ACADEMIC CURRICULA

Open Elective Courses

Regulations - 2018

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram, Tamil Nadu, India

Course Code	18ASO101T	Course Name	ELEMENTS OF AERONAUTICS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil			
Course Offering Department		Aerospace Engineering		Data Book / Codes/Standards		Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)															
CLR-1 :	Understand the art of flying	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Understand variation of pressure, temperature, density in the layers of atmosphere and their effect on the flying objects																		
CLR-3 :	Identify the types of construction of aircrafts and the working of Engines																		
CLR-4 :	Know functions of various components of flying objects and the operating mechanisms																		
CLR-5 :	Know the working of various types of rockets and satellites																		
CLR-6 :	Get a bird's eye view of Aerospace Engineering																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Describe the evolution of aircrafts and their types	2	85	75	H	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Describe about the atmosphere and variation in properties, aircraft flight and different speed regimes	2	85	75	H	H	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Explain the basics of aircraft structures, power plants	2	85	75	H	-	H	H	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Explain the basics of aircraft controls and instruments	2	85	75	H	H	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Describe the basic Space Technology concepts	2	85	75	H	-	H	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Identify the various components and systems in aircraft and describe its working mechanism	2	85	75	H	H	H	H	-	-	-	-	-	-	-	-	-	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	History of Aviation	International Standard Atmosphere	Introduction to aircraft construction	Aircraft controls	Basic principle of rocket propulsion
	SLO-2	Imitation of birds, Ornithopters	Hydrostatic equation	History of Aircraft Construction	Functions of aileron, elevator and rudder.	Applications of Rockets
S-2	SLO-1	Lighter than air vehicles	Temperature, pressure and altitude relationships	Truss and Monocoque construction	Secondary flight controls	Types of Rockets
	SLO-2	Hot air balloons	Gradient and isothermal region	Semi-monocoque construction.	High lift devices	Solid propulsion rockets
S-3	SLO-1	George Cayley's contribution	Bernoulli's equation for incompressible flow	Typical wing Structures	Types of control systems	Liquid propulsion rockets Working
	SLO-2	Otto Lilienthal Contribution	Application	Fuselage Structures	History of Control system evolution	Liquid propulsion rockets Advantages and Disadvantages
S-4	SLO-1	Wright Brothers contribution	Forces acting on aircraft	Materials used in Aircraft	Mechanical control systems	Hybrid and cryogenic rockets
	SLO-2	History	Moments acting on aircraft	Explanation with examples	Powered control systems	Hybrid and cryogenic rockets Advantages and Disadvantages
S-5	SLO-1	Effects of 1st world war	How does an aircraft wing generate lift?	Types of power plants	Fly by wire control systems	History of ISRO
	SLO-2	Effect of 2nd world war	Preliminary explanation	Fundamental Classification	Basic Operation	Establishment of ISRO

S-6	SLO-1	Classification of airplanes	Basic characteristics of airfoils	An insight into air breathing engines	Basic instruments for flying	Launch vehicles designed and developed by ISRO
	SLO-2	Detailed classification	NACA nomenclature	Piston Engines	Pitot static instruments	Examples explanation
S-7	SLO-1	Components of a simple conventional aircraft	Introduction to high speed flight	Gas turbine engines	Altimeter	Principle of Satellite Operation
	SLO-2	Functions of each component of a simple conventional aircraft	propagation of sound, Mach number	Types of Gas turbine engines	ASI, VSI	Types of Satellites
S-8	SLO-1	Introduction to Unmanned aerial vehicles	Subsonic and transonic flows	Relative merits of piston-prop, turboprop, and jet engines	Gyroscopic instruments	Satellite applications
	SLO-2	Applications of UAV	Supersonic and hypersonic flows	Comparison based on performance characteristics	Turn and slip indicator Artificial horizon.	Space Debris
S-9	SLO-1	Aviation for society	Supersonic flows	Relative merits of jet engine	Turn and slip indicator	Case study-I on successful launches
	SLO-2	Aviation for socio economic development	Hypersonic flows	Comparison based on performance characteristics	Artificial horizon	Case study-2 on launch failures

Learning Resources	1. Charles Harrington Kermode,A.C., Flight Without Formulae, 5th ed., Pearson Education,1970 2. Anderson, J.D., Introduction to Flight, 8th ed., Tata McGraw Hill,1996 3. Clancy L.J.., Aerodynamics, 2nd ed., Sterling book house 1975	4. Shevell R.S., Fundamentals of flights, 2nd ed., Pearson education 2004 5. Kermode.A.C., Mechanics of Flight, 12th ed. Pearson Education 1972 6. McKinley, J.L., R.D. Bent, Aircraft Power Plants, McGraw Hill 1993

Learning Assessment										
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu	1. Mr.Abdur Rasheed, SRMIST
2. Dr. A. Sakthivel, CEMILAC, Bangalore, asakthironika@gmail.com	2. Dr.A.P.Haran, Park College of Engineering & Technology, email: ap_haran@rediffmail.com	2. Mr. S. Chandra Sekhar, SRMIST

Course Code	18ASO102T	Course Name	CREATIVITY, INNOVATION AND NEW PRODUCT DEVELOPMENT	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Improve creativity and problem solving methods																			
CLR-2 :	Improve the knowledge in finding innovative approach to issues																			
CLR-3 :	Equip students the skills of project selection																			
CLR-4 :	Understand patent laws and international practices																			
CLR-5 :	Have expose to design, testing of an engineering product																			
CLR-6 :	Set the quality standards in developing a prototype of any engineering product																			

Learning column headers: Level of Thinking (Bloom), Expected Proficiency (%), Expected Attainment (%)

PLO column headers: 1 Engineering Knowledge, 2 Problem Analysis, 3 Design & Development, 4 Analysis, Design, Research, 5 Modern Tool Usage, 6 Society & Culture, 7 Environment & Sustainability, 8 Ethics, 9 Individual & Team Work, 10 Communication, 11 Project Mgt. & Finance, 12 Life Long Learning, 13 PSO-1, 14 PSO-2, 15 PSO-3

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Understand the importance of thinking ability in the field of engineering	2	85	80	H	H	-	-	-	H	H	H	-	H	-	H	-	-	-
CLO-2 :	Update the skills to solve engineering problems	2	85	80	H	H	-	-	-	H	H	H	-	-	-	H	-	-	-
CLO-3 :	Undertake better projects which will be helpful for nation development	2	85	80	H	-	-	H	-	H	H	H	H	-	-	H	-	-	-
CLO-4 :	Perform better research	2	85	80	H	H	-	-	-	H	H	H	-	-	H	H	-	-	-
CLO-5 :	Study and analyze the case studies in the technical way	2	85	80	H	-	H	-	-	H	H	H	H	-	-	H	-	-	-
CLO-6 :	Support for the design of quality products and services	2	85	80	H	H	H	H	-	H	H	H	-	-	H	H	-	-	-

Duration (hour)	9	9	9	9	9
S-1 SLO-1	Introduction	Collection of ideas	Introduction to project evaluation	Evaluation of IPR	Design of product prototype
S-1 SLO-2	The process of technological innovation	Categories of ideas	Preliminary methods	4 traditional forms	Factors of design
S-2 SLO-1	Factors contributing to successful technological innovation	Different routes for collecting ideas	Screening methods	Definition of IPR	Requirement of design
S-2 SLO-2	Examples for the factors	Examples	Examples	Development of 7 types of IPR	Design process
S-3 SLO-1	Technological milestones	Taking different views, Combining the unusual	Product life cycle	Need for IPR in India	Functional design
S-3 SLO-2	Technological evolution	Examples	Different organizations	Patentable innovation	Functional margins
S-4 SLO-1	The need for creativity for individual and nation	Adapt, adopt & improve	Product Evaluation profile	Obligations	Test and Qualification
S-4 SLO-2	The need for innovation for individual and nation	Breaking the rules.	Stability factors	Enforcement measures	Types of tests and their significance
S-5 SLO-1	Creativity -Obstacles	Challenge the assumptions	Growth factors	Patent search and its advantages	Test plan

	SLO-2	Problem solving-Obstacles	Asking searching questions	Marketability factors	IP Council	Issues in concluding a test
S-6	SLO-1	Creativity -keys and questions	Increasing the yield	Research factors	International Treaties	Quality standards
	SLO-2	Problem solving-keys and questions	Implementation methods	Development factors	Conventions	Product Strategy
S-7	SLO-1	Brain Storming	Purpose and types, Indian National Technology Missions	Position factors	WIPO	Six-sigma Practice Procedure
	SLO-2	Examples	Detailed explanation	Production factors	TRIPS	Implementation
S-8	SLO-1	Different techniques for creative intelligence	Project selection criteria	Value Engineering	WTO	Marketing- methods
	SLO-2	Detailed explanation with examples	Analysis methods	Need for value engineering	PCT	Marketing- research
S-9	SLO-1	Case Study-1on technology innovation	Case Study-2 on project selection	Case Study-3 on project evaluation	Case Study-4 on IPR	Case Study -5 on product development
	SLO-2	Example	Example	Example	Example	Example

Learning Resources	1. Keleen A.L., New Product Planning and Development, International Correspondence Schools Division, Scraton, Pennsyvania, 1969 2. Paul Sloane, The Leader's Guide to Lateral Thinking Skills, 2nd ed., Kogan Page India, New Delhi, 2008 3. Department of Space: IPR Manual, Bangalore, 2007 4. Osho, Creativity – Unleashing the Forces Within, St Martin's Griffin, New York, March, 2007	5. Abdul Kalam.A.P.J., Arun Tiwari, "Wings of Fire", Universities Press, Hyderabad,1999 6. Edward de Bono, How to have a beautiful mind, Vermilon, London, 2004 7. Khandwalla, R.N., Fourth Eye (Excellence through creativity), Wheeler Publishing, Allahabad, 1992. 8. Rajiv.V.Dharaskar, Innovation-Growth Engine for Nation. Nice Buzzword but often Misunderstood, www.dharaskar.com 9. Annamalai.N., www.creativitysphere

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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1. Dr. S. Raja, National Aerospace Laboratories, Bangalore, raja@nal.res.in	1. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu	1. Mr.Abdur Rasheed, SRMIST
2. Dr. A. Sakthivel, CEMILAC, Bangalore, asakthironika@gmail.com	2. Dr.A.P.Haran, Park College of Engineering & Technology, email: ap_haran@rediffmail.com	2. Mr. S. Chandra Sekhar, SRMIST

Course Code	18ASO103T	Course Name	AVIATION AND AIRLINE MAINTENANCE MANAGEMENT	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil			
Course Offering Department		Aerospace Engineering		Data Book / Codes/Standards	Nil			

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)															
			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Create insights to the concepts of Air transportation and Airline management																			
CLR-2 :	Familiarize the concept of Airline forecasting and fleet planning																			
CLR-3 :	Identify the significance of airline scheduling and equipment maintenance		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-4 :	Create insights to the concepts of Aircraft reliability and aging aircraft maintenance																			
CLR-5 :	Familiarize the aviation supporting organization and state regulatory																			
CLR-6 :	Familiarize with aviation maintenance and management																			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Identify and understand the organization details in air-transportation		2	85	75	H	-	L	L	M	M	M	H	M	M	L	L	M	M	H
CLO-2 :	Identify the forecasting methods in airline		2	85	75	H	-	L	L	M	L	L	L	M	M	L	L	M	M	H
CLO-3 :	Understand the scheduling process and maintenance of aircraft		2	85	75	M	-	-	-	L	M	M	M	M	M	L	L	H	M	M
CLO-4 :	Understand the aging aircraft maintenance		2	85	75	H	-	L	M	M	M	L	M	M	M	M	M	M	M	H
CLO-5 :	Understand the aviation supporting organizations and state regulatory		2	85	75	H	-	L	L	H	M	M	M	M	M	H	M	M	M	M
CLO-6 :	Understand the concept of aviation maintenance and management		2	85	75	H	-	L	L	M	M	M	M	M	M	L	L	M	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Air Transportation	Airline Economics	Introduction to airline scheduling	Aircraft reliability	Aviation supporting organisations
	SLO-2	Development of Air Transportation	Airline Forecasting	Mission of Airline scheduling	Parameters to monitor	World trade organisation
S-2	SLO-1	Comparison of Air Transportation with other Modes of Transport	Fleet Planning	Equipment maintenance	Maintenance schedule	World tourism organisation
	SLO-2	International Aviation Association	Aircraft Selection Process	Maintenance system of a jet aircraft	Maintenance program	State regulatory
S-3	SLO-1	ICAO	Operating Cost	Flight operations and crew scheduling	Schedule determination	Responsibilities and functions of CAA
	SLO-2	IATA	Passenger Capacity	Objective of ground service	Condition monitoring maintenance	Responsibilities and functions of FAA
S-4	SLO-1	Aviation Classification	Load Factor	Ground operations and facility limitations	ETOPS and EROPS	DGCA
	SLO-2	Factors Affecting General Aviation Industry	Passenger Fare and Tariffs	Schedule planning and coordination	Aircraft depressurization	functions of DGCA
S-5	SLO-1	Aircraft Uses	Influence of Geographical, Economic and Political Factors	Traffic flow	Aging Aircraft	Turbine engine monitoring
	SLO-2	airport classification	On Routes And Route Selection	Schedule salability	Maintenance in aging aircraft	Turbine engine vibration monitoring

					Operating cost associated with maintenance	
S-6	SLO-1	Airline Management	Fleet Commonality	Schedule Adjustment	Operating cost associated with maintenance	Onboard maintenance system
	SLO-2	Levels of Management	Factors Affecting Fleet Choice	Chain reaction effect	Helicopter maintenance	Life usage monitoring
S-7	SLO-1	Functions of management	Valuation and Depreciation	Load factor leverage	Maintenance schedule	Technology in aircraft maintenance
	SLO-2	Management by Objective	Budgeting	Equipment's and types of schedule	Current Capabilities of NDT	Airline financing
S-8	SLO-1	Principle of organization planning	Cost planning	Preparing flight plans	Applications of NDT in maintenance	Sources of fund
	SLO-2	Organizational Chart	Aircrew Analysis	Aircraft scheduling in line with aircraft maintenance practice	Equipment and tools for maintenance	Globalization
S-9	SLO-1	Line management	Route Analysis	Hub and spoke scheduling	Spare maintenance	Globalization of airlines
	SLO-2	Staff Management	Aircraft evaluation	Advantages and Disadvantages	Future aircraft maintenance	Future Challenges

Learning Resources	1. John G Wensveen, Air Transportation – A Management Prespective, Ashgate Publications, 8th ed., 2015 2. Friend C.H., Aircraft Maintenance Management, Longman aviation technology. 2nd ed., 1992	3. Indian Aircraft Manual, DGCA, sterling book House, Mumbai, reprint 2014 4. PS Senguttuvan, Fundamentals of air transport management, excel books, reprint 2010

Learning Assessment											
	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg .Cdr K. Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	1. Mr. D. Balaji, Professor, KPRIET, Coimbatore, dbalajideva@gmail.com	1. K.Iynthezhuthon, SRMIST
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu	2. Mr .G. Mahendra Perumal, SRMIST

Course Code	18ASO104T	Course Name	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Aerospace Engineering		Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 : Identify ground handling tools and equipments to perform ground handling operation of aircraft																			
CLR-2 : Maintain the aircraft ground servicing units																			
CLR-3 : Upkeep the safety aspects and improve the human relations in working environment.																			
CLR-4 : Work in the planning process environment of maintenance industry.																			
CLR-5 : Maintain the tools, accessories, components ,minor & major assemblies																			
CLR-6 : Utilize the knowledge acquired to work as an efficient maintenance engineer.																			

