G5,G8,G7,3)
      CALL SCALP(1.,G7,PIETA,3)
C* A7
      CALL MULT(G7,G2,G4,3)
C* A8
      ETAST(2)=ARSIN(G4(3  ))
      ETAST(1)=ARSIN(-G4(6  )/COS(ETAST(2)))
      ETAST(3)=ARSIN(-G4(2  )/COS(ETAST(2)))
      ETA(1)=ETAST(1)+3.141592653
      ETA(2)=ETAST(2)
      ETA(3)=ETAST(3)
C* A9
      CALL SSIN(PHIST,G4,1)
      CALL SSIN(ETA,G8,1)
C* A10
      CALL SSIN(ETA,G9,-1)
C* A11
      CALL MULT(G4,PHISTD,HOLD,1)
      CALL MULT(G2,THD(1,IPT),SAVE,1)
      CALL MULT(G1,SAVE,ETASTD,1)
      CALL SUBTR(ETASTD,HOLD,SAVE,1)
      CALL MTRAN(G3,SAVE,HOLD,1)
      CALL MTRAN(G1,HOLD,SAVE,1)
      CALL SUBTR(SAVE,THBD(1,IAPT),HOLD,1)
      CALL MTRAN(G5,HOLD,SAVE,1)
      CALL MULT(G9,SAVE,ETASTD,1)
C* A12
      CALL MULT(G7,WX,HOLD,1)
      CALL MULT(G8,ETASTD,SAVE,1)
      CALL ADD(HOLD,SAVE,WY,1)
C* A14
      READ(IN,8)EL
      WRITE(IOUT,700)EL
  700 FORMAT(*0DEPLOYMENT INPUT - L0*/3E17.7)
      CALL ZEROS(ELD,1)
      CALL ZEROS(ELDD,1)
      IF(IFDEPL)7,9,7
    7 CALL LLDLDD
C* A15
    9 CALL ADD(EL,DEL,H1,1)
      CALL ADD(ELD,DELD,H2,1)
      CALL SCALR(1.,H1,ELL,1)
      CALL SCALP(1.,H2,ELLD,1)
C* A16
```

```
      CALL MTRAN(G6,S,HOLD,1)
      CALL ADD(-I(1,IPT),Q(1,IPT),SAVE,1)
      CALL ADD(HOLD,SAVE,HOLD,1)
      CALL MULT(G7,HOLD,RBDOT,1)
      CALL ADD(RA(1,IAPT),QB(1,IAPT),HOLD,1)
      CALL SUBTR(RBDOT,HOLD,HOLD,1)
      CALL MTRAN(G1,H1,SAVE,1)
      CALL ADD(SB,SAVE,ROB ,1)
      CALL MTRAN(G5,ROB ,RB,1)
      CALL SUBTR(HOLD,RB,RB,1)
C* A19
      CALL MULT(G8,ETASTD,HOLD,1)
      CALL GAMMA(HOLD,G6)
      CALL MULT(G6,RBDOT,HOLD,1)
      CALL GAMMA(THD(1,IPT),G8)
      CALL MULT(G8,S,SAVE,1)
      CALL ADD(SAVE,QDOT(1,IPT),SAVE,1)
      CALL MULT(G7,SAVE,RBDOT,1)
      CALL SUBTR(RBDOT,HOLD,RBDOT,1)
      CALL MTRAN(G1,H2 ,HOLD,1)
      CALL MTRAN(G5,HOLD,SAVE,1)
      CALL SUBTR(RBDOT,SAVE,RBDOT,1)
      CALL GAMMA(THBD(1,IAPT),G4)
      CALL MULT(G4,ROB ,SAVE,1)
      CALL ADD(SAVE,QBD(1,IAPT),SAVE,1)
      CALL SUBTR(RBDOT,SAVE,RBDOT,1)
C* A20
      CALL MTRAN(G1,ELD,ROBD,1)
      CALL MTRAN(G1,ELDD,ROBDD,1)
      CALL MTRAN(G1,EL,SAVE,1)
      CALL ADD(SB,SAVE,ROB,1)
      CALL ADD(ROB,RA(1,IAPT),ROB ,1)
      CALL ADD(RI(1,IPT),S,SAVE,1)
      CALL MULT(G2,SAVE,HOLD,1)
      CALL SUBTR(HOLD,ROB,ROB,1)
C* A21
      IF(IFDEPL)28,27,28
   27 CALL SCALR(0.,ROBD,ROBD,1)
      CALL SCALR(0.,ROBDD,ROBDD,1)
      GO TO 17
   28 CALL SCALR(-1.,ROBD,ROBD,1)
      CALL SCALR(-1.,ROBDD,ROBDD,1)
   17 EM=0.
C* A21A
      CALL PIF(GAM,PIGAM)
   33 CALL ZEROS(G0,3)
      CALL ZEROS(G5,3)
      CALL ZEROS(R1,2)
      CALL ZEROS(R2,2)
C*  A22,A23
      DO 210 I=1,NLAB
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```
      EM=EM+XMAS(I)
      CALL GAMMA(RI(1,I),WORK(1,1,I))
      CALL SCALR(XMAS(I),WORK(1,1,I),G3,3)
      CALL ADD(G0,G3,G0,3)
      CALL MULT(G3,WORK(1,1,I),G4,3)
      CALL SUBTR(XINERT(1,1,I),G4,G4,3)
      CALL ADD(G5,G4,G5,3)
      CALL SCALR(XMAS(I),Q(1,I),HOLD,1)
      CALL SCALR(XMAS(I),QDOT(1,I),SAVE,1)
      CALL SUBTR(R1,HOLD,R1,1)
      CALL SUBTR(R2,SAVE,R2,1)
      CALL MULT(WORK(1,1,I),HOLD,H1,1)
      CALL MULT(WORK(1,1,I),SAVE,H2,1)
      CALL MULT(XINERT(1,1,I),TH(1,I),HOLD,1)
      CALL MULT(XINERT(1,1,I),THD(1,I),SAVE,1)
      CALL ADD  (H1,HOLD,HOLD,1)
      CALL ADD  (H2,SAVE,SAVE,1)
      CALL SUBTR(R1(4),HOLD,R1(4),1)
  210 CALL SUBTR(R2(4),SAVE,R2(4),1)
      CALL SCALR(EM,XIDEN,G8,3)
      DO 20 I=1,3
      DO 20 J=1,3
      IJ=3*(J-1)+I
      WORK1(I,J)=G8(IJ)
      WORK1(I+3,J)=G0(IJ)
   20 WORK1(I+3,J+3)=G5(IJ)
      CALL MCPY(G0,DL,3,3,3)
      CALL MCPY(G5,XIL,3,3,3)
      IJ=0
      DO 30 I=1,6
      DO 30 J=1,I
      IJ=IJ+1
   30 WORK2(IJ)=WORK1(I,J)
      CALL INCH(WORK2,6,WORK1,NIX)
C* A24,A40
      IF(NIX.EQ.0)GO TO 35
      WRITE(IOUT,4)NIX
    4 FORMAT(* INVERSION FAILED*/* NIX= *,I2)
   35 IJ=0
      DO 40 I=1,6
      DO 40 J=1,I
      IJ=IJ+1
      WORK1(J,I)=WORK2(IJ)
   40 WORK1(I,J)=WORK2(IJ)
      DO 50 I=1,6
      R3(I)=0.
      R4(I)=0.
      DO 50 J=1,6
      R3(I)=R3(I)+WORK1(I,J)*R1(J)
   50 R4(I)=R4(I)+WORK1(I,J)*R2(J)
C* A25,A41
```

```
      DO 60 I=1,NLAB                                                    C  06820    68500000
      CALL ADD(TH(1,I),R3(4),TH(1,I),1)                                 C  06830    68600000
      CALL ADD(THD(1,I),R4(4),THD(1,I),1)                               C  06840    68700000
      CALL ADD(Q(1,I),R3,Q(1,I),1)                                      C  06850    68800000
      CALL ADD(QDOT(1,I),R4,QDOT(1,I),1)                                C  06860    68900000
      CALL MULT(WORK(1,1,I),R3(4),HOLD,1)                               C  06870    69000000
      CALL MULT(WORK(1,1,I),R4(4),SAVE,1)                               C  06880    69100000
      CALL SUBTR(Q(1,I),HOLD,Q(1,I),1)                                  C  06890    69200000
   60 CALL SUBTR(QDOT(1,I),SAVE,QDOT(1,I),1)                            C  06900    69300000
C* A28,A42,A45                                                          C  06910    69400000
      CALL PIF(R3(4),G3)                                                C  06920    69500000
      CALL GAMMA(R4(4),G6)                                              C  06930    69600000
      CALL MULT(G6,R,SAVE,1)                                            C  06940    69700000
      CALL PIF(GAM,G4)                                                  C  06950    69800000
      CALL MTRAN(G3,WX,HOLD,1)                                          C  06960    69900000
      CALL SUBTR(HOLD,R4(4),WX,1)                                       C  06970    70000000
      CALL MTRAN(G3,RDOT,HOLD,1)                                        C  06980    70100000
      CALL ADD(HOLD,SAVE,HOLD,1)                                        C  06990    70200000
      CALL SUBTR(HOLD,R4,RDOT,1)                                        C  07000    70300000
      CALL MTRAN(G3,G4,PIGAM,3)                                         C  07010    70400000
C* A29                                                                  C  07020    70500000
      GAM(2)=ARSIN(PIGAM(3,1))                                          C  07030    70600000
      C2=COS(GAM(2))                                                    C  07040    70700000
      GAM(3)=ARSIN(-PIGAM(2,1) / C2)                                    C  07050    70800000
      CS=-PIGAM(3,2)/C2                                                 C  07060    70900000
      SC=PIGAM(3,3)/C2                                                  C  07070    71000000
      GAM(1)=ARSIN(CS)                                                  C  07080    71100000
      IF(SC)42,44,44                                                    C  07090    71200000
   44 IF(CS.GE.0.)GO TO 45                                              C  07100    71300000
      GAM(1)=GAM(1)+6.283185306                                         C  07110    71400000
      GO TO 45                                                          C  07120    71500000
   42 GAM(1)=3.141592653-GAM(1)                                         C  07130    71600000
   45 CONTINUE                                                          C  07140    71700000
C* A30                                                                  C  07150    71800000
      CALL MTRAN(G3,R,HOLD,1)                                           C  07160    71900000
      CALL SUBTR(HOLD,R3,R,1)                                           C  07170    72000000
C                                                                       C  07180    72100000
C COUNTERWEIGT DISPLACEMENTS,VELOCITIES                                 C  07190    72200000
C                                                                       C  07200    72300000
C                                                                       C  07210    72400000
C LABORATORY DISPLACEMENTS,VELOCITIES                                   C  07220    72500000
C                                                                       C  07230    72600000
   36 EMC=0.                                                            C  07240    72700000
   38 CALL ZEROS(G0,3)                                                              72800000
      CALL ZEROS(G5,3)                                                              72900000
      CALL ZEROS(R1,2)                                                              73000000
      CALL ZEROS(R2,2)                                                              73100000
C* A31,A32                                                              C  07290    73200000
      DO 110 I=1,NCW                                                    C  07300    73300000
      EMC=EMC+XMBAR(I)                                                  C  07310    73400000
      CALL GAMMA(RA(1,I),WORK(1,1,I))                                   C  07320    73500000
```

```
      CALL SCALR(XMBAR(I),WORK(1,1,I),G9,3)
      CALL ADD(G0,G9,G0,3)
      CALL MULT(G9,WORK(1,1,I),G4,3)
      CALL SUBTR(XIBAR(1,1,I),G4,G4,3)
      CALL ADD(G5,G4,G5,3)
      CALL SCALR(XMBAR(I),QB(1,I),HOLD,1)
      CALL SCALR(XMBAR(I),QBD(1,I),SAVE,1)
      CALL SUBTR(R1,HOLD,R1,1)
      CALL SUBTR(R2,SAVE,R2,1)
      CALL MULT(WORK(1,1,I),HOLD,H1,1)
      CALL MULT(WORK(1,1,I),SAVE,H2,1)
      CALL MULT(XIBAR(1,1,I),THB(1,I),HOLD,1)
      CALL MULT(XIBAR(1,1,I),THBD(1,I),SAVE,1)
      CALL ADD  (H1,HOLD,HOLD,1)
      CALL ADD  (H2,SAVE,SAVE,1)
      CALL SUBTR(R1(4),HOLD,R1(4),1)
  110 CALL SUBTR(R2(4),SAVE,R2(4),1)
      CALL SCALR(EMC,XIDEN,G8,3)

      DO 120 I=1,3
      DO 120 J=1,3
      IJ=3*(J-1)+I
      WORK1(I,J)=G8(IJ)
      WORK1(I+3,J)=G0(IJ)
  120 WORK1(I+3,J+3)=G5(IJ)
      CALL MCPY(G0,DC,3,3,3)
      CALL MCPY(G5,XIC,3,3,3)
      IJ=0
      DO 130 I=1,6
      DO 130 J=1,I
      IJ=IJ+1
  130 WORK2(IJ)=WORK1(I,J)
      CALL INCH(WORK2,6,WORK1,NIX)
      IF(NIX.EQ.0)GO TO 135
      WRITE(IOUT,4)NIX
  135 IJ=0
      DO 140 I=1,6
      DO 140 J=1,I
      IJ=IJ+1
      WORK1(J,I)=WORK2(IJ)
  140 WORK1(I,J)=WORK2(IJ)
      DO 150 I=1,6
      R5(I)=0.
      R6(I)=0.
      DO 150 J=1,6
      R5(I)=R5(I)+WORK1(I,J)*R1(J)
  150 R6(I)=R6(I)+WORK1(I,J)*R2(J)
C* A34,A47
      DO 160 I=1,NCW
      CALL ADD(THB(1,I),R5(4),THB(1,I),1)
      CALL ADD(THBD(1,I),R6(4),THBD(1,I),1)
```

```
      CALL ADD(QB(1,I),R5,QB(1,I),1)                    C 07830  78700000
      CALL ADD(QBD  (1,I),R6,QBD  (1,I),1)              C 07840  78800000
      CALL MULT(WORK(1,1,I),R5(4),HOLD,1)               C 07850  78900000
      CALL MULT(WORK(1,1,I),R6(4),SAVE,1)               C 07860  79000000
      CALL SUBTR(QB(1,I),HOLD,QB(1,I),1)                C 07870  79100000
  160 CALL SUBTR(QBD  (1,I),SAVE,QBD  (1,I),1)          C 07880  79200000
C* A34-A                                                C 07890  79300000
      CALL PIF(R5(4),G9)                                C 07900  79400000
C* A35                                                  C 07910  79500000
      CALL MULT(G3,G2,G4,3)                             C 07920  79600000
      CALL MULT(G7,G4,G5,3)                             C 07930  79700000
      CALL MTRAN(G9,G5,G7,3)                            C 07940  79800000
C* A36,A37                                              C 07950  79900000
      ETAST(2)=ARSIN(G7(3   ))                          C 07960  80000000
      SC=-1/COS(ETAST(2))                               C 07970  80100000
      ETAST(1)=ARSIN(G7(6   ) *SC )                     C 07980  80200000
      ETAST(3)=ARSIN(G7(2   ) *SC )                     C 07990  80300000
      ETA(1)=ETAST(1)+3.141592653                       C 08000  80400000
      ETA(2)=ETAST(2)                                   C 08010  80500000
      ETA(3)=ETAST(3)                                   C 08020  80600000
C* A38                                                  C 08030  80700000
      CALL MULT(G7,G2,PIETA,3)                          C 08040  80800000
C* A51                                                  C 08050  80900000
      CALL MTRAN(G9,WY,HOLD,1)                          C 08060  81000000
      CALL SUBTR(HOLD,R6(4),WY,1)                       C 08070  81100000
C* A54                                                  C 08080  81200000
      CALL MULT(PIETA,WX,HOLD,1)                        C 08090  81300000
      CALL SUBTR(WY,HOLD,H1,1)                          C 08100  81400000
C* A39                                                  C 08110  81500000
      CALL MULT(PIETA,R3,HOLD,1)                        C 08120  81600000
      CALL MTRAN(G9,RB,SAVE,1)                          C 08130  81700000
      CALL ADD(HOLD,SAVE,HOLD,1)                        C 08140  81800000
      CALL SUBTR(HOLD,R5,HOLD,1)                        C 08150  81900000
C* A56                                                  C 08160  82000000
      CALL GAMMA(H1,G1)                                 C 08170  82100000
      CALL MULT(PIETA,R3,G4,1)                          C 08180  82200000
      CALL MULT(G1,G4,H2,1)                             C 08190  82300000
      CALL MULT(PIETA,R4,G6,1)                          C 08200  82400000
      CALL SUBTR(G6,H2,G4,1)                            C 08210  82500000
      CALL GAMMA(R6(4),G1)                              C 08220  82600000
      CALL MULT(G1,RB,SAVE,1)                           C 08230  82700000
      CALL SCALR(1.,HOLD,RB,1)                          C 08240  82800000
      CALL ADD(G4,SAVE,G4,1)                            C 08250  82900000
      CALL MTRAN(G9,RBDOT,SAVE,1)                       C 08260  83000000
      CALL ADD(G4,SAVE,G4,1)                            C 08270  83100000
      CALL SUBTR(G4,R6,RBDOT,1)                         C 08280  83200000
C* A57                                                  C 08290  83300000
   39 CALL SUBTR(RB,ROB,DELRB,1)                        C 08300  83400000
      CALL SUBTR(RBDOT,ROBD,DELRBD,1)                   C 08310  83500000
C* A58                                                  C 08320  83600000
      CALL SSIN(GAM,SGAM,-1)                            C 08330  83700000
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      CALL SSIN(ETA,SETA,-1)
C* A59
      CALL MULT(SGAM,WX,GAMD,1)
      CALL MULT(SETA,H1,ETASTD,1)
C* A60,A61
      IF(KLUE.NE.1 .AND. KLUE.NE.3)GO TO 215
      DO 91 I=1,NLAB
      ISIX=I*6-5
      DO 92 J=1,3
      IJ=ISIX+J-1
      WURK(IJ,1)=Q(J,I)*XMAS(I)
   92 WURK(IJ,2)=QDOT(J,I)*XMAS(I)
      CALL MULT(XINERT(1,1,I),TH(1,I),WURK(ISIX+3,1),1)
   91 CALL MULT(XINERT(1,1,I),THD(1,I),WURK(ISIX+3,2),1)
      N6=NLAB*6
      CALL TPRD(RMODE,WURK,VEC,N6,NMLAB,2,600,20)
      DO 93 I=1,NMLAB
      VEC(I,1)=VEC(I,1)/EMU(I)
   93 VEC(I,2)=VEC(I,2)/EMU(I)
C* A63,A64
  215 IF(KLUE.GT.2)GO TO 99
      DO 94 I=1,NCW
      ISIX=I*6-5
      DO 95 J=1,3
      IJ=ISIX+J-1
      WURK(IJ,1)=QB(J,I)*XMBAR(I)
   95 WURK(IJ,2)=QBD(J,I)*XMBAR(I)
      CALL MULT(XIBAR(1,1,I),THB(1,I),WURK(ISIX+3,1),1)
   94 CALL MULT(XIBAR(1,1,I),THBD(1,I),WURK(ISIX+3,2),1)
      N6=NCW*6
      CALL TPRD(SMODE,WURK,VECBAR,N6,NMCW,2,600,20)
      DO 96 I=1,NMCW
      VECBAR(I,1)=VECBAR(I,1)/EMUBAR(I)
   96 VECBAR(I,2)=VECBAR(I,2)/EMUBAR(I)
   99 TOT=EM+EMC
      CALL SSIN(GAM,SGAM,1)
      CALL SSIN(ETA,SETA,1)
      RETURN
    8 FORMAT(3E15.8)
      END
```