Legend for Learning columns: Level of Thinking (Bloom), Expected Proficiency (%), Expected Attainment (%)

PLO columns: 1 Engineering Knowledge, 2 Problem Analysis, 3 Design & Development, 4 Analysis, Design, Research, 5 Modern Tool Usage, 6 Society & Culture, 7 Environment & Sustainability, 8 Ethics, 9 Individual & Team Work, 10 Communication, 11 Project Mgt. & Finance, 12 Life Long Learning, 13 PSO-1, 14 PSO-2, 15 PSO-3

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Understand the operation of various ground handling equipments & procedures	2	85	75	H	-	L	L	M	M	M	M	M	M	L	L	M	M	H
CLO-2 :	Acquire knowledge on utility of aircraft ground servicing units and their maintenance	2	85	75	H	-	L	L	M	L	L	L	M	M	L	L	M	M	H
CLO-3 :	Know the safety aspects of usage of fluids & the human performance factors	2	85	75	M	-	-	-	L	M	M	M	M	M	L	L	H	M	M
CLO-4 :	Acquire knowledge on different maintenance operational procedures	2	85	75	H	L	L	M	M	M	L	M	M	M	M	M	M	M	H
CLO-5 :	Acquire knowledge on various maintenance practices.	2	85	75	H	L	L	L	H	M	M	M	M	M	H	M	M	M	M
CLO-6 :	Acquire comprehensive knowledge about ground handling & operational procedure of aircraft & its servicing units.	2	85	75	H	L	L	L	M	M	M	M	M	M	L	L	M	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Aircraft Ground Handling Procédures.	Introduction to Maintenance and handling of ground equipment	Safety aspects when working with electricity	Introduction to Maintenance Procedure	Hand Tools
	SLO-2	Aircraft Taxing Procedure	Maintenance and handling of Compressor	Safety aspects when working with oil, gases, oxygen and chemicals	Maintenance Planning	Care of Tools
S-2	SLO-1	Aircraft Towing Operations	Maintenance of Portable Hydraulic Test Stand.	Remedial action during an incident	Modification Procedure	Calibration of tools and equipment
	SLO-2	Safety Precautions during Towing Operations	Handling of Portable Hydraulic Test Stand	Remedial action during an accident.	Stores Procedure	Calibration standards
S-3	SLO-1	Aircraft Jacking Procedure	Maintenance of Electric power supply equipment	Human Factors	Certification Procedure	Control Cables
	SLO-2	Safety Precautions during Jacking Procedure	Handling of Electric power supply equipment	Human Error, Murphy's Law	Release Procedure	Pipes and Unions
S-4	SLO-1	Chocking & Mooring Operations	Maintenance of Charging Trolley	Human performance and limitations – Vision& Hearing	Interface with aircraft operation	Transmissions
	SLO-2	Safety Precautions during Chocking & Mooring Operations	Handling of Charging Trolley	Information Processing	Maintenance, Inspection	Bearing & Hoses
S-5	SLO-1	Aircraft Storage Methods	Maintenance of Air-conditioning and Heating Unit	Attention & Perception	Quality control	Springs

	SLO-2	Storage of Rotables	Handling of Air-conditioning and Heating Unit	Memory & Physical Access	Quality assurance	NDT Techniques
S-6	SLO-1	Refueling Procedures	Maintenance of Ground Support Air Starter Unit	Claustrophobia	Publications	Engineering drawing diagrams
	SLO-2	Defueling Procedures	Handling of Ground Support Air Starter Unit	Factors affecting human performance – Workload	Bulletins	Standards
S-7	SLO-1	Aircraft Deicing Procedures	Maintenance of Oil Pressure Unit	Stress	Airworthiness Directives	Fits and Clearance
	SLO-2	Aircraft Anti-icing Procedures	Handling of Oil Pressure Unit	Time Pressure & Deadlines	Structural Repair Manual	Welding & Swaging
S-8	SLO-1	Effect of environmental condition on aircraft handling and operation	Maintenance of Fire extinguishers	Medication	Overhaul Manual	Brazing & Soldering
	SLO-2	Aircraft cleaning and Maintaining	Handling of Fire extinguishers	Noise & Fumes	Log Books	Bondings
S-9	SLO-1	Ground signaling, Marshaling of aircraft in day time	Maintenance of Jacks, Cranes, Ladders, Platforms, Trestles & Chocks	Climate & Temperature	Introduction to ATA	Corrosion and its removal
	SLO-2	Ground signaling, Marshaling of aircraft in night time.	Handling of Jacks, Cranes, Ladders, Platforms, Trestles & Chocks	Working Environment	ATA Specifications	Trouble shooting techniques.

Learning Resources	1. Airframe and Power plant Mechanics, General Hand Book, Federal Aviation Administration, AC65 – 9A 2. Airframe and Power plant Mechanics, Airframe Hand Book, Federal Aviation Administration, AC65 – 15A 3. Civil Aviation Inspection(CAP 459) Part – II 4. Acceptable Methods, Techniques & Practices (FAA) – EA-AC43.13-1A & 2A	5. Michael J.Kroes, William A.Watkins ad Frank Delp, Aircraft Maintenance and Repair, 7th ed., Tata McGraw Hill, New Delhi, 2013 6. CAP 715 – An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66, Civil Aviation Authority, UK

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
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	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg .Cdr K. Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	1. Dr.A.P.Haran, Park College of Engineering & Technology, email: ap_haran@rediffmail.com	1. Dr. S. Sivakumar, SRMIST
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu	2. Mr .G. Mahendra Perumal, SRMIST

Course Code	18ASO105T	Course Name	FLOW VISUALIZATION TECHNIQUES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil		
Course Offering Department		Aerospace Engineering		Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Identify the type of flow visualization used in air flow	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Identify the type of flow visualization used in water flow																		
CLR-3 :	Identify the type of flow visualization for compressible flow																		
CLR-4 :	Assess the need of image-based measurement like Particle Image Velocimetry	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-5 :	Understand the operation of various other flow visualization techniques																		
CLR-6 :	Utilize the knowledge acquired about various flow visualization for improving the aerodynamics																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Understand Flow Visualization requirements and applications	2	80	70	H	-	H	L	-	-	M	-	-	-	-	-	-	M	L
CLO-2 :	Acquire knowledge on Flow Visualization using air and water	2	80	70	H	-	H	L	-	-	-	-	-	-	-	-	H	M	M
CLO-3 :	Learn the working principles of compressible flow visualization techniques	2	80	70	H	-	H	L	-	-	-	-	-	-	-	-	-	M	M
CLO-4 :	Appreciate the usefulness of Particle Image Velocimetry, setup, working and its applications	2	80	70	H	-	H	L	H	-	-	-	-	-	-	-	H	H	H
CLO-5 :	Gain knowledge on various other visualization techniques	2	80	70	H	-	H	L	M	-	-	-	-	-	-	-	M	M	M
CLO-6 :	Acquire comprehensive understanding of various flow visualization techniques and their applications	2	80	70	H	-	M	L	-	-	M	-	-	-	-	-	M	M	M

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Flow Visualization	Safety requirements	Skin Friction Visualization	Holographic Interferometer	Tracer Methods
	SLO-2	Need for Flow Visualization	Safety procedures	Requirements for Skin Friction	Applications of Holographic Interferometer	Hydrogen Bubble Method
S-2	SLO-1	Applications of Flow Visualization	Chemical Safety	Interferometer	Particle Image Velocimetry (PIV)	Dye Injection
	SLO-2	Types of Flow Visualization	Human Safety	Fringe Imaging	PIV and its Types	Types of dye
S-3	SLO-1	Flow Visualization in Water	Surface Visualization	Compressible Flow Visualization	PIV Setup	Spark Tracer Technique
	SLO-2	Laminar Flow Visualization	Need for Surface Visualization	Gladstone Dale Relation	PIV Procedure	Spark Tracer Setup
S-4	SLO-1	Hele-Shaw Apparatus	Surface Visualization versus Surface Measurements	Requirements for Optics	Pulse Signals	Molecular Tagging Velocimetry (MTV)
	SLO-2	Dye Injection Method	Advantages of Surface Visualization	Optics and Setup procedures	Synchronizer	Setup for MTV
S-5	SLO-1	Flow Visualization in Air	Wall Shear Stress	Shadowgraph	Imaging for PIV	Thermometry
	SLO-2	Usage of Tufts	Need for Wall Shear Stress Study	Shadowgraph procedure	Image Correlation	Devices for Thermometry

S-6	SLO-1	Smoke Generators	Surface Pressure Visualization	Schlieren	Video Recording	Low density flow visualization
	SLO-2	Smoke Injection Methods	Pressure Sensitive Paints (PSP)	Schlieren procedure	Video Imaging	Challenges for low density flow study
S-7	SLO-1	Light Sources	Application of PSP on Surfaces	Mach Zehnder Interferometer	Postprocessing PIV data	Electron Beam Flow visualization
	SLO-2	Light Diffuser	Time resolved PSP	Mach Zehnder Interferometer Setup	Post processing PIV software	Glow Discharge visualization
S-8	SLO-1	Laser Sources	Surface Flow Visualization	Fresnel Equation	Error Sources in PIV	Surface Temperature Visualization
	SLO-2	Laser Sheet for smoke visualization	Shear Sensitivity	Applications of Mach Zehnder Interferometer	Applications of PIV	Temperature Sensitive Paints (TSP)
S-9	SLO-1	Photographic Equipment	Liquid Crystal Coating	Holography	3D PIV	3D Imaging
	SLO-2	Photographic Techniques	Choice of Liquid Crystals	Holography setup	Setup for 3D PIV	3D Image processing

Learning Resources	1. Alexander J Smits, TT Lim, Flow Visualization: Techniques and Examples, 2nd ed., Imperial College Press, 2012 2. Rathakrishnan E, Instrumentation, Measurements, and Experiments in Fluids, 1st ed., CRC Press, 2007 3. Settles G S, Schlieren and Shadowgraph Techniques: Visualizing Phenomena in Transparent Media, 1st ed., Springer, 2001	4. Merzkirch W (Ed Gersten K), Techniques of flow visualization, AGARDograph No. 302, 1984 5. Journal of Visualization, Springer 6. Journal of Visualization and Image processing, Begell House

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Raja S, CSIR-NAL, email: raja@nal.res.in	2. Dr. Parammasivam K M, MIT, Chennai, email: mparams@mitindia.edu	2. Dr. Kannan B T, SRMIST

Course Code	18ASO106T	Course Name	AIRPORT ENGINEERING	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Aerospace Engineering	Data Book / Codes/Standards		Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)															
				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Familiarize about airports and surveys																				
CLR-2 :	Understand about airport planning and forecasting																				
CLR-3 :	Understand and design runway and taxiways																				
CLR-4 :	Understand about air traffic control tower and terminal areas			Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-5 :	Understand about helipads and STOL ports																				
CLR-6 :	Utilize the knowledge acquired to work as an airport engineer																				

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																				
CLO-1 :	Identify airports and surveys involved	2	85	75	H	-	L	L	M	M	M	M	M	M	L	L	M	M	H
CLO-2 :	Identify airport planning and forecasting	2	85	75	H	-	L	L	M	L	L	L	M	M	L	L	M	M	H
CLO-3 :	Understand and design runway and taxiways	2	85	75	M	-	-	-	L	M	M	M	M	M	L	L	H	M	M
CLO-4 :	Understand about air traffic control tower and terminal areas	2	85	75	H	L	L	M	M	M	L	M	M	M	M	M	M	M	H
CLO-5 :	Understand about helipads and STOL ports	2	85	75	H	L	L	L	H	M	M	M	M	M	H	M	M	M	M
CLO-6 :	Acquire comprehensive knowledge about airport and the utilities.	2	85	75	H	L	L	L	M	M	M	M	M	M	L	L	M	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	International airport authority of India	Airport Planning	Runway design	Planning and design of terminal area	Heliport
	SLO-2	Civil aviation department	Improvement of existing Airport	Runway orientation	Terminal building	Advantages of helicopter
S-2	SLO-1	Airport Authority of India	Airport site selection	Change in direction of runway	Passenger Flow	Characteristics of helicopter
	SLO-2	Open sky policy	Factors influence location	Basic runway length	Sequence of activity	Planning of heliport
S-3	SLO-1	Airport terminology	Airport size	Corrections to basic runway length	Size of apron	Site Selection
	SLO-2	Aircraft Classification	Factors affecting size of airport	Runway patterns	Hangars	Obstruction clearance requirements
S-4	SLO-1	Components parts of Aeroplane	Aviation Forecasting	Comparison of runway patterns	Typical airport layout	Elevated heliport
	SLO-2	Aircraft Characteristics	Important aspects	Taxiway design	Air Traffic Control	Marking and lighting of heliport
S-5	SLO-1	Jet Aircraft Characteristics	Airport obstructions	Layout of taxiways	Significance of ATC	Heliport in airport
	SLO-2	Civil and military aircrafts	Imaginary surface	Geometric standards for taxiway	Flight Rules	STOL ports