```
      SUBROUTINE LAB(NLAB)                                              C  08740     87800000
      COMMON T,R,RDOT,XIDEN,RHO,A,RI,RID,WXI,LAM1,LAM2,LAM3,            C  08750     87900000
     *       G1,G2,USE,HOLD,SAVE,XC1,XC2,G3,G4,G5                       C  08760     88000000
      COMMON /BIG/PIETA(3,3),PIGAM(3,3),SUML(3),SUMT,SGAM(3,3),SETA(3,3)C  08770     88100000
     *           ,QP(3,6,100),EMA(6,6,100),EMD(6,6,100)                 C  08780     88200000
      COMMON /LABOR/WX,RIO,QS,QSD,THS,THSD,XMAS,XINERT                  C  08790     88300000
      COMMON /LOADS/ZZ(33),RHSI(6,100)                                  C  08800     88400000
      COMMON /EXTRA/ZFX(3),ZLX(3),ZMX(3),ZCY(3),ZCM(3),EMC,TOT          C  08810     88500000
      COMMON /ALLCNT/IS,O(3)                                            C  08820     88600000
      REAL LAM1(3,3),LAM2(3,3),LAM3(3,3),XIDEN(3,3),G1(3,3),            C  08830     88700000
     1     G2(3,3),USE(3,3),G3(3,3),G4(3,3),G5(3,3),                    C  08840     88800000
     2     R(3),RDOT(3),WX(3),WXI(3,100),RI(3,100),RID(3,100),          C  08850     88900000
     3     HOLD(3),SAVE(3),XC1(3),XC2(3),                               C  08860     89000000
     4     RIO(3,100),XINERT(3,3,100),QS(3,100),                        C  08870     89100000
     5     QSD(3,100),THS(3,100),THSD(3,100),XMAS (100)                 C  08880     89200000
      CALL GAMMA(WX,G5)                                                 C  08890     89300000
      DO 98 I=1,3                                                       C  08900     89400000
      ZFX(I)=0.                                                         C  08910     89500000
      ZLX(I)=0.                                                         C  08920     89600000
      SUML(I)=0.                                                        C  08930     89700000
   98 ZMX(I)=0.                                                         C  08940     89800000
      SUMT=0.                                                           C  08950     89900000
      DO 100 L=1,NLAB                                                   C  08960     90000000
      XMASS=XMAS(L)                                                     C  08970     90100000
      DO 20 I=1,3                                                       C  08980     90200000
      RI(I,L)=R(I)+RIO(I,L)+QS(I,L)                                     C  08990     90300000
      ZLX(I)=ZLX(I)+XMASS*RI(I,L)                                       C  09000     90400000
   20 RID(I,L)=RDOT(I)+QSD(I,L)                                         C  09010     90500000
      CALL GAMMA(THS(1,L),G1)                                           C  09020     90600000
      CALL ADD(XIDEN,G1,G3,3)                                           C  09030     90700000
      CALL SUBTR(XIDEN,G1,USE,3)                                        C  09040     90800000
      CALL MULT(USE,WX,G1,1)                                            C  09050     90900000
      CALL ADD(G1,THSD(1,L),WXI(1,L),1)                                 C  09060     91000000
      IF(L.EQ.IS)CALL MCPY(WXI(1,L),O,3,1,1)                            C  09070     91100000
COMPUTE  LAM1                                                           C  09080     91200000
      CALL SCALR(XMASS,XIDEN,LAM1,3)                                    C  09090     91300000
COMPUTE  LAM2                                                           C  09100     91400000
      CALL GAMMA(RI(1,L),G4)                                            C  09110     91500000
      SC=-XMASS                                                         C  09120     91600000
      CALL SCALR(SC,G4,LAM2,3)                                          C  09130     91700000
COMPUTE  LAM3                                                           C  09140     91800000
      CALL MULT(XINERT(1,1,L),USE,LAM3,3)                               C  09150     91900000
COMPUTE  XC1                                                            C  09160     92000000
      CALL SCALR(2.,G5,G2,3)                                            C  09170     92100000
      CALL MULT(G2   ,RID(1,L),HOLD,1)                                  C  09180     92200000
      CALL MULT(G5,G5,USE,3)                                            C  09190     92300000
      CALL MULT(USE,RI(1,L),SAVE,1)                                     C  09200     92400000
      CALL ADD(HOLD,SAVE,XC1,1)                                         C  09210     92500000
      CALL SCALR(XMASS,XC1,XC1,1)                                       C  09220     92600000
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      CALL SCALR(-1.,XC1,RHSI(1,L),1)
COMPUTE  XC2
      CALL GAMMA(WXI(1,L),G2)
      CALL GAMMA(THSD(1,L),G1)
      CALL MULT(XINERT(1,1,L),G1,USE,3)
      CALL MULT(USE,WX,HOLD,1)
      CALL MULT(G2,XINERT(1,1,L),USE,3)
      CALL MULT(USE,WXI(1,L),SAVE,1)
      CALL SUBTR(SAVE,HOLD,XC2,1)
      CALL SCALR(-1.,XC2,RHSI(4,L),1)
C* INITIALIZE A,D PARTITIONS
      DO 10 I=1,3
      DO 10 J=1,3
      EMD(I,J,L)=LAM1(I,J)
      EMD(I+3,J+3,L)=XINERT(I,J,L)
      EMD(I+3,J,L)=0.
      EMD(I,J+3,L)=0.
      EMA(I,J,L)=LAM1(I,J)
      EMA(I,J+3,L)=LAM2(I,J)
      EMA(I+3,J,L)=0.
   10 EMA(I+3,J+3,L)=LAM3(I,J)
C* FORM QP MATRIX PARTITIONS
      CALL SCALR(1.   ,G3,QP(1,4,L),3)
      CALL SCALR(1.   ,G4,QP(1,1,L),3)
C* SUM L AND T
      CALL MULT(G5,RI(1,L),HOLD,1)
      CALL ADD(RID(1,L),HOLD,HOLD,1)
      SUM=.5*XMASS*DOTP(HOLD,HOLD)
      CALL MULT(G4,HOLD,SAVE,1)
      CALL SCALR(XMASS   ,SAVE,SAVE,1)
      CALL MULT(XINERT(1,1,L),WXI(1,L),HOLD,1)
      SUMT=SUMT+SUM+.5*DOTP(WXI(1,L),HOLD)
      CALL MULT(G3,HOLD,USE,1)
      CALL ADD(SAVE,USE,SAVE,1)
      CALL MTRAN(PIGAM,SAVE,HOLD,1)
      CALL ADD(SUML,HOLD,SUML,1)
  100 CONTINUE
      RETURN
      END
```

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      SUBROUTINE RESVR(L,IPOINT,SUM,V,VDOT,IFLAG)                       C  09620    96600000
      COMMON /INOUT/IN,IOUT,IOFF                                        C  09630    96700000
      COMMON T,R,RDOT,XIDEN,RHO,A,RI,RID,WXI,LAM1,LAM2,LAM3,            C  09640    96800000
     *       HOLD,SAVE,XC,G1,G2,G3,G4,DELU,S,G,XL,XLDOT,UC,             C  09650    96900000
     *       UCDOT,XIF,XDIR,HXC,G5,G6,H1,H2,H3,H4                       C  09660    97000000
      COMMON /LABOR/WX,RIO(900),TH,THD,XMAS,XINERT                      C  09670    97100000
      COMMON/BIG/PIETA(3,3),PIGAM(3,3),SUML(3),SUMT,SGAM(3,3),          C  09680    97200000
     *           SETA(3,3),QP(3,6,100),EMA(6,6,100),EMD(6,6,100)        C  09690    97300000
      COMMON /RES/XMIP,XIIP,SIP,UIR,EIR,UIB,EIB,XJIB,BI,HIO,            C  09700    97400000
     *            HIMAX,HIMIN,GIP,XLI                                   C  09710    97500000
      COMMON /LOADS/ZZ(33),RHSI(6,100)                                  C  09720    97600000
      COMMON /PASS/Q,QDOT,STEP                                          C  09730    97700000
      COMMON /EXTRA/ZFX(3),ZLX(3),ZMX(3),ZCY(3),ZCM(3),EMC,TOT          C  09740    97800000
      DIMENSION XIDEN(3,3),R(3),RDOT(3),TH(3,100),THD(3,100),           C  09750    97900000
     *          XMIP(2),XIIP(3,3,2),SIP(3,2),UIR(3,2),FIR(3,2),UIB(3,2),C  09760    98000000
     *          EIB(3,2),XJIB(3,3,2),GIP(3,2),XLI(3,2),BI(2),HIO(2),    C  09770    98100000
     *          HIMAX(2),HIMIN(2),G1(3,3),G2(3,3),G3(3,3),G4(3,3),      C  09780    98200000
     *          HOLD(3),SAVE(3),XC(3),DELU(3),S(3),G(3),XL(3),XLDOT(3), C  09790    98300000
     *          UC(3),UCDOT(3),XIF(3,3),XDIR(3,3),HXC(3)                C  09800    98400000
     *          ,RI(3,100),RID(3,100),WX(3),WXI(3,100)                  C  09810    98500000
     *          ,G5(3,3),G6(3,3),H1(3),H2(3),H3(3),H4(3)                C  09820    98600000
     *            ,XMAS(100),XINERT(3,3,100)                            C  09830    98700000
     *,HIL(2)                                                           C  09840    98800000
      COMMON /VAROUT/DDD(92),HIL                                        C  09850    98900000
      REAL LAM1(3,3),LAM2(3,3),LAM3(3,3),K                              C  09860    99000000
      IF(IFLAG.EQ.1)GO TO 10                                            C  09870    99100000
      IF(L.EQ.2)GO TO 3                                                 C  09880    99200000
      K=-1.                                                             C  09890    99300000
      DO 15 I=1,2                                                       C  09900    99400000
      K=-K                                                              C  09910    99500000
      AIR=3.141592653*BI(I)*BI(I)                                       C  09920    99600000
      HIL(I)=HIO(I)-K*(A/AIR)*SUM                                       C  09930    99700000
      IF(HIL(I).LE.HIMAX(I))GO TO 19                                    C  09940    99800000
      IFLAG=1                                                           C  09950    99900000
      HIL(I)=HIMAX(I)                                                   C  09960   100000000
      GO TO 15                                                          C  09970   100100000
   19 IF(HIL(I).GE.HIMIN(I))GO TO 15                                    C  09980   100200000
      IFLAG=1                                                           C  09990   100300000
      HIL(I)=HIMIN(I)                                                   C  10000   100400000
   15 CONTINUE                                                          C  10010   100500000
      IF(IFLAG.EQ.0)GO TO 3                                             C  10020   100600000
      VDOT=-V/(STEP/2.)                                                 C  10030   100700000
      V=0                                                               C  10040   100800000
      THOLD=T                                                           C  10050   100900000
      GO TO 3                                                           C  10060   101000000
   10 IF(T.LE.THOLD)GO TO 3                                             C  10070   101100000
      VDOT=0                                                            C  10080   101200000
    3 CONTINUE                                                          C  10090   101300000
      HI=HIL(L)                                                         C  10100   101400000
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      Q=RHO*A*V
      QDOT=RHO*A*VDOT
      K=1.
      IF(L.EQ.2)K=-1.
      AIR=3.14159265*BI(L)*BI(L)
   20 XLI(2,L)=ARSIN(EIR(1,L))
      XLI(3,L)=0.
      CS=COS(XLI(2,L))
      SC=EIR(3,L)/CS
      CS=-EIR(2,L)/CS
      XLI(1,L)=ARSIN(CS)
      IF(SC)42,44,44
   44 IF(CS.GE.0.)GO TO 45
      XLI(1,L)=XLI(1,L)+6.283185306
      GO TO 45
   42 XLI(1,L)=3.141592653-XLI(1,L)
   45 CONTINUE
      CALL PIF(XLI(1,L),LAM1)
      XMIR=RHO*AIR*HI
      XMIF=XMIP(L)+XMIR
      CALL GAMMA(UIR(1,L),G1)
      DO 30 I=1,3
      DELU(I)=UIR(I,L)-UIR(I,L)+HI*EIR(I,L)
      S(I)=SIP(I,L)+XMIR*(UIR(I,L)-HI*EIR(I,L)/2.)
      G(I)=GIP(I,L)+HI*(G1(I,1)*EIR(1,L)+G1(I,2)*EIR(2,L)+G1(I,3)
     **EIR(3,L))
      XL(I)=(3.*BI(L)*BI(L)+HI*HI)*XMIR/12.
      IF(I.EQ.3)XL(I)=.5*BI(L)*BI(L)*XMIR
      XLDOT(I)=-K*Q*(BI(L)*BI(L)+HI*HI)/4.
      IF(I.EQ.3)XLDOT(I)=-K*Q*BI(L)*BI(L)/2.
      UC(I)=UIR(I,L)-.5*HI*LAM1(3,I)
   30 UCDOT(I)=K/2.*V*A/AIR*LAM1(3,I)
COMPUTE  XIF
      CALL GAMMA(UC,G4)
      CALL MULT(G4,G4,G1,3)
      CALL SCALP(XMIR,G1,G3,3)
      CALL PTLP(LAM1,XL,G2)
      CALL SUBTR(G2,G3,G2,3)
      CALL ADD(XIIP(1,1,L),G2,XIF,3)
COMPUTE  XDIR
      CALL PTLP(LAM1,XLDOT,G2)
      SC=K*Q
      CALL SCALR(SC,G1,G1,3)
      CALL ADD(G1,G2,G1,3)
      CALL GAMMA(UCDOT,G3)
      CALL MULT(G3,G4,G2,3)
      CALL MULT(G4,G3,XDIR,3)
      CALL ADD(G2,XDIR,G3,3)
      CALL SCALR(XMIR,G3,G3,3)
      CALL SUBTR(G1,G3,XDIR,3)
COMPUTE  XC5
```

```
      CALL GAMMA(WX,G1)
      CALL GAMMA(TH(1,IPOINT),G2)
      CALL MULT(G1,RID(1,IPOINT),HOLD,1)
      CALL MULT(G1,G1,G3,3)
C
C    *L,T*
      CALL MULT(G1,RI(1,IPOINT),H1,1)
      CALL ADD(RID(1,IPOINT),H1,H1,1)
C    *L,T*
C
      CALL MULT(G3,RI(1,IPOINT),SAVE,1)
      CALL SCALR(2.,HOLD,HOLD,1)
      CALL ADD(HOLD,SAVE,HXC,1)
      CALL SCALR(XMIF,HXC,XC,1)
      CALL ADD(G2,XIDEN,G6,3)
C
C NEXT 5 LINES ADD TO ZFX AND TOT
      CALL MULT(G6,S,HOLD,1)
      CALL SCALR(XMIF,RI(1,IPOINT),SAVE,1)
      CALL ADD(HOLD,SAVE,HOLD,1)
      CALL ADD(HOLD,ZFX,ZFX,1)
      IF(T.EQ.0.)TOT=TOT+XMIF
C
C
      CALL GAMMA (THD(1,IPOINT),G1)
      CALL MULT(G1,WX,H2,1)
      CALL GAMMA(S,G1)
      CALL MULT(G1,H2,HOLD,1)
      CALL GAMMA(WXI(1,IPOINT),G1)
      CALL MULT(G1,G1,G4,3)
      CALL MULT(G4,S,SAVE,1)
C
C    *L,T*
      CALL MULT(G1,S,H2,1)
      SC=K*Q
      CALL SCALR(SC,DELU,H3,1)
      CALL ADD(H2,H3,H3,1)
      CALL MULT(G6,H3,H2,1)
      SUMT=SUMT+DOTP(H1,H2)
      CALL SCALR(XMIF,H1,H3,1)
      CALL ADD(H3,H2,H2,1)
      SUMT=SUMT+.5*DOTP(H3,H1)
C    *L,T*
C
      CALL ADD(HOLD,SAVE,HOLD,1)
      CALL MULT(G1,DELU,SAVE,1)
      SC=K*2.*Q
      CALL SCALR(SC,SAVE,SAVE,1)
      CALL ADD(HOLD,SAVE,HOLD,1)
      SC=A/AIR
      CALL SCALR(SC,EIR(1,L),SAVE,1)
```

```
      CALL SUBTR(EIB(1,L),SAVF,SAVE,1)
      SC=Q*V
      CALL SCALR(SC,SAVE,SAVF,1)
      CALL ADD(SAVE,HOLD,HOLD,1)
      SC=K*QDOT
      CALL SCALR(SC,DELU,SAVE,1)
      CALL ADD(SAVE,HOLD,HOLD,1)
      CALL MULT(G6,HOLD,SAVE,1)
      CALL ADD(XC,SAVE,XC,1)
      CALL SUBTR(RHSI(1,IPOINT),XC,RHSI(1,IPOINT) ,1)
COMPUTE  LAM11
      CALL SCALR(XMIF,XIDEN,LAM1,3)
COMPUTE  LAM12
      CALL SUBTR(XIDEN,G2,G2,3)
      CALL GAMMA(S,G1)
      CALL MULT(G6,G1,G4,3)
      CALL MULT(G4,G2,G5  ,3)
      CALL GAMMA(RI(1,IPOINT),G3)
C
C    *L,T*
      CALL MULT(G3,H2,H3,1)
      CALL MULT(G5,H1,H4,1)
      CALL ADD(H3,H4,H4,1)
C    *L,T*
C
      CALL SCALR(XMIF,G3,LAM3,3)
      CALL ADD(G5,LAM3,LAM2,3)
      CALL SCALR(-1.,LAM2,LAM2,3)
COMPUTE  LAM13
      CALL SCALR(-1.,G4,LAM3,3)
C*   ADD TO A AND D
      DO 40 I=1,3
      DO 40 J=1,3
      EMA(I,J,IPOINT)=EMA(I,J,IPOINT)+LAM1(I,J)
      EMA(I,J+3,IPOINT)=EMA(I,J+3,IPOINT)+LAM2(I,J)
      EMD(I,J,IPOINT)=EMD(I,J,IPOINT)+LAM1(I,J)
   40 EMD(I,J+3,IPOINT)=EMD(I,J+3,IPOINT)+LAM3(I,J)
COMPUTE  LAM14
      CALL MULT(G1,G2,LAM1,3)
COMPUTE  LAM15
      CALL MULT(LAM1,G3,LAM2,3)
      CALL MULT(XIF,G2,LAM3,3)
      CALL SUBTR(LAM3,LAM2,LAM2,3)
COMPUTE  XC6
      CALL MULT(LAM1,HXC,XC,1)
      CALL GAMMA(THD(1,IPOINT),G1)
      CALL MULT(G1,WX,HOLD,1)
      CALL MULT(XIF,HOLD,SAVE,1)
      CALL SUBTR(XC,SAVE,XC,1)
      SC=K*RHO*V
      CALL SCALR(SC,XJIB(1,1,L),G1,3)
```

```
      CALL ADD(XDIR,G1,G1,3)
      CALL MULT(G1,WXI(1,IPOINT),HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      SC=K*Q
      CALL SCALR(SC,G,HOLD,1)
      CALL MULT(XIF,WXI(1,IPOINT),SAVE,1)
      CALL ADD(HOLD,SAVE,HOLD,1)
C
C    *L,T*
      SUMT=SUMT+.5*DOTP(WXI(1,IPOINT),SAVE)
     *           +SC*DOTP(WXI(1,IPOINT),G)
      CALL MULT(G6,HOLD,H2,1)
      CALL ADD(H2,H4,H4,1)
      CALL MTRAN(PIGAM,H4,H3,1)
      CALL ADD(SUML,H3,SUML,1)
      SUMT=SUMT+.5*V*V*(XMIP(L)+XMIR*A*A/(AIR*AIR))
C    *L,T*
C
      CALL GAMMA(WXI(1,IPOINT),G1)
      CALL MULT(G1,HOLD,SAVE,1)
      CALL ADD(XC,SAVE,XC,1)
      SC=K*QDOT
      CALL SCALR(SC,G,HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      CALL GAMMA(UIR(1,L),G1)
      CALL MULT(G1,EIR(1,L),HOLD,1)
      SC=-A/AIR
      CALL SCALR(SC,HOLD,HOLD,1)
      CALL GAMMA(UIB(1,L),G1)
      CALL MULT(G1,EIB(1,L),SAVE,1)
      CALL ADD(HOLD,SAVE,HOLD,1)
      SC=Q*V
      CALL SCALR(SC,HOLD,HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      CALL SUBTR(RHSI(4,IPOINT),XC,RHSI(4,IPOINT) ,1)
C*   ADD TO A AND D
      DO 50 I=1,3
      DO 50 J=1,3
      EMA(I+3,J,IPOINT)=EMA(I+3,J,IPOINT)+LAM1(I,J)
      EMA(I+3,J+3,IPOINT)=EMA(I+3,J+3,IPOINT)+LAM2(I,J)
      EMD(I+3,J,IPOINT)=EMD(I+3,J,IPOINT)+LAM1(I,J)
   50 EMD(I+3,J+3,IPOINT)=EMD(I+3,J+3,IPOINT)+XIF(I,J)
      RETURN
      END
```

```
      SUBROUTINE  PIPE(L,IPOINT,V,VDOT)
      COMMON /INOUT/IN,IOUT,IOFF
      COMMON T,R,RDOT,XIDEN,RHO,A,RI,RID,WXI,LAM1,LAM2,LAM3,
     *      G1,G2,G3,G4, XC,HXC,SAVE,HOLD
     *      ,G5,G6,H1,H2,H3,H4
      COMMON /LABOR/WX,A1(900),TH,THD
      COMMON/BIG/PIETA(3,3),PIGAM(3,3),SUML(3),SUMT,SGAM(3,3),
     *          SETA(3,3),QP(3,6,100),EMA(6,6,100),EMD(6,6,100)
      COMMON /PIPES/XMIF,XIF,S,DELU,DELE,G,DELJ, VEC
      COMMON /LOADS/ZZ(33),RHSI(6,100)
      COMMON /PASS/Q,QDOT
      COMMON /EXTRA/ZFX(3),ZLX(3),ZMX(3),ZCY(3),ZCM(3),EMC,TOT
      DIMENSION R(3),RDOT(3) ,TH(3,100),THD(3,100),WX(3),WXI(3,100),
     *         G1(3,3),G2(3,3),G3(3,3),G4(3,3),XC(3),HXC(3),SAVE(3),
     *         HOLD(3),RI(3,100),RID(3,100),XIDEN(3,3)
     *         ,G5(3,3),G6(3,3),H1(3),H2(3),H3(3),H4(3)
      REAL LAM1(3,3),LAM2(3,3),LAM3(3,3)
      DIMENSION XMIF(30),XIF(3,3,30),S(3,30),DELU(3,30),DELE(3,30),
     *         G(3,30),DELJ(3,3,30),VEC(3,30)
      CALL GAMMA(TH(1,IPOINT),G1)
      CALL SUBTR(XIDEN,G1,G2,3)
      CALL ADD(XIDEN,G1,G1,3)
C
C NEXT 5 LINES ADD TO ZFX AND TOT
      CALL MULT(G1,S(1,L),HOLD,1)
      CALL SCALR(XMIF(L),RI(1,IPOINT),SAVE,1)
      CALL ADD(HOLD,SAVE,HOLD,1)
      CALL ADD(HOLD,ZFX,ZFX,1)
      IF(T.EQ.0.)TOT=TOT+XMIF(L)
C
C
      CALL GAMMA(S(1,  L),LAM2)
      CALL MULT(G1,LAM2,LAM3,3)
C - LAM7
      CALL SCALR(-1.,LAM3,LAM3,3)
      CALL MULT(LAM3,G2,LAM2,3)
C
C  *L,T*
      CALL SCALR(-1.,LAM2,G5,3)
C
C
      CALL GAMMA(RI(1,IPOINT),G4)
      SC=-XMIF(L)
      CALL SCALR(SC,G4,G3,3)
C - LAM6
      CALL ADD(G3,LAM2,LAM2,3)
COMPUTE  XC
      CALL GAMMA(WX,G3)
      CALL MULT(G3,G3,LAM1,3)
```

```
      CALL MULT(LAM1,RI(1,IPOINT),HOLD,1)
      CALL MULT(G3,RID(1,IPOINT),SAVE,1)
C
C  *L,T*
      CALL MULT(G3,RI(1,IPOINT),H1,1)
      CALL ADD(RID(1,IPOINT),H1,H1,1)
      SUMT=SUMT+.5*XMIF(L)*(DOTP(H1,H1)+V*V)
C
C
      CALL SCALR(2.,SAVE,SAVE,1)
      CALL ADD(SAVE,HOLD,HXC,1)
      CALL SCALR(XMIF(L),HXC,XC,1)
      CALL SCALR(QDOT,DELU(1,L),HOLD,1)
      CALL GAMMA(WXI(1,IPOINT),G3)
      CALL MULT(G3,DELU(1,L),SAVE,1)
      SC=2.*Q
      CALL SCALR(SC,SAVE,SAVE,1)
      CALL ADD(HOLD,SAVE,SAVE,1)
      CALL MULT(G3,S(1,L),HOLD,1)
C
C  *L,T*
      CALL SCALR(Q,DELU(1,L),H4,1)
      CALL ADD(HOLD,H4,H4,1)
      CALL MULT(G2,H4,H3,1)
      SUMT=SUMT+DOTP(H1,H3)
      CALL SCALR(XMIF(L),H1,H2,1)
      CALL ADD(H3,H2,H2,1)
      CALL MULT(G4,H2,H3,1)
      CALL MULT(G5,H1,H2,1)
      CALL ADD(H2,H3,H3,1)
C
C
      CALL MULT(G3,HOLD,LAM1,1)
      CALL ADD(SAVE,LAM1,SAVE,1)
      SC=V*Q
      CALL SCALR(SC,DELE(1,L),HOLD,1)
      CALL ADD(HOLD,SAVE,SAVE,1)
      CALL GAMMA(THD(1,IPOINT),G3)
      CALL MULT(G3,WX,H2,1)
      CALL GAMMA(S(1,L),G3)
      CALL MULT(G3,H2,HOLD,1)
      CALL ADD(HOLD,SAVE,SAVE,1)
      CALL MULT(G1,SAVE,HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      CALL SUBTR(RHSI(1,IPOINT),XC,RHSI(1,IPOINT) ,1)
COMPUTE  LAM5
      CALL SCALR(XMIF(L),XIDEN,LAM1,3)
C* ADD TO A AND D
      DO 40 I=1,3
      DO 40 J=1,3
      EMA(I,J,IPOINT)=EMA(I,J,IPOINT)+LAM1(I,J)
```

```
      EMA(I,J+3,IPOINT)=EMA(I,J+3,IPOINT)+LAM2(I,J)
      EMD(I,J,IPOINT)=EMD(I,J,IPOINT)+LAM1(I,J)
   40 EMD(I,J+3,IPOINT)=EMD(I,J+3,IPOINT)+LAM3(I,J)
C - LAM8
      CALL MULT(G3   ,G2,LAM1,3)
      CALL MULT(XIF(1,1,L),G2,LAM2,3)
      CALL MULT(LAM1,G4,LAM3,3)
C - LAM9
      CALL SUBTR(LAM2,LAM3,LAM2,3)
COMPUTE  XC
      CALL MULT(LAM1,HXC,XC,1)
      SC=Q*V
      CALL SCALR(SC,VEC(1,L),HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      CALL SCALR(QDOT,G(1,L),HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      SC=RHO*V
      CALL MULT(DELJ(1,1,L),WXI(1,IPOINT),HOLD,1)
      CALL SCALR(SC,HOLD,HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      CALL MULT(XIF(1,1,L),H2   ,SAVE,1)
      CALL SUBTR(XC,SAVE,XC,1)
      CALL MULT(XIF(1,1,L),WXI(1,IPOINT),HOLD,1)
      CALL SCALR(Q,G(1,L),SAVE,1)
C
C   *L,T*
      SUMT=SUMT+.5*DOTP(WXI(1,IPOINT),HOLD)+DOTP(WXI(1,IPOINT),SAVE)
C
C
      CALL ADD(HOLD,SAVE,SAVE,1)
C
C   *L,T*
      CALL MULT(G2,SAVE,HOLD,1)
      CALL ADD(H3,HOLD,H3,1)
      CALL MTRAN(PIGAM,H3,H2,1)
      CALL ADD(SUML,H2,SUML,1)
C
C
      CALL GAMMA(WXI(1,IPOINT),G1)
      CALL MULT(G1,SAVE,HOLD,1)
      CALL ADD(XC,HOLD,XC,1)
      CALL SUBTR(RHSI(4,IPOINT),XC,RHSI(4,IPOINT) ,1)
C* ADD TO A AND D
      DO 50 I=1,3
      DO 50 J=1,3
      EMA(I+3,J,IPOINT)=EMA(I+3,J,IPOINT)+LAM1(I,J)
      EMA(I+3,J+3,IPOINT)=EMA(I+3,J+3,IPOINT)+LAM2(I,J)
      EMD(I+3,J,IPOINT)=EMD(I+3,J,IPOINT)+LAM1(I,J)
   50 EMD(I+3,J+3,IPOINT)=EMD(I+3,J+3,IPOINT)+XIF(I,J,L)
      RETURN
      END
```

```
      SUBROUTINE LUMP(L,IPOINT)                                          C  13590    136300000
      COMMON /INOUT/IN,IOUT,IOFF                                         C  13600    136400000
      COMMON T,R,RDOT,XIDEN,RHO,A,RI,RID,WXI,LAM1,LAM2,LAM3,             C  13610    136500000
     *        K,LAM,DK,W,WD,HOLD,SAVE,G1,G2,G3,G4,XC                     C  13620    136600000
     *        ,H1,H2,HXC                                                 C  13630    136700000
     *  ,LAM4,LAM5,LAM6,BIGA(6,6),BIGD(6,6)                              C  13640    136800000
      COMMON /BIG/PIETA(3,3),PIGAM(3,3),SUML(3),SUMT                     C  13650    136900000
     *   ,SGAM(1818),EMA(6,6,100),EMD(6,6,100)                           C  13660    137000000
      COMMON /LABOR/WX(3),RIO,Q,QD,TH,THD                                C  13670    137100000
      COMMON /LUMPS/U                                                    C  13680    137200000
      COMMON /LOADS/ZZ(33),RHSI(6,100)                                   C  13690    137300000
      COMMON /EXTRA/ZFX(3),ZLX(3),ZMX(3),ZCY(3),ZCM(3),EMC,TOT           C  13700    137400000
      DIMENSION U(8),UJ(3),UJD(3),UJDD(3),K(16),DK(3,16),RIO(3,100),     C  13710    137500000
     *          W(3),WD(3),HOLD(3),SAVE(3),G1(3,3),G2(3,3),G3(3,3),      C  13720    137600000
     *          G4(3,3),XC(6),TH(3,100),THD(3,100),Q(3,100),QD(3,100),   C  13730    137700000
     *          XIDEN (3,3),R(3),RDOT(3),RI(3,100),RID(3,100),PI(16)     C  13740    137800000
     *          ,H1(3),H2(3),HXC(3)   ,WXI(3,100)                        C  13750    137900000
      REAL LAM(16),LAM1(3,3),LAM2(3,3),LAM3(3,3)                         C  13760    138000000
     *  ,LAM4(3,3),LAM5(3,3),LAM6(3,3)                                   C  13770    138100000
      IF(T.EQ.0.)TOT=TOT+U(L)                                            C  13780    138200000
      IF(L.NE.2)CALL MUCOM(UJ,UJD,UJDD,L)                                C  13790    138300000
      IF(L.EQ.2)CALL BMCON(UJ,UJD,UJDD)                                  C  13800    138400000
      CALL LOOK(L,K,M,IPOINT)                                            C  13810    138500000
      DO 10 I=1,M                                                        C  13820    138600000
      PI(I)=1.                                                           C  13830    138700000
      KI=K(I)                                                                        138800000
   10 CALL SUBTR(UJ,RIO(1,KI   ),DK(1,I),1)                                          138900000
      IF(M.EQ.1)GO TO 29                                                 C  13850    139000000
      DO 20 I=1,M                                                        C  13860    139100000
   20 LAM(I)=DOTP(DK(1,I),DK(1,I))                                       C  13870    139200000
      SUM=0.                                                             C  13880    139300000
      DO 22 I=1,M                                                        C  13890    139400000
      DO 24 J=1,M                                                        C  13900    139500000
      IF(I.EQ.J)GO TO 24                                                 C  13910    139600000
      PI(I)=PI(I)*LAM(J)                                                 C  13920    139700000
   24 CONTINUE                                                           C  13930    139800000
   22 SUM=SUM+PI(I)                                                      C  13940    139900000
      GO TO 25                                                           C  13950    140000000
   29 KSTAR=K(1)                                                         C  13960    140100000
      LSTAR=1                                                            C  13970    140200000
      LAM(1)=1.                                                          C  13980    140300000
      SUM=1.                                                             C  13990    140400000
      GO TO 33                                                           C  14000    140500000
   25 KSTAR=K(1)                                                         C  14010    140600000
      LSTAR=1                                                            C  14020    140700000
      A=PI(1)                                                            C  14030    140800000
      DO 30 I=1,M                                                        C  14040    140900000
      IF(PI(I).LE.A)GO TO 30                                             C  14050    141000000
      KSTAR=K(I)                                                         C  14060    141100000
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```
      LSTAR=I
      A=PI(I)
   30 CONTINUE
   33 DO 35 I=1,3
      W(I)=UJ(I)
   35 WD(I)=UJD(I)
      DO 40 I=1,M
      KI=K(I)
      LAM(I)=PI (I)/SUM
      CALL GAMMA(TH(1,KI   ),G1)
      CALL GAMMA(THD(1,KI   ),G2)
      CALL MULT(G1,DK(1,I),HOLD,1)
      CALL ADD(Q(1,KI   ),HOLD,HOLD,1)
      CALL SCALR(LAM(I),HOLD,HOLD,1)
      CALL ADD(W,HOLD,W,1)
      CALL MULT(G1,UJD,HOLD,1)
      CALL MULT(G2,DK(1,I),SAVE,1)
      CALL ADD(HOLD,SAVE,SAVE,1)
      CALL ADD(QD(1,KI   ),SAVE,SAVE,1)
      CALL SCALR(LAM(I),SAVE,SAVE,1)
   40 CALL ADD(WD,SAVE,WD,1)
C     ADD TO ZMX AND TOT
      CALL ADD(R,W,HOLD,1)
      CALL SCALR(U(L),HOLD,HOLD,1)
      CALL ADD(ZMX,HOLD,ZMX,1)
COMPUTE  ALPHA1,ALPHA3
      CALL SCALR(U(L),XIDEN ,LAM1,3)
      CALL ADD(R,W,HOLD,1)
      CALL GAMMA(HOLD,G3)
      SC=-U(L)
      CALL SCALR(SC,G3,LAM2,3)
COMPUTE  BETA1
      CALL GAMMA(WX,G1)
      CALL ADD(RDOT,WD,H1   ,1)
      CALL MULT(G1,H1   ,SAVE,1)
      CALL SCALR(2.,SAVE,SAVE,1)
      CALL MULT(G1,G1,G2,3)
C
C    *L,T*
      CALL MULT(G1,HOLD,H2,1)
      CALL ADD(H1,H2,H1,1)
      SUMT=SUMT+.5*U(L)*DOTP(H1,H1)
      CALL MULT(G3,H1,H2,1)
      CALL MTRAN(PIGAM,H2,H1,1)
      CALL SCALR(U(L),H1,H1,1)
      CALL ADD(SUML,H1,SUML,1)
C    *L,T*
C
      CALL MULT(G2,HOLD,XC,1)
      CALL ADD(XC,SAVE,XC,1)
      CALL ADD(XC,UJDD,XC,1)
```

```
      DO 50 I=1,M
      KI=K(I)
      CALL GAMMA(TH(1,KI  ),G1)
      CALL GAMMA(THD(1,KI  ),G2)
      CALL MULT(G2,UJD,HOLD,1)
      CALL SCALR(2.,HOLD,HOLD,1)
      CALL MULT(G1,UJDD,SAVE,1)
      CALL ADD(HOLD,SAVE,SAVE,1)
      CALL SCALR(LAM(I),SAVE,SAVE,1)
   50 CALL ADD(XC,SAVE,XC,1)
      CALL SCALR(U(L),XC,XC,1)
COMPUTE ALPHA4
      SC=-U(L)
      CALL GAMMA(DK(1,LSTAR),G1)
      CALL SCALR(SC,G1,LAM3,3)
COMPUTE ALPHA-KSTAR
      DO 78 I=1,3
   78 DK(I,1)=W(I)-RIO(I,KSTAR)-Q(I,KSTAR)
      CALL GAMMA(DK,G1)
      CALL GAMMA(TH(1,KSTAR),G2)
      CALL MULT(G2,G1,G3,3)
      CALL SUBTR(G1,G3,G4,3)
COMPUTE ALPHA5,ALPHA7,ALPHA8, XC
      CALL MULT(G4,LAM1,LAM4,3)
      CALL MULT(G4,LAM2,LAM5,3)
      CALL MULT(G4,LAM3,LAM6,3)
      CALL MULT(G4,XC,XC(4),1)
C
C     INSERT RHS PARTITION
C
      CALL SUBTR(RHSI(1,KSTAR),XC,RHSI(1,KSTAR),2)
C
C     INSERT LHS PARTITIONS
C
      DO 60 I=1,3
      DO 60 J=1,3
      BIGA(I,J)=LAM1   (I,J)
      BIGA(I+3,J)=LAM4(I,J)
      BIGA(I,J+3)=LAM2 (I,J)
      BIGA(I+3,J+3)=LAM5(I,J)
      BIGD(I,J)=LAM1(I,J)
      BIGD(I+3,J)=LAM4(I,J)
      BIGD(I,J+3)=LAM3(I,J)
   60 BIGD(I+3,J+3)=LAM5(I,J)
      CALL XADD(BIGA,EMA(1,1,KSTAR),EMA(1,1,KSTAR),6,6,6,6)
      CALL XADD(BIGD,EMD(1,1,KSTAR),EMD(1,1,KSTAR),6,6,6,6)
      RETURN
      END
```

```
      SUBROUTINE ZLAB(NLAB,NCW)                                          LUM00040   151100000
      COMMON T,R(3),W(14),DR(12000),H1(3)                                LUM00050   151200000
      COMMON /CWT/RB(3),RBD(6),WY(3),RAO(3,100),QB(3,100),QBD(300),      LUM00060   151300000
     *             THB(3,100),THBD(300),XMBAR(100)                       LUM00070   151400000
      COMMON /INOUT/IN,IOUT,IOFF                                         LUM00080   151500000
      COMMON /BIG/PIETA(3,3),PIGAM(3,3),V(22),OP(3,6,100),               LUM00090   151600000
     *             EMA(6,6,100),EMD(6,6,100),NMLAB,                      LUM00100   151700000
     *             RMODE(600,20),NMCW,SMODE(600,20),Z1(6,6),             LUM00110   151800000
     *             Z3(20,6),Z4(20,20),WORK(3,6 ),WORKB(6,1)              LUM00120   151900000
      COMMON /LOADS/GAML(3,3),GAMS(3,3),PIMIX(3,3),FETEST(6),            LUM00130   152000000
     *                PHSI(6,100),DELAB(26)                              LUM00140   152100000
     * , DELCW(26),XDD(1212),KLUCS,KLULAB,KLUCW,CSLDA(6)                 LUM00150   152200000
      COMMON /NEWCOM/FL(3),XX(95),PIBETA(3,3),IFDEPL,                    LUM00160   152300000
     *                  KLUE,CMK(80),IFCON,IFSUPP                        LUM00170   152400000
      COMMON /LABOR/WX(303),Q(3,100)                                     LUM00180   152500000
      COMMON /CONECT/IPT ,S(3),IAPT,SS(9),PHIST(3),WP(21),PZB(3),ELL(3)  LUM00190   152600000
      COMMON /EXTRA/ZFX(3),ZLX(3),ZMX(3),ZCY(3),ZCM(3),EMC,TOT           LUM00200   152700000
      CALL GAMMA(ELL,GAML)                                               LUM00210   152800000
      CALL PIF(PHIST,GAMS)                                               LUM00220   152900000
      CALL MTRAN(PIBETA,GAMS,PIMIX,3)                                    LUM00230   153000000
      CALL GAMMA(S,GAMS)                                                 LUM00240   153100000
      DO 7 I=1,3                                                         LUM00250   153200000
    7 PIMIX(1,I)=-PIMIX(1,I)                                             LUM00260   153300000
C                                                                        LUM00270   153400000
C   COMPUTE ZCY,ZCM,PZB                                                  LUM00280   153500000
C                                                                        LUM00290   153600000
      CALL MULT(PIETA,R,ZCY,1)                                           LUM00300   153700000
      CALL ADD(ZCY,RB,ZCY,1)                                             LUM00310   153800000
      CALL SCALR(EMC,ZCY,ZCY,1)                                          LUM00320   153900000
      DO 6 I=1,NCW                                                       LUM00330   154000000
      DO 6 J=1,3                                                         LUM00340   154100000
    6 ZCY(J)=ZCY(J)+XMBAR(I)*(RAO(J,I)+QB(J,I))                          LUM00350   154200000
      CALL MTRAN(PIETA,ZCY,WORK,1)                                       LUM00360   154300000
      DO 8 I=1,3                                                         LUM00370   154400000
    8 WORK(I,1)=(WORK(I,1)+ZFX(I)+ZLX(I)+ZMX(I))/TOT                     LUM00380   154500000
      CALL MTRAN(PIGAM,WORK,ZCM,1)                                       LUM00390   154600000
      CALL MULT(PIGAM,ZCM,ZFX,1)                                         LUM00400   154700000
      SC=1./EMC                                                          LUM00410   154800000
      CALL SCALR(SC,ZCY,ZCY,1)                                           LUM00420   154900000
      CALL MULT(PIETA,ZFX,H1 ,1)                                         LUM00430   155000000
      CALL SUBTR(ZCY,H1 ,H1 ,1)                                          LUM00440   155100000
      CALL GAMMA(WY,WORK)                                                LUM00450   155200000
      CALL MULT(WORK,H1 ,ZFX,1)                                          LUM00460   155300000
      CALL MULT(WORK, ZFX,H1 ,1)                                         LUM00470   155400000
      CALL GAMMA(THB(1,IAPT),WORK)                                       LUM00480   155500000
      CALL MULT(WORK,H1 ,ZFX,1)                                          LUM00490   155600000
      CALL SUBTR(H1 ,ZFX,ZFX,1)                                          LUM00500   155700000
      CALL MULT(PIBETA,ZFX,H1 ,1)                                        LUM00510   155800000
      CALL SCALR(EMC,H1 ,PZB,1)                                          LUM00520   155900000
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C                                                                       LUM00530   156000000
C  SET UP RHS VECTOR TO MULTIPLIED BY (PHI-TRAN)*Q                      LUM00540   156100000
C                                                                       LUM00550   156200000
      IL=0                                                              LUM00560   156300000
      IF(KLUE.EQ.2 .OR. KLUE.GT.3)IL=1                                  LUM00570   156400000
      IF(KLUE.NE.4)GO TO 14                                             LUM00580   156500000
      CALL ZEROS(FETEST,2)                                                         156600000
      GO TO 15                                                          LUM00600   156700000
   14 CONTINUE                                                          LUM00610   156800000
      CALL CCNSTR(FETEST)                                               LUM00620   156900000
   15 CONTINUE                                                          LUM00630   157000000
      CALL MULT(PIMIX,FETEST,WORKB,2)                                   LUM00640   157100000
      IF(KLUCS.GT.0)CALL MULT(QP(1,4,IPT),WORKB,CSLDA,2)                LUM00650   157200000
      CALL CCNTRL(DR,NLAB,IFCON,1)                                      LUM00660   157300000
      CALL SUPPLM(DR(601),NLAB,IFSUPP,1)                                LUM00670   157400000
      CALL XADD(DR,DR(601),DR,6,NLAB,6,6)                               LUM00680   157500000
      CALL MULT(GAMS,WORKB,H1   ,1)                                     LUM00690   157600000
      CALL ADD(WORKB(4,1),H1   ,WORKB(4,1),1)                           LUM00700   157700000
      ISIX=IPT*6-5                                                      LUM00710   157800000
      CALL ADD(DR(ISIX),WORKB,DR(ISIX),2)                               LUM00720   157900000
      DO  5 I=1,NLAB                                                    LUM00730   158000000
      ISIX=I*6-5                                                        LUM00740   158100000
      CALL MULT(QP(1,4,I),DR(ISIX),H1,1)                                LUM00750   158200000
      CALL ADD(RHSI(1,I),H1   ,RHSI(1,I),1)                             LUM00760   158300000
    5 CALL ADD(RHSI(4,I),DR(ISIX+3),RHSI(4,I),1)                        LUM00770   158400000
      IF(KLULAB.GT.0)CALL LABLD                                         LUM00780   158500000
      IF(IL.EQ.1)GO TO 80                                               LUM00790   158600000
C                                                                       LUM00800   158700000
C FORM D*R                                                              LUM00810   158800000
C                                                                       LUM00820   158900000
      DO 10 I=1,NLAB                                                    LUM00830   159000000
      ISIX=6*I-5                                                        LUM00840   159100000
   10 CALL XMPRD(EMD(1,1,I),RMODE(ISIX,1),DR(ISIX   ),6,6,NMLAB,6,600,  LUM00850   159200000
     *600)                                                              LUM00860   159300000
C                                                                       LUM00870   159400000
C FORM (R-T)*D*R  IN Z4                                                 LUM00880   159500000
C                                                                       LUM00890   159600000
      NLAB6=NLAB*6                                                      LUM00900   159700000
      CALL TPRD(RMODE,DR,Z4,NLAB6,NMLAB,NMLAB,600,20)                   LUM00910   159800000
C                                                                       LUM00920   159900000
C ZERO OUT Z1                                                           LUM00930   160000000
C                                                                       LUM00940   160100000
   80 DO 30 I=1,6                                                       LUM00950   160200000
      DELAB(I)=0.                                                       LUM00960   160300000
      DO 30 J=1,6                                                       LUM00970   160400000
   30 Z1(I,J)=0.                                                        LUM00980   160500000
C                                                                       LUM00990   160600000
C FORM                        F*A IN Z1 AND F * RHSI IN DELAB           LUM01000   160700000
C                                                                       LUM01010   160800000
      DO 50 I=1,NLAB                                                    LUM01020   160900000
      ISIX=6*I-5                                                        LUM01030   161000000
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      CALL ADD(RHSI(1,I),DELAB,DELAB,1)
      CALL XADD(EMA(1,1,I),Z1,Z1,3,6,6,6)
      CALL MPRD(QP(1,1,I),RHSI(1,I),WORK,3,6,1,3,1)
      CALL ADD(DELAB(4),WORK,DELAB(4),1)
      CALL MPRD(QP(1,1,I),EMA(1,1,I),WORK,3,6,6,3,6)
   50 CALL XADD(WORK,Z1(4,1),Z1(4,1),3,6,3,6)
      IF(IL.EQ.1)GO TO 99
C
C PLACE A IN DR
C
      DO 60 I=1,NLAB
      ISIX=6*I-5
      DO 60 L=1,6
      K=ISIX+L-1
      DO 60 J=1,6
      JA=(J-1)*600+K
   60 DR(JA )=EMA(L,J,I)
C
C FORM (R-T)    *A IN Z3 AND R-T  *RHSI IN DELAB
C
      CALL TPRD(RMODE,DR,Z3,NLAB6,NMLAB,6,600,20)
      CALL TPRD(RMODE,RHSI ,DELAB(7),NLAB6,NMLAB,1,600,1)
   99 RETURN
      END
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      SUBROUTINE CONSTR(FETEST)                                          LUM01280    163500000
      COMMON T                                                           LUM01290    163600000
      COMMON /NEWCOM/EL(3)                                               LUM01300    163700000
      COMMON /CONFCT/XX(8),DEL(3),DELD(3),PHIST(3),PHISTD(3),W(20),P     LUM01310    163800000
      COMMON /INOUT/IN,IOUT,IOFF                                         LUM01320    163900000
      DIMENSION FETEST(6)                                                LUM01330    164000000
      IF(T.GT.0)GO TO 10                                                 LUM01340    164100000
      READ(IN,1)CMC,CML,CIC,CIL,CJC,CJL,A,B,AE,EI,GJ,YMIN,GA,GB,GT       LUM01350    164200000
      WRITE(IOUT,770)CMC,CML,CIC,CIL,CJC,CJL                             LUM01360    164300000
  770 FORMAT(*0BEAM SUBROUTINE INPUT*/6X,*CWT MASS*,9X,*LAB MASS*,6X,    LUM01370    164400000
     * *CWT TRANS INRTA  LAB TRANS INRTA   CWT ROLL INRTA   LAB ROLL INRLUM01380    164500000
     *TA*/6E17.7)                                                        LUM01390    164600000
      WRITE(IOUT,771)A,B,AE,EI,GJ                                        LUM01400    164700000
  771 FORMAT(9X,*A*,16X,*B*,16X,*AE*,15X,*EI*,15X,*GJ*/5E17.7)           LUM01410    164800000
      WRITE(IOUT,772)GA,GB,GT                                            LUM01420    164900000
  772 FORMAT(*  AXIAL DAMPING RATIO   BENDING DAMPING RATIO   TORSION DALUM01430    165000000
     *MPING RATIO*/4X,E14.7,2E24.7)                                      LUM01440    165100000
    1 FORMAT(3E15.8)                                                     LUM01450    165200000
      CMB=CMC*CML/(CMC+CML)                                              LUM01460    165300000
      CJB=CJC*CJL/(CJC+CJL)                                              LUM01470    165400000
   10 Y=SQRT(DOTP(EL,EL))                                                LUM01480    165500000
      Z=AMAX1(Y,YMIN)                                                    LUM01490    165600000
      CKA=AE/Z                                                           LUM01500    165700000
      CK3=4.*EI/Z                                                        LUM01510    165800000
      CKT=GJ/Z                                                           LUM01520    165900000
      CK2= 1.5*CK3/Z                                                     LUM01530    166000000
      CK1=2.*CK2/Z                                                       LUM01540    166100000
      CK2=-CK2                                                           LUM01550    166200000
      TEMP=(A+B+Y)                                                       LUM01560    166300000
      CIB=CIC+CIL+CMB*TEMP*TEMP                                          LUM01570    166400000
      CM1=CMB*(CIC+CIL)/CIB                                              LUM01580    166500000
      CM2=CMB*(CIC*A-CIL*(B+Y))/CIB                                      LUM01590    166600000
      CM3=(CMB*(CIL*(B+Y)*(B+Y)+CIC*A*A)+CIC*CIL)/CIB                    LUM01600    166700000
      AA=CM1*CM3-CM2*CM2                                                 LUM01610    166800000
      BB=2.*CK2*CM2-CK1*CM3-CK3*CM1                                      LUM01620    166900000
      CC=CK1*CK3-CK2*CK2                                                 LUM01630    167000000
      TEMP=SQRT(BB*BB-4.*AA*CC)                                          LUM01640    167100000
      W1W1=(-BB-TEMP)/(2.*AA)                                            LUM01650    167200000
      W2W2=(-BB+TEMP)/(2.*AA)                                            LUM01660    167300000
      IF(CK1-W1W1*CM1)20,30,20                                           LUM01670    167400000
   30 DELB1=1.                                                           LUM01680    167500000
      PHIB1=0.                                                           LUM01690    167600000
      GO TO 14                                                           LUM01700    167700000
   20 IF(CK2-W1W1*CM2)40,50,40                                           LUM01710    167800000
   50 DELB1=0.                                                           LUM01720    167900000
      PHIB1=1.                                                           LUM01730    168000000
      GO TO 14                                                           LUM01740    168100000
   40 R1=(CK1-W1W1*CM1)/(W1W1*CM2-CK2)                                   LUM01750    168200000
      IF(ABS(R1).GT.1.)GO TO 11                                          LUM01760    168300000
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      DELB1=1.                                                          LUM01770   168400000
      PHIB1=R1                                                          LUM01780   168500000
      GO TO 14                                                          LUM01790   168600000
   11 PHIB1=1.                                                          LUM01800   168700000
      DELB1=1./R1                                                       LUM01810   168800000
   14 TEMP=CK1-W2W2*CM1                                                 LUM01820   168900000
      TEMPA=CK2-W2W2*CM2                                                LUM01830   169000000
      IF(TEMP)60,70,60                                                  LUM01840   169100000
   70 DELB2=1.                                                          LUM01850   169200000
      PHIB2=0.                                                          LUM01860   169300000
      GO TO 18                                                          LUM01870   169400000
   60 IF(TEMPA)80,90,80                                                 LUM01880   169500000
   90 DELB2=0.                                                          LUM01890   169600000
      PHIB2=1.                                                          LUM01900   169700000
      GO TO 18                                                          LUM01910   169800000
   80 R2=-TEMP/TEMPA                                                    LUM01920   169900000
      IF(ABS(R2).GT.1.)GO TO 100                                        LUM01930   170000000
      DELB2=1.                                                          LUM01940   170100000
      PHIB2=R2                                                          LUM01950   170200000
      GO TO 18                                                          LUM01960   170300000
  100 PHIB2=1.                                                          LUM01970   170400000
      DELB2=1./R2                                                       LUM01980   170500000
   18 T1=DELB1*CM1+PHIB1*CM2                                            LUM01990   170600000
      T2=DELB1*CM2+PHIB1*CM3                                            LUM02000   170700000
      T3=DELB2*CM1+PHIB2*CM2                                            LUM02010   170800000
      T4=DELB2*CM2+PHIB2*CM3                                            LUM02020   170900000
      CM11=T1*DELB1+T2*PHIB1                                            LUM02030   171000000
      CM22=T3*DELB2+T4*PHIB2                                            LUM02040   171100000
      T1=DELB1*CK1+PHIB1*CK2                                            LUM02050   171200000
      T2=DELB1*CK2+PHIB1*CK3                                            LUM02060   171300000
      T3=DELB2*CK1+PHIB2*CK2                                            LUM02070   171400000
      T4=DELB2*CK2+PHIB2*CK3                                            LUM02080   171500000
      CK11=T1*DELB1+T2*PHIB1                                            LUM02090   171600000
      CK22=T3*DELB2+T4*PHIB2                                            LUM02100   171700000
      T1=2.*GB   *SQRT(CK11*CM11)                                       LUM02110   171800000
      T2=2.*GB   *SQRT(CK22*CM22)                                       LUM02120   171900000
      TEMP=DELB1*PHIB2-DELB2*PHIB1                                      LUM02130   172000000
      TEMP=1./(TEMP*TEMP)                                               LUM02140   172100000
      C1=TEMP*( PHIB2*T1*PHIB2+PHIB1*T2*PHIB1)                          LUM02150   172200000
      C2=TEMP*(-PHIB2*T1*DELB2-PHIB1*T2*DELB1)                          LUM02160   172300000
      C3=TEMP*( DELB2*T1*DELB2+DELB1*T2*DELB1)                          LUM02170   172400000
      CA=2.*GA   *SQRT(CMB*CKA)                                         LUM02180   172500000
      CT=2.*GT   *SQRT(CJB*CKT)                                         LUM02190   172600000
      P=P/10.                                                           LUM02200   172700000
      FETEST(1)=(CK1+P*12./Z)*DEL(1)+(CK2-P)*PHIST(2)                   LUM02210   172800000
     *                        +C1*DELD(1)+C2*PHISTD(2)                  LUM02220   172900000
      FETEST(2)=(CK1+P*12./Z)*DEL(2)- (CK2-P)*PHIST(1)                  LUM02230   173000000
     *                        +C1*DELD(2)-C2*PHISTD(1)                  LUM02240   173100000
      FETEST(3)=CKA*DEL(3)+CA*DELD(3)                                   LUM02250   173200000
      FETEST(4)=(P-CK2)*DEL(2)+(CK3+1.3333333*P*Z)*PHIST(1)             LUM02260   173300000
     *                        -C2*DELD(2)+C3*PHISTD(1)                  LUM02270   173400000
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      FETEST(5)=(CK2-P)*DEL(1)+(CK3+1.3333333*P*Z)*PHIST(2)
     *                  +C2*DELD(1)+C3*PHISTD(2)
      FETEST(6)=CKT*PHIST(3)+CT*PHISTD(3)
      RETURN
      END
```