S-6	SLO-1	Classification of aerodrome	Objects with actual height	Exit taxiways	ATC Network	Characteristics of STOL Aircraft
	SLO-2	Classification of airports	Clear Zone	Location of exit taxiway	ATC Aids	Advantages of STOL Aircraft
S-7	SLO-1	Flying Activities	Turning zone	Design of exit taxiways	Classification	Planning of STOL Port
	SLO-2	Scheduled and non-scheduled flights	Zoning Laws	Loading aprons	Automation in ATC Aids	Aspects of the planning
S-8	SLO-1	Airport Survey	Environmental considerations	Holding Aprons	GPS ATC	Obstruction clearance requirements
	SLO-2	Objectives and types of survey	Factors influenced by airport activity	Fillets	Free Flight ATC	Runway and taxiway of STOL port
S-9	SLO-1	Drawings to be Prepared	Pollution factor	Separation Clearance	Free flight types	Lighting of STOL Port
	SLO-2	Types of plan	Social factor	Bypass or turnaround taxiway	Approaches of free flight	Marking of STOL Port

Learning Resources	1. Rangwala. Airport Engineering, Charotar Publishing House Pvt., 15th ed., 2015	2. Norman J. Ashford, Saleh A. Mumayiz, Paul H. Wright. Airport Engineering: Planning, Design and Development of 21St - Century Airports", 4th ed., CBS Publishers & Distributors. April 2011

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	2. Dr. K. M. Parammasivam, Madras Institute of Technology, Chennai, mparams@mitindia.edu	2. Mr .G. Mahendra Perumal, SRMIST

Course Code	18ASO107T	Course Name	MOLECULAR GAS DYNAMICS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Aerospace Engineering		Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Understand need for molecular description of fluid flow	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Know the importance of binary collision and the Boltzmann equation																		
CLR-3 :	Understand the significance of elastic and inelastic collision																		
CLR-4 :	Demonstrate the chemical reactions and thermal radiation with respect to engineering problem				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
CLR-5 :	Know importance of collisionless flow																		
CLR-6 :	Understand the numerical technique for microscopic and mesoscopic method																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Explain the importance of molecular perspective fluid flow	2	85	80	H	-	-	-	-	-	-	-	-	-	-	-	M	M	M
CLO-2 :	Describe the binary collision and need for Boltzmann equation	2	80	75	H	H	-	-	-	-	-	-	-	-	-	-	L	H	L
CLO-3 :	Explain the difference between inelastic and elastic collision and its significance	2	85	80	H	-	-	-	-	-	-	-	-	-	-	-	M	M	M
CLO-4 :	Explain the role of bimolecular reactions and termolecular reactions in chemical reaction	2	80	75	H	H	-	L	-	-	-	-	-	-	-	-	M	M	M
CLO-5 :	Describe the significance of collisionless flow	2	80	75	H	H	-	L	-	-	-	-	-	-	-	-	M	H	M
CLO-6 :	Explain the need for mesoscopic and microscopic numerical technique for fluid flow	2	80	75	H	H	-	L	M	-	-	-	-	-	-	-	L	H	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to kinetic theory	The bolzamnn equation: The evaluation of phase-space distribution function	Collision theory for bimolecular reactions	Bimodal distributions	Computational technique for mesoscopic method: The Direct Simulation Monte Carlo (DSMC) method, Lattice Boltzmann Method (LBM)
	SLO-2	Hydrostatitics, hydrodynamics				
S-2	SLO-1	Gas kinetic theroy	The Boltzmann collision intergral	Reaction cross-sections for given reaction rates	Molecular effusion and transpiration	DSMC algorithm
	SLO-2		The H-theorem			
S-3	SLO-1	Molecular model: need for a molecular description of fluid flow	BGK approximation	Extension to termolecular reactions	One dimensional steady flwos	DSMC working principle, advances in DSMC method
	SLO-2		Nonequilibrium solutions of Boltzmann equation			
S-4	SLO-1	The simple dilute gas, real gas effects	Ellastic collision: collision corss-section, collision dynamics	Chemical equilibrium	One-dimensional unsteady flows	Lattice gas automata (LGA)
	SLO-2					
S-5	SLO-1	Macroscopic properties in a simple gas	The inverse power law model, hard sphere model	The equilibrium collision theory	Transfer of normal, tangential momentum, transfer of translational energy	LGA to lattice Boltzmann equation
	SLO-2					

S-6	SLO-1	Distribution function, Phase space distributions	Variable hard sphere model	The dissociation reaction, recombination reaction	Free molecular heat transfer, recovery temperature	LBM algorithm, boundary and initial conditions
	SLO-2	The Maxwell-Boltzmann distribution	Variable soft sphere model			
S-7	SLO-1	Maxwell assumption, Distribution of molecular speeds	Generalized hard sphere model, Maxwell model	The exchange and ionization reactions	Stanton number and thermal recovery factor	Computational technique for microscopic method: Molecular Dynamics (MD)
	SLO-2					
S-8	SLO-1	Mixture of gases	Larsen-Borgnakke model in a simple gas and gas mixture	Classical model for rotation radiation	Thermophoresis, flow with multiple reaction	Description of MD method, the force calculation
	SLO-2					
S-9	SLO-1	Moments of Maxwell-Boltzmann distribution	Vibrational and electronic energy, gas-surface interaction	Bound-bound radiation	Test-particle Monte Carlo mehtod	Integrating equations of motion and solution methods.
	SLO-2					

Learning Resources	1. Gombosi, Tamas I., and Atmo Gombosi. Gaskinetic theory. No. 9. Cambridge University Press, 1994. 2. Bird, Graeme A., and J. M. Brady. Molecular gas dynamics and the direct simulation of gas flows. Vol. 5. Oxford: Clarendon press, 1994. 3. Kruger, Ch H., and W. G. Vincenti. "Introduction to physical gas dynamics." John Wlley & Sons (1965).	4. Frenkel, Daan, et al. "Understanding molecular simulation." Computers in Physics 11.4 (1997): 351-354. 5. Anderson, John David. Modern compressible flow: with historical perspective. Vol. 12. New York: McGraw-Hill, 1990.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Expert
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Course Code	18BTO101T	Course Name	HUMAN HEALTH AND DISEASES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	State the basic structural organization of human health system																			
CLR-2 :	Summarize the etiology of human infectious diseases																			
CLR-3 :	Describe immune system of human body and immune disorders																			
CLR-4 :	Impart information about genetic disease																			
CLR-5 :	Indicate the high risk diseases associated with modern society																			
CLR-6 :	State about disease diagnosis and treatment strategies																			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Recall basic human biology at the genetic, cellular, and physiological levels	2	80	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-2 :	Interpret how the human body maintains a healthy balance, and how disturbances of this balance underlie diseases	2	85	75	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-3 :	Discuss about infectious organism and understand defense mechanism of our human body	2	75	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-4 :	Describe disease causing agents	2	85	80	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-5 :	Familiarize with modern biomedical scientific approaches to treat disease.	2	85	75	-	-		L	-	M	-	M	-	H	-	H	H	H	H
CLO-6 :	Demonstrates the importance of taking responsibility for one's own health	2	80	70	-	-	-	L	-	M	-	H	-	H	-	H	-	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to human heath	Concepts of human disease	Immune system	Mendelian genetics	Disease Diagnosis
	SLO-2	Anatomy and physiology	Disease Disorder and syndrome	Physical chemical and cellular barrier	Genetics of simple and complex traits	Treatment strategy
S-2	SLO-1	Respiratory system	Pathology of disease	Types of Immune cell	Hereditary disease	Biomedical Instruments
	SLO-2	Circulatory system	Mechanism of disease	Humoral and cell mediated immunity	Karyotype preparation and analysis Chromosome abnormality	Biosensors
S-3	SLO-1	Digestive system	Infectious disease	Cells Involved in inflammation	Thalassemia	Drug designing and development
	SLO-2	Execratory system	Causative agents Bacteria, virus and parasites	Inflammatory Process	Cystic fibrosis	Computer aided drug designing
S-4	SLO-1	Reproductive system	Bacteria: Introduction Pathogenesis	Immune disorders	Duchene Muscular dystrophy	Drug metabolism
	SLO-2	Fertilization and embryogenesis	Bacterial toxins	Abscesses, ulcer, cellulitis And Allergy	Sickle cell anemia	ADME property of a drug
S-5	SLO-1	Cell structure	virulence of bacterial infection	Autoimmunity	Indian genetic disease database	Sources of drug- plants and microbes
	SLO-2	Tissue types	Antibiotic resistance strains	Immunodeficiency	Human gene mutation database	Route of administration

S-6	SLO-1	How body gets energy	Virus: An overview of replication cycle of virus	High risk disease of modern society	Principle class of metabolic disorders	Bulk Drugs and processing
	SLO-2	ATP Synthesis	Effect of virus infection in the host cell	Obesity, Hypertension and diabetics	Inherited Metabolic disorders	Active pharmaceutical ingredient
S-7	SLO-1	Cell metabolism	Epidemiology	Neoplasm	Metabolic syndrome	Vaccines types, Recommendation by age
	SLO-2	Cell cycle	Roots of spreading, Emerging and reemerging virus	Oncogenes and tumor suppressor genes	Risk factors	Vaccines – Recent advancement
S-8	SLO-1	Checkpoints in cell division	Parasitosis, common parasites of human	Types of cancer	Lysozyme storage disease: Molecular basis	Immunotherapy
	SLO-2	Cell division -Mitosis and Meiosis	Plasmodium – life cycle and disease	Stages of cancer	List of proteins involved in LSD	Immunotherapeutic approaches currently in use
S-9	SLO-1	Growth factors- overview	Fungal Infections	Cancer in future	Balanced nutrition and Malnutrition	Stem cell therapy
	SLO-2	Types and function	Endemic mycoses in immunocompromised patients	Life style and cancer risk	Deficiency disease	Gene therapy

Learning Resources	1. Goodenough and McGuire, Biology of Humans: Concepts, Applications and issues, 4th ed., Benjamin Cummins/Pearson Publisher, 2011	2. Marianne Neighbors, Ruth Tannehil, Human Diseases, 4th ed.,Jones Cengage learning, 2015

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. Lilly M Saleena, SRMIST
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in	2. Dr.Priya Swaminathan, SRMIST

Course Code	18BTO102T	Course Name	MODELLING OF BIOMOLECULES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	State the basic structural organization of human health system																			
CLR-2 :	Summarize the etiology of human infectious diseases																			
CLR-3 :	Describe immune system of human body and immune disorders																			
CLR-4 :	Impart information about genetic disease																			
CLR-5 :	Indicate the high risk diseases associated with modern society																			
CLR-6 :	State about disease diagnosis and treatment strategies																			

Level of Thinking (Bloom) · Expected Proficiency (%) · Expected Attainment (%) · Engineering Knowledge · Problem Analysis · Design & Development · Analysis, Design, Research · Modern Tool Usage · Society & Culture · Environment & Sustainability · Ethics · Individual & Team Work · Communication · Project Mgt. & Finance · Life Long Learning · PSO - 1 · PSO - 2 · PSO – 3

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Recall basic human biology at the genetic, cellular, and physiological levels	2	80	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-2 :	Interpret how the human body maintains a healthy balance, and how disturbances of this balance underlie diseases	2	85	75	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-3 :	Discuss about infectious organism and understand defense mechanism of our human body	2	75	70	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-4 :	Describe disease causing agents	2	85	80	-	-	-	L	-	M	-	-	-	H	-	H	-	L	H
CLO-5 :	Familiarize with modern biomedical scientific approaches to treat disease.	2	85	75	-	-		L	-	M	-	M	-	H	-	H	H	H	H
CLO-6 :	Demonstrates the importance of taking responsibility for one's own health	2	80	70	-	-	-	L	-	M	-	H	-	H	-	H	-	H	H

Duration (hour)	9	9	9	9	9
S-1 SLO-1	Introduction to human heath	Concepts of human disease	Immune system	Mendelian genetics	Disease Diagnosis
S-1 SLO-2	Anatomy and physiology	Disease Disorder and syndrome	Physical chemical and cellular barrier	Genetics of simple and complex traits	Treatment strategy
S-2 SLO-1	Respiratory system	Pathology of disease	Types of Immune cell	Hereditary disease	Biomedical Instruments
S-2 SLO-2	Circulatory system	Mechanism of disease	Humoral and cell mediated immunity	Karyotype preparation and analysis Chromosome abnormality	Biosensors
S-3 SLO-1	Digestive system	Infectious disease	Cells Involved in inflammation	Thalassemia	Drug designing and development
S-3 SLO-2	Execratory system	Causative agents Bacteria, virus and parasites	Inflammatory Process	Cystic fibrosis	Computer aided drug designing
S-4 SLO-1	Reproductive system	Bacteria: Introduction Pathogenesis	Immune disorders	Duchene Muscular dystrophy	Drug metabolism
S-4 SLO-2	Fertilization and embryogenesis	Bacterial toxins	Abscesses, ulcer, cellulitis And Allergy	Sickle cell anemia	ADME property of a drug
S-5 SLO-1	Cell structure	virulence of bacterial infection	Autoimmunity	Indian genetic disease database	Sources of drug- plants and microbes
S-5 SLO-2	Tissue types	Antibiotic resistance strains	Immunodeficiency	Human gene mutation database	Route of administration