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      SUBROUTINE CW(NCW)                                                LUM02330   174000000
      COMMON/INOUT/IN,IOUT,IOFF                                         LUM02340   174100000
      COMMON T,R,RDOT,XIDEN,RHO,A     ,G1,G2,G3,G4,XC,LAM1,LAM2,LAM3,LAM4LUM02350  174200000
     *      ,H1,H2,H3,H4,H5,HOLD,SAVE                                   LUM02360   174300000
     *   ,G5(3,3),G6(3,3),SX(11886),RA(3,3)                             LUM02370   174400000
      COMMON /BIG/PIETA(3,3),PIGAM(3,3),SUML(3),SUMT,SGAM(3,3),SETA(3,3)LUM02380   174500000
     *          ,SASAB(3,3,100),RABAR(3,3,100),EMB(3,6,100),EMC(600,6), LUM02390   174600000
     *              EME(3,6,100)                                        LUM02400   174700000
      COMMON /LABOR/WX(3)                                               LUM02410   174800000
      COMMON /CWT/RB,RBDOT,FTA,WY,RAO,QB,QDB,THB,THDB,XMBAR,XIBAR       LUM02420   174900000
      COMMON /LOADS/ZZ(33),RHSA(6,100)                                  LUM02430   175000000
      COMMON /NEWCOM/ZN(15),RDBDD(3)                                    LUM02440   175100000
      DIMENSION XIBAR(3,3,100),XMBAR(100),QB(3,100),QDB(3,100),         LUM02450   175200000
     *          THB(3,100),THDB(3,100),HOLD(3),SAVE(3),G1(3,3),G2(3,3), LUM02460   175300000
     *          G3(3,3),G4(3,3),XC(3),RB(3),RBDOT(3),ETA(3),WY(3),      LUM02470   175400000
     *          RAO(3,100),R(3),RDOT(3),XIDEN(3,3)                      LUM02480   175500000
     *          ,H1(3),H2(3),H3(3),H4(3),H5(3)                          LUM02490   175600000
      REAL LAM1(3,3),LAM2(3,3),LAM3(3,3),LAM4(3,3)                      LUM02500   175700000
      CALL GAMMA(R,G2)                                                  LUM02510   175800000
      CALL GAMMA(WY,G4)                                                 LUM02520   175900000
      CALL GAMMA(WX,G6)                                                 LUM02530   176000000
CQP                                                                     LUM02540   176100000
      DO 20 I=1,3                                                       LUM02550   176200000
      DO 20 J=1,3                                                       LUM02560   176300000
      RA(I,J  )=0.                                                      LUM02570   176400000
      DO 20 K=1,3                                                       LUM02580   176500000
   20 RA(I,J  )=RA(I,J  )+G2(I,K)*PIETA(J,K)                            LUM02590   176600000
      DO 100 L=1,NCW                                                    LUM02600   176700000
COMPUTE  LAM17,LAM18,LAM19,LAM20                                        LUM02610   176800000
      CALL SCALR(XMBAR(L),PIETA,LAM1,3)                                 LUM02620   176900000
      CALL MULT(LAM1,G2,LAM2,3)                                         LUM02630   177000000
      CALL SCALR(-1.,LAM2,LAM2,3)                                       LUM02640   177100000
      CALL SCALR(XMBAR(L),XIDEN,LAM3,3)                                 LUM02650   177200000
      CALL ADD(RB,RAO(1,L),HOLD,1)                                      LUM02660   177300000
      CALL ADD(HOLD,QB(1,L),H2   ,1)                                    LUM02670   177400000
      CALL GAMMA(H2   ,G3)                                              LUM02680   177500000
CQP                                                                     LUM02690   177600000
      CALL SCALR(1.   ,G3,RABAR(1,1,L),3)                               LUM02700   177700000
      SC=-XMBAR(L)                                                      LUM02710   177800000
      CALL SCALR(SC,G3,LAM4,3)                                          LUM02720   177900000
COMPUTE  XC7                                                            LUM02730   178000000
      CALL ADD(RBDOT,QDB(1,L),H4   ,1)                                  LUM02740   178100000
      CALL MULT(G4,H4   ,XC,1)                                          LUM02750   178200000
      CALL SCALR(2.,XC,XC,1)                                            LUM02760   178300000
      CALL MULT(G4,G4,G3,3)                                             LUM02770   178400000
      CALL MULT(G3,H2   ,SAVE,1)                                        LUM02780   178500000
C******   L,T   *********                                               LUM02790   178600000
      CALL MULT(G4,H2,H3,1)                                             LUM02800   178700000
      CALL ADD(H4,H3,H3,1)                                              LUM02810   178800000
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C************************
      CALL ADD(XC,SAVE,XC,1)
      CALL MULT(G6,RDOT,HOLD,1)
      CALL SCALR(2.,HOLD,HOLD,1)
      CALL MULT(G6,G6,G3,3)
      CALL MULT(G3,R,SAVE,1)
C******   L,T   *********
      CALL MULT(G6,R,H4,1)
      CALL ADD(RDOT,H4,H4,1)
      CALL MULT(PIETA,H4,H5,1)
      CALL ADD(H5,H3,H3,1)
      CALL MULT(PIETA,R,H4,1)
      CALL ADD(H2,H4,H2,1)
      CALL GAMMA(H2,G3)
      CALL MULT(G3,H3,H4,1)
      CALL SCALR(XMBAR(L),H4,H4,1)
C************************
      CALL ADD(HOLD,SAVE,SAVE,1)
      CALL MULT(PIETA,SAVE,HOLD,1)
      CALL ADD(HOLD,XC,XC,1)
      CALL SCALR(XMBAR(L),XC,XC,1)
      CALL SCALR(-1.,XC ,RHSA(1,L),1)
      CALL MULT(LAM3,ROBDD,HOLD,1)
      CALL SUBTR(RHSA(1,L),HOLD,RHSA(1,L),1)
C*  FORM B,C,E  PARTITIONS
      DO 40 I=1,3
      IL=6*(L-1)+I
      DO 40 J=1,3
      EMB(I,J,L)=LAM1(I,J)
      EMB(I,J+3,L)=LAM2(I,J)
      EMC(IL,J)=LAM3(I,J)
      EMC(IL,J+3)=LAM4(I,J)
   40 EME(I,J,L)=LAM3(I,J)
COMPUTE  LAM21,LAM22
      CALL GAMMA(THB(1,L),G1)
      CALL ADD(XIDEN,G1,G3,3)
      CALL SUBTR(XIDEN,G1,G1,3)
CQP
      DO 60 I=1,3
      DO 60 J=1,3
   60 SASAB(I,J,L)=G3(I,J)
      CALL MULT(XIBAR(1,1,L),G1,LAM1,3)
      CALL GAMMA(THDB(1,L),G5)
      CALL MULT(G5,WY,HOLD,1)
      CALL MULT(XIBAR(1,1,L),HOLD,SAVE,1)
      CALL MULT(G1,WY,HOLD,1)
      CALL ADD(HOLD,THDB(1,L),HOLD,1)
      CALL MULT(XIBAR(1,1,L),HOLD,H1,1)
C******   L,T   *********
      SUMT=SUMT+.5*(DOTP(HOLD,H1)+XMBAR(L)*DOTP(H3,H3))
C************************
```

```
      CALL GAMMA(HOLD,G1)                                           LUM03330   184000000
      CALL MULT(G1,H1,HOLD,1)                                       LUM03340   184100000
C******    L,T    *********                                         LUM03350   184200000
      CALL MULT(G3,H1,H2,1)                                         LUM03360   184300000
      CALL ADD(H2,H4,H2,1)                                          LUM03370   184400000
      CALL MTRAN(PIETA,H2,H3,1)                                     LUM03380   184500000
      CALL MTRAN(PIGAM,H3,H2,1)                                     LUM03390   184600000
      CALL ADD(SUML,H2,SUML,1)                                      LUM03400   184700000
C************************                                           LUM03410   184800000
      CALL SUBTR(HOLD,SAVE,XC,1)                                    LUM03420   184900000
      CALL SCALR(-1.,XC ,RHSA(4,L),1)                               LUM03430   185000000
C*  FORM  B,C,E  PARTITIONS                                         LUM03440   185100000
      DO 50 I=1,3                                                   LUM03450   185200000
      IL=6*L+I-3                                                    LUM03460   185300000
      DO 50 J=1,3                                                   LUM03470   185400000
      EMC(IL,J)=0.                                                  LUM03480   185500000
      EMC(IL,J+3)=LAM1(I,J)                                         LUM03490   185600000
   50 EME(I,J+3,L)=XIBAR(I,J,L)                                     LUM03500   185700000
  100 CONTINUE                                                      LUM03510   185800000
      RETURN                                                        LUM03520   185900000
      END                                                           LUM03530   186000000
```

```
      SUBROUTINE ZCW(NCW)                                              LUM03540   186100000
      COMMON /CWT/RAO(312),QB(3,100)                                   LUM03550   186200000
      COMMON /BIG/PIETA(3,3),PIGAM(3,3),S(4),SGAM(3,3),SETA(3,3),      LUM03560   186300000
     *      SASAB(3,3,100),RABAR(3,3,100),EMB(3,6,100),EMC(600,6),     LUM03570   186400000
     *         EME(3,6,100),NMLAB,RMODE(600,20),NMCW,                  LUM03580   186500000
     *         SMODE(600,20),Z1(6,6),Z(520)                    ,Z6(6,6)LUM03590   186600000
     *         ,Z7(6,6)          ,Z9(20,6),Z10(20,6),Z11(20,20),       LUM03600   186700000
     *         WORK(3,6 ),WORKA(3,3),WORKB(20,6),WORKC(3,3)            LUM03610   186800000
      COMMON /LOADS/GAML(3,3),GAMSB(3,3),PIMIX (3,3),FETEST(6),        LUM03620   186900000
     *           RHSA(6,100),DELAB(26),DELCW(26)                       LUM03630   187000000
     * , XDD(1212),KLUCS,KLULAB,KLUCW,CSLDA(6),CSLDB(6)                LUM03640   187100000
      COMMON /NEWCOM/EL(98),PIBETA(10),KLUE,CMK(80), IFCON,IFSUPP      LUM03650   187200000
      COMMON /CONECT/IPT,SZ(3),IAPT,SB(3)                              LUM03660   187300000
      COMMON W(18),ES(600,20),RA(3,3)                                  LUM03670   187400000
      CALL GAMMA(SB,GAMSB)                                             LUM03680   187500000
C                                                                      LUM03690   187600000
C  SET UP RHS VECTOR TO BE MULTIPLIED BY (PHI-TRAN)*Q                  LUM03700   187700000
C  ZERO OUT Z6,Z7,Z9                                                   LUM03710   187800000
C                                                                      LUM03720   187900000
C                                                                      LUM03730   188000000
      CALL MULT(GAML,FETEST,WORKC,1)                                   LUM03740   188100000
      CALL ADD(FETEST(4),WORKC,FETEST(4),1)                            LUM03750   188200000
      CALL MTRAN(PIBETA,FETEST,WORKC,2)                                LUM03760   188300000
      IF(KLUCS.GT.0)CALL MULT(SASAB(1,1,IAPT),WORKC,CSLDB,2)           LUM03770   188400000
      CALL CONTRL(ES,NCW,IFCON,-1)                                     LUM03780   188500000
      CALL SUPPLM(ES(1,2),NCW,IFSUPP,-1)                               LUM03790   188600000
      CALL XADD(ES,ES(1,2),ES,6,NCW,6,6)                               LUM03800   188700000
      CALL MULT(GAMSB,WORKC,GAML,1)                                    LUM03810   188800000
      CALL ADD(WORKC(1,2),GAML,WORKC(1,2),1)                           LUM03820   188900000
      ISIX=IAPT*6-5                                                    LUM03830   189000000
      CALL ADD(ES(ISIX,1),WORKC,ES(ISIX,1),2)                          LUM03840   189100000
      DO 20 I=1,NCW                                                    LUM03850   189200000
      ISIX=6*I-5                                                       LUM03860   189300000
      CALL MULT(SASAB(1,1,I),ES(ISIX,1),GAML,1)                        LUM03870   189400000
      CALL ADD(RHSA(1,I),GAML,RHSA(1,I),1)                             LUM03880   189500000
   20 CALL ADD(RHSA(4,I),ES(ISIX+3,1),RHSA(4,I),1)                     LUM03890   189600000
      IF(KLUCW.GT.0)CALL CWLD                                          LUM03900   189700000
C                                                                      LUM03910   189800000
C                                                                      LUM03920   189900000
      NCW6=NCW*6                                                       LUM03930   190000000
C                                                                      LUM03940   190100000
C  FORM ES                                                             LUM03950   190200000
C                                                                      LUM03960   190300000
      IF(KLUE.GT.2)GO TO 80                                            LUM03970   190400000
      DO 10 I=1,NCW                                                    LUM03980   190500000
      ISIX=6*I-5                                                       LUM03990   190600000
      CALL XMPRD(EME(1,1,I),SMODE(ISIX,1),ES(ISIX,1),3,3,NMCW,3,600,600)LUM04000  190700000
   10 CALL XMPRD(EME(1,4,I),SMODE(ISIX+3,1),ES(ISIX+3,1),3,3,NMCW,     LUM04010   190800000
     *3,600,600)                                                       LUM04020   190900000
```

```
C
   80 DO 35 I=1,6
      DELCW(I)=0.
      DO 30 J=1,6
      Z6(I,J)=0.
   30 Z7(I,J)=0.
      DO 35 J=1,NMCW
   35 Z9(J,I)=0.
C
C
      DO 50 I=1,NCW
      ISIX=I*6-5
C
C  FORM HB,HC     AND H*RHSA
C
      CALL XADD(EMB(1,1,I),Z6,Z6,3,6,3,6)
      CALL XADD(EMC(ISIX,1),Z7,Z7,3,6,600,6)
      CALL ADD(RHSA(1,I),DELCW,DELCW,1)
      CALL MULT(RABAR(1,1,I),EMB(1,1,I),WORK,6)
      CALL XADD(WORK,Z6(4,1),Z6(4,1),3,6,3,6)
      CALL MULT(RABAR(1,1,I),RHSA(1,I ),WORK,1)
      CALL ADD(WORK,DELCW(4),DELCW(4),1)
      CALL MPRD(RABAR(1,1,I),EMC(ISIX,1),WORK,3,3,6,3,600)
      CALL XADD(WORK,Z7(4,1),Z7(4,1),3,6,3,6)
      CALL MPRD(SASAB(1,1,I),EMC(ISIX+3,1),WORK,3,3,6,3,600)
      CALL XADD(WORK,Z7(4,1),Z7(4,1),3,6,3,6)
      CALL MULT(SASAB(1,1,I),RHSA( 4,I  ),WORK,1)
      CALL ADD(WORK,DELCW(4),DELCW(4),1)
      IF(KLUE.GT.2)GO TO 81
C
C  FORM (S-TRANSPOSE)B
C
      CALL XTPRD(SMODE(ISIX,1),EMB(1,1,I),WORKB,3,NMCW,6,600,3,20)
      CALL XADD(WORKB,Z9,Z9,NMCW,6,20,20)
   81 CONTINUE
C
C  FORM GB AND ADD TO Z1 AND G*RHSA AND ADD TO DELAB
C
   90 CALL MTRAN(PIETA,EMB(1,1,I),WORK,6)
   91 CALL XADD(WORK,Z1,Z1,3,6,3,6)
      CALL MULT(RA      ,EMB(1,1,I),WORK,6)
   93 CALL XADD(WORK,Z1(4,1),Z1(4,1),3,6,3,6)
      CALL MTRAN(PIETA,RHSA(1,I ),WORK,1)
      CALL ADD(WORK,DELAB,DELAB,1)
      CALL MULT(RA      ,RHSA( 1,I  ),WORK,1)
   50 CALL ADD(WORK,DELAB(4),DELAB(4),1)
      IF(KLUE.NE.4)GO TO 99
      DELAB(4)=DELAB(4)+DELCW(4)
      DELAB(5)=DELAB(5)-DELCW(5)
      DELAB(6)=DELAB(6)-DELCW(6)
      CALL XADD(Z1(4,1),Z6(4,1),Z1(4,1),1,6,6,6)
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      DO 65 I=5,6                                                       LUM04540   196100000
      DO 65 J=1,6                                                       LUM04550   196200000
   65 Z1(I,J)=Z1(I,J)-Z6(I,J)                                           LUM04560   196300000
      DO 66 I=1,6                                                       LUM04570   196400000
      DO 66 J=1,I                                                       LUM04580   196500000
      IF(I.EQ.J)GO TO 66                                                LUM04590   196600000
      SC=Z6(I,J)                                                        LUM04600   196700000
      Z6(I,J)=Z6(J,I)                                                   LUM04610   196800000
      Z6(J,I)=SC                                                        LUM04620   196900000
   66 CONTINUE                                                          LUM04630   197000000
      CALL SCALR(-1.,Z6(1,5),Z6(1,5),4)                                 LUM04640   197100000
      DO 67 I=5,6                                                       LUM04650   197200000
      Z7(I,4)=-Z7(I,4)                                                  LUM04660   197300000
   67 Z7(4,I)=-Z7(4,I)                                                  LUM04670   197400000
      CALL XADD(Z6(4,4),Z7(4,4),Z6(4,4),3,3,6,6)                        LUM04680   197500000
      CALL ADD(Z1(1,4),Z6(1,4) ,Z1(1,4),6)                              LUM04690   197600000
   99 CONTINUE                                                          LUM04700   197700000
      IF(KLUE.GT.2)GO TO 100                                            LUM04710   197800000
C                                                                       LUM04720   197900000
C  FORM (S-TRANSPOSE)ES IN Z11 AND (S-T)   *RHSA IN DELCW               LUM04730   198000000
C                                                                       LUM04740   198100000
      CALL TPRD(SMODE,ES,Z11,NCW6,NMCW,NMCW,600,20)                     LUM04750   198200000
      CALL TPRD(SMODF,RHSA,DELCW(7),NCW6,NMCW,1,600,1)                  LUM04760   198300000
C                                                                       LUM04770   198400000
C  FORM (S-TRANSPOSE)  *C IN Z10                                        LUM04780   198500000
C                                                                       LUM04790   198600000
      CALL TPRD(SMODE,EMC,Z10,NCW6,NMCW,6,600,20)                       LUM04800   198700000
  100 CONTINUE                                                          LUM04810   198800000
      RETURN                                                            LUM04820   198900000
      END                                                               LUM04830   199000000
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      SUBROUTINE MINCY(NLAB,NCW,DELT,NCYCLE,V,VDOT)                    LUM04840   199100000
      DOUBLE PRECISION YPRED,YDERV,YNEW                                LUM04850   199200000
      COMMON T,R(3),RDOT(3),X(11),YICS(120),YDOT(120),B(600),C(600),   LUM04860   199300000
     * PRED(120)                                                       LUM04870   199400000
      DIMENSION YPRED(120),YDERV(120),YNEW(120),YCORR(120),Z(720)      LUM04880   199500000
      COMMON /LOADS/ZZ(633),DELAB(26),DELCW(26),XDD(606)               LUM04890   199600000
      COMMON /LABOR/WX(3),RIO(300),Q(3,100),QD(3,100),TH(3,100),       LUM04900   199700000
     *              THD(3,100)                                         LUM04910   199800000
      COMMON /CWT/XC(9),WY(3),XCW(300),QB(3,100),QBD(3,100),THB(3,100), LUM04920  199900000
     *           THBD(3,100)                                           LUM04930   200000000
      COMMON/INOUT/ IN,IOUT,IOFF,IC,IPLOUT(14)                         LUM04940   200100000
     *,N1,N2,N3,N4,N5,N6,N7                                            LUM04950   200200000
      COMMON /PASS/QDUM(2),STEP                                        LUM04960   200300000
      COMMON /CLUES/IFPLT,IFLUID,NPIPE,NMLM,MLM(8),IRES(2),IPIPES(30)  LUM04970   200400000
      COMMON /NEWCOM/XNEW(18),VEC(20,2),VECBAR(20,2),XNEWC(10),KLUE,   LUM04980   200500000
     *          CMK(20,4),IFCON                                        LUM04990   200600000
      COMMON /CONECT/IPT,S(3),IAPT,SB(3),DEL(3),DELD(3),PHIST(3),      LUM05000   200700000
     *         PHISTD(3),DELRB(3),DELRBD(3),GAM(3),GAMD(3),ETAST(3),   LUM05010   200800000
     *        ETASTD(3),PZB(3),FLL(3),ELLD(3)                          LUM05020   200900000
      COMMON /BIG/XBIG(18),SUML(3),SUMT,XB(18),                        LUM05030   201000000
     *            A(52,52),XBI(6296),NMLAB,RMODE(600,20),NMCW,         LUM05040   201100000
     *            SMODE(600,20),Z1(6,6)          ,Z3(20,6),Z4(20,20),  LUM05050   201200000
     *                           Z6(6,6),Z7(6,6)          ,Z9(20,6),   LUM05060   201300000
     *            Z10(20,6),Z11(20,20)                                 LUM05070   201400000
      COMMON /EXTRA/XEX(12),ZCM(3)                                     LUM05080   201500000
      COMMON /ALLCNT/DUMAL(41),YICSCN(10),YPREDC(10),YDOTCN(10),NEQCN  LUM05090   201600000
     * ,ADUM(12),TAJ(3),BDUM(6),BETDES                                 LUM05100   201700000
      COMMON /VAROUT/F01,D01C,F3,F9,F10,F16,F4,F11,F15,D01,EL03D,ELD3, LUM05110   201800000
     *                ELD03,O1CD,OD                                    LUM05120   201900000
     *,O1C,NCMG                                                        LUM05130   202000000
     *,UJO(3,3,8),XXCS,ERRDDX,UJ3,HIL(2),UJD23                         LUM05140   202100000
     *,F1,F2,F5,F6,F7,F8,F12,F13,F14                                   LUM05150   202200000
     *,U13MO,U23MO                                                     LUM05160   202300000
     *,EFILT                                                           LUM05170   202400000
      COMMON /LODPAS/LL(16),FTL(6,16),NLL                              LUM05180   202500000
      DIMENSION ERR(120)                                               LUM05190   202600000
      DIMENSION LPCINT(100),JPOINT(100)                                LUM05200   202700000
      DIMENSION XDBL(6,202)                                                       202800000
      EQUIVALENCE (XDD(1),XDBL(1,1))                                              202900000
C                                                                      LUM05210   203000000
C                                                                      LUM05220   203100000
C  ADD FM TO DELR                                                      LUM05230   203200000
C                                                                      LUM05240   203300000
      NC6=NCW*6                                                        LUM05250   203400000
      NL6=NLAB*6                                                       LUM05260   203500000
      IOFF=1                                                           LUM05270   203600000
      KLAB=0                                                           LUM05280   203700000
      TOLD=T                                                           LUM05290   203800000
      IF(KLUE.EQ.2 .OR. KLUE.GT.3)KLAB=1                               LUM05300   203900000
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      IF(KLAB.EQ.1)GO TO 15                                             LUM05310  204000000
      DO 10 I=1,NMLAB                                                   LUM05320  204100000
      L=I+6                                                             LUM05330  204200000
   10 DELAB(L)=DELAB(L)-CMK(I,3)*VEC(I,1)-CMK(I,1)*VEC(I,2)             LUM05340  204300000
   15 IF(KLUE.GT.2)GO TO 25                                             LUM05350  204400000
      DO 20 I=1,NMCW                                                    LUM05360  204500000
      L=I+6                                                             LUM05370  204600000
   20 DELCW(L)=DELCW(L)-CMK(I,4)*VECBAR(I,1)-CMK(I,2)*VECBAR(I,2)       LUM05380  204700000
C                                                                       LUM05390  204800000
C     CONSTRUCT YICS                                                    LUM05400  204900000
C                                                                       LUM05410  205000000
   25 IF(T.GT.0.)GO TO 100                                              LUM05420  205100000
      NEQNS=6                                                           LUM05430  205200000
      DO 30 I=1,3                                                       LUM05440  205300000
      YICS(I)=RDOT(I)                                                   LUM05450  205400000
   30 YICS(I+3)=WX(I)                                                   LUM05460  205500000
      IF(KLAB.EQ.1)GO TO 45                                             LUM05470  205600000
      NEQNS=NEQNS+NMLAB                                                 LUM05480  205700000
      DO 35 I=1,NMLAB                                                   LUM05490  205800000
   35 YICS(I+6)=VEC(I,2)                                                LUM05500  205900000
   45 IF(KLUE.EQ.4)GO TO 50                                             LUM05510  206000000
      DO 40 I=1,3                                                       LUM05520  206100000
      J=NEQNS+I                                                         LUM05530  206200000
      YICS(J)=DELRBD(I)                                                 LUM05540  206300000
   40 YICS(J+3)=WY(I)                                                   LUM05550  206400000
      NEQNS=NEQNS+6                                                     LUM05560  206500000
      IF(KLUE.GT.2)GO TO 50                                             LUM05570  206600000
      DO 48 I=1,NMCW                                                    LUM05580  206700000
   48 YICS(NEQNS+I)=VECBAR(I,2)                                         LUM05590  206800000
      NEQNS=NEQNS+NMCW                                                  LUM05600  206900000
   50 NEQ=NEQNS                                                         LUM05610  207000000
      DO 55 I=1,3                                                       LUM05620  207100000
      J=NEQNS+I                                                         LUM05630  207200000
      YICS(J)=R(I)                                                      LUM05640  207300000
   55 YICS(J+3)=GAM(I)                                                  LUM05650  207400000
      NEQNS=NEQNS+6                                                     LUM05660  207500000
      IF(KLAB.EQ.1)GO TO 65                                             LUM05670  207600000
      DO 60 I=1,NMLAB                                                   LUM05680  207700000
   60 YICS(NEQNS+I)=VEC(I,1)                                            LUM05690  207800000
      NEQNS=NEQNS+NMLAB                                                 LUM05700  207900000
   65 IF(KLUE.EQ.4)GO TO 100                                            LUM05710  208000000
      DO 70 I=1,3                                                       LUM05720  208100000
      J=NEQNS+I                                                         LUM05730  208200000
      YICS(J)=DELRB(I)                                                  LUM05740  208300000
   70 YICS(J+3)=ETAST(I)                                                LUM05750  208400000
      NEQNS=NEQNS+6                                                     LUM05760  208500000
      IF(KLUE.GT.2)GO TO 100                                            LUM05770  208600000
      DO 75 I=1,NMCW                                                    LUM05780  208700000
   75 YICS(NEQNS+I)=VECBAR(I,1)                                         LUM05790  208800000
      NEQNS=NEQNS+NMCW                                                  LUM05800  208900000
C                                                                       LUM05810  209000000
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C  SET UP LAMBDA MATRIX IN ARRAY A                                     LUM05820   209100000
C                                                                      LUM05830   209200000
  100 CALL XMCPY(Z1,A,6,6,6)                                           LUM05840   209300000
      NQ=6                                                             LUM05850   209400000
      IF(KLAB.EQ.1)GO TO 120                                           LUM05860   209500000
      CALL XMCPY(Z3,A(7,1),NMLAB,6,20)                                 LUM05870   209600000
      CALL XMCPY(Z4,A(7,7),NMLAB,NMLAB,20)                             LUM05880   209700000
      NQ=NQ+NMLAB                                                      LUM05890   209800000
  120 IF(KLUE.EQ.4)GO TO 200                                           LUM05900   209900000
      J=NQ+1                                                           LUM05910   210000000
      CALL XMCPY(Z6,A(J,1),6,6,6)                                      LUM05920   210100000
      CALL XMCPY(Z7,A(J,J),6,6,6)                                      LUM05930   210200000
      IF(KLAB.EQ.1)GO TO 140                                           LUM05940   210300000
      DO 130 I=7,NQ                                                    LUM05950   210400000
      DO 130 L=1,6                                                     LUM05960   210500000
  130 A(L+NQ,I)=0.                                                     LUM05970   210600000
  140 IF(KLUE.GT.2)GO TO 200                                           LUM05980   210700000
      CALL XMCPY(Z9,A(NQ+7,1),NMCW,6,20)                               LUM05990   210800000
      CALL XMCPY(Z10,A(NQ+7,NQ+1),NMCW,6,20)                           LUM06000   210900000
      CALL XMCPY(Z11,A(NQ+7,NQ+7),NMCW,NMCW,20)                        LUM06010   211000000
      IF(KLAB.EQ.1)GO TO 200                                           LUM06020   211100000
      DO 180 I=1,NMLAB                                                 LUM06030   211200000
      DO 180 J=1,NMCW                                                  LUM06040   211300000
      NL=NQ+6+J                                                        LUM06050   211400000
  180 A(NL,I+6)=0.                                                     LUM06060   211500000
C                                                                      LUM06070   211600000
C  SET UP DEL SUB R                                                    LUM06080   211700000
C                                                                      LUM06090   211800000
  200 NL=NMLAB+6                                                       LUM06100   211900000
      NQ=NMCW+6                                                        LUM06110   212000000
      IF(KLUE.EQ.4)GO TO 211                                           LUM06120   212100000
      IF(KLUE.GT.2)NQ=6                                                LUM06130   212200000
      IF(KLAB.EQ.1)NL=6                                                LUM06140   212300000
      DO 210 I=1,NQ                                                    LUM06150   212400000
  210 DELAB(NL+I)=DELCW(I)                                             LUM06160   212500000
C                                                                      LUM06170   212600000
C  SOLVE SYSTEM OF EQUATIONS , PUT INTO YDOT                           LUM06180   212700000
C                                                                      LUM06190   212800000
  211 IJ=0                                                             LUM06200   212900000
      DO 214 I=1,NEQ                                                   LUM06210   213000000
      DO 214 J=1,I                                                     LUM06220   213100000
      IJ=IJ+1                                                          LUM06230   213200000
  214 XBI(IJ)=A(I,J)                                                   LUM06240   213300000
      CALL CHASE(XBI,NEQ,DELAB,1,1,IND)                                LUM06250   213400000
      IF(IND)220,220,221                                               LUM06260   213500000
  221 WRITE(IOUT,215)                                                  LUM06270   213600000
  215 FORMAT(* ERROR IN SOLVING SYSTEM OF EQUATIONS*/)                 LUM06280   213700000
      RETURN                                                           LUM06290   213800000
C                                                                      LUM06300   213900000
C  SET UP YDOT                                                         LUM06310   214000000
C                                                                      LUM06320   214100000
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  220 DO 291 I=1,NEQ                                                    LUM06330  214200000
  291 YDOT(I)=DELAB(I)                                                  LUM06340  214300000
      NEQP=NEQ                                                          LUM06350  214400000
      DO 300 I=1,3                                                      LUM06360  214500000
      J=I+NEQ                                                           LUM06370  214600000
      YDOT(J)=RDOT(I)                                                   LUM06380  214700000
  300 YDOT(J+3)=GAMD(I)                                                 LUM06390  214800000
      NEQ=NEQ+6                                                         LUM06400  214900000
      DO 410 I=1,3                                                      LUM06410  215000000
      XDD(I)=YDOT(I)                                                    LUM06420  215100000
  410 XDD(I+3)=YDOT(I+3)                                                LUM06430  215200000
      DO 510 I=1,3                                                      LUM06440  215300000
      INML=I+NMLAB+6                                                    LUM06450  215400000
      XDD(I+606)=YDOT(INML)                                             LUM06460  215500000
  510 XDD(I+609)=YDOT(INML+3)                                           LUM06470  215600000
      IF(KLUE.EQ.4)GO TO 400                                            LUM06480  215700000
      IF(KLAB.EQ.1)GO TO 320                                            LUM06490  215800000
      DO 340 I=1,NMLAB                                                  LUM06500  215900000
  340 YDOT(NEQ+I)=VEC(I,2)                                              LUM06510  216000000
      NEQ=NEQ+NMLAB                                                     LUM06520  216100000
      CALL MPRD(RMODE,YDOT(7),XDD(7),NL6,NMLAB,1,600,1)                 LUM06530  216200000
  320 IF(KLUE.EQ.4)GO TO 400                                            LUM06540  216300000
      DO 360 I=1,3                                                      LUM06550  216400000
      J=I+NEQ                                                           LUM06560  216500000
      YDOT(J)=DELRBD(I)                                                 LUM06570  216600000
  360 YDOT(J+3)=ETASTD(I)                                               LUM06580  216700000
      NEQ=NEQ+6                                                         LUM06590  216800000
      IF(KLUE.GT.2)GO TO 400                                            LUM06600  216900000
      DO 380 I=1,NMCW                                                   LUM06610  217000000
  380 YDOT(NEQ+I)=VECBAR(I,2)                                           LUM06620  217100000
      NEQ=NEQ+NMCW                                                      LUM06630  217200000
      CALL MPRD(SMODE,YDOT(NMLAB+13),XDD(613),NC6,NMCW,1,600,1)         LUM06640  217300000
C                                                                       LUM06650  217400000
C  SET UP THE INTEGRATION CYCLE                                         LUM06660  217500000
C                                                                       LUM06670  217600000
  400 IF(IFCON.EQ.0)GO TO 401                                           LUM06680  217700000
      DO 381 I=1,NEQCN                                                  LUM06690  217800000
  381 YDOT(I+NEQ)=YDOTCN(I)                                             LUM06700  217900000
  401 IF(T.GT.0)GO TO 550                                               LUM06710  218000000
      READ(IN,405)DELTA,EPSIL,STEP,DTAU,NTIME                           LUM06720  218100000
  405 FORMAT(3E15.8/E15.8,I3)                                           LUM06730  218200000
      PTAU=NTIME*DTAU                                                   LUM06740  218300000
      IF(IFPLT.EQ.0)GO TO 943                                           LUM06750  218400000
      WRITE(IOUT,944)                                                   LUM06760  218500000
  944 FORMAT(*0PLOTTING GROUPS SELECTED FOR THIS RUN*)                  LUM06770  218600000
      DO 945 I=1,13                                                     LUM06780  218700000
      IF(IPLOUT(I).EQ.0)GO TO 945                                       LUM06790  218800000
      WRITE(IOUT,946)I                                                  LUM06800  218900000
  946 FORMAT(17X,I2)                                                    LUM06810  219000000
      IF(I.EQ. 4)WRITE(IOUT,947)N1                                      LUM06820  219100000
      IF(I.EQ. 5)WRITE(IOUT,947)N2                                      LUM06830  219200000
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      IF(I.EQ. 6)WRITE(IOUT,947)N3                                      LUM06840   219300000
      IF(I.EQ. 7)WRITE(IOUT,947)N4                                      LUM06850   219400000
      IF(I.EQ. 8)WRITE(IOUT,947)N5                                      LUM06860   219500000
      IF(I.EQ.12)WRITE(IOUT,947)N6                                      LUM06870   219600000
      IF(I.EQ.13)WRITE(IOUT,947)N7                                      LUM06880   219700000
  947 FORMAT(1H+,20X,*AT MASS NO.*,I3)                                  LUM06890   219800000
  945 CONTINUE                                                          LUM06900   219900000
  943 CONTINUE                                                          LUM06910   220000000
      WRITE(IOUT,471)                                                   LUM06920   220100000
  471 FORMAT(*ONUMERICAL INTEGRATION DATA*)                             LUM06930   220200000
      WRITE(IOUT,900)DELTA,EPSIL,STEP,DTAU,NTIME                        LUM06940   220300000
  900 FORMAT(6X,*DELTA*,12X,*EPSIL*,12X,*STEP*,13X,*DTAU*,13X,*NTIME*/  LUM06950   220400000
     *4E17.7,6X,I3)                                                     LUM06960   220500000
      PO=0.                                                             LUM06970   220600000
  402 FORMAT(3E15.8)                                                    LUM06980   220700000
      IF(IFCON.EQ.0)GO TO 404                                           LUM06990   220800000
      DO 382 I=1,NEQCN                                                  LUM07000   220900000
  382 YICS(I+NEQ)=YICSCN(I)                                             LUM07010   221000000
      NEQNS=NEQNS+NEQCN                                                 LUM07020   221100000
  404 NCYCLF=0                                                          LUM07030   221200000
      N=0                                                               LUM07040   221300000
      TIC=0.                                                            LUM07050   221400000
      IF(DELTA.EQ.0.)GO TO 440                                          LUM07060   221500000
      READ(IN,402)(ERR(I),I=1,NEQNS)                                    LUM07070   221600000
      WRITE(IOUT,910)(ERR(I),I=1,NEQNS)                                 LUM07080   221700000
  910 FORMAT(* ERROR PARAMETERS*/(8E16.7))                              LUM07090   221800000
  440 CONTINUE                                                          LUM07100   221900000
      WRITE(IOUT,619)                                                   LUM07110   222000000
  619 FORMAT(*1TIME HISTORY*//)                                         LUM07120   222100000
      I6=1                                                              LUM07130   222200000
      I7=1                                                              LUM07140   222300000
      IF(NLL.EQ.0)GO TO 971                                             LUM07150   222400000
      DO 970 I=1,NLL                                                    LUM07160   222500000
      IF(N6.EQ.LL(I))I6=I                                               LUM07170   222600000
  970 IF(N7.EQ.LL(I))I7=I                                               LUM07180   222700000
  971 CONTINUE                                                          LUM07190   222800000
      CALL SETUP(MAGIN,MAGOUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,T,    LUM07200   222900000
     *           DTIME,YICS,YPRED,YCORR,YDOT,YNEW,YDERV,Z,7(105),Z(209),LUM07210   223000000
     *           Z(313),Z(417),Z(521))                                  LUM07220   223100000
      MAGIN=-1                                                          LUM07230   223200000
  550 CALL MAGIC(MAGIN,MAGOUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,T,    LUM07240   223300000
     *           DTIME,YICS,YPPED,YCORR,YDOT,YNEW,YDERV,Z,Z(105),Z(209),LUM07250   223400000
     *           Z(313),Z(417),Z(521))                                  LUM07260   223500000
      IF(IFCON.EQ.0)GO TO 403                                           LUM07270   223600000
      DO 554 I=1,NEQCN                                                  LUM07280   223700000
  554 YPREDC(I)=YPRED(NEQ+I)                                            LUM07290   223800000
  403 CONTINUE                                                          LUM07300   223900000
      IF(MAGOUT)560,560,570                                             LUM07310   224000000
  560 MAGIN=-1                                                          LUM07320   224100000
      DO 565 I=1,NEQNS                                                  LUM07330   224200000
  565 PRED(I)=YPRED(I)                                                  LUM07340   224300000
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      NEQ=NEQP
      GO TO 600
  570 IF(T.EQ.0.)GO TO 230
      TT=T-PO
      IF(TT.LT.PTAU)GO TO 831
      PO=T
  230 CONTINUE
      WRITE(IOUT,235)
  235 FORMAT(/53H*****************************************************/)
      IF(KLUE.NE.4)GO TO 1700
      WRITE(IOUT,620)T,DTIME
  620 FORMAT(//* RIGID PROBLEM OUTPUT AT TIME T=*,E15.8,* STEP=*,E15.8/
     *6X,*RDOT*,13X,*WX*,12X,*RDDOT*,11X,*WXDOT*,12X,*R*,13X,
     **GAM*,14X,*WY*)
      DO 630 I=1,3
  630 WRITE(IOUT,640)RDOT(I),WX(I),YDOT(I),YDOT(I+3),R(I),GAM(I),WY(I)
  640 FORMAT(7E16.8)
      GO TO 1000
 1700 CONTINUE
      IF(T.GT.0.)GO TO 9
      IF(KLUE.GE.4)GO TO 9
      READ(IN,1)KLOUTL,KLOUTC
    1 FORMAT(2I3)
      DO 6 I=1,100
      LPOINT(I)=I
    6 JPOINT(I)=I
      IF(KLOUTL.GT.0)READ(IN,2)(LPOINT(I),I=1,KLOUTL)
      IF(KLOUTC.GT.0)READ(IN,2)(JPOINT(I),I=1,KLOUTC)
    2 FORMAT(20I3)
    9 CONTINUE
      WRITE(IOUT,711)T,DTIME
  711 FORMAT(//* TIME=*,E15.8,* STEP=*,E15.8//8X*R                RDOT
     *        GAMMA                WX                DELRB             DELRBD
     *    ETA-STAR            WY*)
      DO 712 I=1,3
  712 WRITE(IOUT,713)R(I),RDOT(I),GAM(I),WX(I),DELRB(I),DELRBD(I),
     *ETAST(I),WY(I)
  713 FORMAT(8E16.7)
      WRITE(IOUT,813)(XDD(I),XDD(I+3),XDD(I+606),XDD(I+609),DEL(I),
     *     DELD(I),PHIST(I),PHISTD(I),I=1,3)
  813 FORMAT(*0     RDDOT*,11X,*WXDOT*,10X,*DELRBDD*,10X,*WYDOT*,14X,*DEL
     **    12X,*DELDOT*,10X,*PHISTAR*,8X,*PHISTARDOT*/(8E16.7))
      IF(KLAB.EQ.1)GO TO 1998
      WRITE(IOUT,751)
  751 FORMAT(/* MASS PT.*,5X,*Q*,16X,*Q-DOT*,12X,*QDDOT*,12X,*THETA*,
     * 12X,*THETA-DOT*,9X,*THETADDOT*)
      DO 811 I=1,KLOUTL
      IJ=6*LPOINT(I)
      IJ3=IJ+3
      JI=LPOINT(I)
  811 WRITE(IOUT,752)JI,(Q(J,JI),QD(J,JI),XDBL(J,JI+1),
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      *   TH(J,JI),THD(J,JI),XDBL(J+3,JI+1 ),J=1,3)                                 229500000
  752 FORMAT(/I4,6E18.8/(4X,6E18.8))                                      LUM07870  229600000
 1998 IF(KLUE.GT.2)GO TO 1000                                             LUM07880  229700000
      WRITE(IOUT,780)                                                     LUM07890  229800000
  780 FORMAT(/* MASS PT.     Q BAR*,12X,*Q BAR-DOT*,7X,*Q BAR-DDOT*                   229900000
     *          ,8X,*THETA BAR*,7X,*THETA BAR-DOT*, 4X,*THETA BAR-DDOT*)             230000000
      DO 812 I=1,KLOUTC                                                   LUM07920  230100000
      IJ=6*JPOINT(I)+606                                                  LUM07930  230200000
      IJ3=IJ+3                                                            LUM07940  230300000
      JI=JPOINT(1)                                                                  230400000
  812 WRITE(IOUT,752)JI,(QB(J,JI),QBD(J,JI),XDBL(J,JI+102),                         230500000
     *   THB(J,JI),THBD(J,JI),XDBL(J+3,JI+102),J=1,3)                               230600000
 1000 CONTINUE                                                            LUM07980  230700000
      WRITE(IOUT,11)ZCM                                                   LUM07990  230800000
   11 FORMAT(/* LOCATION OF CENTER OF MASS IN INERTIAL (Z) COORDINATES*/LUM08000  230900000
     *(3F17.8))                                                           LUM08010  231000000
      WRITE(IOUT,1001)SUML,SUMT                                           LUM08020  231100000
 1001 FORMAT(/* ANGULAR MOMENTUM IN Z- COORDINATES*/3E18.8//              LUM08030  231200000
     *         * TOTAL KINETIC ENERGY*/E18.8)                             LUM08040  231300000
      CALL MINMAX(NLAB,NCW)                                               LUM08050  231400000
      CALL LDOUT                                                          LUM08060  231500000
 1234 CONTINUE                                                            LUM08070  231600000
 2010 IF(IFLUID.EQ.0)GO TO 2020                                           LUM08080  231700000
      WRITE(IOUT,2015)V,VDOT,IRES(1),HIL(1),IRES(2),HIL(2)                LUM08090  231800000
 2015 FORMAT(*0FLUID DATA     V=*,E15.8,*  VDOT=*,E15.8/                  LUM08100  231900000
     * (* FLUID HEIGHT IN RES(*,I3,*)=*,E15.8))                           LUM08110  232000000
 2020 IF(NMLM.EQ.0)GO TO 2030                                             LUM08120  232100000
      DO 2021 I=1,8                                                       LUM08130  232200000
      IF(MLM(I).EQ.0 .OR. I.EQ.2)GO TO 2021                               LUM08140  232300000
      WRITE(IOUT,2022)I,((UJ0(J,L,I),J=1,3),L=1,3)                        LUM08150  232400000
 2022 FORMAT(*0MOTION OF MOVING MASS*,I3/* UJ  =*,3E17.7/* UJD =*,3E17.7LUM08160  232500000
     */* UJDD=*,3E17.7)                                                   LUM08170  232600000
 2021 CONTINUE                                                            LUM08180  232700000
 2030 IF(MLM(2).EQ.0)GO TO 2040                                           LUM08190  232800000
      IF(T.EQ.0.)GO TO 2041                                               LUM08200  232900000
      WRITE(IOUT,2031)UJ3,UJD23,YDOTCN(5),ERRDDX,XXCS                     LUM08210  233000000
 2031 FORMAT(*0BALANCE MASS DATA*/* U(2,3)=*,E15.8,*  UDOT(2,3)=*,E15.8 LUM08220  233100000
     *,*  UDDOT(2,3)=*,E15.8/                                             LUM08230  233200000
     ** SENSOR ACCELERATION ERROR =*,E15.8/* SENSOR TO CM POS ERROR =*,  LUM08240  233300000
     *E15.8)                                                              LUM08250  233400000
      WRITE(IOUT,2048)EFILT                                               LUM08260  233500000
 2048 FORMAT(* SENSOR ACCELERATION ERROR (FILTERED) =*,E15.8)            LUM08270  233600000
      GO TO 2040                                                          LUM08280  233700000
 2041 WRITE(IOUT,2031)UJ3,UJD23,YDOTCN(5),ERRDDX                          LUM08290  233800000
 2040 CONTINUE                                                            LUM08300  233900000
      IF(IFCON.EQ.0.)GO TO 831                                            LUM08310  234000000
      WRITE(IOUT,2050)F1,F2,F3,F4,F5,F6,F7,F8,F9,F10,F11,F12,F13,F14,F15LUM08320  234100000
     *,F16,TAJ                                                            LUM08330  234200000
 2050 FORMAT(/* CONTROL SYSTEM DATA*/* JET THRUST*/                       LUM08340  234300000
     **  F1 =*,E14.7,*  F2 =*,E14.7,*  F3 =*,E14.7,                       LUM08350  234400000
     **  F4 =*,E14.7,*  F5 =*,E14.7,*  F6 =*,E14.7/                       LUM08360  234500000
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   **  F7 =*,F14.7,*  F8 =*,E14.7,*  F9 =*,E14.7,
   **  F10=*,E14.7,*  F11=*,F14.7,*  F12=*,E14.7/
   **  F13=*,E14.7,*  F14=*,F14.7,*  F15=*,E14.7,
   **  F16=*,E14.7/* CMG TORQUE =*,3E17.7)
    WRITE(IOUT,664)     NCMG
 664 FORMAT(                *   NCMG=*,I3)
    WRITE(IOUT,2060)XNEW(3),ELD3,ELDD3
2060 FORMAT(* LO3=*,E14.7,*  LO3D=*,E14.7,*  LO3DD=*,E14.7)
    WRITE(IOUT,2070)D1C,DD1C
2070 FORMAT(* SPIN SPEED COMMAND =*,E14.7/* SPIN ACCELERATION COMMAND =
   **,E14.7)
 831 CONTINUE
    MAGIN=0
    IF(IFPLT.EQ.0)GO TO 550
    NCYCLF=NCYCLE+1
    IF(NCYCLE.GT.850)GO TO 550
    WRITE(1)T,WX
    IF(IPLOUT( 1).EQ.1)WRITE(1)GAM
    IF(IPLOUT( 2).EQ.1)WRITE(1)DEL
    IF(IPLOUT( 3).EQ.1)WRITE(1)PHIST
    IF(IPLOUT( 4).EQ.1)WRITE(1)(Q(I,N1),I=1,3)
    IF(IPLOUT( 5).EQ.1)WRITE(1)(TH(I,N2),I=1,3)
    IF(IPLOUT( 6).EQ.1)WRITE(1)(Q(I,N3),I=1,3)
    IF(IPLOUT( 7).EQ.1)WRITE(1)(TH(I,N4),I=1,3)
    IF(IPLOUT( 8).EQ.1)WRITE(1)(Q(I,N5),I=1,3)
    IF(IPLOUT( 9).EQ.1)WRITE(1)XNEW(3),XNEW(6),XNEW(9)
    IF(IPLOUT(10).EQ.1)WRITE(1)U13MO,U23MO    ,XXCS
    IF(IPLOUT(11).EQ.1)WRITE(1)V,VDOT,HIL(1)
    IF(IPLOUT(12).EQ.1)WRITE(1)(FTL(I,I6),I=1,3)
    IF(IPLOUT(13).EQ.1)WRITE(1)(FTL(I,I7),I=4,6)
    GO TO 550
C
C  TRANSFORM COORDINATES
C
 600 IF(KLUE.NE.4)GO TO 700
    DO 610 I=1,3
    RDOT(I)=YPRED(I)
    WX(I)=YPRED(I+3)
    XDD(I)=YDOT(I)
    XDD(I+3)=YDOT(I+3)
    J=I+NEQ
    R(I)=YPRED(J)
    GAM(I)=YPRED(J+3)
 610 WY(I)=-YPRED(I+3)
    WY(1)=-WY(1)
    GO TO 999
 700 DO 710 I=1,3
    RDOT(I)=YPRED(I)
    WX(I)=YPRED(I+3)
    J=I+NEQ
    R(I)=YPRED(J)
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      GAM(I)=YPRED(J+3)                                                 LUM08880   239700000
      NQ=NMLAB+6+I                                                      LUM08890   239800000
      IF(KLUE.EQ.2 .OR. KLUE.EQ.5)NQ=I+6                                           239900000
      DELRBD(I)=YPRED(NQ)                                               LUM08900   240000000
      WY(I)=YPRED(NQ+3)                                                 LUM08910   240100000
      NQ=NQ+NEQ                                                         LUM08920   240200000
      DELRB(I)=YPRED(NQ)                                                LUM08930   240300000
  710 ETAST(I)=YPRED(NQ+3)                                              LUM08940   240400000
  716 IF(KLAB.EQ.1)GO TO 998                                            LUM08950   240500000
      CALL MPRD(RMODE, PRED(7),B       ,NL6,NMLAB,1,600,1)              LUM08960   240600000
      CALL MPRD(RMODE, PRED(NEQ+7),C  ,NL6,NMLAB,1,600,1)               LUM08970   240700000
      DO 740 I=1,NMLAB                                                  LUM08980   240800000
      IJ=NEQ+I+6                                                        LUM08990   240900000
      VEC(I,1)=YPRED(IJ)                                                LUM09000   241000000
  740 VEC(I,2)=YPRED(I+6)                                               LUM09010   241100000
      DO 750 I=1,NLAB                                                   LUM09020   241200000
      ISIX=6*(I-1)                                                      LUM09030   241300000
      DO 750 J=1,3                                                      LUM09040   241400000
      IJ=ISIX+J                                                         LUM09050   241500000
      QD(J,I)=B(IJ)                                                     LUM09060   241600000
      THD(J,I)=B(IJ+3)                                                  LUM09070   241700000
      Q(J,I)=C(IJ)                                                      LUM09080   241800000
  750 TH(J,I)=C(IJ+3)                                                   LUM09090   241900000
  998 IF(KLUE.GT.2)GO TO 999                                            LUM09100   242000000
      NQ=NMLAB+13                                                       LUM09110   242100000
      IF(KLUE.EQ.2)NQ=13                                                           242200000
      CALL MPRD(SMODE, PRED(NQ),B,NC6,NMCW,1,600,1)                     LUM09120   242300000
      CALL MPRD(SMODE, PRED(NEQ+NQ),C,NC6,NMCW,1,600,1)                 LUM09130   242400000
      DO 760 I=1,NMCW                                                   LUM09140   242500000
      IJ=I+NMLAB+12                                                     LUM09150   242600000
      IF(KLUE.EQ.2)IJ=I+12                                                         242700000
      VECBAR(I,1)=YPRED(IJ+NEQ)                                         LUM09160   242800000
  760 VECBAR(I,2)=YPRED(IJ)                                             LUM09170   242900000
      DO 775 I=1,NCW                                                    LUM09180   243000000
      ISIX=6*(I-1)                                                      LUM09190   243100000
      DO 775 J=1,3                                                      LUM09200   243200000
      IJ=ISIX+J                                                         LUM09210   243300000
      QBD(J,I)=B(IJ)                                                    LUM09220   243400000
      THBD(J,I)=B(IJ+3)                                                 LUM09230   243500000
      QB(J,I)=C(IJ)                                                     LUM09240   243600000
  775 THB(J,I)=C(IJ+3)                                                  LUM09250   243700000
  999 DELT=T-TOLD                                                       LUM09260   243800000
      RETURN                                                            LUM09270   243900000
      END                                                               LUM09280   244000000
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      SUBROUTINE LAST(NLAB,NCW)                                          LUM09290   244100000
      COMMON T,R(3),RDOT(3),XIDEN(3,3),RHO,A,H1(3),H2(3),H3(3),H4(3),    LUM09300   244200000
     *       G1(3,3),G2(3,3),G3(3,3),G4(3,3),G5(3,3),H5(3)               LUM09310   244300000
      COMMON /BIG/PIETA(3,3),PIGAM(3,3),SUM(4),SGAM(3,3),SETA(3,3)       LUM09320   244400000
      COMMON /LABOR/WX(3),RI(3,100),Q(3,100),QDOT(3,100),TH(3,100),     LUM09330   244500000
     *             THD(3,100)                                            LUM09340   244600000
      COMMON /CWT/RB(3),RBDOT(3),ETA(3),WY(3),RA(3,100),QB(3,100),      LUM09350   244700000
     *            QBD(3,100),THB(3,100),THBD(3,100)                      LUM09360   244800000
      COMMON /CONECT/IPT,S(3),IAPT,SB(3),DEL(3),DELD(3),PHIST(3),       LUM09370   244900000
     *        PHISTD(3),DELRB(3),DELRBD(3),GAM(3),GAMD(3),ETAST(3),      LUM09380   245000000
     *       ETASTD(3),PZB(3),FLL(3),ELLD(3)                             LUM09390   245100000
      COMMON /NEWCOM/EL(3),ELD(3),ELDD(3),ROB(3),ROBD(3),ROBDD(3),      LUM09400   245200000
     *                VEC(30),PIBETA(3,3),IFDEPL                         LUM09410   245300000
C*   STEP 79                                                             LUM09420   245400000
      ETA(1)=ETAST(1)+3.141592653                                        LUM09430   245500000
      ETA(2)=ETAST(2)                                                    LUM09440   245600000
      ETA(3)=ETAST(3)                                                    LUM09450   245700000
C*   STEP 80                                                             LUM09460   245800000
      CALL SSIN(ETA,G2,-1)                                               LUM09470   245900000
      CALL SSIN(GAM,G3,-1)                                               LUM09480   246000000
C*   STEP 81                                                             LUM09490   246100000
      CALL PIF(ETAST,G1)                                                 LUM09500   246200000
C*   STEP 82                                                             LUM09510   246300000
      CALL SCALR(-1.,G1,PIETA,3)                                         LUM09520   246400000
      CALL SCALR(-1.,PIETA,PIETA,1)                                      LUM09530   246500000
C*   STEP 83                                                             LUM09540   246600000
      CALL MULT(G3,WX,GAMD,1)                                            LUM09550   246700000
C*   STEP 84                                                             LUM09560   246800000
      CALL MULT(PIETA,WX,H1,1)                                           LUM09570   246900000
      CALL SUBTR(WY,H1,H1,1)                                             LUM09580   247000000
      CALL MULT(G2,H1,ETASTD,1)                                          LUM09590   247100000
C*   STEP 85                                                             LUM09600   247200000
      IF(IFDEPL .EQ. 0)GO TO 20                                          LUM09610   247300000
      CALL LLDLDD                                                        LUM09620   247400000
C*   STEP 86                                                             LUM09630   247500000
      CALL MTRAN(PIBETA,EL,ROB,1)                                        LUM09640   247600000
      CALL MTRAN(PIBETA,ELD,ROBD,1)                                      LUM09650   247700000
      CALL MTRAN(PIBETA,ELDD,ROBDD,1)                                    LUM09660   247800000
      CALL SCALR(-1.,ROBD,ROBD,1)                                        LUM09670   247900000
      CALL SCALR(-1.,ROBCD,ROBDD,1)                                      LUM09680   248000000
      CALL ADD(S,RI(1,IPT),H1,1)                                         LUM09690   248100000
      H1(1)=-H1(1)                                                       LUM09700   248200000
      CALL ADD(SB,RA(1,IAPT),H2,1)                                       LUM09710   248300000
      DO 10 I=1,3                                                        LUM09720   248400000
   10 ROB(I)=-ROB(I)-H1(I)-H2(I)                                         LUM09730   248500000
C*   STEP 87                                                             LUM09740   248600000
   20 CALL ADD(ROB,DELRB,RB,1)                                           LUM09750   248700000
      CALL ADD(ROBD,DELRBD,RBDOT,1)                                      LUM09760   248800000
C*   STEP 88                                                             LUM09770   248900000
```

4

```
      CALL GAMMA(TH(1,IPT),G2)                                          LUM09780   249000000
      CALL GAMMA(THB(1,IAPT),G3)                                        LUM09790   249100000
      CALL GAMMA(THD(1,IPT),G4)                                         LUM09800   249200000
      CALL GAMMA(THBD(1,IAPT),G5)                                       LUM09810   249300000
C*    STEP 89                                                           LUM09820   249400000
      DO 30 I=1,3                                                       LUM09830   249500000
      H1(I)=SIN(ETAST(I)/2.)                                            LUM09840   249600000
      H1(I)=H1(I)*H1(I)                                                 LUM09850   249700000
      H2(I)=SIN(ETAST(I))                                               LUM09860   249800000
   30 H3(I)=COS(ETAST(I))                                               LUM09870   249900000
      G1(1,1)=2.*(2.*H1(2)*H1(3)-H1(2)-H1(3))                           LUM09880   250000000
      G1(1,2)=-(H2(3)*H3(1)+H3(3)*H2(2)*H2(1))                          LUM09890   250100000
      G1(1,3)=-(H2(3)*H2(1)-H3(3)*H2(2)*H3(1))                          LUM09900   250200000
      G1(2,1)=-H2(3)*H3(2)                                              LUM09910   250300000
      G1(2,2)=-(2.*(2.*H1(1)*H1(3)-H1(1)-H1(3)-H2(1)*H2(2)*H2(3)))      LUM09920   250400000
      G1(2,3)=-(H3(3)*H2(1)+H2(3)*H2(2)*H3(1))                          LUM09930   250500000
      G1(3,1)=H2(2)                                                     LUM09940   250600000
      G1(3,2)=H3(2)*H2(1)                                               LUM09950   250700000
      G1(3,3)=-2.*(2.*H1(1)*H1(2)-H1(1)-H1(2))                          LUM09960   250800000
C*    STEP 90                                                           LUM09970   250900000
      CALL MULT(G2,S,H4,1)                                              LUM09980   251000000
      DO 40 I=1,3                                                       LUM09990   251100000
   40 H2(I)=RI(I,IPT)+Q(I,IPT)+S(I)+H4(I)                               LUM10000   251200000
      CALL MULT(PIETA,H2,H1,1)                                          LUM10010   251300000
      DO 50 I=1,3                                                       LUM10020   251400000
   50 H2(I)=H1(I)-RB(I)-RA(I,IAPT)-QB(I,IAPT)                           LUM10030   251500000
      CALL MULT(G3,H2,H3,1)                                             LUM10040   251600000
      CALL ADD(Q(1,IPT),H4,H4,1)                                        LUM10050   251700000
      CALL MULT(PIETA,H4,H2,1)                                          LUM10060   251800000
      CALL ADD(RI(1,IPT),S,H5,1)                                        LUM10070   251900000
      CALL MULT(G1,H5,H4,1)                                             LUM10080   252000000
      DO 60 I=1,3                                                       LUM10090   252100000
   60 H5(I)=-DELRB(I)+H4(I)-QB(I,IAPT)+H2(I)-H3(I)                      LUM10100   252200000
      CALL MULT(PIBETA,H5,DEL,1)                                        LUM10110   252300000
C*    STEP 91                                                           LUM10120   252400000
      CALL SSIN(ETA,SETA,1)                                             LUM10130   252500000
      CALL SSIN(GAM,SGAM,1)                                             LUM10140   252600000
      CALL PIF(GAM,PIGAM)                                               LUM10150   252700000
C*    STEP 92                                                           LUM10160   252800000
      CALL ADD(EL,DEL,H2,1)                                             LUM10170   252900000
      CALL SCALR(1.,H2,ELL,1)                                           LUM10180   253000000
C*    STEP 93                                                           LUM10190   253100000
      CALL MULT(SETA,ETASTD,H3,1)                                       LUM10200   253200000
      CALL GAMMA(H3,G1)                                                 LUM10210   253300000
      CALL MULT(G1,H1,H4,1)                                             LUM10220   253400000
      CALL MULT(G4,S,H1,1)                                              LUM10230   253500000
      CALL ADD(H1,QDOT(1,IPT),H1,1)                                     LUM10240   253600000
      CALL MULT(PIETA,H1,H5,1)                                          LUM10250   253700000
      CALL MTRAN(PIBETA,H2,H1,1)                                        LUM10260   253800000
      CALL ADD(H1,SB,H1,1)                                              LUM10270   253900000
      CALL MULT(G5,H1,H2,1)                                             LUM10280   254000000
```