S-6	SLO-1	How body gets energy	Virus: An overview of replication cycle of virus	High risk disease of modern society	Principle class of metabolic disorders	Bulk Drugs and processing
	SLO-2	ATP Synthesis	Effect of virus infection in the host cell	Obesity, Hypertension and diabetics	Inherited Metabolic disorders	Active pharmaceutical ingredient
S-7	SLO-1	Cell metabolism	Epidemiology	Neoplasm	Metabolic syndrome	Vaccines types, Recommendation by age
	SLO-2	Cell cycle	Roots of spreading, Emerging and reemerging virus	Oncogenes and tumor suppressor genes	Risk factors	Vaccines – Recent advancement
S-8	SLO-1	Checkpoints in cell division	Parasitosis, common parasites of human	Types of cancer	Lysozyme storage disease: Molecular basis	Immunotherapy
	SLO-2	Cell division -Mitosis and Meiosis	Plasmodium – life cycle and disease	Stages of cancer	List of proteins involved in LSD	Immunotherapeutic approaches currently in use
S-9	SLO-1	Growth factors- overview	Fungal Infections	Cancer in future	Balanced nutrition and Malnutrition	Stem cell therapy
	SLO-2	Types and function	Endemic mycoses in immunocompromised patients	Life style and cancer risk	Deficiency disease	Gene therapy

Learning Resources	1. Goodenough and McGuire, Biology of Humans: Concepts, Applications and issues, 4th ed., Benjamin Cummins/Pearson Publisher, 2011	2. Marianne Neighbors, Ruth Tannehil, Human Diseases, 4th ed.,Jones Cengage learning, 2015

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. Lilly M Saleena, SRMIST
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in	2. Dr.Priya Swaminathan, SRMIST

Course Code	18BTO103T	Course Name	ACTIVATED CARBON TECHNOLOGY	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	State a basic understanding of activated carbon and its industrial applications.																		
CLR-2 :	Demonstrate the preparation of the material from different sources of waste																		
CLR-3 :	Apply the engineering aspects of the adsorbents																		
CLR-4 :	Prepare the adsorbents for the waste water treatment plants																		
CLR-5 :	Analyze the problems of the industrial effluents that are hazardous to the environment																		
CLR-6 :	Apply a solution to solve the industrial effluent problems																		

Column headers for Learning / PLO section: Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	LoT	EP	EA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Discuss about the activated carbon from different sources and subsequent knowledge to apply industrially	1	80	80	H	H	H	H	-	M	L	H	H	H	H	H	H	H	H
CLO-2 :	Prepare the activated carbon from different sources	2	85	75	H	H	H	H	-	-	M	H	H	H	H	H	H	H	H
CLO-3 :	Explain the kinetics on the adsorption of heavy metals, dyes and toxic substances	2	75	80	M	H	M	H	M	M	-	M	H	H	H	H	H	H	H
CLO-4 :	Evaluate mechanism of activated carbon that is ultimately responsible for removing the toxic substance from the effluent	2	85	80	H	H	H	H	-	-	H	L	H	H	H	H	H	H	H
CLO-5 :	Design an alternative adsorption process and present the solution to adsorption problems.	3	85	75	H	H	H	H	-	M	H	H	H	L	H	H	H	H	H
CLO-6 :	Formulate the activated carbon for better environment	2	80	80	H	H	H	H	L	M	M	M	H	H	H	H	H	H	H

| Duration (hour)	9	9	9	9	9
S-1 SLO-1	Activated Carbon and Its Surface Structure	Principle of Adsorption Kinetics	Activated adsorption from solutions	Principle of AAS and its applications	Application of activated adsorption technology in the waste water treatment
S-1 SLO-2	Basics of activated carbon	Effect of contact time on the adsorption characteristics	Types of isotherms for solution phase	AAS analysis of dyes adsorption by activated carbon	Application of Activated Carbon in Environmental Pollution
S-2 SLO-1	Historical Perspective ofActivated Carbon Adsorption and its Integration with Biological Processes	Effect of pH on the adsorption characteristics	Types of adsorption isotherm sorbent selection	Characterizing the pore structure of the carbon by SEM	Integration of Activated Carbon Adsorption with Biological Processes in Wastewater and Water Treatment
S-2 SLO-2	Activated carbon-crystalline structure, porous structure and chemical structure	Effect of agitation and adsorbent dosage on the adsorption characteristics	Regeneration of activated carbon	Proximate analysis of activated carbon prepared from various raw materials	Industrial waste water treatment using natural material as an adsorbent
S-3 SLO-1	Types of materials from different sources	Thermodynamic parameters like change in free energy, enthalpy and entropy for the process of removal	Batch adsorption kinetics	Principles of FTIR analysis for the prepared activated carbon	AC on the removal of hazardous organic and inorganic compounds from industrial waste water
S-3 SLO-2	Preparation of granulated and powder activated carbon	Contact Oxidation Process Followed by Activated Carbon	Factors influencing adsorption from binary solution	X-ray refractive diffraction (XRD) studies for activated carbon	AC on the removal of hazardous gases and vapors from industrial flue gases
S-4 SLO-1	Influence of carbon-oxygen surface groups of adsorption properties	Models, and types of adsorption	Transport processes in adsorption from liquid phase on activated carbon	X-ray photoelectron spectroscopy (XPS) studies for activated carbon	Application of activated adsorption technology in pharmaceutical industries
S-4 SLO-2	Influence of other surface groups of adsorption properties	Influencing factors for adsorption properties	Capillary transport in adsorption from liquid phase on activated carbon	Interpretation of results	Application of activated adsorption technology in leather industries

S-5	SLO-1	Chemical activation using acids	Influencing factors for the Adsorption equilibrium	Adsorption behaviour of Low-Bio-degradable Organics on Activated Carbon Surfaces	X-ray absorption spectroscopy (XAS) studies for activated carbon	Application of activated adsorption technology in food industries
	SLO-2	Chemical activation using alkalis	Development of adsorption isotherms	Adsorption behaviour of Non-Bio-degradable Organics on Activated Carbon Surfaces	Interpretation of analysis	Application of activated adsorption technology in paint industries
S-6	SLO-1	Preparation of carbon from agricultural wastes	Linear, Freundlich, Langmuir adsorption isotherms	Design for packed columns	BET Principle and analysis	Adsorption for Textile Wastewater Treatment
	SLO-2	Preparation of activated carbon from agricultural waste using chemical agents	Temkin and Dubinin–Radushkevich isotherm models	Process design factors of fixed-bed adsorption columns	Interpretation of BET analysis	Improved Control of Pollutants through Integrated Adsorption and Biological Treatment
S-7	SLO-1	Preparation of activated carbon from lower cost materials	Adsorption Equilibria of the Light Hydrocarbon Gases on the Activated Carbon and Silica Gel	Phenol wastewater treatment by a two-step adsorption–oxidation process on activated carbon	Analysis and design of GAC and PAC Contactors	Application of activated adsorption technology in plating industries
	SLO-2	Effect of activating agents	Adsorption Equilibria of the heavy Hydrocarbon Gases on the Activated Carbon and Silica Gel	Hydrocarbon wastewater treatment process on activated carbon	Interpretation of results	Application of activated adsorption technology in dye industries
S-8	SLO-1	Activated carbon from e-waste such as PCB, Metallic and non-metallic components	Simulated Binary Isothermal Adsorption on Activated Carbon in Periodic Countercurrent Column Operation	Scale-up laboratory adsorption column	Thermal analysis of prepared activated carbon	Application of activated adsorption technology in drug industries
	SLO-2	Using physical and chemical methods for the preparation of AC from e waste	Solving problems	Criteria for scale up	Interpretation of results	Application of activated adsorption technology in brewing industries
S-9	SLO-1	pH, solubility and Iodine number of activated carbon	A Liquid-Phase Adsorption and rate of diffusion of phenol from aqueous solution into Activated Carbon	Adsorption of phenols onto granular activated carbon in a liquid–solid fluidized bed	Differential Scanning Calorimetry for the analysis of activated carbon	Adsorption of Normal Paraffins and Sulfur Compounds on Activated Carbon
	SLO-2	Different types of carbon Nano-materials: CNT, CNF, CNB, their structure	Solving problems	Desorption of phenols onto granular activated carbon in a liquid–solid fluidized bed	Interpretation of results	Application of activated adsorption technology in dairy industries

Learning Resources	1. Bansal, R.C. and M. Goyal, Activated Carbon Adsorption, Boca Raton, FL: CRC Press, 2013 2. Harry Marsh Francisco Rodríguez Reinoso, Activated Carbon, I Edition, Elsevier Science, June 2006 3. Douglas M. Ruthven, Principles of Adsorption and Adsorption Processes, Wiley, 1984	4. Jean Rouquerol, Francoise Rouquerol, Kenneth S.W.Sing, Adsorption by Powders and Porous Solids: Principles, Methodology and Applications, Academic Press, 1998 5. Richard I. Masel, Principles of Adsorption and Reaction on Solid Surfaces, Wiley, 1996

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
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2. Mr.Vinod Kanth, Consultant,svkuvk71@yahoo.com	2. Dr. R. Aravindan, CLRI, Anna Universwity, aravindhan@clri.res.in	2. Dr. B.Samuel Jacob, SRMIST
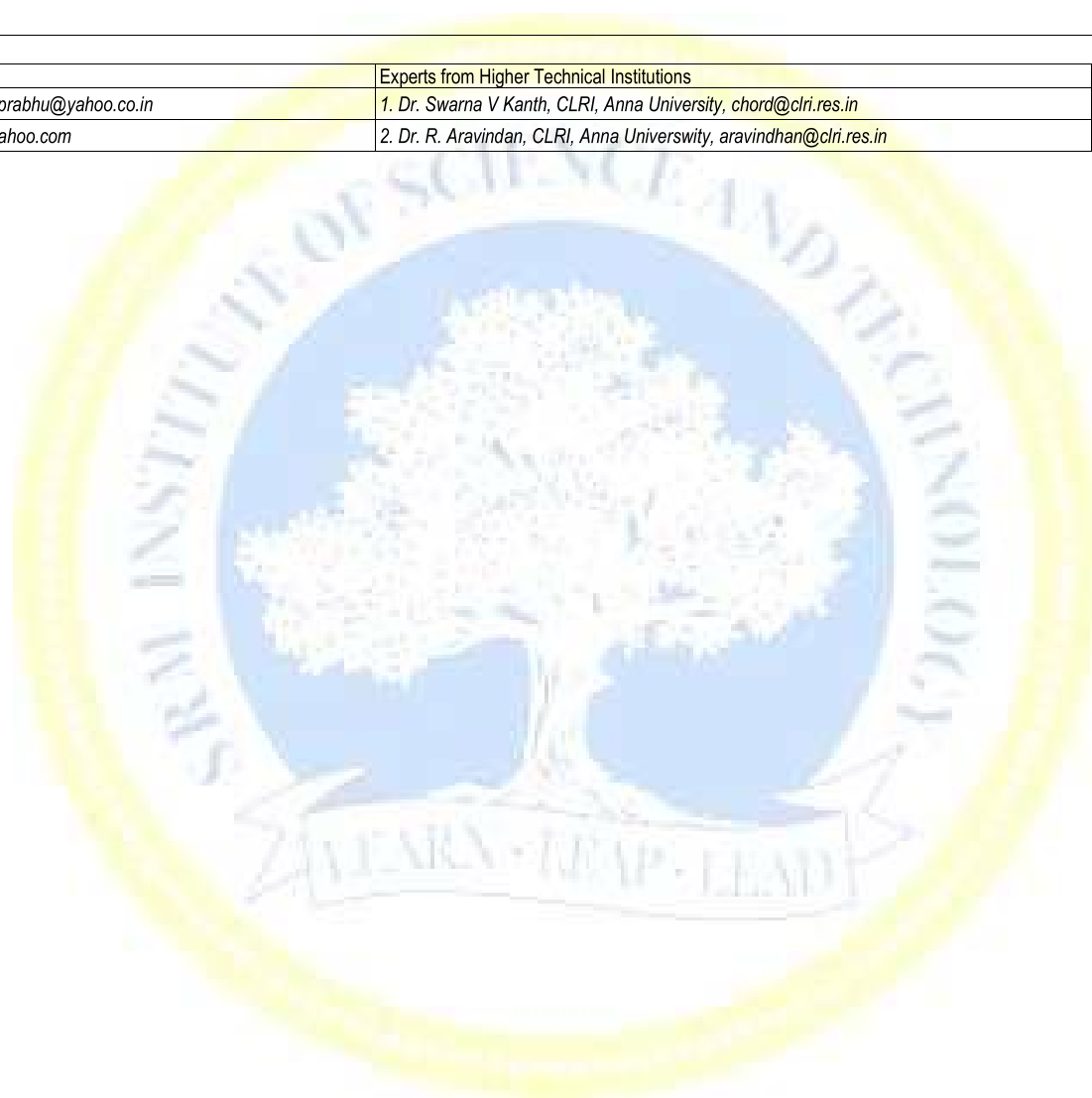
Course Code	18BTO104T	Course Name	DEFENCE FORCES IN OUR BODY	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:				Learning			Program Learning Outcomes (PLO)															
CLR-1 :	Analyze the various components of the immune system				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Discuss the innate immune cells and their role in fighting against pathogens																					
CLR-3 :	Demonstrate the adoptive immune system and their function																					
CLR-4 :	Illustrate the methods and techniques used in immunology																					
CLR-5 :	Discuss how the human body respond to pathogens																					
CLR-6 :	Apply immunotherapy																					