```
      DO 70 I=1,3                                              LUM10290   254100000
   70 H1(I)=-H2(I)-RBDOT(I)-QBD(I,IAPT)-H4(I)+H5(I)            LUM10300   254200000
      CALL MULT(G3,H1,H2,1)                                    LUM10310   254300000
      CALL SUBTR(H1,H2,H1,1)                                   LUM10320   254400000
      CALL MULT(PIBETA,H1,H2,1)                                LUM10330   254500000
      CALL SCALR(1.,H2,ELLD,1)                                 LUM10340   254600000
C*  STEP 94                                                    LUM10350   254700000
      CALL SUBTR(H2,ELD,DELD,1)                                LUM10360   254800000
C*  STEP 95                                                    LUM10370   254900000
      DO 80 I=1,3                                              LUM10380   255000000
      DO 80 J=1,3                                              LUM10390   255100000
      G4(I,J)=0.                                               LUM10400   255200000
      DO 80 K=1,3                                              LUM10410   255300000
      G=G3(I,K)                                                LUM10420   255400000
      IF(I.EQ.K)G=G+1.                                         LUM10430   255500000
   80 G4(I,J)=G4(I,J)+G*PIBETA(J,K)                            LUM10440   255600000
      CALL MTRAN(PIETA,G4,G1,3)                                LUM10450   255700000
      CALL MULT (G2,G1,G4,3)                                   LUM10460   255800000
      CALL SUBTR(G1,G4,G4,3)                                   LUM10470   255900000
      DO 90 I=2,3                                              LUM10480   256000000
      DO 90 J=1,3                                              LUM10490   256100000
   90 G4(I,J)=-G4(I,J)                                         LUM10500   256200000
      CALL MULT(PIBETA,G4,G1,3)                                LUM10510   256300000
C*  STEP 96                                                    LUM10520   256400000
      PHIST(2)=ARSIN(G1(3,1))                                  LUM10530   256500000
      G=COS(PHIST(2))                                          LUM10540   256600000
      PHIST(1)=ARSIN(-G1(3,2)/G)                               LUM10550   256700000
      PHIST(3)=ARSIN(-G1(2,1)/G)                               LUM10560   256800000
C*  STEP 97                                                    LUM10570   256900000
      CALL SSIN(PHIST,G4,-1)                                   LUM10580   257000000
C*  STEP 98                                                    LUM10590   257100000
      CALL MULT(G3,H3,H2,1)                                    LUM10600   257200000
      CALL SUBTR(H3,H2,H2,1)                                   LUM10610   257300000
      CALL ADD(H2,THBD(1,IAPT),H2,1)                           LUM10620   257400000
      CALL MULT(PIBETA,H2,H1,1)                                LUM10630   257500000
      CALL MULT(G1,H1,H2,1)                                    LUM10640   257600000
      H1(1)=THD (1,IPT)                                        LUM10650   257700000
      H1(2)=-THD (2,IPT)                                       LUM10660   257800000
      H1(3)=-THD (3,IPT)                                       LUM10670   257900000
      CALL MULT(PIBETA,H1,H3,1)                                LUM10680   258000000
      CALL SUBTR(H3,H2,H2,1)                                   LUM10690   258100000
      CALL MULT(G4,H2,PHISTD,1)                                LUM10700   258200000
      RETURN                                                   LUM10710   258300000
      END                                                      LUM10720   258400000
```

```
      SUBROUTINE SUBTR(A,B,C,N)                                          LUM10730   258500000
      DIMENSION A(3,N),B(3,N),C(3,N)                                     LUM10740   258600000
      DO 10 I=1,3                                                        LUM10750   258700000
      DO 10 J=1,N                                                        LUM10760   258800000
   10 C(I,J)=A(I,J)-B(I,J)                                               LUM10770   258900000
      RETURN                                                             LUM10780   259000000
      END                                                                LUM10790   259100000
```

```
      SUBROUTINE MULT(A,B,C,N)                                          LUM10800    259200000
      DIMENSION A(3,3),B(3,N),C(3,N)                                    LUM10810    259300000
      DO 10 I=1,3                                                       LUM10820    259400000
      DO 10 J=1,N                                                       LUM10830    259500000
      C(I,J)=0.                                                         LUM10840    259600000
      DO 10 K=1,3                                                       LUM10850    259700000
   10 C(I,J)=C(I,J)+A(I,K)*B(K,J)                                       LUM10860    259800000
      RETURN                                                            LUM10870    259900000
      END                                                               LUM10880    260000000
```

```
      SUBROUTINE ADD(A,B,C,N)                                          LUM10890   260100000
      DIMENSION A(3,N),B(3,N),C(3,N)                                   LUM10900   260200000
      DO 10 I=1,3                                                      LUM10910   260300000
      DO 10 J=1,N                                                      LUM10920   260400000
   10 C(I,J)=A(I,J)+B(I,J)                                             LUM10930   260500000
      RETURN                                                           LUM10940   260600000
      END                                                              LUM10950   260700000
```

```
      SUBROUTINE SCALR(S,A,B,N)                                         LUM10960   260800000
      DIMENSION A(3,N),B(3,N)                                           LUM10970   260900000
      DO 10 I=1,3                                                       LUM10980   261000000
      DO 10 J=1,N                                                       LUM10990   261100000
   10 B(I,J)=A(I,J)*S                                                   LUM11000   261200000
      RETURN                                                            LUM11010   261300000
      END                                                               LUM11020   261400000
```

```
      SUBROUTINF PIF(A,B)                                   LUMI1030   261500000
      DIMENSION A(3),B(9),C(6)                              LUMI1040   261600000
      DO 10 I=1,3                                           LUMI1050   261700000
      C(I)=COS(A(I))                                        LUMI1060   261800000
   10 C(I+3)=SIN(A(I))                                      LUMI1070   261900000
      B(1)=C(3)*C(2)                                        LUMI1080   262000000
      B(2)=-C(6)*C(2)                                       LUMI1090   262100000
      B(3)=C(5)                                             LUMI1100   262200000
      B(4)=C(6)*C(1)+C(4)*C(5)*C(3)                         LUMI1110   262300000
      B(5)=C(3)*C(1)-C(5)*C(6)*C(4)                         LUMI1120   262400000
      B(6)=-C(2)*C(4)                                       LUMI1130   262500000
      B(7)=C(6)*C(4)-C(5)*C(3)*C(1)                         LUMI1140   262600000
      B(8)=C(3)*C(4)+C(5)*C(6)*C(1)                         LUMI1150   262700000
      B(9)=C(1)*C(2)                                        LUMI1160   262800000
      RETURN                                                LUMI1170   262900000
      END                                                   LUMI1180   263000000
```

```
      SUBROUTINE PTLP(A,B,C)                                LUM11190   263100000
      DIMENSION A(3,3),B(3),C(3,3)                          LUM11200   263200000
      DO 10 I=1,3                                           LUM11210   263300000
      DO 10 J=1,3                                           LUM11220   263400000
      C(I,J)=0.                                             LUM11230   263500000
      DO 10 K=1,3                                           LUM11240   263600000
   10 C(I,J)=C(I,J)+B(K)*A(K,I)*A(K,J)                      LUM11250   263700000
      RETURN                                                LUM11260   263800000
      END                                                   LUM11270   263900000
```

```
      SUBROUTINE MTRAN(A,B,C,N)                              LUM11280   264000000
      DIMENSION A(3,3),B(3,1),C(3,1)                         LUM11290   264100000
      DO 10 I=1,3                                            LUM11300   264200000
      DO 10 J=1,N                                            LUM11310   264300000
      C(I,J)=0.                                              LUM11320   264400000
      DO 10 K=1,3                                            LUM11330   264500000
   10 C(I,J)=C(I,J)+A(K,I)*B(K,J)                            LUM11340   264600000
      RETURN                                                 LUM11350   264700000
      END                                                    LUM11360   264800000
```

```
      FUNCTION DOTP(A,B)                                               LUM11370   264900000
      DIMENSION A(3),B(3)                                              LUM11380   265000000
      DOTP=A(1)*B(1)+A(2)*B(2)+A(3)*B(3)                               LUM11390   265100000
      RETURN                                                           LUM11400   265200000
      END                                                              LUM11410   265300000
```

```
      SUBROUTINE XADD(A,B,C,M,N,ID1,ID2)                          LUM11420   265400000
      DIMENSION A(ID1,1),B(ID2,1),C(ID2,1)                        LUM11430   265500000
      DO 10 I=1,M                                                 LUM11440   265600000
      DO 10 J=1,N                                                 LUM11450   265700000
   10 C(I,J)=A(I,J)+B(I,J)                                        LUM11460   265800000
      RETURN                                                      LUM11470   265900000
      END                                                         LUM11480   266000000
```

```
      SUBROUTINE XMPRD(A,B,C,N,M,K,NDIM1,NDIM2,NDIM3)                   LUM11490   266100000
      DIMENSION A(NDIM1,1),B(NDIM2,1),C(NDIM3,1)                        LUM11500   266200000
      DO 10 I=1,N                                                       LUM11510   266300000
      DO 10 J=1,K                                                       LUM11520   266400000
      C(I,J)=0.                                                         LUM11530   266500000
      DO 10 L=1,M                                                       LUM11540   266600000
   10 C(I,J)=C(I,J)+A(I,L)*B(L,J)                                       LUM11550   266700000
      RETURN                                                            LUM11560   266800000
      END                                                               LUM11570   266900000
```

```
      SUBROUTINE XTPRD(A,B,C,N,M,K,IDIM1,IDIM2,IDIM3)                   LUM11580    267000000
      DIMENSION A(IDIM1,1),B(IDIM2,1),C(IDIM3,1)                        LUM11590    267100000
      DO 10 I=1,M                                                       LUM11600    267200000
      DO 10 J=1,K                                                       LUM11610    267300000
      C(I,J)=0.                                                         LUM11620    267400000
      DO 10 L=1,N                                                       LUM11630    267500000
   10 C(I,J)=C(I,J)+A(L,I)*B(L,J)                                       LUM11640    267600000
      RETURN                                                            LUM11650    267700000
      END                                                               LUM11660    267800000
```

```
      SUBROUTINE SSIN(A,B,KLUE)                          LUM11670   267900000
      DIMENSION A(3),B(3,3)                              LUM11680   268000000
      B(1,3)=0.                                          LUM11690   268100000
      B(2,3)=0.                                          LUM11700   268200000
      S2=SIN(A(2))                                       LUM11710   268300000
      S3=SIN(A(3))                                       LUM11720   268400000
      C2=COS(A(2))                                       LUM11730   268500000
      C3=COS(A(3))                                       LUM11740   268600000
      B(3,3)=1.                                          LUM11750   268700000
      B(2,2)=C3                                          LUM11760   268800000
      IF(KLUE.LT.0)GO TO 10                              LUM11770   268900000
      B(1,1)=C3*C2                                       LUM11780   269000000
      B(1,2)=S3                                          LUM11790   269100000
      B(3,1)=S2                                          LUM11800   269200000
      B(3,2)=0.                                          LUM11810   269300000
      B(2,1)=-S3*C2                                      LUM11820   269400000
      GO TO 20                                           LUM11830   269500000
   10 B(1,1)=C3/C2                                       LUM11840   269600000
      B(1,2)=-S3/C2                                      LUM11850   269700000
      B(3,1)=-C3*S2/C2                                   LUM11860   269800000
      B(3,2)=S3*S2/C2                                    LUM11870   269900000
      B(2,1)=S3                                          LUM11880   270000000
   20 RETURN                                             LUM11890   270100000
      END                                                LUM11900   270200000
```

G

```
      SUBROUTINE XMCPY(A,B,N,M,K)                                       LUM11910   270300000
      DIMENSION A(K,1),B(52,1)                                          LUM11920   270400000
      DO 10 I=1,N                                                       LUM11930   270500000
      DO 10 J=1,M                                                       LUM11940   270600000
   10 B(I,J)=A(I,J)                                                     LUM11950   270700000
      RETURN                                                            LUM11960   270800000
      END                                                               LUM11970   270900000
```

```
      SUBROUTINE MCPY(A,B,N,M,NDIM)                                     LUM11980   271000000
      DIMENSION A(NDIM,1),B(NDIM,1)                                     LUM11990   271100000
      DO 10 I=1,N                                                       LUM12000   271200000
      DO 10 J=1,M                                                       LUM12010   271300000
   10 B(I,J)=A(I,J)                                                     LUM12020   271400000
      RETURN                                                            LUM12030   271500000
      END                                                               LUM12040   271600000
```

```
      SUBROUTINE MPRD(A,B,C,N,M,K,NDIM1,NDIM2)                    LUM12050   271700000
      DIMENSION A(NDIM1,1),B(NDIM2,1),C(NDIM1,1)                  LUM12060   271800000
      DO 10  I=1,N                                                LUM12070   271900000
      DO 10  J=1,K                                                LUM12080   272000000
      C(I,J)=0.                                                   LUM12090   272100000
      DO 10  L=1,M                                                LUM12100   272200000
   10 C(I,J)=C(I,J)+A(I,L)*B(L,J)                                 LUM12110   272300000
      RETURN                                                      LUM12120   272400000
      END                                                         LUM12130   272500000
```

```
      SUBROUTINE TPRD(A,B,C,N,M,K,IDIM1,IDIM2)
      DIMENSION A(IDIM1,1),B(IDIM1 ,1),C(IDIM2,1)
      DO 10 I=1,M
      DO 10 J=1,K
      C(I,J)=0.
      DO 10 L=1,N
   10 C(I,J)=C(I,J)+A(L,I)*B(L,J)
      RETURN
      END
```

```
      SUBROUTINE INCH (A,MO,Y,NIX)
C
C  INVERSION OF POSITIVE DEFINITE REAL SYMMETRIC MATRIX A.  A IS ASSUMED
C  TO BE STORED BY ROWS IN LOWER TRIANGULAR FORM. THE INVERSE IS STORED
C  OVER A.
      COMMON /BOND/ M,K  /WINTER/ KOLD
      COMMON /OPT2/ PRINT
      REAL A(1),Y(1)
   10 FORMAT ( 8H1INVERSE/1H0)
   20 FORMAT (I5,1P6E20.7/(5X,1P6E20.7))
      IF (PRINT .GT. 0.) WRITE (6,10)
      KOLD = 0
      M = IABS(MO)
      CALL FUTILE(A,M,NIX)
      IF (NIX) 120,100,100
  100 KK = 0
      K1 = 1
      DO 115  K = 1,M
      KK = KK + K
      DO 105  I = K,M
  105 Y(I) = 0.
      Y(K) = 1.
      CALL TRIEQ(A(K1),Y)
      IK = KK
      DO 110  I = K,M
      A(IK) = Y(I)
      IK = IK + I
  110 CONTINUE
      IF (PRINT .GT. 0.) WRITE (6,20) K,(Y(I), I = K,M)
  115 K1 = K1 + K
  120 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GAMMA(A,B)                                             LUM12560   276800000
      DIMENSION A(3),B(3,3)                                             LUM12570   276900000
      DO 10 I=1,3                                                       LUM12580   277000000
   10 B(I,I)=0.                                                         LUM12590   277100000
      B(1,2)=-A(3)                                                      LUM12600   277200000
      B(2,1)=A(3)                                                       LUM12610   277300000
      B(1,3)=A(2)                                                       LUM12620   277400000
      B(3,1)=-A(2)                                                      LUM12630   277500000
      B(2,3)=-A(1)                                                      LUM12640   277600000
      B(3,2)=A(1)                                                       LUM12650   277700000
      RETURN                                                            LUM12660   277800000
      END                                                               LUM12670   277900000
```

```
      SUBROUTINE PLO3AX                                                 LUM12680  278000000
      COMMON VAR,SCPT,TPL,PLT1,PLT2,PLT3,PLT4,PLT5,PLT6,                LUM12690  278100000
     *           PLT7,PLT8,PLT9,PLT10,PLT11,PLT12                       LUM12700  278200000
      DIMENSION TPL(852),PLT1(852),PLT2(852),PLT3(852),PLT4(852),       LUM12     278300000
     1           PLT5(852),PLT6(852),PLT7(852),PLT8(852),PLT9(852),     LU        278400000
     2          PLT10(852),PLT11(852),PLT12(852)                                  278500000
      DIMENSION VAR(30),SCPT(50)                                        LUM12740  278600000
      COMMON /BIG/PLT13(852),PLT14(852),PLT15(852),PLT16(852),PLT17(852)LUM12750  278700000
     *            ,PLT18(852),PLT19(852),PLT20(852),PLT21(852),         LUM12760  278800000
     *             PLT22(852),PLT23(852),PLT24(852)                     LUM12770  278900000
      EQUIVALENCE (VAR(1 ),DYP1 ),(VAR(2 ),DYP2 ),(VAR(3 ),DYP3 ),      LUM12780  279000000
     1            (VAR(4 ),DYP4 ),(VAR(5 ),DYP5 ),(VAR(6 ),DYP6 ),      LUM12790  279100000
     1            (VAR(7 ),DYP7 ),(VAR(8 ),DYP8 ),(VAR(9 ),DYP9 ),      LUM12800  279200000
     1            (VAR(10),DYP10),(VAR(11),DYP11),(VAR(12),DYP12),      LUM12810  279300000
     1            (VAR(13),DYP13),(VAR(14),DYP14),(VAR(15),DYP15),      LUM12820  279400000
     1            (VAR(16),DYP16),(VAR(17),DYP17),(VAR(18),DYP18),      LUM12830  279500000
     1            (VAR(19),DYP19),(VAR(20),DYP20),(VAR(21),DYP21)       LUM12840  279600000
     1           ,(VAR(22),DYP22),(VAR(23),DYP23),(VAR(24),DYP24)       LUM12850  279700000
      NC=1                                                              LUM12860  279800000
      JL=0.                                                                       279900000
      S=0.                                                                        280000000
      BCD=0.                                                                      280100000
      REWIND 1                                                          LUM12870  280200000
      READ(1)NRUN,PBLOCK,TEND,DTPLOT                                    LUM12880  280300000
      NPOINT=1                                                          LUM12890  280400000
   10 READ(1)       TPL(NPOINT),PLT1(NPOINT),PLT2(NPOINT),PLT3(NPOINT)  LUM12900  280500000
      IF(EOF,1)20,101                                                             280600000
  101 CONTINUE                                                                    280700000
      IF(PBLOCK.EQ.1.)GO TO 15                                          LUM12910  280800000
      READ(1)       PLT4(NPOINT),PLT5(NPOINT),PLT6(NPOINT)                        280900000
      IF(EOF,1)20,102                                                             281000000
  102 CONTINUE                                                                    281100000
      IF(PBLOCK.EQ.2.)GO TO 15                                          LUM12930  281200000
      READ(1)       PLT7(NPOINT),PLT8(NPOINT),PLT9(NPOINT)                        281300000
      IF(EOF,1)20,103                                                             281400000
  103 CONTINUE                                                                    281500000
      IF(PBLOCK.EQ.3.)GO TO 15                                          LUM12950  281600000
      READ(1)       PLT10(NPOINT),PLT11(NPOINT),PLT12(NPOINT)                     281700000
      IF(EOF,1)20,104                                                             281800000
  104 CONTINUE                                                                    281900000
      IF(PBLOCK.EQ.4.)GO TO 15                                          LUM12970  282000000
      READ(1)       PLT13(NPOINT),PLT14(NPOINT),PLT15(NPOINT)                     282100000
      IF(EOF,1)20,105                                                             282200000
  105 CONTINUE                                                                    282300000
      IF(PBLOCK.EQ.5.)GO TO 15                                          LUM12990  282400000
      READ(1)       PLT16(NPOINT),PLT17(NPOINT),PLT18(NPOINT)                     282500000
      IF(EOF,1)20,106                                                             282600000
  106 CONTINUE                                                                    282700000
      IF(PBLOCK.EQ.6.)GO TO 15                                          LUM13010  282800000
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      READ(1)       PLT19(NPOINT),PLT20(NPOINT),PLT21(NPOINT)                         282900000
      IF(EOF,1)20,107                                                                 283000000
  107 CONTINUE                                                                        283100000
      IF(PBLOCK.EQ.7.)GO TO 15                                             LUM13030   283200000
      READ(1)       PLT22(NPOINT),PLT23(NPOINT),PLT24(NPOINT)                         283300000
      IF(EOF,1)20,108                                                                 283400000
  108 CONTINUE                                                                        283500000
   15 NPOINT=NPOINT+1                                                      LUM13050   283600000
      GO TO 10                                                             LUM13060   283700000
   20 NPOINT=NPOINT-1                                                      LUM13070   283800000
      REWIND 1                                                             LUM13080   283900000
      DO 67 I=1,24                                                         LUM13090   284000000
   67 VAR(I)=0.0                                                           LUM13100   284100000
      SCPT(1)=0.0001                                                       LUM13110   284200000
      SCPT(2)=0.0002                                                       LUM13120   284300000
      SCPT(3)=0.0004                                                       LUM13130   284400000
      SCPT(4)=0.0006                                                       LUM13140   284500000
      SCPT(5)=0.0008                                                       LUM13150   284600000
      SCPT(6)=0.001                                                        LUM13160   284700000
      SCPT(7)=0.002                                                        LUM13170   284800000
      SCPT(8)=0.004                                                        LUM13180   284900000
      SCPT(9)=0.006                                                        LUM13190   285000000
      SCPT(10)=0.008                                                       LUM13200   285100000
      SCPT(11)=0.01                                                        LUM13210   285200000
      SCPT(12)=0.02                                                        LUM13220   285300000
      SCPT(13)=0.04                                                        LUM13230   285400000
      SCPT(14)=0.06                                                        LUM13240   285500000
      SCPT(15)=0.08                                                        LUM13250   285600000
      SCPT(16)=0.1                                                         LUM13260   285700000
      SCPT(17)=0.2                                                         LUM13270   285800000
      SCPT(18)=0.4                                                         LUM13280   285900000
      SCPT(19)=0.6                                                         LUM13290   286000000
      SCPT(20)=0.8                                                         LUM13300   286100000
      SCPT(21)=1.0                                                         LUM13310   286200000
      SCPT(22)=2.0                                                         LUM13320   286300000
      SCPT(23)=4.0                                                         LUM13330   286400000
      SCPT(24)=6.0                                                         LUM13340   286500000
      SCPT(25)=8.0                                                         LUM13350   286600000
      SCPT(26)=10.0                                                        LUM13360   286700000
      SCPT(27)=20.0                                                        LUM13370   286800000
      SCPT(28)=40.0                                                        LUM13380   286900000
      SCPT(29)=60.0                                                        LUM13390   287000000
      SCPT(30)=80.0                                                        LUM13400   287100000
      SCPT(31)=100.0                                                       LUM13410   287200000
      SCPT(32)=200.0                                                       LUM13420   287300000
      SCPT(33)=400.0                                                       LUM13430   287400000
      SCPT(34)=600.0                                                       LUM13440   287500000
      SCPT(35)=800.0                                                       LUM13450   287600000
      SCPT(36)=1000.0                                                      LUM13460   287700000
      SCPT(37)=2000.0                                                      LUM13470   287800000
      SCPT(38)=4000.0                                                      LUM13480   287900000
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      SCPT(39)=6000.0                                                   LUM13490   288000000
      SCPT(40)=8000.0                                                   LUM13500   288100000
      SCPT(41)=10000.0                                                  LUM13510   288200000
      SCPT(42)=20000.0                                                  LUM13520   288300000
      SCPT(43)=40000.0                                                  LUM13530   288400000
      SCPT(44)=60000.0                                                  LUM13540   288500000
      SCPT(45)=80000.0                                                  LUM13550   288600000
      SCPT(46)=100000.0                                                 LUM13560   288700000
      SCPT(47)=1.E6                                                     LUM13570   288800000
      SCPT(48)=5.E6                                                     LUM13580   288900000
      SCPT(49)=1.E7                                                     LUM13590   289000000
      SCPT(50)=1.E8                                                     LUM13600   289100000
      RUN=NRUN                                                          LUM13610   289200000
      CALL NUMBER(3.00,9.8,0.17,RUN,0.0,-1)                             LUM13620   289300000
      CALL SYMBL4(1.0,9.8,0.2,10HRUN NUMBER,0.0,10)                                289400000
      CALL SCALE(TPL,NPOINT,S,0.0,DTPLOT,1,1)                           LUM13640   289500000
      DO 8000 I=1,NPOINT                                                LUM13650   289600000
      DYP1 =AMAX1(DYP1,ABS(PLT1(I)))                                    LUM13660   289700000
      DYP2 =AMAX1(DYP2,ABS(PLT2(I)))                                    LUM13670   289800000
      DYP3 =AMAX1(DYP3,ABS(PLT3(I)))                                    LUM13680   289900000
      IF(PBLOCK.EQ.1.)GO TO 8000                                        LUM13690   290000000
      DYP4 =AMAX1(DYP4,ABS(PLT4(I)))                                    LUM13700   290100000
      DYP5 =AMAX1(DYP5,ABS(PLT5(I)))                                    LUM13710   290200000
      DYP6 =AMAX1(DYP6,ABS(PLT6(I)))                                    LUM13720   290300000
      IF(PBLOCK.EQ.2.)GO TO 8000                                        LUM13730   290400000
      DYP7 =AMAX1(DYP7,ABS(PLT7(I)))                                    LUM13740   290500000
      DYP8 =AMAX1(DYP8,ABS(PLT8(I)))                                    LUM13750   290600000
      DYP9 =AMAX1(DYP9,ABS(PLT9(I)))                                    LUM13760   290700000
      IF(PBLOCK.EQ.3.)GO TO 8000                                        LUM13770   290800000
      DYP10=AMAX1(DYP10,ABS(PLT10(I)))                                  LUM13780   290900000
      DYP11=AMAX1(DYP11,ABS(PLT11(I)))                                  LUM13790   291000000
      DYP12=AMAX1(DYP12,ABS(PLT12(I)))                                  LUM13800   291100000
      IF(PBLOCK.EQ.4.)GO TO 8000                                        LUM13810   291200000
      DYP13=AMAX1(DYP13,ABS(PLT13(I)))                                  LUM13820   291300000
      DYP14=AMAX1(DYP14,ABS(PLT14(I)))                                  LUM13830   291400000
      DYP15=AMAX1(DYP15,ABS(PLT15(I)))                                  LUM13840   291500000
      IF(PBLOCK.EQ.5.)GO TO 8000                                        LUM13850   291600000
      DYP16=AMAX1(DYP16,ABS(PLT16(I)))                                  LUM13860   291700000
      DYP17=AMAX1(DYP17,ABS(PLT17(I)))                                  LUM13870   291800000
      DYP18=AMAX1(DYP18,ABS(PLT18(I)))                                  LUM13880   291900000
      IF(PBLOCK.EQ.6.)GO TO 8000                                        LUM13890   292000000
      DYP19=AMAX1(DYP19,ABS(PLT19(I)))                                  LUM13900   292100000
      DYP20=AMAX1(DYP20,ABS(PLT20(I)))                                  LUM13910   292200000
      DYP21=AMAX1(DYP21,ABS(PLT21(I)))                                  LUM13920   292300000
      IF(PBLOCK.EQ.7.)GO TO 8000                                        LUM13930   292400000
      DYP22=AMAX1(DYP22,ABS(PLT22(I)))                                  LUM13940   292500000
      DYP23=AMAX1(DYP23,ABS(PLT23(I)))                                  LUM13950   292600000
      DYP24=AMAX1(DYP24,ABS(PLT24(I)))                                  LUM13960   292700000
 8000 CONTINUE                                                          LUM13970   292800000
      DO 8813 I=1,24                                                    LUM13980   292900000
      DO 8814 J=1,49                                                    LUM13990   293000000
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      IF(VAR(I)-SCPT(J))8815,8815,8814                                    LUM14000   293100000
 8814 CONTINUE                                                            LUM14010   293200000
 8815 VAR(I)=SCPT(J)                                                      LUM14020   293300000
 8813 CONTINUE                                                            LUM14030   293400000
      VGP1 =-7.5*DYP1                                                     LUM14040   293500000
      VGP2 =-4.5*DYP2                                                     LUM14050   293600000
      VGP3 =-1.5*DYP3                                                     LUM14060   293700000
      IF(PBLOCK.EQ.1.)GO TO 25                                            LUM14070   293800000
      VGP4 =-7.5*DYP4                                                     LUM14080   293900000
      VGP5 =-4.5*DYP5                                                     LUM14090   294000000
      VGP6 =-1.5*DYP6                                                     LUM14100   294100000
      IF(PBLOCK.EQ.2.)GO TO 25                                            LUM14110   294200000
      VGP7 =-7.5*DYP7                                                     LUM14120   294300000
      VGP8 =-4.5*DYP8                                                     LUM14130   294400000
      VGP9 =-1.5*DYP9                                                     LUM14140   294500000
      IF(PBLOCK.EQ.3.)GO TO 25                                            LUM14150   294600000
      VGP10=-7.5*DYP10                                                    LUM14160   294700000
      VGP11=-4.5*DYP11                                                    LUM14170   294800000
      VGP12=-1.5*DYP12                                                    LUM14180   294900000
      IF(PBLOCK.EQ.4.)GO TO 25                                            LUM14190   295000000
      VGP13=-7.5*DYP13                                                    LUM14200   295100000
      VGP14=-4.5*DYP14                                                    LUM14210   295200000
      VGP15=-1.5*DYP15                                                    LUM14220   295300000
      IF(PBLOCK.EQ.5.)GO TO 25                                            LUM14230   295400000
      VGP16=-7.5*DYP16                                                    LUM14240   295500000
      VGP17=-4.5*DYP17                                                    LUM14250   295600000
      VGP18=-1.5*DYP18                                                    LUM14260   295700000
      IF(PBLOCK.EQ.6.)GO TO 25                                            LUM14270   295800000
      VGP19=-7.5*DYP19                                                    LUM14280   295900000
      VGP20=-4.5*DYP20                                                    LUM14290   296000000
      VGP21=-1.5*DYP21                                                    LUM14300   296100000
      IF(PBLOCK.EQ.7.)GO TO 25                                            LUM14310   296200000
      VGP22=-7.5*DYP22                                                    LUM14320   296300000
      VGP23=-4.5*DYP23                                                    LUM14330   296400000
      VGP24=-1.5*DYP24                                                    LUM14340   296500000
   25 CONTINUE                                                            LUM14350   296600000
      CALL SCALE(PLT1 ,NPOINT,S,VGP1 ,DYP1 ,1,1)                          LUM14360   296700000
      CALL SCALE(PLT2 ,NPOINT,S,VGP2 ,DYP2 ,1,1)                          LUM14370   296800000
      CALL SCALE(PLT3 ,NPOINT,S,VGP3 ,DYP3 ,1,1)                          LUM14380   296900000
      CALL AXIS(0.0,6.5,5HPLT1 ,5,2.0,90.0,VGP1 ,DYP1 ,0)                            297000000
      CALL AXIS(0 .,3.5,5HPLT2 ,5,2.0,90.0,VGP2 ,DYP2 ,0)                            297100000
      CALL AXIS(0.0,0.5,5HPLT3 ,5,2.0,90.0,VGP3 ,DYP3 ,0)                            297200000
      TAXIS=TEND/DTPLOT                                                   LUM14420   297300000
      CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                    LUM14430   297400000
      CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)      LU        297500000
      CALL AXIS( 00,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                    LUM14450   297600000
      CALL LINE(TPL,PLT1 ,NPOINT,1,1,1,JL,S)                              LUM14460   297700000
      CALL LINE(TPL,PLT2 ,NPOINT,1,1,1,JL,S)                              LUM14470   297800000
      CALL LINE(TPL,PLT3 ,NPOINT,1,1,1,JL,S)                              LUM14480   297900000
      XNEW=TAXIS+5                                                        LUM14490   298000000
      CALL PLOT(XNEW,0.0,-3)                                              LUM14500   298100000
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      IF(PBLOCK.EQ.1.)GO TO 703                                        LUM14510   298200000
      CALL SCALE(PLT4 ,NPOINT,S,VGP4 ,DYP4 ,1,1)                       LUM14520   298300000
      CALL SCALE(PLT5 ,NPOINT,S,VGP5 ,DYP5 ,1,1)                       LUM14530   298400000
      CALL SCALE(PLT6 ,NPOINT,S,VGP6 ,DYP6 ,1,1)                       LUM14540   298500000
      CALL AXIS(0.0,6.5,5HPLT4 ,5,2.0,90.0,VGP4 ,DYP4 ,0)                         298600000
      CALL AXIS(0.0,3.5,5HPLT5 ,5,2.0,90.0,VGP5 ,DYP5 ,0)                         298700000
      CALL AXIS(0.0,0.5,5HPLT6 ,5,2.0,90.0,VGP6 ,DYP6 ,0)                         298800000
      CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                 LUM14580   298900000
      CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)             299000000
      CALL AXIS(0.0,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                 LUM14600   299100000
      CALL LINE(TPL,PLT4 ,NPOINT,1,1,1,JL,S)                           LUM14610   299200000
      CALL LINE(TPL,PLT5 ,NPOINT,1,1,1,JL,S)                           LUM14620   299300000
      CALL LINE(TPL,PLT6 ,NPOINT,1,1,1,JL,S)                           LUM14630   299400000
      XNEW=TAXIS+5                                                     LUM14640   299500000
      CALL PLOT(XNEW,0.0,-3)                                           LUM14650   299600000
      IF(PBLOCK.EQ.2.)GO TO 703                                        LUM14660   299700000
 8500 CALL SCALE(PLT7,NPOINT,S,VGP7,DYP7,1,1)                          LUM14670   299800000
      CALL SCALE(PLT8 ,NPOINT,S,VGP8 ,DYP8 ,1,1)                       LUM14680   299900000
      CALL SCALE(PLT9 ,NPOINT,S,VGP9 ,DYP9 ,1,1)                       LUM14690   300000000
      CALL AXIS(0.0,6.5,5HPLT7 ,5,2.0,90.0,VGP7 ,DYP7 ,0)                         300100000
      CALL AXIS(0.0,3.5,5HPLT8 ,5,2.0,90.0,VGP8 ,DYP8 ,0)                         300200000
      CALL AXIS(0.0,0.5,5HPLT9 ,5,2.0,90.0,VGP9 ,DYP9 ,0)                         300300000
      CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                 LUM14730   300400000
      CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)             300500000
      CALL AXIS(0.0,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                 LUM14750   300600000
      CALL LINE(TPL,PLT7 ,NPOINT,1,1,1,JL,S)                           LUM14760   300700000
      CALL LINE(TPL,PLT8 ,NPOINT,1,1,1,JL,S)                           LUM14770   300800000
      CALL LINE(TPL,PLT9 ,NPOINT,1,1,1,JL,S)                           LUM14780   300900000
      XNEW=TAXIS+5                                                     LUM14790   301000000
      CALL PLOT(XNEW,0.0,-3)                                           LUM14800   301100000
      IF(PBLOCK.EQ.3.)GO TO 703                                        LUM14810   301200000
      CALL SCALE(PLT10,NPOINT,S,VGP10,DYP10,1,1)                       LUM14820   301300000
      CALL SCALE(PLT11,NPOINT,S,VGP11,DYP11,1,1)                       LUM14830   301400000
      CALL SCALE(PLT12,NPOINT,S,VGP12,DYP12,1,1)                       LUM14840   301500000
      CALL AXIS(0.0,6.5,5HPLT10,5,2.0,90.0,VGP10,DYP10,0)                         301600000
      CALL AXIS(0.0,3.5,5HPLT11,5,2.0,90.0,VGP11,DYP11,0)                         301700000
      CALL AXIS(0.0,0.5,5HPLT12,5,2.0,90.0,VGP12,DYP12,0)                         301800000
      CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                 LUM14880   301900000
      CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)             302000000
      CALL AXIS(0.0,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                 LUM14900   302100000
      CALL LINE(TPL,PLT10,NPOINT,1,1,1,JL,S)                           LUM14910   302200000
      CALL LINE(TPL,PLT11,NPOINT,1,1,1,JL,S)                           LUM14920   302300000
      CALL LINE(TPL,PLT12,NPOINT,1,1,1,JL,S)                           LUM14930   302400000
      XNEW=TAXIS+5                                                     LUM14940   302500000
      CALL PLOT(XNEW,0.0,-3)                                           LUM14950   302600000
      IF(PBLOCK.EQ.4.)GO TO 703                                        LUM14960   302700000
      CALL SCALE(PLT13,NPOINT,S,VGP13,DYP13,1,1)                       LUM14970   302800000
      CALL SCALE(PLT14,NPOINT,S,VGP14,DYP14,1,1)                       LUM14980   302900000
      CALL SCALE(PLT15,NPOINT,S,VGP15,DYP15,1,1)                       LUM14990   303000000
      CALL AXIS(0.0,6.5,5HPLT13,5,2.0,90.0,VGP13,DYP13,0)                         303100000
      CALL AXIS(0.0,3.5,5HPLT14,5,2.0,90.0,VGP14,DYP14,0)                         303200000
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CALL AXIS(0.0,0.5,5HPLT15,5,2.0,90.0,VGP15,DYP15,0)                         303300000
CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00030     303400000
CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)             303500000
CALL AXIS(0.0,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00050     303600000
CALL LINE(TPL,PLT13,NPOINT,1,1,1,JL,S)                          E 00060     303700000
CALL LINE(TPL,PLT14,NPOINT,1,1,1,JL,S)                          E 00070     303800000
CALL LINE(TPL,PLT15,NPOINT,1,1,1,JL,S)                          E 00080     303900000
XNEW=TAXIS+5                                                    E 00090     304000000
CALL PLOT(XNEW,0.0,-3)                                          E 00100     304100000
IF(PBLOCK.EQ.5.)GO TO 703                                       E 00110     304200000
CALL SCALE(PLT16,NPOINT,S,VGP16,DYP16,1,1)                      E 00120     304300000
CALL SCALE(PLT17,NPOINT,S,VGP17,DYP17,1,1)                      E 00130     304400000
CALL SCALE(PLT18,NPOINT,S,VGP18,DYP18,1,1)                      E 00140     304500000
CALL AXIS(0.0,6.5,5HPLT16,5,2.0,90.0,VGP16,DYP16,0)                         304600000
CALL AXIS(0.0,3.5,5HPLT17,5,2.0,90.0,VGP17,DYP17,0)                         304700000
CALL AXIS(0.0,0.5,5HPLT18,5,2.0,90.0,VGP18,DYP18,0)                         304800000
CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00180     304900000
CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)             305000000
CALL AXIS(0.0,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00200     305100000
CALL LINE(TPL,PLT16,NPOINT,1,1,1,JL,S)                          E 00210     305200000
CALL LINE(TPL,PLT17,NPOINT,1,1,1,JL,S)                          E 00220     305300000
CALL LINE(TPL,PLT18,NPOINT,1,1,1,JL,S)                          E 00230     305400000
XNEW=TAXIS+5                                                    E 00240     305500000
CALL PLOT(XNEW,0.0,-3)                                          E 00250     305600000
IF(PBLOCK.EQ.6.)GO TO 703                                       E 00260     305700000
CALL SCALE(PLT19,NPOINT,S,VGP19,DYP19,1,1)                      E 00270     305800000
CALL SCALE(PLT20,NPOINT,S,VGP20,DYP20,1,1)                      E 00280     305900000
CALL SCALE(PLT21,NPOINT,S,VGP21,DYP21,1,1)                      E 00290     306000000
CALL AXIS(0.0,6.5,5HPLT19,5,2.0,90.0,VGP19,DYP19,0)                         306100000
CALL AXIS(0.0,3.5,5HPLT20,5,2.0,90.0,VGP20,DYP20,0)                         306200000
CALL AXIS(0.0,0.5,5HPLT21,5,2.0,90.0,VGP21,DYP21,0)                         306300000
CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00330     306400000
CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)             306500000
CALL AXIS(0.0,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00350     306600000
CALL LINE(TPL,PLT19,NPOINT,1,1,1,JL,S)                          E 00360     306700000
CALL LINE(TPL,PLT20,NPOINT,1,1,1,JL,S)                          E 00370     306800000
CALL LINE(TPL,PLT21,NPOINT,1,1,1,JL,S)                          E 00380     306900000
XNEW=TAXIS+5                                                    E 00390     307000000
CALL PLOT(XNEW,0.0,-3)                                          E 00400     307100000
IF(PBLOCK.EQ.7.)GO TO 703                                       E 00410     307200000
CALL SCALE(PLT22,NPOINT,S,VGP22,DYP22,1,1)                      E 00420     307300000
CALL SCALE(PLT23,NPOINT,S,VGP23,DYP23,1,1)                      E 00430     307400000
CALL SCALE(PLT24,NPOINT,S,VGP24,DYP24,1,1)                      E 00440     307500000
CALL AXIS(0.0,6.5,5HPLT22,5,2.0,90.0,VGP22,DYP22,0)                         307600000
CALL AXIS(0.0,3.5,5HPLT23,5,2.0,90.0,VGP23,DYP23,0)                         307700000
CALL AXIS(0.0,0.5,5HPLT24,5,2.0,90.0,VGP24,DYP24,0)                         307800000
CALL AXIS(0.0,7.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00480     307900000
CALL AXIS(0.0,4.5,15HTIME IN SECONDS,15,TAXIS,0.0,0.0,DTPLOT,0)             308000000
CALL AXIS(0.0,1.5,BCD,NC,TAXIS,0.0,0.0,DTPLOT,3)                E 00500     308100000
CALL LINE(TPL,PLT22,NPOINT,1,1,1,JL,S)                          E 00510     308200000
CALL LINE(TPL,PLT23,NPOINT,1,1,1,JL,S)                          E 00520     308300000
```