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:				Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Explain about the basic concept of immune system				1	80	80	H	H	H	H		M	L	H	H	H	H	H	H	H	H
CLO-2 :	Describe the different type of immune cells and organs				2	85	75	H	H	H	H			M	H	H	H	H	H	H	H	H
CLO-3 :	Analyse how the body respond to pathogens				2	75	80	M	H	M	H	M	M		M	H	H	H	H	H	H	H
CLO-4 :	Discuss about the immunotechniques used to assess immune functions				2	85	80	H	H	H	H			H	L	H	H	H	H	H	H	H
CLO-5 :	Evaluate immunity to infections				2	85	75	H	H	H	H		M	H	H	H	L	H	H	H	H	H
CLO-6 :	Describe immunotherapy				2	80	80	H	H	H	H	L	M	M	M	H	H	H	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to the immune system	Introduction to innate immune system	Introduction to adaptive immune system	Antigen –antibody interaction	What is an infection?
	SLO-2	History of modern immunology	Components of the innate immune system	Components of the adaptive immune system	Forces in antigen-antibody interaction	Human infectious agents
S-2	SLO-1	What is immunity?	Anatomical barriers- Chemical and mechanical	Types of adaptive response	Affinity and avidity	Bacterial diseases
	SLO-2	Concept of self and non-self	Anatomical barriers- Biological	Innate versus adaptive immune response	Cross-reactivity and specificity	Immunity to bacteria
S-3	SLO-1	Primary lymphoid organ Blood marrow	Humoral components-complements	Antibody mediated immune response	Antibody as Immunoassays	Viral diseases
	SLO-2	Primary lymphoid organ Thymus	Humoral components-coagulation factors	What are antibodies and antigens?	Agglutination	Immunity to viruses
S-4	SLO-1	Hematopoietic stem cell	Cytokines	Immunoglobulin structure	Blood typing	Fungi and human diseases
	SLO-2	Development of blood cell lineage	Properties and functions of cytokines	Role of antibodies	Immuno electrophoresis	Immunity to fungi
S-5	SLO-1	Red blood cells and platelets	Phagocytosis and macrophages	Effect of antigen-antibody binding	Principle of ELISA Clinical utility	Protozoan and worms
	SLO-2	White Blood cells	Neutrophil granules and killing	Types of antibodies	Types of ELISA	Immunity to protozoan

S-6	SLO-1	The myeloid cells- granulocytic	NK cell cytotoxicity	Cell mediated immunity- T cells	Western Blot and confirmation	Vaccination-how does it work?
	SLO-2	The myeloid cells- monocytic	Dendritic cells and its action	Different types of T cells and their functions	ELISPOT- detection of virus	Different types of vaccination
S-7	SLO-1	The lymphoid cells- T and B cells	Pathogen recognition	T cell receptor	Tissue sectioning	Immunodeficiency
	SLO-2	The lymphoid cells- NK cells	Innate immune receptors	How does a T cell recognize antigen?	Immunohistochemistry	Autoimmune diseases
S-8	SLO-1	Secondary lymphoid organs-Spleen	Inflammation and its process	Antigen presenting cells	Fluorescence and its utility in immunoassays	Introduction to cancer
	SLO-2	Secondary lymphoid organs-Lymph nodes	Signs of inflammation	Interaction of APC with the T cells	Flow cytometry	Immunity to cancer
S-9	SLO-1	The lymph	Mechanism of inflammation	Clonal selection	Isolation of immune cells	Strategies of cancer treatment
	SLO-2	The lymphatic system	Role of inflammation in diseases	Primary and secondary immune response	Activation of immune cells	Immunotherapy

Learning Resources	1. A.K. Chakravarty, Immunology and Immunotechnology,Oxford University Press, 2006 2. Peter Wood, Understanding Immunology,2nd ed., Pearson Education, 2006	3. Sudha Gangal, Shubhangi Sontakke, Textbook of basic and clinical immunology, Universities Press, 2013 4. Richard Coico, Geoffrey Sunshine, Immunology: A short course, 6th ed., Wiley-Blackwell, 2009

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. E.Berla Thangam, SRMIST
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Course Code	18BTO105T	Course Name	ANIMAL MODELS FOR RESEARCH	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR): The purpose of learning this course is to:

		Learning			Program Learning Outcomes (PLO)
CLR-1 :	Learn the basics of animal experiments	1	2	3	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
CLR-2 :	Apply the concept of living model organism and selection of appropriate model				
CLR-3 :	Use of various animal models available				
CLR-4 :	Analyze the different alternatives and ethical issues				
CLR-5 :	Use pilot experiments to evaluate their working/living environment				
CLR-6 :	Analyze animal experiment data and correlate with human case reports				

Course Learning Outcomes (CLO): At the end of this course, learners will be able to:

Course Learning Outcomes (CLO):	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 : Describe about the fundamentals of animal experiments	1	85	80	L	M	H	H	H	L	M	H		M	H	H	H	H	H
CLO-2 : Recognize the similarities between anima models and humans	2	85	70	M	M	H	H	H	M	M	H		M	H	H	M	L	M
CLO-3 : Discuss the knowledge on different animal models available	2	80	75	M	H	M	H	H	L	L	H		L	H	H	H	M	L
CLO-4 : Explain the functions that can be studied in animal models	2	75	80	M	H	H	H	H		H	H		L	H	H	M	M	M
CLO-5 : Analyze the animal alternatives and ethical issues	3	85	75	H	M	H	H	H		H	H	L	H	H	H	H	L	M
CLO-6 : Interpret pilot experiments to study animal model experiment	3	80	80	H	H	H	H	H	M	M	M	L	H	H	H	H	M	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to biology of animals	Selection of animal models	Transgenesis and transgenic animal models	Drugs and compound administration	Animals in laboratory environment
	SLO-2	Structure and organs	Mammals, bovine, aquatic, insect	Knockout, Knockin, Mutation models	Need for animal models to test new compounds prior clinical study	Light cycle, temperature and humidity
S-2	SLO-1	Classification of animals	Mammal biology – life cycle	CRISPR cas 9	Oral administration	Pathogen free environment lab
	SLO-2	Vertebrate and Invertebrate	Rats, mice, sheep and bovine	UAS gal 4 systems	Nasal dosage	Precautions and protective gear to be followed by researchers
S-3	SLO-1	Human evolution	Rats – types of rats	Animal models for cataracts and retinitis pigmentosa	Inhalation	Housing and Animal husbandry
	SLO-2	Darwinism theory	Genetic background among different sub species	Animal models for Atherosclerosis and myocardial infarction	Inhalation related experiment animal models	Animal husbandry training
S-4	SLO-1	Human diseases	Mice – types of mice	Animal models for cardiac and cardiovascular disease	Inhalation related experiment animal models and issues that can be replicated	3 R`s and Alternative for animal models
	SLO-2	Need for animal models	Genetic background among different sub species	Animal models for metabolic syndrome	Invasive administrations – intravenous	Tissue culture – cell lines
S-5	SLO-1	Experimental animal models	Sheep and cow as animal models	Animal models for diabetes and obesity	Invasive administrations – intravenous and intra-peritoneal	Primary tissue culture

	SLO-2	Monkey, rat, rabbit - living animals models	Disease research on sheep and cow	Animal models for liver diseases	Invasive administrations – intraocular	3D cell culture reconstructing and replacing organs
S-6	SLO-1	Chicken, pig tissues – non living animal models	Aquatic animals models	Animal models for skin disorders and regeneration	Invasive administrations – intraocular and intramuscular	Limitation and ethical issues in research on humans
	SLO-2	Pig heart as cardiovascular model	Life cycle of zebra fish and Japanese rice fish and research	Animal models for stroke, olfactory and neuromuscular dysfunction	Invasive administrations – Subcutaneous	Lower order animal models
S-7	SLO-1	Classical animal models used – squid	Hydra as an aquatic animal model	Animal models for schizophrenia	Invasive administrations – Subcutaneous	Ethical issues in using humans samples
	SLO-2	Nervous system in squid and early evidences	Life cycle and environmental toxin researches	Animal models for Alzheimer`s and Huntington disease	Non invasive drug administration	Ethical issues in using experiments animals
S-8	SLO-1	Classical animal models used – cats	Non vertebrate insect models – Drosophila and C. elegans	Animal models for Parkinson and multiple sclerosis.	Skin adsorption	Computer science – simulations and animal models
	SLO-2	Visuals tracks in cats and early evidences	Life cycle of C. elegans and research	Animal models for Mood disorders	Selecting appropriate drug administration route	Heart diseases and simulation
S-9	SLO-1	Classical animal models – primates	Life cycle of Drosophila as evolution models	Animal disorder for mania	Understand route of exposure in toxicity cases	Computational models
	SLO-2	Behavioral assays in primates.	Drosophila genetics	Animal disorder for stress coping and resilience.	Human-animal equivalent dose calculation and problems	Computational models to repalce animal cognition

Learning Resources	1. Hau J, Van Hoosier GL Jr, Handbook of Laboratory Animal Science, Volume I: Essential Principles and Practices" 2nd ed., CRC Press: Boca Raton, FL, 2003	2. Micheal Conn P, Animal Models for the Study of Human Disease,2nd ed., Academic Press, 2017 3. Jerome Y Yager, Animal Models of Neuro-developmental Disorders, Human Press, 2015

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. S. Sahabudeen, SRMIST
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in	2. Dr.R.A. Nazeer, SRMIST

Course Code	18BTO106T	Course Name	WASTE TO WEALTH TO WHEELS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR): *The purpose of learning this course is to:*

CLR-1 : Identify the applications of engineering concepts for sustainable waste management
CLR-2 : Identify the applications of energy conversion technology
CLR-3 : Identify the significance of eco-friendly process
CLR-4 : Create insights to the concepts of zero-waste process
CLR-5 : Analyze the important fuel properties of wastes and biomass
CLR-6 : Utilize the concepts basic engineering calculations (mass and heat balances) for biomass based energy systems

Course Learning Outcomes (CLO): *At the end of this course, learners will be able to:*

Course Learning Outcomes (CLO)	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 : Formulate the methodology for waste segregation based on international policy	1	80	70	H	H	M	M	M	M	H	H	H	M	H	H	H	M	H	H
CLO-2 : Analyze calorific parameters of wastes and biomass	2	85	75	H	M	M	M	M	H	H	H	M	L	H	H	M	H	H
CLO-3 : Apply thermo-chemical conversion process for waste to energy conversion	2	75	70	H	H	M	M	M	H	H	H	H	M	H	H	H	M	H
CLO-4 : Apply bioprocessing techniques to convert waste to biofuel and value added chemicals	2	85	80	H	H	M	M	M	H	H	H	H	M	H	H	H	H	H
CLO-5 : Identify the applications of mass and energy balance for making commercially viable Waste to wealth process	2	85	75	H	H	M	M	M	H	H	H	M	H	M	H	H	H	H
CLO-6 : Describe the National policy towards biofuel production and Energy security	1	80	70	H	M	M	M	M	H	H	H	M	H	M	H	H	M	H

Duration (hour)	9	9	9	9	9
S-1 SLO-1	Sources of industrial wastes	Thermal processing of wastes: Combustion, Co-generation/co-firing	Catalytic depolymerization of biomass-derived oxygenated feedstocks	Treatment based on aerobic and anaerobic waste bioprocessing	Energy content estimation of wastes and products by bomb (solid and liquid)(ASTM)
S-1 SLO-2	Sources of agro and MSW wastes	Pyrolysis and torrefecation	Biosynthetic pathway for lignin synthesis	Vermi-composting of solid wastes for bio-fertilizer; Vermi-wash	For gaseous fuel (ASTM)
S-2 SLO-1	Impact of wastes on biodiversity	Hydrolysis and plasma treatment for waste to energy conversion	Hydrolysis of cellulose from lignocellulosic wastes over novel solid acids	Production of hydrocarbons (bioalkanes) from lignocelluloses	Process calculations for energy and mass balance of waste and by product recovery
S-2 SLO-2	Effect on food chain/food web	Catalytic conversion process	Inhibitory compounds of lignin degradation that impedes bioprocessing	Quality comparison between conventional and bio-based chemicals	Software hands on training for mass and energy balance
S-3 SLO-1	Waste segregation methodologies	Syngas production	Synthesis of polyols by hydrogenation / hydrogenolysis of cellulose and sugar	Production of biodiesel (Oil seeds/Algae)	Case : non-conventional transportation fuels and their manufacturers obtained by processing of wastes
S-3 SLO-2	Hazardous and non-hazardous wastes	Flue gas filters and value addition from particulate matter	Role of green solvents and ionic liquids in fuel production	Whole crop biorefinery approach	Municipal leachate processing and value product development
S-4 SLO-1	Recalcitrant and non-recalcitrant wastes	Waste heat recovery	Hybrid energy system using biological routes	Oleagenous organisms (Fungi and yeast)	Management of post-energy recovery residues (bottom ash, fly ash, digestate)
S-4 SLO-2	Xenobiotics and Rationale for bioprocessing	Hydrothermal electricity production	Clean coal technologies bioleaching and biosorption	Enzymatic transesterification Vs. Chemical methods	Bioenergy-Biochar energy cycle

S-5	SLO-1	Waste characterization	Bio refinery demonstration projects on ethanol	Unified oils and biodiesel from oil seeds and algae by chemical catalysis	Biobutanol, ABE synthesis, bioalkanes	R& D scope in WWW Gas to liquids (GTL) technology
	SLO-2	Calorific value estimation: Bomb and Junker's calorimeter	Case study on India's potential on second generation bioethanol	Case study on India's potential on second generation biodiesel from Jatropha	Biopolymers and plastics (PHA, PHB and PLA)	CO_2 sequestration by biological modes
S-6	SLO-1	Point source collection and non-point source wastes collection	Distillation technology for bioethanol	Fischer–Tropsch process – Gas to liquid fuels	Gaseous fuels: Biomethane	Landill fill emission control
	SLO-2	Role of smart dustbins	Adsorption technology for ethanol fractionation	Comparison of fuel quality standards from FT and fossil fuel	Energy conversion strategies from biogas	Land fill and flue gas recovery for its commercial application
S-7	SLO-1	Energy crops – Terrestrial	Bio refinery demonstration projects on Biodiesel	3rd generation biofuel: For transportation	Biohydrogen and Gas to liquid fuel technologies	Current and Emerging Challenges to Renewable Energy Development
	SLO-2	Energy crops – Aquatic	Case study of implementation of Biodiesel project by Indian Railways	3rd generation biofuel: For value added hydrocarbons	ABE biosynthesis (Acetone Butanol and Ethanol)	Government policies for energy security
S-8	SLO-1	Potential Benefits of Replacing Fossil Fuels with Biofuel, Biomass and Biogas	Transesterification and distillation	Genetically modified (GM) organisms for improved fuel production	Metabolic pathway engineering for ABE biosynthesis	Community Participation in Renewable Energy Development
	SLO-2	Implication of fossil fuel on National economy, environment and energy security	Refining technologies for biodisesel	GM bioenergy crops and its implication for developing countries	Aircraft liquid biofuel from biomass feedstocks	Contract farming strategy for non-edible feedstock production
S-9	SLO-1	Political Drivers for Biofuel Development	By product processing of biodiesel production	Algal based technologies for biofuel and value added chemical preparation	Bio-alkanes and alkenes from waste biomass to be used as jet engines fuels	Combined industrial waste treatment for energy recovery
	SLO-2	Activities of MNRE, Government of India and International Energy Agency	Conversion of de-oiled cake into value added products	GM algae and its regulatory issues	New energy research Projects pertaining to transportation fuels in Global context	Urban and rural integration system for sustainable waste utilization for value added product generation