```
      CALL LINE(TPL,PLT24,NPOINT,1,1,1,JL,S)                    E  00530    308400000
      XNEW=TAXIS+5                                              E  00540    308500000
      CALL PLOT(XNEW,0.0,-3)                                    E  00550    308600000
  703 CONTINUE                                                  E  00560    308700000
      RETURN                                                    E  00570    308800000
      END                                                       E  00580    308900000
```

```
SUBROUTINE SYMBL4(X,Y,HEIGHT,BCD,THETA,N)                       E  00590    309000000
CALL       NOTATE(X,Y,HEIGHT,BCD,THETA,N)                       E  00600    309100000
RETURN                                                          E  00610    309200000
END                                                             E  00620    309300000
```

```
      SUBROUTINE PLOT(A,B,I)                                         E 00630   309400000
      CALL CALPLT(A,B,I)                                             E 00640   309500000
      RETURN                                                         E 00650   309600000
      END                                                            E 00660   309700000
```

```
      SUBROUTINE SCALE(V,N,S,VORG,DV,JV,K)                E  00670   309800000
      DIMENSION V(1)                                      E  00680   309900000
      DO 10 I=1,N                                         E  00690   310000000
   10 V(I)=(V(I)-VORG)/DV                                 E  00700   310100000
      V(N+1)=0.                                                      310200000
      V(N+2)=1.                                                      310300000
      RETURN                                              E  00730   310400000
      END                                                 E  00740   310500000
```

```
SUBROUTINE LINE(TPL,PLT,NPOINT,I,J,K,L,M)              E  00750    310600000
DIMENSION TPL(1),PLT(1)                                E  00760    310700000
CALL LINPLT(TPL,PLT,NPOINT,1,0,0,0,0)                  E  00770    310800000
RETURN                                                 E  00780    310900000
END                                                    E  00790    311000000
```

```
SUBROUTINF AXIS(XO,YO,BC ),NC,S,THETA,VORG,DV,N)              E  00800   311100000
DIMENSION BCD(1)                                              E  00810   311200000
IF(VOPG.NE.0.)VORG=-DV                                                   311300000
IF(NC.EQ. 1)CALL AXES(XO,YO,THETA,S,VORG,DV,1.,0.,1H ,0.,1)    E  00820   311400000
IF(NC.EQ. 5)CALL AXES(XO,YO,THETA,S,VORG,DV,1.,0.,BCD,.1875,5) E  00830   311500000
IF(NC.EQ.15)CALL AXES(XO,YO,THETA,S,VORG,DV,1.,0.,BCD,.1875,-15) E 00840  311600000
RETURN                                                        E  00850   311700000
END                                                           E  00860   311800000
```

```
      SUBROUTINE PMPCOM(V,VDOT)
      COMMON T
      COMMON /INOUT/IN, IOUT,IOFF
      IF(T.GT.0.)GO TO 100
      READ(IN,1)V,VELCU,TIMCU,ACCMAG
    1 FORMAT(4E15.8)
      WRITE(IOUT,300)
  300 FORMAT(*0PUMP COMMAND INPUT*)
      WRITE(IOUT,2)V,VELCU,TIMCU,ACCMAG
    2 FORMAT(8X,*V*,14X,*VELCU*,12X,*TIMCU*,12X,*ACCMAG*/4E17.7)
      A=V
  100 IF(T.GT.TIMCU)GO TO 10
      OUT=0.
      V=A
      VDOT=0.
   10 CONTINUE
      CALL VELCOM(T,VELCU,TIMCU,OUT,TIME0,TIME1,ACC01,VELCO,ACCMAG,
     *            VDOT,V)
  200 RETURN
      END
```

```
      SUBROUTINE MUCOM(UJ,UJD,UJDD,L)
      COMMON T
      COMMON /INOUT/IN,IOUT,IOFF
      DIMENSION UJ(3),UJD(3),UJDD(3),X(3,8,13),UJO(3,3,8),UU(3,8),TU(3,8
     *          ),ACCMAG(3,8),IAXIS(3,8),VELMAX(3,8),A(3,8)
      COMMON /VAROUT/XX(17),UJO
      IF(T.GT.0.)GO TO 100
      DO 8 I=1,3
      UJ(I)=0.
      UJD(I)=0.
      UJDD(I)=0.
      DO 8 J=1,3
    8 UJO(I,J,L)=0.
      READ(IN,1)(IAXIS(I,L),I=1,3)
    1 FORMAT(3I2)
      READ(IN,5)(UJO(I,1,L),I=1,3)
      WRITE(IOUT,6)L,(UJO(I,1,L),I=1,3)
    6 FORMAT(*0MUCOM INPUT FOR MOVING MASS*,I4/*  UJ =*,3E17.8)
      DO 10 I=1,3
      IF(IAXIS(I,L).EQ.0)GO TO 10
      A(I,L)=UJO(I,1,L)
      READ(IN,5)UU(I,L),TU(I,L),ACCMAG(I,L),VELMAX(I,L)
      WRITE(IOUT,7)I,UU(I,L),TU(I,L),ACCMAG(I,L),VELMAX(I,L)
    7 FORMAT(* AXIS =*,I3/*          UU*, 15X,*TU*,13X,*ACCMAG*,
     *    11X,*VELMAX* /4E17.8)
    5 FORMAT(4E15.8)
   10 CONTINUE
  100 CALL MCPY(UJO(1,1,L),UJ,3,3,3)
      DO 120 I=1,3
      IF(IAXIS(I,L).EQ.0)GO TO 120
      IF(T.GT.TU(I,L))GO TO 20
      UJ(I)=A(I,L)
      UJD(I)=0.
      UJDD(I)=0.
      X(I,L,1)=0.
   20 CONTINUE
      CALL POSCOM(T,UU(I,L),TU(I,L),X(I,L,1),X(I,L,2),X(I,L,3),X(I,L,4),
     *          X(I,L,5),X(I,L,6),X(I,L,7),X(I,L,8),X(I,L,9),X(I,L,10),
     *                X(I,L,11),X(I,L,12),X(I,L,13),ACCMAG(I,L),
     *                VELMAX(I,L),UJDD(I),UJD(I),UJ(I) )
  120 CONTINUE
      CALL MCPY(UJ,UJO(1,1,L),3,3,3)
      RETURN
      END
```

```
      SUBROUTINE TRIEQ(A,Y)                         E  01510   318300000
      REAL A(1),Y(1)                                E  01520   318400000
      COMMON /WINTER/INDIC8                         E  01530   318500000
      COMMON /BOND/ M,L                             E  01540   318600000
      EQUIVALENCE (SUN,SUM)                         E  01550   318700000
      L1 = L                                        E  01560   318800000
      MML=M-L1                                      E  01570   318900000
      MM1 = M - 1                                   E  01580   319000000
      IF (INDIC8) 130,100,100                       E  01590   319100000
  100 Y(L1) = Y(L1) / A(L1)                         E  01600   319200000
      I1 = L1                                       E  01610   319300000
      II=I1                                         E  01620   319400000
      IF(MML)105,125,105                            E  01630   319500000
  105 DO 120  I = L1,MM1                            E  01640   319600000
      I1 = I1 + I                                   E  01650   319700000
      SUM = -Y(I+1)                                 E  01660   319800000
      IJ = I1                                       E  01670   319900000
      DO 110  J = L1,I                              E  01680   320000000
      SUM = SUM + A(IJ)*Y(J)                        E  01690   320100000
  110 IJ = IJ + 1                                   E  01700   320200000
      II = IJ                                       E  01710   320300000
  120 Y(I+1) = -SUM / A(II)                         E  01720   320400000
  125 IF (INDIC8) 170,140,170                       E  01730   320500000
  130 II=((MML+1)*(M+L1))/2                         E  01740   320600000
  140 I = M                                         E  01750   320700000
  145 Y(I) = Y(I) / A(II)                           E  01760   320800000
      II = II - I                                   E  01770   320900000
      I = I - 1                                     E  01780   321000000
      IF (I - L1) 170,150,150                       E  01790   321100000
  150 SUN = -Y(I+1)                                 E  01800   321200000
      IJ = II + L1                                  E  01810   321300000
      DO 160  J = L1,I                              E  01820   321400000
      Y(J) = Y(J) + SUN*A(IJ)                       E  01830   321500000
  160 IJ = IJ + 1                                   E  01840   321600000
      GO TO 145                                     E  01850   321700000
  170 RETURN                                        E  01860   321800000
       END                                          E  01870   321900000
      SUBROUTINE FUTILE(A,N,NIX)                    E  01880   322000000
      DIMENSION A(1)                                E  01890   322100000
      DOUBLE PRECISION SUM                          E  01900   322200000
      EQUIVALENCE (SUN,SUM)                         E  01910   322300000
      K1 = 1                                        E  01920   322400000
      KK = 0                                        E  01930   322500000
      DO 210  K = 1,N                               E  01940   322600000
      KK = KK + K                                   E  01950   322700000
      IK = KK                                       E  01960   322800000
      KK1 = KK - 1                                  E  01970   322900000
      IF (KK1) 60,50,60                             E  01980   323000000
   50 ASSIGN 100 TO LEAP                            E  01990   323100000
```

```
      GO TO 70                                                          E  02000   323200000
   60 ASSIGN  80 TO LEAP                                                E  02010   323300000
   70 I1 = K1                                                           E  02020   323400000
      DO 140  I = K,N                                                   E  02030   323500000
      SUM = -A(IK)                                                      E  02040   323600000
      GO TO LEAP, (80,100)                                              E  02050   323700000
   80 IJ = I1                                                           E  02060   323800000
      DO 90 KJ = K1,KK1                                                 E  02070   323900000
      SUM = SUM + A(IJ)*A(KJ)                                           E  02080   324000000
   90 IJ = IJ + 1                                                       E  02090   324100000
  100 I1 = I1 + I                                                       E  02100   324200000
      IF (I - K) 120,105,120                                            E  02110   324300000
  105 DENOM = -SUM                                                      E  02120   324400000
      IF (DENOM) 980,980,110                                            E  02130   324500000
  110 DENOM = -SQRT(DENOM)                                              E  02140   324600000
      A(IK) = -DENOM                                                    E  02150   324700000
      GO TO 130                                                         E  02160   324800000
  120 A(IK) = SUM / DENOM                                               E  02170   324900000
  130 IK = IK + I                                                       E  02180   325000000
  140 CONTINUE                                                          E  02190   325100000
      K1 = K1 + K                                                       E  02200   325200000
  210 CONTINUE                                                          E  02210   325300000
      NIX = 0                                                           E  02220   325400000
  220 RETURN                                                            E  02230   325500000
  980 NIX = -K                                                          E  02240   325600000
      GO TO 220                                                         E  02250   325700000
       END                                                              E  02260   325800000
      SUBROUTINE CONTRL(A,N,IFCON,LABCW)                                E  02270   325900000
      DIMENSION A(1),GAMIS(3),GAMDIS(3),FAJ(3,16),XAJ(3,17)             E  02280   326000000
     *  ,RC(3),RCB(3),RSS(3)                                            E  02290   326100000
      COMMON T,W(1000),HOLD(3),SAVE(3),                                 E  02300   326200000
     *        G1(3,3),G2(3,3),G3(3,3)                                   E  02310   326300000
      COMMON /LABOR/WX(3),   RI (900),TH(3,100),THD(3,100)              E  02320   326400000
     *        /LOADS/ZZ(685),RDDOT(3),WXDOT(3),XDD(6,100)               E  02330   326500000
     *        /EXTRA/CC(15),EMC,TOT                                     E  02340   326600000
      COMMON /CONECT/DUM3(26),GAM(3),GAMD(3)                            E  02350   326700000
      COMMON /NEWCOM/EL(3),ELD(3),ELDD(3),ROB(3)                        E  02360   326800000
     *        /INOUT/IN,IOUT,IOFF                                       E  02370   326900000
     *        /ALLCNT/IS,O(3),DL(3,3),DC(3,3),EML,XIL(3,3),XIC(3,3),    E  02380   327000000
     *             YICS(10),YPRED(10),YDOT(10),NEQS,DO(3),XI(3,3),TAJ(3),  E  02390   327100000
     *                  WKT,TQLIM,WKDBET,WMOMCM,WIBGIM,O1CMAG           E  02400   327200000
      COMMON /VAROUT/EO1,DO1C,F3,F9,F10,F16,F4,F11,F15,DO1,ELO3D,ELD3,  E  02410   327300000
     *                  ELDD3,O1CD,OD                                   E  02420   327400000
     *,O1C,NCMG                                                         E  02430   327500000
     *,UJDUM(78)                                                        E  02440   327600000
     *,F1,F2,F5,F6,F7,F8,F12,F13,F14                                    E  02450   327700000
      N6=6*N                                                            E  02460   327800000
      IENT=0                                                            E  02470   327900000
      DO 5 I=1,N6                                                       E  02480   328000000
    5 A(I)=0.                                                           E  02490   328100000
      IF(LABCW.LT.0)GO TO 99                                            E  02500   328200000
```

```
      IF(IFCON.EQ.0)GO TO 99
      IF(T.GT.0.)GO TO 20
      IF(NEQS.NE.3)NEQS=0
      NEQS=NEQS+4
      OI=O(1)
      O1CI=O1C
      EL03I=EL(3)
      DO 140 I=1,4
      XAJ(1,I   )=-XJ1
      XAJ(2 , I)= 0.
      XAJ(3 , I)= RI(3)
      XAJ(1,I+4)=-XJ1
      XAJ(2,I+4)= 0.
      XAJ(3,I+4)= RI(15)
      XAJ(1,I+8)= XJ1
      XAJ(2,I+8)= 0.
      XAJ(3,I+8)= RI(15)
      XAJ(1,I+12)=XJ1
      XAJ(2,I+12)=0.
  140 XAJ(3,I+12)=RI(3)
      RC(1)=DL(3,2)
      RC(2)=DL(1,3)
      RC(3)=DL(2,1)
      SC=1./EML
      CALL SCALR(SC,RC,RC,1)
      RCB(1)=DC(3,2)
      RCB(2)=DC(1,3)
      RCB(3)=DC(2,1)
      SC=1./EMC
      CALL SCALR(SC,RCB,RCB,1)
      CALL ADD(ROB,RCB,HOLD,1)
      HOLD(2)=-HOLD(2)
      HOLD(3)=-HOLD(3)
      CALL SCALR(EMC,HOLD,HOLD,1)
      CALL SCALR(EML,RC,SAVE,1)
      CALL ADD(HOLD,SAVE,HOLD,1)
      SC=1./(EML+EMC)
      CALL SCALR(SC,HOLD,RSS,1)
      GO TO 21
   20 IF(T.LE.TXB3CU.OR. EL(3).EQ.XB3CU)GO TO 25
   21 CALL ADD(XIL,XIC,XI,3)
      CALL GAMMA(RC,G1)
      CALL MULT(G1,G1,G2,3)
      CALL SUBTR(RC,RSS,HOLD,1)
      CALL GAMMA(HOLD,G1)
      CALL MULT(G1,G1,G3,3)
      CALL SUBTR(G2,G3,G2,3)
      CALL SCALR(EML,G2,G2,3)
      CALL ADD(XI,G2,XI,3)
      CALL GAMMA(RCB,G1)
      CALL MULT(G1,G1,G2,3)
```

```
      DO 10 I=1,3                                                        E   03020    333400000
   10 HOLD(I)=ROB(I)+RCB(I)+RSS(I)                                       E   03030    333500000
      HOLD(1)=HOLD(1)-2.*RSS(1)                                          E   03040    333600000
      CALL GAMMA(HOLD,G1)                                                E   03050    333700000
      CALL MULT(G1,G1,G3,3)                                              E   03060    333800000
      CALL SUBTR(G2,G3,G1,3)                                             E   03070    333900000
      CALL SCALR(EMC,G1,G1,3)                                            E   03080    334000000
      CALL ADD(XI,G1,XI,3)                                               E   03090    334100000
      GO TO 25                                                           E   03100    334200000
      ENTRY EARLY                                                        E   03110    334300000
      IENT=1                                                             E   03120    334400000
   25 CONTINUE                                                           E   03130    334500000
      CALL ADD(GAM,TH(1,IS),GAMIS,1)                                     E   03140    334600000
      CALL ADD(GAMD,THD(1,IS),GAMDIS,1)                                  E   03150    334700000
      CALL GAMMA(TH(1,IS),G1)                                            E   03160    334800000
      CALL MULT(G1,WXDOT,HOLD,1)                                         E   03170    334900000
      CALL SUBTR(WXDOT,HOLD,HOLD,1)                                      E   03180    335000000
      CALL GAMMA(THD(1,IS),G1)                                           E   03190    335100000
      CALL MULT(G1,WX,SAVE,1)                                            E   03200    335200000
      DO 30 I=1,3                                                        E   03210    335300000
   30 DD(I)=HOLD(I)-SAVE(I)+XDD(I+3,IS)                                  E   03220    335400000
      IF(IENT.EQ.1)RETURN                                                E   03230    335500000
      GO TO 89                                                           E   03240    335600000
      ENTRY LLDLDD                                                       E   03250    335700000
      CALL CWCOM(T,XB3CU,TXB3CU,ACCB3C,VELMBC,ELDD(3),ELD(3),EL(3))      E   03260    335800000
      GO TO 99                                                           E   03270    335900000
   89 CONTINUE                                                           E   03280    336000000
      CALL SPNCOM(T,O1CU,TO1CU,ACCO1C,FJET,XAJ,XI,O1C,O1CMAG)            E   03290    336100000
      CALL SPNCTR(O1C,O,EO1DB,FJET,O1CMAG,FAJ)                           E   03300    336200000
      O1CD=O1C-O1CI                                                      E   03310    336300000
      OD=O(1)-OI                                                         E   03320    336400000
      CALL ATTCTR(GAMIS,GAMDIS,ETDB,DETMAX,XAJ,FJET,FAJ)                 E   03330    336500000
      CALL WBLCTR                                                        E   03340    336600000
      F1 =FAJ(2,1)                                                       E   03350    336700000
      F2 =FAJ(2,2)                                                       E   03360    336800000
      F3=FAJ(2,3)                                                        E   03370    336900000
      F4=FAJ(1,4)                                                        E   03380    337000000
      F5 =FAJ(2,5)                                                       E   03390    337100000
      F6 =FAJ(2,6)                                                       E   03400    337200000
      F7 =FAJ(2,7)                                                       E   03410    337300000
      F8 =FAJ(1,8)                                                       E   03420    337400000
      F9=FAJ(2,9)                                                        E   03430    337500000
      F10=FAJ(2,10)                                                      E   03440    337600000
      F11=FAJ(2,11)                                                      E   03450    337700000
      F12=FAJ(1,12)                                                      E   03460    337800000
      F13=FAJ(2,13)                                                      E   03470    337900000
      F14=FAJ(2,14)                                                      E   03480    338000000
      F15=FAJ(2,15)                                                      E   03490    338100000
      F16=FAJ(1,16)                                                      E   03500    338200000
      EL03D=EL(3)-EL03I                                                  E   03510    338300000
      ELD3=ELD(3)                                                        E   03520    338400000
```

```
      ELDD3=ELDD(3)                                                      E  03530     338500000
      A( 1)= FAJ(1,4)+FAJ(1,16)                                          E  03540     338600000
      A( 2)= FAJ(2,1)+FAJ(2,2)+FAJ(2,3)+FAJ(2,13)+FAJ(2,14)+FAJ(2,15)    E  03550     338700000
      A( 3)= 0.                                                          E  03560     338800000
      A( 4)= 0.                                                          E  03570     338900000
      A( 5)= 0.                                                          E  03580     339000000
      A( 6)=XJ1*(-FAJ(2,1)-FAJ(2,2)-FAJ(2,3)+FAJ(2,13)+FAJ(2,14)+FAJ(2,1E  03590     339100000
     *5))                                                                E  03600     339200000
      A(25)=FAJ(1,8)+FAJ(1,12)                                           E  03610     339300000
      A(26)=FAJ(2,5)+FAJ(2,6)+FAJ(2,7)+FAJ(2,9)+FAJ(2,10)+FAJ(2,11)      E  03620     339400000
      A(27)= 0.                                                          E  03630     339500000
      A(28)= 0.                                                          E  03640     339600000
      A(29)= 0.                                                          E  03650     339700000
      A(30)=XJ1*(-FAJ(2,5)-FAJ(2,6)-FAJ(2,7)+FAJ(2,9)+FAJ(2,10)+FAJ(2,11E  03660     339800000
     *))                                                                 E  03670     339900000
      IL=6*IS-3                                                          E  03680     340000000
      DO 40 I=1,3                                                        E  03690     340100000
   40 A(IL+I)=TAJ(I)                                                     E  03700     340200000
      GO TO 99                                                           E  03710     340300000
      ENTRY CONTRD                                                       E  03720     340400000
C                                                                        E  03730     340500000
C  GENERAL INPUT                                                         E  03740     340600000
C                                                                        E  03750     340700000
      E01=0.                                                             E  03760     340800000
      DO 88 I=1,3                                                        E  03770     340900000
      DO 88 J=1,16                                                       E  03780     341000000
   88 FAJ(I,J)=0.                                                        E  03790     341100000
      READ(IN,2)IS,FJET                                                  E  03800     341200000
    2 FORMAT(I3,E15.8)                                                   E  03810     341300000
      WRITE(IOUT,102)IS,FJET                                             E  03820     341400000
  102 FORMAT(*0CONTROLS INPUT , SENSOR ON MASS POINT*,I4,* , FJET=*,E15.E  03830     341500000
     *8)                                                                 E  03840     341600000
C  CWCOM                                                                 E  03850     341700000
      READ(IN,1)XB3CU,TXB3CU,ACCB3C,VELMBC                               E  03860     341800000
      WRITE(IOUT,103)XB3CU,TXB3CU,ACCB3C,VELMBC                          E  03870     341900000
  103 FORMAT(* COUNTERWEIGHT COMMAND*/*  LENGTH UPDATE   TIME OF UPDATE E  03880     342000000
     *   ACCEL. MAG      VEL. MAX*/E16.7,E17.7,E17.7,E15.7)              E  03890     342100000
C  SPNCOM                                                                E  03900     342200000
      READ(IN,1)O1C,TO1CU,O1CU,ACCO1C                                    E  03910     342300000
      O1CMAG=ABS(O1C)                                                    E  03920     342400000
      WRITE(IOUT,104)O1C,O1CU,ACCO1C,TO1CU                               E  03930     342500000
  104 FORMAT(* SPIN COMMAND*/* ANG. VEL. COMMAND   ANG. VEL. UPDATE      E  03940     342600000
     *  ACCEL MAG*,9X,*TIME OF UPDATE*/4(2X,E14.7,4X))                   E  03950     342700000
C  SPNCTR                                                                E  03960     342800000
      READ(IN,1)E01DB                                                    E  03970     342900000
      WRITE(IOUT,105)E01DB                                               E  03980     343000000
  105 FORMAT(* SPIN CONTROL*/* SPIN RATE ERROR DEAD BAND=*,E15.8)        E  03990     343100000
C  ATTCTR                                                                E  04000     343200000
      READ(IN,1)ETDB,DETMAX,XJ1                                          E  04010     343300000
      WRITE(IOUT,106)ETDB,DETMAX,XJ1                                     E  04020     343400000
  106 FORMAT(* ATTITUDE CONTROL*/4X,*DEAD BAND*,6X,*MAX. ANG. VEL.   JETE  04030     343500000
```

```
     * MOMENT ARM*/E15.7,3X,E14.7,3X,E14.7)                            E  04040     343600000
C   WBLCTR                                                              E  04050     343700000
      READ(IN,1)    YICS(2),YICS(1),WKT,TQLIM,WKDBET,WMOMCM,WIBGIM      E  04060     343800000
      WRITE(IOUT,701)YICS(2),YICS(1),WKT,TQLIM,WKDBET,WMOMCM,WIBGIM     E  04070     343900000
  701 FORMAT(* WOBBLE DAMPING*/8X,*BET*,12X,*DBET*,13X,*KT*,13X,*TQLIM*,E  04080     344000000
     *11X,*KDBET*,10X,*MOMCMG*,7X,*GIMBAL INERTIA* / 7E16.7)            E  04090     344100000
    1 FORMAT(4E15.8)                                                    E  04100     344200000
   99 RETURN                                                            E  04110     344300000
      END                                                               E  04120     344400000
```

```
      SUBROUTINE ATTCTR(T,DT,ETDB,DETMAX,XAJ,      FJET,        FAJ)     E  04130    344500000
C     THIS SUBROUTINE GENERATES THE FORCES APPLIED BY JETS               E  04140    344600000
C     TO CONTROL THE ATTITUDE OF THE VEHICLE AS MEASURED BY              E  04150    344700000
C     EULER ANGLES.                                                      E  04160    344800000
C     T      =THETA,EULER ANGLES                                         E  04170    344900000
C     DT     =DERIVATIVE OF THETA                                        E  04180    345000000
C     ETDB   =DEAD BAND OF ET                                            E  04190    345100000
C     DETMAX=DERIVATIVE OF ERROR,THETA,MAXIMUM VALUE                     E  04200    345200000
C     ACCTS =ACCELERATION MAGNITUDE USED TO COMPUTE PARABOLIC            E  04210    345300000
C            SWITCHING CURVE                                             E  04220    345400000
C     FAJ    =FORCES EXERTED BY JETS LOCATED AT POINTS AJ                E  04230    345500000
C                                                                        E  04240    345600000
      DIMENSION T(3),DT(3),XAJ(3,17),WM11(3,3),FAJ(3,16),FBJ(3,16),      E  04250    345700000
     1      ACCTS(3),ET(3),DET(3),ACCT(3)                                E  04260    345800000
      COMMON /ALLCNT/DUM1(75),WM11,DUM2(8),O1CMAG                        E  04270    345900000
      IF(O1CMAG)192,61,192                                               E  04280    346000000
   61 DO 181 J=1,16                                                      E  04290    346100000
      DO 181 I=1,3                                                       E  04300    346200000
  181 FAJ(I,J)=0.                                                        E  04310    346300000
      ACCTS(1)=FJET*(XAJ(3,13)-XAJ(3,10))/WM11(1,1)                      E  04320    346400000
      ACCTS(2)= FJET*(XAJ(3,4)-XAJ(3,12))/WM11(2,2)                      E  04330    346500000
      ACCTS(3)= FJET*(XAJ(1,15)-XAJ(1,1))/WM11(3,3)                      E  04340    346600000
      DO 191 J=1,3                                                       E  04350    346700000
      ET(J)=T(J)-0.                                                      E  04360    346800000
      DET(J)=DT(J)-0.                                                    E  04370    346900000
      CALL PCSCTR(ET(J),ETDB,DET(J),DETMAX,ACCTS(J),ACCT(J))             E  04380    347000000
      IF(J-2)182,185,188                                                 E  04390    347100000
  182 IF(ACCT(1))184,191,183                                             E  04400    347200000
  183 FAJ(2,13)=-FJET                                                    E  04410    347300000
      FAJ(2,10)=+FJET                                                    E  04420    347400000
      GO TO 191                                                          E  04430    347500000
  184 FAJ(2,14)=+FJET                                                    E  04440    347600000
      FAJ(2,9) =-FJET                                                    E  04450    347700000
      GO TO 191                                                          E  04460    347800000
  185 IF(ACCT(2))187,191,186                                             E  04470    347900000
  186 FAJ(1,4) =+FJET                                                    E  04480    348000000
      FAJ(1,12)=-FJET                                                    E  04490    348100000
      GO TO 191                                                          E  04500    348200000
  187 FAJ(1,16)=-FJET                                                    E  04510    348300000
      FAJ(1,8 )=+FJET                                                    E  04520    348400000
      GO TO 191                                                          E  04530    348500000
  188 IF(ACCT(3))190,191,189                                             E  04540    348600000
  189 FAJ(2,15)=+FJET                                                    E  04550    348700000
      FAJ(2,1 )=-FJET                                                    E  04560    348800000
      GO TO 191                                                          E  04570    348900000
  190 FAJ(2,11)=-FJET                                                    E  04580    349000000
      FAJ(2,6)=FJET                                                      E  04590    349100000
  191 CONTINUE                                                           E  04600    349200000
      GO TO 192                                                          E  04610    349300000
```

B

```
192 RETURN                                          E  04620    349400000
    END                                             F  04630    349500000
```

```
      SUBROUTINE WBLCTR                                                  E 04640   349600000
C     THIS SUBROUTINE GENERATES THE CMG GIMBAL ANGLE ACCELERATION.       E 04650   349700000
C     THIS ACCELERATION IS INTEGRATED TO GET THE CMG GIMBAL ANGLE        E 04660   349800000
C     RATE AND POSITION. THE TORQUES EXERTED BY THE CMG ON THE           E 04670   349900000
C     VEHICLE ARE ALSO COMPUTED.                                         E 04680   350000000
C     O      =OMEGA,ANGULAR VELOCITY OF LAB                              E 04690   350100000
C     WM11   =MOMENT OF INERTIA, STATION INCLUDING MOVING PARTS          E 04700   350200000
C     BET    =CMG GIMBAL ANGLE, REFERENCE COORDINATE IS LAB AXIS 3       E 04710   350300000
C     DBET   =CMG GIMBAL ANGLE RATE                                      E 04720   350400000
C     DBETMX=MAXIMUM CMG GIMBAL ANGLE RATE (USED IN SHORTEST PATH LOGIC)E 04730   350500000
C     WKT    =CONSTANT, MULTIPLIES ERROR ERRF TO GIVE TORQUE TQKGIM      E 04740   350600000
C     TQLIM =TORQUE LIMIT                                                E 04750   350700000
C     WKDBET=CONSTANT, MULTIPLIES DBET TO GIVE TQFDBK                    E 04760   350800000
C     WMOMCM=MOMENT OF MOMENTUM, CMG                                     E 04770   350900000
C     WIBGIM=CMG GIMBAL INERTIA (SAME FOR ALL 3 VEHICLE AXES, ROTOR      E 04780   351000000
C             INERTIA NOT INCLUDED ALONG ROTOR AXIS)                     E 04790   351100000
C     TIME= TIME                                                         E 04800   351200000
C    TIMEL = TIME ONE ITRRATION AGO                                      E 04810   351300000
C     DDBET =CMG GIMBAL ANGLE ACCELERATION                               E 04820   351400000
C     TAJ    =TORQUES EXERTED BY CMG ON LAB                              E 04830   351500000
C                                                                        E 04840   351600000
      COMMON TIME                                                        E 04850   351700000
      COMMON /ALLCNT/IS,O,DLC(37),YICS(10),YPRED(10),YDOT(10),NEQS,DO,   E 04860   351800000
     *             WM11,TAJ,WKT,TQLIM,WKDBET,WMOMCM,WIBGIM,O1CMAG        E 04870   351900000
     * ,BETDES                                                           E 04880   352000000
      COMMON /VAROUT/DUM(16),NCMG                                        E 04890   352100000
      DIMENSION O(3),WM11(3,3),TAJ(3),DO(3)                              E 04900   352200000
      EQUIVALENCE (BET,YPRED(2)),(DBET,YPRED(1)),(ERRKTI,YPRED(3))       E 04910   352300000
     *           ,(ERRLLI,YPRED(4))                                      E 04920   352400000
C                                                                        E 04930   352500000
      TIMEL=TIME                                                         E 04940   352600000
      IF(TIME .NE. 0.)GO TO 10                                           E 04950   352700000
      BET=YICS(2)                                                        E 04960   352800000
      DBET=YICS(1)                                                       E 04970   352900000
C                                                                        E 04980   353000000
C  FOR TEST                                                              E 04990   353100000
C                                                                        E 05000   353200000
      DBETMX=TQLIM/WKDBET                                                E 05010   353300000
      WLEAD=10.*WIBGIM/WKDBET                                            E 05020   353400000
      BETDES=0.                                                          E 05030   353500000
      NCMG=0                                                             E 05040   353600000
      ERRKTI=0.                                                          E 05050   353700000
      ERRLLI=WKDBET*DBET                                                 E 05060   353800000
      TIMEL=-0.025                                                       E 05070   353900000
   10 IF(O1CMAG-0.02)93,84,84                                            E 05080   354000000
   93 DDBET=0.                                                           E 05090   354100000
      DO 83 I=1,3                                                        E 05100   354200000
   83 TAJ(I)=0.                                                          E 05110   354300000
      GO TO 94                                                           E 05120   354400000
```

```
   84 CONTINUE                                                      E  05130    354500000
    2 WMU=SQRT((WM11(1,1)-WM11(3,3))*(WM11(1,1)-WM11(2,2))/         E  05140    354600000
     1         (WM11(2,2)*WM11(3,3)))                               E  05150    354700000
      SWITCH=3.1415926*(1.-(WMU*O(1)/DBETMX))                       E  05160    354800000
      O23=0.                                                        E  05170    354900000
      IF(O(3) .EQ. 0.0 .AND. O(2) .EQ. 0.0)GO TO 6                  E  05180    355000000
    5 O23=ATAN2(O(3),O(2))                                          E  05190    355100000
    6 E1=0.5*(WM11(2,2)*((O(2))**2)+((WM11(1,1)-WM11(3,3))/         E  05200    355200000
     1   (WM11(1,1)-WM11(2,2)))*WM11(3,3)*((O(3))**2))              E  05210    355300000
      E2=WMOMCM*O(1)                                                E  05220    355400000
      E3=10.*(E1/E2)                                                E  05230    355500000
      IF(BET)200,202,202                                            E  05240    355600000
  200 BET=BET+6.2831853                                             E  05250    355700000
  202 BETDE=O23-1.5707963                                           E  05260    355800000
      IF(BETDE)204,215,215                                          E  05270    355900000
  204 BETDE=BETDE+6.2831853                                         E  05280    356000000
  215 IF(NCMG .EQ. 1)GO TO 206                                      E  05290    356100000
      IF(E3-.01)208,205,205                                         E  05300    356200000
  205 SPCASE=2.*WMU*O(1)*(TIME-TIMEL)                               E  05310    356300000
      IF(BETDE .LE. SPCASE)GO TO 213                                E  05320    356400000
      IF(BETDE-BET)208,208,211                                      E  05330    356500000
  213 BBETDE=BETDE+6.2831853                                        E  05340    356600000
      IF(BBETDE-BET)208,208,211                                     E  05350    356700000
  206 IF(E3-.001)207,212,212                                        E  05360    356800000
  207 NCMG=0                                                        E  05370    356900000
      ERRKTI=0.                                                     E  05380    357000000
      ERRLLI=WKDBET*DBET                                            E  05390    357100000
  208 ERDBET=-O(1)-DBET                                             E  05400    357200000
      ERRKT=WKT*ERDBET                                              E  05410    357300000
      ERRLL=ERRKTI+WLEAD*ERRKT                                      E  05420    357400000
      SINBET=SIN(BET)                                               E  05430    357500000
      COSBET=COS(BET)                                               E  05440    357600000
      TQPASS=WMOMCM*(O(3)*COSBET-O(2)*SINBET)                       E  05450    357700000
      TQKGIM=ERRLLI-TQPASS                                          E  05460    357800000
      IF(ABS(TQKGIM)-TQLIM)622,622,621                              E  05470    357900000
  211 NCMG=1                                                        E  05480    358000000
      ERRKTI=WKDBET*DBET                                            E  05490    358100000
  212 BETDES=BETDE                                                  E  05500    358200000
  604 ERRBET=BETDES-BET                                             E  05510    358300000
      IF(ERRBET)607,610,605                                         E  05520    358400000
  605 IF(ERRBET-SWITCH)610,610,606                                  E  05530    358500000
  606 ERRBET=ERRBET-6.2831853                                       E  05540    358600000
      GO TO 610                                                     E  05550    358700000
  607 ERRBET=ERRBET+6.2831853                                       E  05560    358800000
      IF(ERRBET-SWITCH)610,610,609                                  E  05570    358900000
  609 ERRBET=ERRBET-6.2831853                                       E  05580    359000000
  610 ERRF=ERRBET                                                   E  05590    359100000
C                                                                   E  05600    359200000
C     GIMBAL DYNAMICS                                               E  05610    359300000
C                                                                   E  05620    359400000
  624 SINBET=SIN(BET)                                               E  05630    359500000
```

```
      COSBET=COS(BET)
      TQPASS=WMOMCM*(O(3)*COSBET-O(2)*SINBET)
      ERRKT=WKT*ERRF
      ERRLL=ERRKTI+WLEAD*ERRKT
      TQKGIM=ERRLL-TQPASS
      IF(ABS(TQKGIM)-TQLIM)622,622,621
  621 TQLGIM=SIGN(TQLIM,TQKGIM)
      GO TO 623
  622 TQLGIM=TQKGIM
  623 TQFDBK=WKDBET*DBET
      TQTGIM=TQLGIM-TQFDBK
      TQGIM=TQTGIM+TQPASS
      DDBETP=TQGIM/WIBGIM
      DDBET=DDBETP-DO(1)
C                BET  IS COMPUTED IN INTEGRATION SECTION
C               DBET  IS COMPUTED IN INTEGRATION SECTION
C
C     TORQUES ON VEHICLE DUE TO CMG
C
      E1=DBET+O(1)
      TAJ(1)=WMOMCM*(-SINBET*O(2)+COSBET*O(3))-WIBGIM*(DO(1)+DDBET)
      TAJ(2)=WMOMCM*SINBET*E1-WIBGIM*(DO(2)+O(3)*DBET)
      TAJ(3)=-WMOMCM*COSBET*E1-WIBGIM*(DO(3)-O(2)*DBET)
C
   94 IF(TIME.GT.0.)GO TO 96
      YICS(3)=ERRKTI
      YICS(4)=ERRLLI
   96 YDOT(1)=DDBET
      YDOT(2)=DBET
      YDOT(3)=ERRKT
      YDOT(4)=ERRLL
      RETURN
      END
```

```
      SUBROUTINE SPNCOM(TIME,O1CU,TO1CU,ACCO1C,FJET,XAJ,WM11      ,O1C,  E  05970   362900000
     1      O1CMAG)                                                      E  05980   363000000
      DIMENSION XAJ(3,17),WM11(3,3)                                      E  05990   363100000
      COMMON /VAROUT/EO1,DO1C                                            E  06000   363200000
      IF(TIME.EQ.0.)A=O1C                                                E  06010   363300000
      IF(TIME.GT.TO1CU)GO TO 10                                          E  06020   363400000
      O1C=A                                                              E  06030   363500000
      DO1C=0.                                                            E  06040   363600000
      OUTO=0.                                                            E  06050   363700000
   10 CONTINUE                                                           E  06060   363800000
      CALL VELCOM(TIME,O1CU,TO1CU,OUTO,TIME00,TIME10,ACCO10,             E  06070   363900000
     1      VELC00,ACCO1C,DO1C,O1C)                                      E  06080   364000000
      O1CMAG=ABS(O1C)                                                    E  06090   364100000
      RETURN                                                             E  06100   364200000
      END                                                                E  06110   364300000
```

```
      SUBROUTINE SPNCTR(O1C,O,EO1DB,FJET,O1CMAG,     FAJ)               E 06120  364400000
C     THIS SUBROUTINE GENERATES THE FORCES EXERTED BY THE JETS          E 06130  364500000
C     ON THE VEHICLE TO CONTROL THE SPIN RATE ABOUT AXIS 1.             E 06140  364600000
C     O1C    =OMEGA 1 COMMAND(SPIN RATE ABOUT LAB AXIS 1)               E 06150  364700000
C     O      =OMEGA(ANGULAR VELOCITY VECTOR OF LAB)                     E 06160  364800000
C     EO1DB =ERROR,OMEGA 1,DEAD BAND                                    E 06170  364900000
C     FAJ    =FORCES EXERTED BY JETS ON VEHICLE. JETS ARE LOCATED       E 06180  365000000
C              AT POINTS AJ IN LAB.                                     E 06190  365100000
C     FJET   =THRUST OF JET                                             E 06200  365200000
C                                                                       E 06210  365300000
      DIMENSION O(3),FAJ(3,16)                                          E 06220  365400000
      COMMON /VAROUT/EO1                                                E 06230  365500000
      IF(O1CMAG)61,196,61                                               E 06240  365600000
   61 DO 181 J=1,16                                                     E 06250  365700000
      DO 181 I=1,3                                                      E 06260  365800000
  181 FAJ(I,J)=0.                                                       E 06270  365900000
      EO1=O(1)-O1C                                                      E 06280  366000000
      CALL VELCTR(EO1,EO1DB,ACCNO1)                                     E 06290  366100000
      IF(ACCNO1)195,196,194                                             E 06300  366200000
  194 FAJ(2,13)=-FJET                                                   E 06310  366300000
      FAJ(2,10)=+FJET                                                   E 06320  366400000
      FAJ(2,3)=-FJET                                                    E 06330  366500000
      FAJ(2,7)=+FJET                                                    E 06340  366600000
      GO TO 196                                                         E 06350  366700000
  195 FAJ(2,14)=+FJET                                                   E 06360  366800000
      FAJ(2,9 )=-FJET                                                   E 06370  366900000
      FAJ(2,2)=+FJET                                                    E 06380  367000000
      FAJ(2,5)=-FJET                                                    E 06390  367100000
C                                                                       E 06400  367200000
  196 RETURN                                                            E 06410  367300000
      END                                                               E 06420  367400000
```

```
      SUBROUTINE VELCTR(EDOT,EDOTDB,ACCNOW)                    E  06430    367500000
C     THIS SUBROUTINE GENERATES VELOCITY CONTROL.              E  06440    367600000
C     EDOT      ERROR RATE(RATE - RATE COMMAND)                E  06450    367700000
C     EDOTDB    ERROR RATE DEAD BAND                           E  06460    367800000
C     ACCNOW    ACCERATION TO BE APPLIED NOW (+1.,0.,OR -1.)   E  06470    367900000
C                                                              E  06480    368000000
      COMMON T                                                             368100000
      IF(T.EQ.0.)ACCNOW=0.                                                 368200000
      IF(EDOT-EDOTDB)10,5,5                                    E  06490    368300000
    5 ACCNOW=-1.                                               E  06500    368400000
      GO TO 30                                                 E  06510    368500000
   10 IF(EDOT + EDOTDB)20,20,15                                E  06520    368600000
   20 ACCNOW=+1.                                               E  06530    368700000
      GO TO 30                                                 E  06540    368800000
   15 IF(EDOT)25,26,26                                         E  06550    368900000
   26 IF(ACCNOW .EQ. -1.)GO TO 5                               E  06560    369000000
      ACCNOW=0.                                                E  06570    369100000
      GO TO 30                                                 E  06580    369200000
   25 IF(ACCNOW .EQ. +1.)GO TO 20                              E  06590    369300000
      ACCNOW=0.                                                E  06600    369400000
   30 RETURN                                                   E  06610    369500000
      END                                                      E  06620    369600000
```

```
      SUBROUTINE POSCOM(TIME,POSCU,TIMCU,OUT,TIME0,TIME1,TIME2,TIME3,    E  06630    369700000
     1     ACC01,ACC12,ACC23,POSC0,POSC1,POSC2,VELC1,VELC2,               E  06640    369800000
     1     ACCMAG,VELMAX,ACCCMN,VELCMN,POSCMN)                            E  06650    369900000
C     THIS SUBROUTINE GENERATES A POSITION COMMAND                        E  06660    370000000
C     TIME = TIME                                                         E  06670    370100000
C     POSCU = POSITION COMMAND UPDATE                                     E  06680    370200000
C     TIMCU = TIME OF POSITION COMMAND UPDATE                             E  06690    370300000
C     OUT   = 0.   FIRST UPDATE NOT YET ACTIVATED                         E  06700    370400000
C             1.    FIRST UPDATE DATA COMPUTED                            E  06710    370500000
C     ACCMAG=MAGNITUDE OF NONZERO ACCELERATION COMMAND                    E  06720    370600000
C     VELMAX= MAXIMUM VELOCITY OF COMMAND                                 E  06730    370700000
C     TIME0     COMMENCE ACCELERATION                                     E  06740    370800000
C     TIME1     END ACCELERATION, COMMENCE COAST                          E  06750    370900000
C     TIME2     END COAST, COMMENCE DECELERATION                          E  06760    371000000
C     TIME3     END DECELERATION, OBJECT HAS ARRIVED                      E  06770    371100000
C     ACC01     ACCELERATION FROM TIME0 TO TIME1                          E  06780    371200000
C     ACC12     ACCELERATION FROM TIME1 TO TIME2                          E  06790    371300000
C     ACC23     ACCELERATION FROM TIME2 TO TIME3                          E  06800    371400000
C     POSC0 =POSITION COMMAND AT TIME0                                    E  06810    371500000
C     POSC1 =POSITION COMMAND AT TIME1                                    E  06820    371600000
C     POSC2 =POSITION COMMAND AT TIME2                                    E  06830    371700000
C     VELC1=VELOCITY COMMAND AT TIME1                                     E  06840    371800000
C     VELC2 =VELOCITY COMMAND AT TIME2                                    E  06850    371900000
C     ACCCMN= ACCELERATION COMMAND                                        E  06860    372000000
C     VELCMN= VELOCITY COMMAND                                            E  06870    372100000
C     POSCMN= POSITION COMMAND                                            E  06880    372200000
C                                                                         E  06890    372300000
C                                                                         E  06900    372400000
      IF(TIME .NE. 0.)GO TO 143                                           E  06910    372500000
      OUT=0.                                                              E  06920    372600000
      ACCCMN=0.                                                           E  06930    372700000
      VELCMN=0.                                                           E  06940    372800000
  143 IF(TIME-TIMCU)162,144,144                                           E  06950    372900000
  144 IF(OUT)145,145,160                                                  E  06960    373000000
  145 ERROR=POSCU-POSCMN                                                  E  06970    373100000
      ABSERR=ABS(ERROR)                                                   E  06980    373200000
C                                                                         E  06990    373300000
    2 T1HAF=SQRT(ABSERR/ACCMAG)                                           E  07000    373400000
      VELHAF=SQRT(ABSERR*ACCMAG)                                          E  07010    373500000
      IF(VELHAF-VELMAX)4,4,10                                             E  07020    373600000
C                                                                         E  07030    373700000
    4 TIME0=TIMCU                                                         E  07040    373800000
      TIME1=TIME0+T1HAF                                                   E  07050    373900000
      TIME2=TIME1                                                         E  07060    374000000
      TIME3=TIME2+T1HAF                                                   E  07070    374100000
      ACC01=(ERROR/ABSERR)*ACCMAG                                         E  07080    374200000
      ACC12=0.                                                            E  07090    374300000
      ACC23=(-ERROR/ABSERR)*ACCMAG                                        E  07100    374400000
      OUT=1.                                                              E  07110    374500000
```

```
      GO TO 160                                                         E 07120   374600000
C                                                                       E 07130   374700000
   10 T1=VELMAX/ACCMAG                                                  E 07140   374800000
      T2=ABSERR/VELMAX                                                  E 07150   374900000
      TIMEO=TIMCU                                                       E 07160   375000000
      TIME1=TIMEO+T1                                                    E 07170   375100000
      TIME2=TIMEO+T2                                                    E 07180   375200000
      TIME3=TIME2+T1                                                    E 07190   375300000
      ACC01=(ERROR/ABSERR)*ACCMAG                                       E 07200   375400000
      ACC12=0.                                                          E 07210   375500000
      ACC23=(-ERROR/ABSERR)*ACCMAG                                      E 07220   375600000
      OUT=1.                                                            E 07230   375700000
  160 IF(TIME-TIME3)150,159,159                                         E 07240   375800000
  150 IF(TIME-TIME2)153,50,50                                           E 07250   375900000
   50 IF(ACCCMN .EQ. ACC23)GO TO 58                                     E 07260   376000000
      IF(ACCCMN .EQ. ACC01)GO TO 52                                     E 07270   376100000
      POSCMN=POSC1+VELC1*(TIME2-TIME1)                                  E 07280   376200000
      GO TO 54                                                          E 07290   376300000
   52 VELCMN=ACC01*(TIME1-TIMEO)                                        E 07300   376400000
      POSCMN=POSCO+0.5*ACC01*((TIME1-TIMEO)**2)                         E 07310   376500000
      POSCMN=POSCMN+VELCMN*(TIME2-TIME1)                                E 07320   376600000
   54 VELC2=VELCMN                                                      E 07330   376700000
      POSC2=POSCMN                                                      E 07340   376800000
      ACCCMN=ACC23                                                      E 07350   376900000
   58 VELCMN=VELC2+ACC23*(TIME-TIME2)                                   E 07360   377000000
      POSCMN=POSC2+VELC2*(TIME-TIME2)+0.5*ACC23*((TIME-TIME2)**2)       E 07370   377100000
      GO TO 162                                                         E 07380   377200000
  153 IF(TIME-TIME1)156,60,60                                           E 07390   377300000
   60 IF(ACCCMN .EQ. ACC12)GO TO 62                                     E 07400   377400000
      VELCMN=ACC01*(TIME1-TIMEO)                                        E 07410   377500000
      POSCMN=POSCO+0.5*ACC01*((TIME1-TIMEO)**2)                         E 07420   377600000
      VELC1=VELCMN                                                      E 07430   377700000
      POSC1=POSCMN                                                      E 07440   377800000
      ACCCMN=ACC12                                                      E 07450   377900000
      VELCMN=VELC1                                                      E 07460   378000000
   62 POSCMN=POSC1+VELC1*(TIME-TIME1)                                   E 07470   378100000
      GO TO 162                                                         E 07480   378200000
  156 IF(TIME-TIMEO)159,70,70                                           E 07490   378300000
   70 IF(ACCCMN .EQ. ACC01)GO TO 72                                     E 07500   378400000
      ACCCMN=ACC01                                                      E 07510   378500000
      POSCO=POSCMN                                                      E 07520   378600000
   72 VELCMN=+ACC01*(TIME-TIMEO)                                        E 07530   378700000
      POSCMN=POSCO+0.5*ACC01*((TIME-TIMEO)**2)                          E 07540   378800000
      GO TO 162                                                         E 07550   378900000
  159 IF(ACCCMN .EQ. 0.)GO TO 162                                       E 07560   379000000
      VELCMN=0.                                                         E 07570   379100000
      POSCMN=POSC2+VELC2*(TIME3-TIME2)+0.5*ACC23*((TIME3-TIME2)**2)     E 07580   379200000
      ACCCMN=0.                                                         E 07590   379300000
  162 RETURN                                                            E 07600   379400000
      END                                                               E 07610   379500000
```

```
      SUBROUTINE BMCON(UJ,UJD,UJDD)                                       E  07620     379600000
      DIMENSION UJO(3),UJ(3),UJD(3),UJDD(3),UJDO(3),GO(3,3),GDO(3,3),     E  07630     379700000
     *          XAIS(3),XSNCM(3),DDXSNS(3),XSCM(3),DDXI(3,2)              E  07640     379800000
      COMMON /INOUT/IN,IOUT,IOFF                                          E  07650     379900000
      COMMON T,R(17),RI(3,100),RID(3,100),WXI(3,100),H1(3),H2(3),H3(3),   E  07660     380000000
     *          H4(3),G1(3,3),G2(3,3)                                     E  07670     380100000
      COMMON /LABOR/WX(3),RIO(900),TH(3,100)                              E  07680     380200000
      COMMON /ALLCNT/IS,O(40),YICS(10),YPRED(10),YDOT(10),NEQS,DO(3),     E  07690     380300000
     *                XI(17),O1CMAG                                       E  07700     380400000
      COMMON /LOADS/ZZ(685),RDDOT(3),WXDOT(3),QDD(6,100)                  E  07710     380500000
      COMMON /EXTRA/ZFX(12),ZCM(3),EMC,TOT                                E  07720     380600000
      COMMON /LUMPS/U(8)                                                  E  07730     380700000
      COMMON /BIG/PIETA(9),PIGAM(3,3)                                     E  07740     380800000
      COMMON /VAROUT/DD(89),XXCS,ERRDDX,UJ3,HIL(2),UJD23                  E  07750     380900000
     *,F1(9),U13MO,U23MO                                                  E  07760     381000000
     *,EFILT                                                              E  07770     381100000
      COMMON /NEWCOM/EL(3),ELD(3)                                         E  07780     381200000
      DO 8 I=1,2                                                          E  07790     381300000
      UJ(I)=0.                                                            E  07800     381400000
      UJD(I)=0.                                                           E  07810     381500000
    8 UJDD(I)=0.                                                          E  07820     381600000
      IF(T.GT.0.)GO TO 100                                                E  07830     381700000
      READ(IN,2)UJO,UJDO,WM1EST,WKEXSE,WKDESE,TAUBAL,O1CBAL,XAIS,XSCM     E  07840     381800000
    2 FORMAT(2(3E15.8/),5E15.8/3E15.8/3E15.8)                             E  07850     381900000
      WRITE(IOUT,3)WM1EST,WKEXSE,WKDESE,TAUBAL,O1CBAL,XAIS,XSCM,UJO,UJDOE  07860     382000000
    3 FORMAT(*OBALANCE MASS CONTROL INPUT*/3X,*EL MASS EST*,9X,* KEXSE*,E  07870     382100000
     *11X,*KDESE*,6X,*FILTER TIME CONST*                                  E  07880     382200000
     *    ,2X,*OMEGA BAL (MIN)*/5F17.7/                                   E  07890     382300000
     ** LOCAL SENSOR COORDS    =*,3E16.7/                                 E  07900     382400000
     ** DIST CM TO SENSOR CMND=*,3E16.7/                                  E  07910     382500000
     ** U2    INITIAL          =*,3E16.7/                                 E  07920     382600000
     ** U2D   INITIAL          =*,3E16.7)                                 E  07930     382700000
      YICS(5)=UJDO(3)                                                     E  07940     382800000
      YICS(6)=UJO(3)                                                      E  07950     382900000
      YICS(7)=0.                                                          E  07960     383000000
      XSNCM(3)=0.                                                         E  07970     383100000
      U13MO=0.                                                            E  07980     383200000
      U13H=UJ(3)                                                          E  07990     383300000
      CALL MCPY(UJO,UJ,3,1,3)                                             E  08000     383400000
      CALL MCPY(UJDO,UJD,3,1,3)                                           E  08010     383500000
      NEQS=3                                                              E  08020     383600000
      DDXI(3,2)=0.                                                        E  08030     383700000
  100 CALL EARLY                                                          E  08040     383800000
C                                                                         E  08050     383900000
COMPUTE  DDXSNS                                                           E  08060     384000000
C                                                                         E  08070     384100000
      CALL GAMMA(WX,G1)                                                   E  08080     384200000
      CALL MULT(G1,RID(1,IS),H1,1)                                        E  08090     384300000
      CALL SCALP(2.,H1,H1,1)                                              E  08100     384400000
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      CALL MULT(G1,RI(1,IS),H3,1)                                      E  08110   384500000
      CALL MULT(G1,H3,H2,1)                                            E  08120   384600000
      CALL GAMMA(RI(1,IS),G1)                                          E  08130   384700000
      CALL MULT(G1,WXDOT,H3,1)                                         E  08140   384800000
      DO 10 I=1,3                                                      E  08150   384900000
   10 H1(I)=RDDOT(I)+QDD(I,IS)+H1(I)+H2(I)-H3(I)                       E  08160   385000000
      CALL GAMMA(TH(1,IS),G1)                                          E  08170   385100000
      CALL MULT(G1,H1,H2,1)                                            E  08180   385200000
      CALL SUBTR(H1,H2,H1,1)                                           E  08190   385300000
      CALL GAMMA(WXI(1,IS),GO)                                         E  08200   385400000
      CALL GAMMA(DO,GDO)                                               E  08210   385500000
      CALL MULT(GO,XAIS,H3,1)                                          E  08220   385600000
      CALL MULT(GO,H3,H2,1)                                            E  08230   385700000
      CALL GAMMA(XAIS,G2)                                              E  08240   385800000
      CALL MULT(G2,DO,H3,1)                                            E  08250   385900000
      DO 20 I=1,3                                                      E  08260   386000000
   20 DDXSNS(I)=H1(I)+H2(I)-H3(I)                                      E  08270   386100000
      IF(T.EQ.0.)GO TO 40                                              E  08280   386200000
C                                                                      E  08290   386300000
COMPUTE XSNCM                                                          E  08300   386400000
C                                                                      E  08310   386500000
      CALL MULT(G1,XAIS,H1,1)                                          E  08320   386600000
      CALL ADD(XAIS,H1,H1,1)                                           E  08330   386700000
      CALL MULT(PIGAM,ZCM,H2,1)                                        E  08340   386800000
      DO 30 I=1,3                                                      E  08350   386900000
   30 XSNCM(I)=RI(I,IS)+H1(I)-H2(I)                                    E  08360   387000000
      U13MO=UJ(3)-U13H                                                 E  08370   387100000
      UJ(3)=YPRED(6)                                                   E  08380   387200000
      UJD(3)=YPRED(5)                                                  E  08390   387300000
      EFILT=YPRED(7)                                                   E  08400   387400000
   40 CONTINUE                                                         E  08410   387500000
      CALL MCPY(UJDD,DDXI,3,1,3)                                       E  08420   387600000
      CALL BMCTR(ELD,DO,TOT,U,GDO,GO,UJ,WM1EST,WKEXSE       ,          E  08430   387700000
     *          O1CMAG,DDXSNS(3),DDXI,XSCM,O1CBAL,TAUBAL,EFILTD,WKDESE)E  08440   387800000
      CALL MCPY(DDXI(1,2),UJDD,3,1,3)                                  E  08450   387900000
      XXCS=XSCM(3)-XSNCM(3)                                            E  08460   388000000
      IF(T.EQ.0.)XXCS=0.                                               E  08470   388100000
      UJ3=UJ(3)                                                        E  08480   388200000
      UJD23=UJD(3)                                                     E  08490   388300000
      YDOT(5)=UJDD(3)                                                  E  08500   388400000
      YDOT(6)=UJD(3)                                                   E  08510   388500000
      YDOT(7)=EFILTD                                                   E  08520   388600000
      U23MO=UJ3-UJO(3)                                                 E  08530   388700000
      RETURN                                                           E  08540   388800000
      END                                                              E  08550   388900000
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      SUBROUTINE BMCTR(DXB,DO,WM,WMI,GDO,GO,DXI,WM1EST,WKEXSE            E 08560   389000000
     *  ,O1CMAG,DDXSNS,DDXI,XSCM,O1CBAL,TAUBAL,EFILTD,WKDESE)            E 08570   389100000
C                                                                        E 08580   389200000
      DIMENSION DXB(3),DO(3),                                            E 08590   389300000
     1          WMI(2),          DXI(3,2),DDXI(3,2),                     E 08600   389400000
     2          A1(3),A2(3),A3(3),A4(3),                                 E 08610   389500000
     3          GDO(3,3),GO(3,3)                                         E 08620   389600000
     4          ,XSCM(3)                                                 E 08630   389700000
      COMMON T(918),A1,A2,A3,A4                                          E 08640   389800000
      COMMON /VAROUT/DDD(90),ERRDDX                                      E 08650   389900000
     * ,E(15),EFILT                                                      E 08660   390000000
C                                                                        E 08670   390100000
      IF(T(1) .NE. 0.)GO TO 10                                           E 08680   390200000
      DDXI(1,2)=0.                                                       E 08690   390300000
      DDXI(2,2)=0.                                                       E 08700   390400000
      EFILTD=0.                                                          E 08710   390500000
      EFILT=0.                                                           E 08720   390600000
   10 IF(DXB(3))66,63,66                                                 E 08730   390700000
   63 IF(O1CMAG-O1CBAL)66,65,65                                          E 08740   390800000
   66 DDXI(3,2)=0.                                                       E 08750   390900000
      DXI(3,2)=0.                                                        E 08760   391000000
      EFILTD=0.                                                          E 08770   391100000
      GO TO 64                                                           E 08780   391200000
   65 CONTINUE                                                           E 08790   391300000
      CALL MULT(GO,XSCM,A1,1)                                            E 08800   391400000
      CALL MULT(GO,A1,A2,1)                                              E 08810   391500000
      CALL MULT(GDO,XSCM,A1,1)                                           E 08820   391600000
      SC=WM1EST/WM                                                       E 08830   391700000
      CALL SCALR(SC,DDXI,A3,1)                                           E 08840   391800000
      SC=WMI(2)/WM                                                       E 08850   391900000
      CALL SCALR(SC,DDXI(1,2),A4,1)                                      E 08860   392000000
      DO 20 I=1,3                                                        E 08870   392100000
   20 A4(I)=A1(I)+A2(I)-A3(I)-A4(I)                                      E 08880   392200000
      DDXCMN=A4(3)                                                       E 08890   392300000
      ERRDDX=DDXCMN-DDXSNS                                               E 08900   392400000
      IF(TAUBAL.NE.0.)GO TO 80                                           E 08910   392500000
      EFILT=ERRDDX                                                       E 08920   392600000
      GO TO 90                                                           E 08930   392700000
   80 EFILTD=(ERRDDX-EFILT)/TAUBAL                                       E 08940   392800000
C                                                                        E 08950   392900000
C     MASS 2 POSITION CONTROL                                            E 08960   393000000
C                                                                        E 08970   393100000
   90 DDXI(3,2)=-WKDESE*DXI(3,2)+WKEXSE*EFILT                            E 08980   393200000
C                                                                        E 08990   393300000
   64 RETURN                                                             E 09000   393400000
      END                                                                E 09010   393500000
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      SUBROUTINE LOOK(L,K,M,IPOINT)                          E  09020   393600000
      DIMENSION K(8)                                         E  09030   393700000
      COMMON T                                                          393800000
      M=8                                                    E  09040   393900000
      DO 10 I=1,8                                            E  09050   394000000
   10 K(I)=I                                                 E  09060   394100000
      RETURN                                                 E  09070   394200000
      END                                                    E  09080   394300000
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      SUBROUTINE LOADIN                                                    E  09090   394400000
      COMMON T,W(17),HOLD(6),SAVE(6),XLP(3),XLPI(3),WFI(6),G1(3,3)         E  09100   394500000
      COMMON /INOUT/IN,IOUT,IOFF                                           E  09110   394600000
      COMMON /LABOR/WX(3),RI(3,100),Q(3,100)                               E  09120   394700000
      COMMON /CWT/DUMMY(9),WY(3),RA(3,100),QB(3,100)                       E  09130   394800000
      COMMON /BIG/V(40),QP(3,6,100),A(6,6,100),D(6,6,100)                  E  09140   394900000
      COMMON /LOADS/DUML(33),RHS(6,100),DEL(52),DDLAB(606),DDCW(606),      E  09150   395000000
     *               KLUCS,KLULAB,KLUCW,CSLDA(6),CSLDB(6)                  E  09160   395100000
      COMMON /LOOPAS/L,FTL,N                                               E  09170   395200000
      DIMENSION SA(3,3,100),L(16),TL(3,16),LB(16),TLB(3,16),FTL(6,16),     E  09180   395300000
     *   FTC(6,16),IXL(100),IXC(100),NIXL(16),NIXC(16),B(3,6,100),         E  09190   395400000
     *   C(600,6),E(3,6,100)                                               E  09200   395500000
      DIMENSION FTCSMM(6,17,4)                                             E  09210   395600000
      EQUIVALENCE(SA(1,1,1),QP(1,1,1)),(A(1,1,1),B(1,1,1)),                E  09220   395700000
     *           (A(1,1,51),C(1,1)),(E(1,1,1),D(1,1,51))                   E  09230   395800000
      READ(IN,1)KLUCS,KLULAB,KLUCW,N,NB                                    E  09240   395900000
    1 FORMAT(5I2)                                                          E  09250   396000000
      DO 10 I=1,6                                                          E  09260   396100000
      DO 10 J=1,17                                                         E  09270   396200000
      FTL(J,I)=0.                                                                     396300000
      DO 10 K=1,4                                                          E  09280   396400000
   10 FTCSMM(I,J,K)=0.                                                     E  09290   396500000
      LOOP=0                                                               E  09300   396600000
      IF(KLULAB.EQ.0)GO TO 30                                              E  09310   396700000
      INEW=0                                                               E  09320   396800000
      IOLD=1                                                               E  09330   396900000
      WRITE(IOUT,600)                                                      E  09340   397000000
  600 FORMAT(*0LOADS COMPUTED ON LABORATORY*)                              E  09350   397100000
      DO 20 IL=1,N                                                         E  09360   397200000
      READ(IN,1)L(IL),NIXL(IL)                                             E  09370   397300000
      INEW=INEW+NIXL(IL)                                                   E  09380   397400000
      READ(IN,2)(TL(J,IL),J=1,3),(IXL(I),I=IOLD,INEW)                      E  09390   397500000
    2 FORMAT(3E15.8/(10I2))                                                E  09400   397600000
      WRITE(IOUT,45) L(IL),          (TL (J,IL),J=1,3),NIXL(IL)            E  09410   397700000
     * ,(IXL(I),I=IOLD,INEW)                                               E  09420   397800000
   20 IOLD=INEW+1                                                          E  09430   397900000
   30 IF(KLUCW.EQ.0)GO TO 50                                               E  09440   398000000
      INEW=0                                                               E  09450   398100000
      IOLD=1                                                               E  09460   398200000
      WRITE(IOUT,700)                                                      E  09470   398300000
  700 FORMAT(*0LOADS COMPUTED ON COUNTERWEIGHT*)                           E  09480   398400000
      DO 40 IL=1,NB                                                        E  09490   398500000
      READ(IN,1) LB(IL),NIXC(IL)                                           E  09500   398600000
      INEW=INEW+NIXC(IL)                                                   E  09510   398700000
      READ(IN,2)(TLB(J,IL),J=1,3),(IXC(I),I=IOLD,INEW)                     E  09520   398800000
      WRITE(IOUT,45)LB(IL),          (TLB(J,IL),J=1,3),NIXC(IL)            E  09530   398900000
     * ,(IXC(I),I=IOLD,INEW)                                               E  09540   399000000
   40 IOLD=INEW+1                                                          E  09550   399100000
   50 RETURN                                                               E  09560   399200000
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C