Learning Resources	1. David M. Mousdale, Biofuels: Biotechnology, Chemistry, and Sustainable Development, CRC Press, 2008 2. Roland A. Jansen, Second Generation Biofuels and Biomass, Wiley, 2013	3. A.H.Scragg, Biofuels, Production, Application and Development, CAB International, 2009 4. Robert C. Brown, Tristan R.Brown, Biorenewable Resources: Engineering New Products from Agriculture, 2nd ed., Wiley, 2014

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. Samuel Jacob, SRMIST
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in	2. Dr. K.Ramani, SRMIST

Course Code	18BTO107T	Course Name	FUNDAMENTAL NEUROBIOLOGY	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Biotechnology		Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Recall the brain function from its organization																		
CLR-2 :	Discuss Molecular signaling in neurons																		
CLR-3 :	Compare Neural basis of senses																		
CLR-4 :	Explain different methods for studying neuro-immune functions																		
CLR-5 :	Analyze genetic variations in brain development																		
CLR-6 :	Analyze genetic variation and inheritance pertaining to nervous system disorders																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Describe the fundamental organization of brain and its functions	1	80	80	L	H	H	H	-	M	L	H	H	H	H	H	L	H	H
CLO-2 :	Explain the concepts and experiments in the neurotransmitters	2	85	75	M	H	H	M	-	-	M	H	L	H	H	H	L	H	H
CLO-3 :	Recognize the pattern of brain energy metabolism	2	75	80	M	H	M	H	M	M	-	M	H	H	H	H	L	H	H
CLO-4 :	Discuss the different methods in the neuroendocrine and immune interactions	2	85	80	L	H	H	H	-	-	H	L	L	H	H	H	M	H	H
CLO-5 :	Analyze the role of genes in brain development and functions	3	85	75	L	H	H	M	-	M	H	H	H	L	H	H	H	H	H
CLO-6 :	Explain the concepts of nervous system disorder and the diseases associated with it	2	80	80	M	H	H	H	L	H	M	M	H	H	H	H	H	H	H

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Basics of Neurobiology	Membrane potential	Brain energy metabolism at the cellular level	Nature of central systems	Disorders of the nervous system
	SLO-2	Understanding brain function	Action potential	Sensory systems	Survey methods	Developmental disorder:
S-2	SLO-1	Orientation of Central nervous system	Resting potential	Receptors to perceptions	Neuroendocrine circuits	Autism, Dyslexia, ADHD
	SLO-2	Peripheral nervous system	Electrochemical basis of nerve function	Chemical and somatic senses	Functions of neuroendocrine system	Mental Disorder
S-3	SLO-1	Levels of Neural organization	Electrical and Thermodynamic Forces in Passive Distribution of Ions	Molecular and neural basis of visual perception	Neuroendocrine tumors	Schizophrenia
	SLO-2	Concept of functional units	Hyperpolarization or Depolarization	Organization of autonomic nervous system and functions	Global epidemiology of neuroendocrine tumors	Degenerative disorders
S-4	SLO-1	Cellular basis of Neurobiology	Chemical basis for neuronal communication	Nature of motor system and its functions	Neuro-immune circuits	Alzheimer's disease
	SLO-2	Clinical issues in neurobiology	Ion pumps and Ion gradients	Reflexes and fixed motor responses	Neuro-immune functions	Parkinson's disease
S-5	SLO-1	Neuron terminology	Ion channels	Locomotion	Neuroendocrine-immune interactions in neurological disorders	Psychiatric disorder

	SLO-2	Cell biology of neurons and glia	Hyperpolarization-Activated Ionic Currents	Food intake and metabolism	Neuroendocrine-immune interactions in autoimmune diseases	Depression and anxiety
S-6	SLO-1	Differentiation of axon and dendrite	Neurotransmitters	Water intake and body fluids	Developmental genetics of the brain.	Vascular disorders
	SLO-2	Structural neuroscience methods: A brief history	Neuropeptides	Sleep, dreaming and wakefulness	Genes for human brain development	Stroke
S-7	SLO-1	Sensorimotor, autonomic and enteric divisions	Receptors of neurotransmitters	Reward and motivation	Genes in neurological disorders.	Other disorders
	SLO-2	Synapses and spines	Non-classical neurotransmitters	Emotion and addiction	Epigenetics of the brain.	Epilepsy
S-8	SLO-1	Inhibitory circuit neurons	Synthesis of neurotransmitters and neuropeptides	Cognitive development and aging	Epigenetics in brain disorders	Drug addiction
	SLO-2	Inhibitory projection neurons	Release and metabolism of neurotransmitters	Cognitive impairment	Role of Environmental factors in neurodevelopment.	Neural Plasticity, Goat Brain Dissection
S-9	SLO-1	Excitatory neurons	Molecular mechanisms nerve terminal	Learning and memory	Exposure of lead and methyl mercury in neurodevelopmental disorders.	Understanding brain by Artificial Intelligence
	SLO-2	Neuroglia and glial sheaths	Molecular signaling in neurons	Language, communication and consciousness	Neurotoxins	Neural network for analyzing brains network

Learning Resources	1. Larry Squire, Darwin Berg,Floyd E. Bloom,Sascha du Lac,Anirvan Ghosh,Nicholas C. Spitzer, Fundamental Neuroscience, 4th ed., Academic Press, 2012	2. Michael Aschner, Lucio G. Costa,Environmental factors in Neurodevelopmentaland neurodegenerative disorders, Academic Press, 2015

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. S. ThyagaRajan, SRMIST
2. Dr. Karthik Periyasamy, Aurobindo Pharma Limited, Hyderabad, karthikmpk@gmail.com	2. Prof. R. B. Narayanan, SVCE, Chennai, rbn@svce.ac.in	2. Dr. R. VasanthaRekha, SRMIST

Course Code	18ECO106J	Course Name	PCB DESIGN AND MANUFACTURING	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil		Co-requisite Courses	Nil		Progressive Courses	Nil			
Course Offering Department		Electronics and Communication		Data Book / Codes/Standards	Nil					

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Explore the terminologies of PCB design and Electronic components		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	Design consideration involved in PCB design																			
CLR-3 :	Utilize the PCB design consideration for special application circuits																			
CLR-4 :	Design a PCB layout using CAD tool																			
CLR-5 :	Explore various PCB manufacturing techniques																			
CLR-6 :	Equip the learners to explore and understand PCB design technology, design constraints and manufacturing technique																			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Identify the various types of PCB and electronics components packaging	2	80	70	H	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CLO-2 :	Select suitable design and consider appropriate parameters involved in PCB design	3	80	70	M	-	L	-	-	-	-	-	-	-	-	-	-	-	-
CLO-3 :	Apply the appropriate design rules in designing PCB for special application circuits	2	80	70	M	-	-	L	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Design and develop a PCB layout using CAD tool	3	80	70	M	-	-	M	H	-	-	-	-	-	-	-	-	-	-
CLO-5 :	Identify and select the required PCB manufacturing technology	3	80	70	L	-	-	-	H	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Develop PCB layout using PCB design CAD (Computer Aided Design) tool and proficiency in PCB fabrication	1	80	70	H	-	L	L	H	-	-	-	-	-	-	-	-	-	-

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Nomenclature of a Printed Circuit Board	PCB Design Considerations - Important Design Elements	Design Rules for Analog Circuits	Schematic Capture - Introduction schematic capture tool	Image Transfer Techniques- Screen Printing, Pattern Transferring Techniques
	SLO-2	Classification of Printed Circuit Boards	PCB Design Considerations - Important Performance Parameters	Design Rules for Analog Circuits		
S-2	SLO-1	Manufacturing of basic PCB - Single-and Double-sided Plated Through-holes	PCB Design Considerations - Mechanical Design Considerations	Design Rules for Digital Circuits	Schematic Capture - Simulation of simple electronic circuit	Image Transfer Techniques- Printing Inks, Photo Printing, Laser Direct Imaging (LDI)
	SLO-2	Manufacturing of Multi-Layer Boards - Flexible Boards, Challenges in modern PCB Design and Manufacture, Standards	PCB Design Considerations - Mechanical Design Considerations	Design Rules for Digital Circuits	Schematic Capture - Schematic to layout transfer	Copper Clad Laminates - Properties of Laminates, Types of Laminates, Evaluation of Laminates
S 3-4	SLO-1	Study of electronic components- Passive electronic components	Design and analysis of RL and RC time constants. Schematic in CAD tool	Schematic and PCB Layout in CAD tool. Regulated power supply design. - Full wave rectifier circuit design with fixed voltage regulator	PCB Layout Design of single digit pulse counter using PCB design tool.	Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.
	SLO-2					
S-5	SLO-1	Types, Symbols, Packaging shapes and terminal details of Electronic Components –Resistors, Thermistors Capacitors, Inductors	PCB Design Considerations - Electrical Design Considerations	Design Rules for High Frequency Circuits	PCB Layout Design - Conception Level Introduction	Etching Techniques – wet Etching chemicals
	SLO-2	Diodes, Light Emitting Diodes (LED), Photodiode,	PCB Design Considerations - Conductor Patterns	Design Rules for Fast Pulse Circuits	PCB Layout Design - Specifying Parts, Packages and Pin Names, Libraries	Etching Techniques - Mechanical Etching

S-6	SLO-1	Transistors, Field-effect Transistors, Insulated Gate Bipolar Transistor (IGBT), Thyristor	Component Placement Rules	Design Rules for Microwave Circuits	PCB Layout Design - Checking foot prints of the components, Part list, Net list, Making Net list Files	PCB Assembly Process
	SLO-2	Integrated Circuits (ICs), Three-terminal Voltage Regulator	Fabrication and Assembly Considerations	Design Rules for Microwave Circuits	PCB Layout Design – Placing Parts, Routing Traces, Modifying Traces	Through-hole
S 7-8	SLO-1	Study of electronic components- active devices, analog and digital integrated circuits (IC)	Design and analysis of RLC circuits. Schematic in CAD tool	Schematic and PCB Layout in CAD tool. Regulated power supply design. -Full wave rectifier circuit design with fixed voltage regulator	PCB Design of single digit pulse counter: Schematic and PCB layout using PCB design tool.	Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using IC555and construct and test the designed circuit.
	SLO-2					
S-9	SLO-1	Digital Integrated Circuits, Random Access Memory	Environmental Factors	Design Rules for High-density Interconnection Structures	PCB Layout Design - Mounting Holes	PCB Assembly Process
	SLO-2	Read Only Memory	Cooling Requirements	Design Rules for High-density Interconnection Structures	Adding Text, PCB Layout	Surface Mount, Mixed Technologies
S-10	SLO-1	Microcontrollers, Surface Mount Devices	Packaging Density	Electromagnetic Interference (EMI)	PCB Layout Design - DRC,	PCB Assembly Process
	SLO-2	Transformer, Relays, Connectors	Layout Design	Electromagnetic Compatibility (EMC)	Pattern Transfer, Layout printing	Soldering
S 11-12	SLO-1	Study of testing and measuring Instruments: Logic analyzer, spectrum analyzer, IC tester (Analog and Digital), LCR meters	PCB Layout Design - of RL, RC and RLC circuits	Schematic and PCB Layout in CAD tool. Regulated power supply design. Full wave rectifier circuit design with fixed voltage regulator	Mini Project - PCB Layout Design of electronic turn ON/OFF timer using IC555 using PCB design tool.	Mini Project - Manufacture the PCB for electronic turn ON/OFF timer using IC555and construct and test the designed circuit.
	SLO-2					

Learning Resources	1. Raghbir Singh Khandpur, Printed Circuit Boards: Design, Fabrication, and Assembly, McGraw-Hill Electronic Engineering, 2006 2. Charles A. Harpe, High Performance Printed Circuit Boards, McGraw Hill Professional, 2000 3. Bruce R. Archambeault, James Drewniak, PCB Design for Real-World EMI Control, Volume 696 of The Springer International Series in Engineering and Computer Science, Springer Science & Business Media, 2013 4. Kraig Mitzner, Complete PCB Design Using OrCAD Capture and PCB Editor, Newnes / Elsevier, 2009	5. Douglas Brooks, Signal Integrity Issues and Printed Circuit Board Design, Prentice Hall PTR, 2003 6. Mark I. Montrose, Printed Circuit Board Design Techniques for EMC Compliance: A handbook for designers, 2nd ed., Wiley, 2015 7. Esim open source tool: http://esim.fossee.in/ 8. TINA/Orcad User manual

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. P. Eswaran, SRMIST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. D. Malathi, SRMIST

Course Code	18ECO108J	Course Name	EMBEDDED SYSTEM DESIGN USING ARDUINO	Course Category	O	Open Elective	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Electronics and Communication	Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
CLR-1 :	Get to know about ARDUINO hardware details and environment		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-2 :	To understand the core elements of ARDUINO programming language																			
CLR-3 :	Create insights to the concepts of serial communication																			
CLR-4 :	To use common input and output devices																			
CLR-5 :	Apply the ARDUINO programming into real time applications																			
CLR-6 :	Apply the ARDUINO programming into real time applications																			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Analyze the programming skill		2	80	70	H	-	-	-	-	-	-	-	-	-	-	-	-	H	H
CLO-2 :	Apply the real time data's into digital		2	85	75	H	H	H	H	H	-	-	-	H	-	H	-	-	H	H
CLO-3 :	Interact with almost many devices		2	75	70	H	-	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-4 :	Learn techniques to handle timer delays and IO devices		2	85	80	H	H	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-5 :	Use and modifying the existing libraries		2	85	75	H	-	H	H	H	-	-	-	H	-	H	-	H	H	-
CLO-6 :	Use and modifying the existing libraries		2	85	80	H	H	H	H	H	-	-	-	H	-	H	-	H	H	H

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Introduction to arduino platform	Introduction to Arduino C	Analog and Serial Communication	IO Programming	Case Studies
	SLO-2	Block diagram	Arduino C Data Types	Introduction to Analog Communication	Introduction to Timer/Counters	Wireless Communication Using Zigbee
S-2	SLO-1	AT mega 328p architecture	Decision Making in C	Pulse Width Modulation	Introduction to Timer/Counters	Bluetooth
	SLO-2	AT mega 328p architecture	Decision Making in C	RS232	Timer programming	Robotics -Motor and Sensor
S 3-4	SLO-1	Lab 1 Getting Started with Adriano	Lab 4 -Sensor Interfacing for Temperature Monitoring	Lab 7: Actuators – Stepper Motor	Lab10: Interrupt Programming	Lab 13: Mini Project
	SLO-2	CCS and AVR Studio 7 Blinking Led	Lab 4 -Sensor Interfacing for Displacement Measurement	Lab 7: Actuators – Stepper Motor	Lab10: Interrupt Programming	Lab 13: Mini Project
S-5	SLO-1	Pin function	Program Loops in C	I2C	Timer programming	Security-RFID, Infrared
	SLO-2	Overview of main features-I/O ports	Functions in C	I2C	Timer programming	Security-RFID, Infrared
S-6	SLO-1	Features-timers,interrupts	Introduction to Pointers	I2C	Timer programming	Bio medical application
	SLO-2	Features-timers,interrupts	Introduction to Pointers	I2C	Timer programming	Bio medical application

S 7-8	SLO-1	Lab 2 GPIO LED	Lab 5: PWM BASED SERVO MOTOR INTERFACING	Lab 8: DC MOTOR	Lab11: Watch Dog Timer	Lab14: Model Practical
	SLO-2	Switch Based Led Control	Lab 5: PWM Based Servo Motor Interfacing	Lab 8: DC MOTOR	Lab11: Watch Dog Timer	Lab14: Model Practical
S-9	SLO-1	Features-PWM,SERIAL PORT	Using Pointers Effectively	SPI Protocol	Interrupts	Bio medical application
	SLO-2	Features-ADC	Structures, Unions, and Data Storage	SPI Protocol	Interrupt programming	Bio medical application
S-10	SLO-1	Introduction to Arduino IDE	Arduino Libraries	Interfacing with sensors	External interrupt	GPS Navigation
	SLO-2	Writing ,saving,compiling with IDE.	Arduino Libraries	Interfacing with sensors	External interrupt	GPS Navigation
S 11-12	SLO-1	Lab 3: DISPLAY INTERFACE-7 SEGMENT	Lab 6: SERIAL COMMUNICATION	Lab 9: Repeat/Revision of Experiments	Lab 12 : I2C	Lab:15 University Practical
	SLO-2	LCD 16x2 Matrix	Lab 6: Serial Communication	Lab 9: Repeat/Revision of Experiments	Lab 12: I2C	Lab:15 University Practical

Learning Resources	1. Michael-Margolis,Arduino-Cookbook., Revised edition, O'Reilly,1st edition, 2011 2. D.Dale.Wheat, Arduino.Internals, TIA publication, 5th edition, 2011	3. James M. Fiore, Embedded Controllers Using C and Arduino, ARDUINO open source community, 2018 4. Jack Purdum ,Beginning C for Arduino , Apress, 2012

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
	Understand										
Level 2	Apply	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
	Analyze										
Level 3	Evaluate	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1.Mrs. S. Suhasini,, SRM IST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	18ECO121T	Course Name	BASIC BIOMEDICAL ENGINEERING	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil

Course Offering Department	Electronics and Communication	Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)															
		1	2	3		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

CLR-1 : Analyze the scopes and roles of Biomedical Engineering
CLR-2 : Utilize biomedical instrumentation modules
CLR-3 : Utilize medical imaging principles and its applications
CLR-4 : Analyze the scope of biomechanics and its applications
CLR-5 : Utilize biomaterials and its applications
CLR-6 : Gain the knowledge about Biomedical Engineering

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Analyze the areas in which biomedical engineers can work	2	85	75	-	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L
CLO-2 :	Analyze the basic biomedical instrumentation unit	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-3 :	Analyze basic medical imaging principles	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Apply the concepts of biomechanics on human body	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	Identify domains where biomedical engineers can work	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Analyze the applications of Biomedical Engineer	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-	L

		Introduction to Biomedical Engineering	Biomedical Instrumentation	Medical Imaging system	Biomechanics	Biomaterials
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Evolution of the modern health care system	Introduction: Bioinstrumentation	X-Ray production	Introduction: Principal Areas of Biomechanics	Biomaterials Introduction
	SLO-2	Modern Healthcare system	Basic Bioinstrumentation System	X-Ray Imaging principle	Fundamentals of biomechanics and qualitative analysis	Classification of Biomaterials
S-2	SLO-1	What is Biomedical Engineering	Physiological Systems of the body	Application of X-ray imaging	Kinematics of Human Body Models	Properties of Biomaterials: Mechanical
	SLO-2	Roles played by the Biomedical Engineers	Sources of Biomedical Signals	CT-Imaging principle	Kinetics of Human Body Models	Properties of Biomaterials: Chemical
S-3	SLO-1	Types of Biomedical Engineering	Origin of Bioelectric Signals	CT-Imaging Applications	Modelling of Bio systems	Properties of Biomaterials: Biological
	SLO-2	Surgical instruments and medical devices	Origin of Bioelectric Signals	MRI- Introduction	Tissue Biomechanics	Biomedical alloys and its medical applications- titanium
S-4	SLO-1	Biomaterials	Various Electrodes used for picking the biomedical signals	MRI Imaging principles	Modelling in Cellular Biomechanics	Biomedical alloys and its applications- Stainless steel, Cobalt-Chromium alloys
	SLO-2	Biomechanics	Various Electrodes used for picking the biomedical signals	MRI Imaging principles	Fluid mechanics	Introduction to ceramics
S-5	SLO-1	Tissue Engineering	ECG Introduction	MRI Imaging Applications	Mechanics of the musculoskeletal system impact	Alumina, Zirconia

	SLO-2	Neural Engineering	ECG system Block diagram and its uses	Ultrasound basics	Mechanics of Blood Vessels	Titanium, Hydroxyapatite
S-6	SLO-1	Telehealth	EEG Introduction	Ultrasound Imaging	Cardiac Biomechanics	Glass ceramics
	SLO-2	Bio signal processing	EEG system Block diagram and its uses	Ultrasound Application	Biomechanics of Chest and Abdomen	Introduction to polymers
S-7	SLO-1	Medical Imaging	EMG Introduction	fMRI Imaging	Cochlear Mechanics	Types of polymers
	SLO-2	Computational modelling	EMG system Block diagram and its uses	fMRI Imaging Application	Dynamics of Human Body Models	Biodegradable polymers and its applications
S-8	SLO-1	BioMEMS	Cardiac pacemakers and its uses	PET- Imaging	Gait analysis	Composites and its applications
	SLO-2	Mobile POCT	Cardiac Defibrillators and its uses	PET Imaging Application	Biomechanics in physical education	Wound-Healing process
S-9	SLO-1	Professional Status of Biomedical Engineering	Patient Monitoring System Introduction	SPECT Imaging	Biomechanics in strength and conditioning	Biomaterials for artificial valve, Ear
	SLO-2	Professional Societies	Patient Monitoring System Block diagram and its uses	SPECT Imaging Application	Biomechanics in sports medicine and rehabilitation	Biomaterials for artificial Skin, Eye

Learning Resources	1. Anthony Y. K. Chan, Biomedical Device Technology: Principles and Design, Charles C Thomas publisher, 2008 2. R.S Khandpur, Handbook of Biomedical Instrumentation, 3rd ed., McGraw Hill, 2014 3. Joseph J. Carr, John M.Brown, Introduction to Biomedical Equipment Technology, 4th ed., Pearson, 2002	4. John Enderle, Joseph Bronzino, Introduction to Biomedical Engineering, Academic Press, 2011 5. Andrew R Webb, Introduction to Biomedical Imaging, Wiley-IEEE Press, 2003 6. Sujata V. Bhat, Biomaterials, 2nd ed., Alpha Science International, 2005

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	1. Ms. Oinam Robita Chanu, SRMIST
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	2. Dr. D. Kathirvelu, SRMIST

Course Code	18ECO122T	Course Name	HOSPITAL INFORMATION SYSTEMS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
			1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Utilize the planning and organizational activities of Hospitals																			
CLR-2 :	Analyze the concepts in clinical and diagnostic services																			
CLR-3 :	Utilize the policies and procedures about support services and material management																			
CLR-4 :	Utilize the features in staff and safety management in hospital																			
CLR-5 :	Analyze the reporting system and recent advancement in hospital administration																			
CLR-6 :	Apply all the advanced application the field of telemedicine																			

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	Analyze the role of hospitals and ensure proper healthcare delivery	2	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-
CLO-2 :	Suggest appropriate technologies and services in clinical and diagnostic field	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	L	-	-
CLO-3 :	Analyze the supportive services and the use of proper material management	3	85	75	M	-	-	-	-	-	M	L	-	-	-	-	M	-	L
CLO-4 :	Identify objectives of staff management and ensure safety management in hospitals	3	85	75	M	-	-	-	-	-	-	L	-	-	-	L	L	-	-
CLO-5 :	Implement the advance technologies and effectively evaluate the healthcare information	3	85	75	L	-	-	-	-	M	-	L	L	-	-	-	L	L	L
CLO-6 :	Implement the various standards in hospital and healthcare services	3	85	75	L	-	-	-	-	M	-	-	-	-	-	-	L	-	-

		Planning and designing of hospitals	Inpatient and Outpatient services	Material management services	Management services in hospitals	Patient record and advancement in healthcare services
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Hospital as a social system	Design and planning of emergency department	Pharmacy services- goals of hospital pharmacy services	Human resource management- Human resource development	Medical record management- Importance of medical record
	SLO-2	Primary health care and hospitals	Health information and counselling	Staff organization and divisions of hospital pharmacy services	Hospital staff skill development	Methods of record keeping
S-2	SLO-1	Hospital planning and design-Guiding principles in planning	Outpatient services –Types and functions of outpatient department	Benefits of formulatory system	Nursing management-Functions of nursing management	Electronic medical record-Benefits and drawbacks
	SLO-2	Regionalization of Hospital service	Physical features of outpatient department	Other services of hospital pharmacy	Nursing management- organizational structure	Record retention and disposal
S-3	SLO-1	Role of health promotion approach in hospitals	Ward/Indoor services-Components of the ward system	Transport services-Types of ambulance	Biomedical waste management- Types and Composition of Biomedical Waste	Office management -skills required by the office staff
	SLO-2	Health promoting hospital system	Design of special units	Communication and physical facilities of ambulance service	Categories of biomedical waste	Functions of office management
S-4	SLO-1	Healthy hospital environment	Operation theatre services-Planning and designing of Operation theatres	Staff transport services	Concept of total quality management	Operations research in hospitals-Phases of operation research
	SLO-2	Components of healthy hospital environment	Types of Operation theatres	Other transport services in hospitals	Types of approaches in quality management	Operations research in hospitals- Tools and techniques of operations research
S-5	SLO-1	Creating manpower services	Policies and procedures of operation theatres	Medicolegal services- Steps for Medicolegal Examination	Quality assessment and management tools	Emerging health insurance – components of health insurance

	SLO-2	Hospital engineering: Key to efficient healthcare services	Assessing operation theatre utilisation	Problems faced by healthcare professionals in medicolegal service	Clinical audit	Emerging health insurance-Types of health insurance
S-6	SLO-1	Designing disabled friendly hospitals-Barriers faced and implications in Persons with disabilities	Clinical laboratory services-Introduction and role of laboratory medicine	Food safety in hospitals-Need of food safety	Quality improvement-Cause and effect method	Advantages and common problems of health insurance schemes
	SLO-2	Need for disabled-friendly health services	Testing procedure in clinical laboratory	Sources of food contamination	Pareto analysis	Role of health and hospital administrators in Health insurance
S-7	SLO-1	Barrier-Free Environment to Universal Design	Radio diagnosis and imaging services-Planning and equipments of radiology department	Materials management- Principles of material management	Failure mode and effect analysis	Telemedicine clinic –functions and classification of telemedicine
	SLO-2	Overcoming the barriers	Advancement in radiology service	Concepts of Inventory control	Triggers of quality improvement strategy in a hospital	Challenges for telemedicine
S-8	SLO-1	Energy conservation- Classification	Radiation oncology service-Radiotherapy facilities	Modern techniques for inventory control	Occupational safety-Roles and responsibilities	Growth of mobile phones and potential of mobile health
	SLO-2	Types of energy streams in hospitals	Nuclear medicine services-Categorization and nuclear medicine department	Integrated concept for materials management	Prevention of hazards specific to health sector	Mobile health and its applications
S-9	SLO-1	Need for energy conservation	Planning of nuclear medicine department	Purchase and procurement system-Essentials for procurement process	Hospital security-Physical security	Challenges in implementing information and Communication technology in healthcare
	SLO-2	Energy conservation opportunities in hospitals	Ancillary requirements	Purchase system	Organizational chart of security wing	Information and communication technology applications in healthcare