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      FNTRY IABLD                                                     E 09570
      INEW=0                                                          E 09580
      IOLD=1                                                          E 09590
      IF(T.EQ.O.)RETURN                                               E 09630
      DO 100 I=1,N                                                    E 09600
      LI=L(I)
      DO 101 J=1,6                                                    E 09610
  101 FTL(J,I)=0.                                                     E 09620
      CALL MULT(QP(1,4,LI   ),TL(1,I),SAVE,1)
      DO 110 J=1,3                                                    E 09650
  110 XLP(J)=SAVE(J)+RI(J,LI    )+Q(J,LI    )
      INEW=INEW+NIXL(I)                                               E 09670
      DO 120 J=IOLD,INEW                                              E 09680
      IXLJ=IXL(J)
      ISIX=6*IXL(J)-5                                                 E 09690
      CALL MPRD(A(1,1,IXLJ   ),DDLAB,HOLD,6,6,1,6,1)
      CALL MPRD(D(1,1,IXLJ   ),DDLAB(ISIX+6),SAVE,6,6,1,6,1)
      DO 140 K=1,6                                                    E 09720
  140 WFI(K)=RHS(K,IXLJ   )-HOLD(K)-SAVE(K)
      CALL MULT(QP(1,4,IXLJ   ),WFI(4),HOLD,1)
      DO 160 K=1,3                                                    E 09750
  160 XLPI(K)=RI(K,IXLJ   )+Q(K,IXLJ   )-XLP(K)
      CALL GAMMA(XLPI,G1)                                             E 09770
      CALL MULT(G1,WFI,SAVE,1)                                        E 09780
      DO 180 K=1,3                                                    E 09790
      FTL(K,I)=FTL(K,I)+WFI(K)                                        E 09800
  180 FTL(K+3,I)=FTL(K+3,I)+HOLD(K)+SAVE(K)                           E 09810
  120 CONTINUE                                                        E 09820
  100 IOLD=INEW+1                                                     E 09830
      RETURN                                                          E 09840
      ENTRY CWLD                                                      E 09850
      INEW=0                                                          E 09860
      IOLD=1                                                          E 09870
      IF(T.EQ.O.)RETURN                                               E 09910
      DO 200 I=1,NB                                                   E 09880
      LI=LB(I)
      DO 201 J=1,6                                                    E 09890
  201 FTC(J,I)=0.                                                     E 09900
      CALL MULT(SA(1,1,LI    ),TLB(1,I),SAVE,1)
      DO 210 J=1,3                                                    E 09930
  210 XLP(J)=SAVE(J)+RA(J,LI    )+QB(J,LI    )
      INEW=INEW+NIXC(I)                                               E 09950
      DO 220 J=IOLD,INEW                                              E 09960
      IXLJ=IXC(J)
      ISIX=6*IXC(J)-5                                                 E 09970
      CALL MPRD(B(1,1,IXLJ   ),DDLAB,HOLD,3,6,1,3,1)
      CALL MPRD(C(ISIX,1),DDCW,SAVE,6,6,1,600,1)                      E 09990
      CALL MPRD(E(1,1,IXLJ   ),DDCW(ISIX+6),G1,3,3,1,3,1)
      CALL MPRD(E(1,4,IXLJ   ),DDCW(ISIX+9),G1(1,2),3,3,1,3,1)
      DO 240 K=1,3                                                    E 10020
      WFI(K)=RHS(K,IXLJ   )-HOLD(K)-SAVE(K)-G1(K,1)
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240 WFI(K+3)=RHS(K+3,IXLJ  )-SAVE(K+3)-G1(K,2)                          404400000
    CALL MULT(SA(1,1,IXLJ  ),WFI(4),HOLD,1)                             404500000
    DO 260 K=1,3                                             E  10060   404600000
260 XLPI(K)=RA(K,IXLJ  )+QB(K,IXLJ  )-XLP(K)                            404700000
    CALL GAMMA(XLPI,G1)                                      E  10080   404800000
    CALL MULT(G1,WFI,SAVE,1)                                 E  10090   404900000
    DO 280 K=1,3                                             E  10100   405000000
    FTC(K,I)=FTC(K,I)+WFI(K)                                 E  10110   405100000
280 FTC(K+3,I)=FTC(K+3,I)+HOLD(K)+SAVE(K)                    E  10120   405200000
220 CONTINUE                                                 E  10130   405300000
200 IOLD=INEW+1                                              E  10140   405400000
    RETURN                                                   E  10150   405500000
    ENTRY LMMOUT                                             E  10160   405600000
    JUMP=KLUCS+KLULAB+KLUCW                                  E  10170   405700000
    IF(JUMP.EQ.0)RETURN                                      E  10180   405800000
800 LOOP=LOOP+1                                              E  10190   405900000
    IF(LOOP.EQ.1)WRITE(IOUT,801)                             E  10200   406000000
    IF(LOOP.EQ.2)WRITE(IOUT,802)                             E  10210   406100000
801 FORMAT(//* MAXIMUM LOADS COMPUTED*/)                     E  10220   406200000
802 FORMAT(//* MINIMUM LOADS COMPUTED*/)                     E  10230   406300000
    DO 850 I=1,6                                             E  10240   406400000
    CSLDA(I)=FTCSMM(I,17,LOOP)                               E  10250   406500000
    CSLDB(I)=FTCSMM(I,17,LOOP+2)                             E  10260   406600000
    DO 850 J=1,16                                            E  10270   406700000
    FTL(I,J)=FTCSMM(I,J,LOOP)                                E  10280   406800000
850 FTC(I,J)=FTCSMM(I,J,LOOP+2)                              E  10290   406900000
    ENTRY LDOUT                                              E  10300   407000000
    IF(T.EQ.0.)RETURN                                        E  10310   407100000
    IF(KLUCS.EQ.0)GO TO 310                                  E  10320   407200000
    DO 400 I=1,6                                             E  10330   407300000
    FTCSMM(I,17,1)=AMAX1(FTCSMM(I,17,1),CSLDA(I))            E  10340   407400000
    FTCSMM(I,17,2)=AMIN1(FTCSMM(I,17,2),CSLDA(I))            E  10350   407500000
    FTCSMM(I,17,3)=AMAX1(FTCSMM(I,17,3),CSLDB(I))            E  10360   407600000
400 FTCSMM(I,17,4)=AMIN1(FTCSMM(I,17,4),CSLDB(I))            E  10370   407700000
    WRITE(IOUT,301)CSLDA,CSLDB                               E  10380   407800000
301 FORMAT(*OSTRUCTURAL LOADS APPLIED BY CONNECTING STRUCTURE*  E  10390   407900000
   *,* (ON LAB IN X AXES AND ON CWT IN Y AXES)*/31X,         E  10400   408000000
   *   *FORCE*,50X,*TORQUE*/* ON LAB    *,3E16.7,8X,3E16.7/  E  10410   408100000
   *   * ON CWT.   *,3E16.7,8X,3E16.7)                       E  10420   408200000
310 IF(KLULAB.EQ.0)GO TO 350                                 E  10430   408300000
    DO 410 I=1,6                                             E  10440   408400000
    DO 410 J=1,N                                             E  10450   408500000
    FTCSMM(I,J,1)=AMAX1(FTCSMM(I,J,1),FTL(I,J))              E  10460   408600000
410 FTCSMM(I,J,2)=AMIN1(FTCSMM(I,J,2),FTL(I,J))              E  10470   408700000
    WRITE(IOUT,320)                                          E  10480   408800000
320 FORMAT(*OSTRUCTURAL LOADS ON LAB IN X AXES*)             E  10490   408900000
    DO 340 I=1,N                                             E  10500   409000000
340 WRITE(IOUT,330)L(I),(TL(J,I),J=1,3),(FTL(J,I),J=1,6)     E  10510   409100000
330 FORMAT(*OMASS POINT =*,I2   /* LOCATION =*,3E17.7/21X,*FORCE*,  E  10520   409200000
   *  50X,*TORQUE*/3E16.7,8X,3E16.7)                         E  10530   409300000
350 IF(KLUCW.EQ.0)GO TO 300                                  E  10540   409400000
```

```
      DO 420 I=1,6                                                        E  10550   409500000
      DO 420 J=1,NB                                                       E  10560   409600000
      FTCSMM(I,J,3)=AMAX1(FTCSMM(I,J,3),FTC(I,J))                         E  10570   409700000
  420 FTCSMM(I,J,4)=AMIN1(FTCSMM(I,J,4),FTC(I,J))                         E  10580   409800000
      WRITE(IOUT,360)                                                     E  10590   409900000
  360 FORMAT(*0STRUCTURAL LOADS ON COUNTERWEIGHT IN Y AXES*)              E  10600   410000000
      DO 380 I=1,NB                                                       E  10610   410100000
  380 WRITE(IOUT,330)LB(I),(TLB(J,I),J=1,3),(FTC(J,I),J=1,6)             E  10620   410200000
  300 IF(LOOP.EQ.1)GO TO 800                                              E  10630   410300000
      RETURN                                                              E  10640   410400000
   45 FORMAT(* LOAD TO BE COMPUTED AT MASS POINT*,I4/                     E  10650   410500000
     * * LOCATION IN LOCAL COORDINATES*,3E17.7/                           E  10660   410600000
     * I4,* MASS POINT NUMBERS COMPRISING FREE BODY*/(20I4))              E  10670   410700000
      END                                                                 E  10680   410800000
```

```
      SUBROUTINE MINMAX(NLAB,NCW)                                      E  10690   410900000
      COMMON T                                                         E  10700   411000000
      COMMON /LABOR/QL(303),Q(3,100,4)                                 E  10710   411100000
      COMMON /INOUT/IN,IOUT,IOFF                                       E  10720   411200000
      COMMON /CWT/QC(312),QB(3,100,4)                                  E  10730   411300000
      COMMON /NEWCOM/XXX(108),KLUE                                     E  10740   411400000
      COMMON/LOADS/ZZ(691),XDD(3,2,101),YDD(3,2,100)                   E  10750   411500000
      DIMENSION QMAX(3,100,4),QMIN(3,100,4),QBMAX(3,100,4),QBMIN(3,100,4E  10760   411600000
     *),DDMIN(3,100,4),DDMAX(3,100,4)                                  E  10770   411700000
      IF(T.GT.0.)GO TO 100                                             E  10780   411800000
      IF(KLUE.EQ.2 .OR. KLUE.GT.3)GO TO 20                             E  10790   411900000
      DO 10 I=1,3                                                      E  10800   412000000
      DO 10 J=1,NLAB                                                   E  10810   412100000
      DDMIN(I,J,1)=XDD(I,1,J)                                          E  10820   412200000
      DDMIN(I,J,2)=XDD(I,2,J)                                          E  10830   412300000
      DDMAX(I,J,1)=XDD(I,1,J)                                          E  10840   412400000
      DDMAX(I,J,2)=XDD(I,2,J)                                          E  10850   412500000
      DO 10 L=1,4                                                      E  10860   412600000
      QMIN(I,J,L)=Q(I,J,L)                                             E  10870   412700000
   10 QMAX(I,J,L)=Q(I,J,L)                                             E  10880   412800000
   20 IF(KLUE.GE.3)GO TO 50                                            E  10890   412900000
      DO 30 I=1,3                                                      E  10900   413000000
      DO 30 J=1,NCW                                                    E  10910   413100000
      DDMIN(I,J,3)=YDD(I,1,J)                                          E  10920   413200000
      DDMIN(I,J,4)=YDD(I,2,J)                                          E  10930   413300000
      DDMAX(I,J,3)=YDD(I,1,J)                                          E  10940   413400000
      DDMAX(I,J,4)=YDD(I,2,J)                                          E  10950   413500000
      DO 30 L=1,4                                                      E  10960   413600000
      QBMIN(I,J,L)=QB(I,J,L)                                           E  10970   413700000
   30 QBMAX(I,J,L)=QB(I,J,L)                                           E  10980   413800000
   50 RETURN                                                           E  10990   413900000
  100 IF(KLUE.EQ. 2 .OR. KLUE.GT.3)GO TO 120                           E  11000   414000000
      DO 110 I=1,3                                                     E  11010   414100000
      DO 110 J=1,NLAB                                                  E  11020   414200000
      IF(XDD(I,1,J).LT.DDMIN(I,J,1))DDMIN(I,J,1)=XDD(I,1,J)            E  11030   414300000
      IF(XDD(I,2,J).LT.DDMIN(I,J,2))DDMIN(I,J,2)=XDD(I,2,J)            E  11040   414400000
      IF(XDD(I,1,J).GT.DDMAX(I,J,1))DDMAX(I,J,1)=XDD(I,1,J)            E  11050   414500000
      IF(XDD(I,2,J).GT.DDMAX(I,J,2))DDMAX(I,J,2)=XDD(I,2,J)            E  11060   414600000
      DO 110 L=1,4                                                     E  11070   414700000
      IF(Q(I,J,L).LT.QMIN(I,J,L))QMIN(I,J,L)=Q(I,J,L)                  E  11080   414800000
      IF(Q(I,J,L).GT.QMAX(I,J,L))QMAX(I,J,L)=Q(I,J,L)                  E  11090   414900000
  110 CONTINUE                                                         E  11100   415000000
  120 IF(KLUE.GE.3)GO TO 200                                           E  11110   415100000
      DO 130 I=1,3                                                     E  11120   415200000
      DO 130 J=1,NCW                                                   E  11130   415300000
      IF(YDD(I,1,J).LT.DDMIN(I,J,3))DDMIN(I,J,3)=YDD(I,1,J)            E  11140   415400000
      IF(YDD(I,2,J).LT.DDMIN(I,J,4))DDMIN(I,J,4)=YDD(I,2,J)            E  11150   415500000
      IF(YDD(I,1,J).GT.DDMAX(I,J,3))DDMAX(I,J,3)=YDD(I,1,J)            E  11160   415600000
      IF(YDD(I,2,J).GT.DDMAX(I,J,4))DDMAX(I,J,4)=YDD(I,2,J)            E  11170   415700000
```

```
      DO 130 L=1,4
      IF(QB(I,J,L).LT.QBMIN(I,J,L))QBMIN(I,J,L)=QB(I,J,L)
      IF(QB(I,J,L).GT.QBMAX(I,J,L))QBMAX(I,J,L)=QB(I,J,L)
  130 CONTINUE
  200 RETURN
      ENTRY MMOUT
      IF(KLUE.LE.3)WRITE(IOUT,300)
  300 FORMAT(//* MAXIMUM AND MINIMUM ELASTIC MOTIONS*)
      IF(KLUE.EQ.2 .OR. KLUE.GT.3)GO TO 350
      WRITE(IOUT,600)
  600 FORMAT(* MASS NO.*,7X,*QMIN*,13X,*QMAX*,12X,*QDOTMIN*,10X,
     *     *QDOTMAX*,9X,*QDDOTMIN*,9X,*QDDOTMAX*)
      WRITE(IOUT,500)(J,(QMIN(I,J,1),QMAX(I,J,1),QMIN(I,J,2),
     *          QMAX(I,J,2),DDMIN(I,J,1),DDMAX(I,J,1) ,I=1,3),J=1,NLAB)
      WRITE(IOUT,601)
  601 FORMAT(* MASS NO.*,5X,*THETAMIN*,9X,*THETAMAX*,8X,*THETADOTMIN*,6X
     *     *THETADOTMAX*,5X,*THETADDOTMIN*,5X,*THETADDOTMAX*)
      WRITE(IOUT,500)(J,(QMIN(I,J,3),QMAX(I,J,3),QMIN(I,J,4),
     *          QMAX(I,J,4),DDMIN(I,J,2),DDMAX(I,J,2) ,I=1,3),J=1,NLAB)
  350 IF(KLUE.GE.3)GO TO 1000
      WRITE(IOUT,602)
  602 FORMAT(* MASS NO.*,5X,*QBARMIN*,10X,*QBARMAX*,9X,*QBARDOTMIN*,7X,
     *     *QBARDOTMAX*,6X,*QBARDDOTMIN*,6X,*QBARDDOTMAX*)
      WRITE(IOUT,500)(J,(QBMIN(I,J,1),QBMAX(I,J,1),QBMIN(I,J,2),
     *          QBMAX(I,J,2),DDMIN(I,J,3),DDMAX(I,J,3),I=1,3),J=1,NCW)
      WRITE(IOUT,603)
  603 FORMAT(* MASS NO.    THETABARMIN      THETABARMAX      THETABARDOTMI
     *N    THETABARDOTMAX   THETABARDDOTMIN  THETABARDDOTMAX*)
      WRITE(IOUT,500)(J,(QBMIN(I,J,3),QBMAX(I,J,3),QBMIN(I,J,4),
     *          QBMAX(I,J,4),DDMIN(I,J,4),DDMAX(I,J,4),I=1,3),J=1,NCW)
 1000 RETURN
  500 FORMAT(2X,I3,3X,6E17.7/8X,6E17.7/8X,6E17.7/)
      END
```

```
      SUBROUTINE SUPPLM(A,N,IF,K)                          E  11510   419100000
      DIMENSION A(1)                                       E  11520   419200000
      N6=N*6                                               E  11530   419300000
      DO 10 I=1,N6                                         E  11540   419400000
   10 A(I)=0.                                              E  11550   419500000
   99 RETURN                                               E  11560   419600000
      END                                                  E  11570   419700000
```

```
      SUBROUTINE CWCOM(TIME,XB3CU,TXB3CU,ACCB3C,VELMBC,                E  11580   419800000
     1     DDXB3C,DXB3C,XB3C)                                          E  11590   419900000
      IF(TIME.EQ.0.)A=XB3C                                             E  11600   420000000
      IF(TIME.GT.TXB3CU)GO TO 10                                       E  11610   420100000
      XB3C=A                                                           F  11620   420200000
      OUTXB=0.                                                         E  11630   420300000
      DXB3C=0.                                                         E  11640   420400000
      DDXB3C=0.                                                        E  11650   420500000
   10 CALL POSCOM(TIME,XB3CU,TXB3CU,OUTXB,TIME0B,TIME1B,TIME2B,TIME3B, E  11660   420600000
     1     ACC01B,ACC12B,ACC23B,POSC0B,POSC1B,POSC2B,VELC1B,VELC2B,    E  11670   420700000
     1     ACCB3C,VELMBC,DDXB3C,DXB3C,XB3C)                            E  11680   420800000
      RETURN                                                           F  11690   420900000
      END                                                              E  11700   421000000
```

```
      SUBROUTINE POSCTR(E,EDB,EDOT,EDOTMX,ACCS,ACCNOW)                  E  11710   421100000
C     THIS SUBROUTINE GENERATES A CONTROL POLICY. A CONSTANT            E  11720   421200000
C     ACCELERATION +A, 0, OR -A IS COMMANDED, BASED ON THE              E  11730   421300000
C     LOCATION OF THE STATE IN THE PHASE PLANE E, EDOT. PARABOLIC       E  11740   421400000
C     AND CONSTANT RATE SWITCHING CURVES ARE USED.                      E  11750   421500000
C     E          ERROR, ATTITUDE - ATTITUDE COMMAND                     E  11760   421600000
C     EDB        ERROR DEAD BAND                                        E  11770   421700000
C     EDOT       ERROR RATE, RATE-RATE COMMAND                          E  11780   421800000
C     EDOTMX     ERROR RATE MAXIMUM(FOR SWITCHING)                      E  11790   421900000
C     ACCS   = ACCELERATION MAGNITUDE (FOR SWITCHING)                   E  11800   422000000
C     ACCNOW     ACCELERATION COMMANDED NOW +1.,0.,-1.)                 E  11810   422100000
C                                                                       E  11820   422200000
      E1=+1.                                                            E  11830   422300000
      IF(EDOT)40,5,5                                                    E  11840   422400000
C                                                                       E  11850   422500000
    5 IF(E+EDB)10,24,24                                                 E  11860   422600000
   10 E2=SQRT(-2.*ACCS*(E+EDB))                                         E  11870   422700000
      IF(EDOT-E2)20,20,25                                               E  11880   422800000
   20 IF(EDOT-EDOTMX)21,21,22                                           E  11890   422900000
C                                                                       E  11900   423000000
   24 IF(E-EDB)25,36,36                                                 E  11910   423100000
   25 E3=SQRT(-2.*ACCS*(E-EDB))                                         E  11920   423200000
      IF(EDOT-E3)22,36,36                                               E  11930   423300000
   21 ACCNOW=E1                                                         E  11940   423400000
      GO TO 80                                                          E  11950   423500000
   22 ACCNOW=0.                                                         E  11960   423600000
      GO TO 80                                                          E  11970   423700000
   36 ACCNOW=-E1                                                        E  11980   423800000
      GO TO 80                                                          E  11990   423900000
C                                                                       E  12000   424000000
   40 E=-E                                                              E  12010   424100000
      EDOT=-EDOT                                                        E  12020   424200000
      E1=-1.                                                            E  12030   424300000
      GO TO 5                                                           E  12040   424400000
C                                                                       E  12050   424500000
   80 RETURN                                                            E  12060   424600000
      END                                                               E  12070   424700000
```

```
      SUBROUTINE VELCOM(TIMF,VELCU,TIMCU,OUT,TIMEO,TIME1,ACCO1,VELCO,
     1      ACCMAG,ACCCMN,VELCMN)
C     THIS SUBROUTINE GENERATES A VELOCITY COMMAND
C     TIME= TIME
C     VELCU = VELOCITY COMMAND UPDATE
C     TIMCU = TIME OF VELOCITY COMMAND UPDATE
C     OUT   = 0.   FIRST UPDATE NOT YET ACTIVATED
C               1.   ALL DATA ASSOCIATED WITH FIRST UPDATE COMPUTED
C     ACCMAG= MAGNITUDE OF NON-ZERO ACCELERATION COMMAND
C     TIMEO     TIME TO COMMENCE ACCELERATION OF COMMAND
C     TIME1     TIME TO END ACCELERATION. OCOM IS NOW OCOMU.
C     ACCO1     ACCELERATION OF COMMAND FROM TIMEO TO TIME1
C     VELCO =VELOCITY COMMAND AT TIMEO
C     ACCCMN= ACCERERATION COMMAND
C     VELCMN= VELOCITY COMMAND
C
      IF(TIME .NE. 0.)GO TO 163
      ACCCMN=0.
      OUT=0.
  163 IF(TIME-TIMCU)175,164,164
  164 IF(OUT)165,165,174
  165 ERROR=VELCU-VELCMN
      ABSERR=ABS(ERROR)
   10 T1=ABSERR/ACCMAG
      TIMEO=TIMCU
      TIME1=TIMEO+T1
      ACCO1=(ERROR/ABSERR)*ACCMAG
      OUT=1.
C
  174 IF(TIME-TIME1)170,172,172
  170 IF(TIME-TIMEO)175,171,171
  171 IF(ACCCMN .EQ. ACCO1)GO TO 20
      VELCO=VELCMN
      ACCCMN=ACCO1
   20 VELCMN=VELCO+ACCO1*(TIME-TIMEO)
      GO TO 175
  172 IF(ACCCMN .EQ. 0.)GO TO 175
      VELCMN=VELCO+ACCO1*(TIME1-TIMEO)
      ACCCMN=0.
C
  175 RETURN
      END
```

```
      SUBROUTINE ZEROS(A,N)                                            429000000
      DIMENSION A(1)                                                   429100000
      K=3*N                                                            429200000
      DO 10 I=1,K                                                      429300000
   10 A(I)=0.                                                          429400000
      RETURN                                                           429500000
      END                                                              429600000
```

```
      SUBROUTINE SETUP ( MAGIN , MAGOUT ,TIC,STEP, NEQNS , DTAU , EPSIL E  12510    429700000
     1, DELTA ,ERR, TIME , DTIME ,YICS,YPRED,YCORR,YDOT,YNEW                        429800000
     2                    ,YDERV,  YDEV,FWDEL,BKDEL,TBDEL,PARTY,YNEWB)     E  12530    429900000
      DIMENSION YICS( 1),YPRED( 1),YCORR( 1), YDOT( 1), YNEW( 1),          E  12540    430000000
     1          YDERV( 1), YDEV( 1),FWDEL( 1),BKDEL( 1),TBDEL( 1),         E  12550    430100000
     2          PARTY( 1),YNEWB( 1),  ERR( 1)                              E  12560    430200000
      DIMENSION C(3),D(3)                                                  E  12570    430300000
      DOUBLE PRECISION YNEW,YPRED,YDERV                                    E  12580    430400000
      DATA C,D / .5,.5,1.0,.5,.0,.5/                                       E  12590    430500000
      TIME = TIC                                                           E  12600    430600000
      TAU  = TIC                                                           E  12610    430700000
      IF (DELTA)200,201,200                                                E  12620    430800000
  200 DTIME = 0.0078125                                                    E  12630    430900000
      GO TO 225                                                            E  12640    431000000
  201 DTIME = STEP                                                         E  12650    431100000
  225 DO 102 I = 1,NEQNS                                                   E  12660    431200000
      YDEV(I)  = 0.0                                                       E  12670    431300000
      YPRED(I) = YICS(I)                                                   E  12680    431400000
      YCORR(I) = YICS(I)                                                   E  12690    431500000
  102 YNEW(I)  = YICS(I)                                                   E  12700    431600000
      MAGOUT   =-2                                                         E  12710    431700000
      GO TO 264                                                            E  12720    431800000
      ENTRY MAGIC                                                          E  12730    431900000
  300 CONTINUE                                                             E  12740    432000000
      IF (MAGOUT) 305,101,101                                              E  12750    432100000
  101 IF(MAGIN) 21, 27, 14                                                 E  12760    432200000
   27 K = 0                                                                E  12770    432300000
      DO 202 I = 1,NEQNS                                                   E  12780    432400000
  202 YNEW(I)  = YPRED(I)                                                  E  12790    432500000
   21 K = K +1                                                             E  12800    432600000
  210 DO  2  I = 1,NEQNS                                                   E  12810    432700000
      GO TO (9,6,7,4,11),K                                                 E  12820    432800000
    9 FWDEL(I) = YDOT(I)                                                   E  12830    432900000
      GO TO 105                                                            E  12840    433000000
    6 TBDEL(I) = YDOT(I)                                                   E  12850    433100000
      GO TO 105                                                            E  12860    433200000
    7 TBDEL(I) = TBDEL(I) + YDOT(I)                                        E  12870    433300000
  105 YPRED(I) = YNEW(I) + C(K)*DTIME*YDOT(I)                              E  12880    433400000
      GO TO (2,2,400),K                                                    E  12890    433500000
  400 YCORR(I) = YPRED(I)                                                  E  12900    433600000
    2 CONTINUE                                                             E  12910    433700000
      TIME     = TIME + D(K)*DTIME                                         E  12920    433800000
   99 MAGOUT   = 0.0                                                       E  12930    433900000
  264 RETURN                                                               E  12940    434000000
    4 DO  8  I = 1,NEQNS                                                   E  12950    434100000
      YPRED(I) = YNEW(I) + DTIME*(FWDEL(I) + 2.*TBDEL(I) + YDOT(I))/6.     E  12960    434200000
    8 YDEV(I)  = YCORR(I) - YPRED(I)                                       E  12970    434300000
      GO TO 99                                                             E  12980    434400000
   11 IF (DELTA)80, 5,80                                                   E  12990    434500000
```

```
 80 IF(DTIME.LT.STEP)GO TO  500                                       E  13000   434600000
    DO  13 I = 1,NEQNS                                                E  13010   434700000
    IF (EPSIL* ABS(YCORR(I)) + ERR(I) -  ABS(YDEV(I)))14, 13, 13      E  13020   434800000
 13 CONTINUE                                                          E  13030   434900000
500 IF (SIGB)15,15,205                                                E  13040   435000000
205 SIGB = 0.0                                                        E  13050   435100000
    GO TO 5                                                           E  13060   435200000
 15 SIGB = 0.0                                                        E  13070   435300000
    DO 207 I = 1,NEQNS                                                E  13080   435400000
    IF (ERR(I)/100.+ DELTA* ABS(YCORR(I)) -  ABS(YDEV(I))) 5,207,207  E  13090   435500000
207 CONTINUE                                                          E  13100   435600000
    DTIME     = 2.*DTIME                                              E  13110   435700000
  5 DO 208 I = 1,NEQNS                                                E  13120   435800000
208 YCORR(I) = YPRED(I)                                               E  13130   435900000
305 IF (DTAU) 19,30,19                                                E  13140   436000000
 19 IF (TAU - TIME)20,20,27                                           E  13150   436100000
 20 TAU = TAU + DTAU                                                  E  13160   436200000
 30 MAGOUT = 2                                                        E  13170   436300000
    GO TO 264                                                         E  13180   436400000
 14 DTIME = DTIME/2.0                                                 E  13190   436500000
 25 IF (K-3)48,26,26                                                  E  13200   436600000
 26 TIME  = TIME - DTIME - DTIME                                      E  13210   436700000
    GO TO 47                                                          E  13220   436800000
 48 TIME  = TIME - DTIME                                              E  13230   436900000
 47 SIGB     = +2.                                                    E  13240   437000000
    DO 209 I = 1,NEQNS                                                E  13250   437100000
209 YDOT(I) = FWDEL(I)                                                E  13260   437200000
212 K          = 0                                                    E  13270   437300000
    GO TO 21                                                          E  13280   437400000
     END                                                              E  13290   437500000
    SUBROUTINE CHASE(A,MO,Y,NO,MID,NIX)                               E  13300   437600000
    REAL A(1),Y(1)                                                    E  13310   437700000
    COMMON /WINTER/ INDIC8                                            E  13320   437800000
    COMMON /BOND/ M,L                                                 E  13330   437900000
    COMMON /OPT2/ PRINT                                               E  13340   438000000
  9 FORMAT(12H1SOLUTION(S)/1H0)                                       E  13350   438100000
 10 FORMAT (I5,1P8E15.7/(5X,8E15.7))                                  E  13360   438200000
    M = MO                                                            E  13370   438300000
    INDIC8 = 0                                                        E  13380   438400000
    N = IABS(NO)                                                      E  13390   438500000
    IF (NO) 110,100,100                                               E  13400   438600000
100 CALL FUTILE(A,M,NIX)                                              E  13410   438700000
    IF (NIX) 170,110,110                                              E  13420   438800000
110 IF (PRINT .GT. 0.) WRITE (6,9)                                    E  13430   438900000
    MK1 = 1                                                           E  13440   439000000
    L = 1                                                             E  13450   439100000
    I1 = M                                                            E  13460   439200000
    DO 160  K = 1,N                                                   E  13470   439300000
    CALL TRIEQ(A,Y(MK1))                                              E  13480   439400000
    IF (PRINT .GT. 0.) WRITE (6,10) K,(Y(K1), K1 = MK1,I1)            E  13490   439500000
    I1 = I1 + MID                                                     E  13500   439600000
```

```
      MK1 = MK1 + MID
  160 CONTINUE
  170 RETURN
      END
```

```
      FUNCTION ARSIN(X)                                   E 13550  440100000
      ARSIN=ASIN(X)                                       E 13560  440200000
      RETURN                                              E 13570  440300000
      ENTRY ARCOS                                         E 13580  440400000
      ARCOS=ACOS(X)                                       E 13590  440500000
      RETURN                                              E 13600  440600000
      END                                                 E 13610  440700000
```