Learning Resources	1. SonuGoel, Anil Kumar Gupta, Amarjeet Singh, Hospital administration A problem- solving approach, 1st ed., Elsevier, 2014	2. Sakharkar B M, Principles of hospital administration and planning, 2nd ed., Jaypee Brothers Medical Publishers, 2009 3. Kunders G D, Hospitals: Facilities planning and management, 1st ed., Tata Mcgraw Hill, 2008

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
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2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Mr. P. Muthu, SRMIST

Course Code	18ECO123T	Course Name	BIOMEDICAL IMAGING	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Electronics and Communication		Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:
CLR-1 :	Utilize the working principle of X-ray imaging
CLR-2 :	Analyze the principle behind tomographic imaging and the reconstruction techniques
CLR-3 :	Interpret the theory behind nuclear medicine and utilize the working of imaging modalities in nuclear medicine
CLR-4 :	Analyze the physics of ultrasound and the different imaging modes using ultrasound
CLR-5 :	Utilize the physical principle of nuclear magnetic resonance and magnetic resonance image reconstruction
CLR-6 :	Utilize imaging modalities X-ray, computed tomography, nuclear medicine, ultrasound and magnetic resonance imaging

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Analyze the physics and principle behind the working of X-ray imaging	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Identify the principle behind working of tomographic imaging and reconstruction procedures.	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-3 :	Analyze the working principle of nuclear medicine imaging modalities	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-4 :	Identify the physics of ultrasound and the modes of ultrasound imaging	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-5 :	Explain the physical principle of magnetic resonance imaging and the instrumental components involved in MR imaging	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Understand the basic principle and working of medical Imaging systems	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

		X-ray	Computed Tomography	Ultrasound	Magnetic Resonance Imaging	Nuclear medicine
Duration (hour)		9	9	9	9	9
S-1	SLO-1	General principles of Imaging with X-rays	Introduction: Tomographic Imaging	Characteristics of sound: Propagation, wavelength, frequency and speed	Principles of NMR Imaging	Radionuclide decay terms and relationship
	SLO-2	X-ray Production –X-ray source	Comparison between tomographic and planar imaging	Pressure, Intensity and dB scale	Free Induction decay	Nuclear transformation
S-2	SLO-1	X-ray tube current, tube output	Basic principle: Technique of producing CT images	Interaction of ultrasound with matter: Acoustic impedance, reflection, refraction	Excitation, Emission	Radionuclide production
	SLO-2	Beam intensity, X-ray Energy Spectrum	Contrast scale	Scattering, Attenuation	Relaxation times-T1 & T2	Radiopharmaceuticals
S-3	SLO-1	Coherent and Compton scattering	System components: first generation, second generation, third generation,	Transducers: Piezoelectric materials, resonance transducers	Spin echo technique	Radiation detection and measurement: types of detectors, Gas-filled detectors
	SLO-2	Photoelectric effect	Fourth, fifth and spiral/helical CT	Damping block, matching layer, Resolution	Spin echo contrast weighting	Scintillation detectors
S-4	SLO-1	Linear and Mass attenuation coefficient of X-rays in tissue	X-ray source, types of detectors	Transducer arrays	T1 weighted image	Semiconductor detectors
	SLO-2	Instrumentation for Planar X-ray Imaging: Collimators	Gantry and slip ring technology, Collimation and filtration	Multi-element linear array scanners	T2 weighted image	Pulse height spectroscopy

S-5	SLO-1	Antiscatter grids Intensifying screens	Processing system	Multi-linear and phased array	Gradient recalled sequence	Non-imaging detector applications
	SLO-2	X-ray films	Iterative reconstruction, back projection reconstruction	Generation and detection of ultrasound	Proton density weighted images, pulse sequence for fast imaging	Counting statistics
S-6	SLO-1	Instrumentation for computed and digital radiography	Filtered back projection	Basic pulse echo apparatus: A-scan	Slice selection gradient	Nuclear imaging
	SLO-2	X-ray Image characteristics: Signal to Noise ratio	Helical /Spiral CT: Helical pitch	B-Mode	Frequency encode gradient	Anger scintillation camera
S-7	SLO-1	Spatial resolution, Contrast to Noise ratio	Basic reconstruction approaches	M-mode	Phase encode gradient	Basic principle :Emission computed tomography
	SLO-2	X-ray contrast agents, X-ray angiography	Slice sensitivity profile	Echocardiograph	2D spin echo data acquisition	Single photon emission computed tomography
S-8	SLO-1	X-ray Fluoroscopy	Multislice CT	Duplex scanner	Basic NMR components: Main magnet, RF transmitter/receiver	Positron emission tomography
	SLO-2	X-ray mammography	Detector configuration	Intravascular imaging	Body coils, gradient coils	Imaging techniques and scanner instrumentation
S-9	SLO-1	Dual energy Imaging	Measurement of X-ray dosage	Artefacts: Refraction, shadowing and enhancement	fMRI : Basic principle	Dual modality: PET/CT
	SLO-2	Abdominal X-ray scans	Methods for dose reduction	Reverberation	BOLD concept, MR spectroscopy	Working and applications

Learning Resources	1. R.S.Khandpur, Handbook of Biomedical instrumentation, 3rd ed., Tata McGraw Hill, 2014	2. Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	1. Dr. T. Jayanthi, SRMIST
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	2. Dr. U. Snekhalatha, SRMIST

Course Code	18ECO124T	Course Name	HUMAN ASSIST DEVICES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Utilize the latest technology and device used for assisting human disability																		
CLR-2 :	Analyze various devices used for mobility																		
CLR-3 :	Utilize the various assist device used for hearing																		
CLR-4 :	Utilize the various assist device used for vision																		
CLR-5 :	Utilize the various assist device used in orthopaedic																		
CLR-6 :	Analyze the working principles of cardiac assist devices and Artificial kidney																		

PLO column legend:
1 - Engineering Knowledge; 2 - Problem Analysis; 3 - Design & Development; 4 - Analysis, Design, Research; 5 - Modern Tool Usage; 6 - Society & Culture; 7 - Environment & Sustainability; 8 - Ethics; 9 - Individual & Team Work; 10 - Communication; 11 - Project Mgt. & Finance; 12 - Life Long Learning; 13 - PSO - 1; 14 - PSO - 2; 15 - PSO - 3
Learning column legend: 1 - Level of Thinking (Bloom); 2 - Expected Proficiency (%); 3 - Expected Attainment (%)

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Comprehend the assistive technology (AT) used for mobility	2	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-2 :	Analyze the Assist technology used for hearing	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	L	-
CLO-3 :	Evaluate the Assist technology used for sensory impairment of vision	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	L	-
CLO-4 :	Evaluate the assist device used in orthopedic	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	L	-
CLO-5 :	Analyze the latest use of assist technology in health care	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-
CLO-6 :	Design the prosthetic heart valves and pacemaker	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	M	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Basic assessment and evaluation for mobility	Basic ear anatomy, Mechanism of hearing	Anatomy of eye	Anatomy of upper & lower extremities -	Basic Anatomy and physiology of heart.
	SLO-2	Basic assessment and evaluation for mobility	Common tests audiograms	Categories of visual impairment	Classification of amputation types	Cardiac assist devices
S-2	SLO-1	Manual wheelchairs	Air conduction, Bone conduction	Intraocular Devices	Prosthesis prescription	Intra-Aortic Balloon Pump (IABP),
	SLO-2	Electric power wheelchairs	Masking techniques,	Extraocular Devices	Hand and arm replacement	Prosthetic heart valves
S-3	SLO-1	Power assisted wheelchairs	SISI	Permanent Vision Restoration	Different types of models, externally powered limb prosthesis	Evaluation of prosthetic valve
	SLO-2	Wheel chair standards & tests -	Hearing aids principles	Non-Permanent Vision Restoration	Different types of models, externally powered limb prosthesis	Heart pacemaker
S-4	SLO-1	Wheel chair transportation	Drawbacks in the conventional unit	Voice Control Sound Control.	Foot orthosis	CABG
	SLO-2	Control systems, navigation in virtual space by wheelchairs	DSP based hearing aids	Sensor Technology Adapted for the Vision Impaired	Pediatric orthoses	Extracorporeal support
S-5	SLO-1	Wheel chair seating and pressure ulcers.	Cochlear Implants	Libraille	Wrist-hand orthosis	Vascular prosthesis

	SLO-2	EOG based voice controlled wheelchair	Internal Hearing Aid	GRAB	feedback in orthotic system	Vascular prosthesis
S-6	SLO-1	BCI based wheelchair	External Hearing Aid	mathematical Braille	Components of upper limb prosthesis	Artificial heart
	SLO-2	Fuzzy logic expert system for automatic tuning of myoelectric prostheses	Permanent Hearing Restoration	Blind mobility aids	Components of lower limb prosthesis	Intermittent positive pressure breathing (IPPB) type assistance for lungs
S-7	SLO-1	Intelligent prosthesis	Non-Permanent Hearing Restoration	Reading writing & graphics access,	Lower extremity- and upper extremity-orthoses	Dialysis for kidneys
	SLO-2	Intelligent prosthesis	Touch Tactile Haptic Technology	Orientation & navigation Aids	Lower extremity- and upper extremity-orthoses	Artificial Kidney
S-8	SLO-1	Future trends in assistive technology	Sound Coding Translation	Wearable Assistive Devices for the Blind	functional electrical stimulation	Haemodialysis
	SLO-2	virtual reality based training system for disabled children	Acoustic Transducers Hearing Quality	Wearable tactile display for the fingertip.	Sensory assist devices	Membrane dialysis
S-9	SLO-1	Information technology, telecommunications,	Electric Electronic Stimulation	Cortical implants	Sensory assist devices	Portable dialysis monitoring and functional parameter
	SLO-2	new media in assisting healthcare	Hearing Enhancement	Retinal implants	Slints – materials used	Latest use of assistive technology for chronic heart diseases and healthcare

Learning Resources	1. Levine S.N. Advances in Bio-medical engineering and Medical physics, 1st ed., Vol. I, II, IV, Interuniversity publications, 1968. 2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, 1st ed., Springer Science & Business Media, 2010 3. Kopff W.J, Artificial Organs, 1st ed., John Wiley and Sons, 1976 4. Daniel Goldstein, Mehmet Oz, Cardiac assist Devices, Wiley, 2000 5. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, 1st ed., Springer, 2011	6. Albert M.Cook, Webster J.G, Therapeutic Medical Devices, Prentice Hall Inc.,1982 7. Gerr .M. Craddock Assistive Technology-Shaping the future, 1st ed., IOS Press, 2003 8. Brownsell, Simon, et al,. A systematic review of lifestyle monitoring technologies, Journal of telemedicine and telecare 17.4 (2011): 185-189 9. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, 1st ed., CRC Press, 2010 10. Pascal Verdonck, Advances in Biomedical Engineering, 1st ed., Elsevier, 2009

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sathyanarayanan J, Mindray Medical India Pvt Ltd, sathyanarayananjayagopal@mindray.com	1. Dr. S. Poonguzhali, Anna University, poongs@annauniv.edu	1. Mrs. Lakshmi Prabha, SRMIST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	2. Dr. U. Snekhalatha, SRMIST

Course Code	18ECO125T	Course Name	QUALITY CONTROL FOR BIOMEDICAL DEVICES	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Electronics and Communication	Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:			Learning			Program Learning Outcomes (PLO)															
				1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Utilize Quality, Quality control measures essential for an organization																				
CLR-2 :	Utilize the quality management principles and good management practices																				
CLR-3 :	Utilize the various quality control tools			Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLR-4 :	Utilize the various quality management tools																				
CLR-5 :	Analyze the various standards applicable to healthcare globally and nationally																				
CLR-6 :	Implement the global standards in healthcare																				

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																				
CLO-1 :	Analyze the underlying concepts of quality and quality control concepts of an organization	2	85	75	-	-	-	M	-	-	-	M	M	-	-	L	-	M	L
CLO-2 :	Evaluate the various quality management principles and good management practices	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-3 :	Evaluate various tools of quality control	3	85	75	M	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-4 :	Analyze the various quality management tools	3	85	75	L	-	-	-	-	-	-	-	-	-	-	-	-	-	L
CLO-5 :	Analyze the various standards applicable to healthcare globally and nationally	3	85	75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLO-6 :	Analyze the outcomes of implementing global standards	3	85	75	M	-	-	-	-	-	-	-	-	-	-	L	-	-	L

		Introduction to quality	TQM principles	Statistical process control	TQM tools	Quality systems
Duration (hour)		9	9	9	9	9
S-1	SLO-1	Definition of Quality	Customer satisfaction – Customer Perception of Quality	The seven tools of quality	Benchmarking	ISO 9000 Systems
	SLO-2	Dimensions of Quality	Customer Complaints	Cause-and-effect diagram	Reasons to Benchmark	ISO 9000 Systems
S-2	SLO-1	Quality Planning	Service Quality	Check sheet	Benchmarking Process	ISO 9000:2000 Quality System –Elements
	SLO-2	Quality Planning	Customer Retention	Check sheet	Benchmarking Process	ISO 9000:2000 Quality System –Elements
S-3	SLO-1	Quality costs	Employee Involvement	Control chart	Quality Function Deployment (QFD)	Need for Accreditation of hospitals
	SLO-2	Quality costs	Motivation	Control chart	Quality Function Deployment (QFD)	Need for Accreditation of hospitals
S-4	SLO-1	Basic concepts of Total Quality Management	Empowerment	Histogram	House of Quality	FDA Regulations
	SLO-2	Principles of TQM	Teams and Team Work	Histogram	House of Quality	FDA Regulations
S-5	SLO-1	Leadership – Concepts	Recognition and Reward	Pareto chart	QFD Process - Benefits	Joint Commission

	SLO-2	Role of Senior Management	Performance Appraisal	Pareto chart	QFD Process - Benefits	Joint Commission
S-6	SLO-1	Quality Council	Juran Trilogy	Scatter diagram	Total Productive Maintenance (TPM) – Concept	Regulatory Bodies of India
	SLO-2	Quality Statements	Juran Trilogy	Scatter diagram	Total Productive Maintenance	Medical Council of India
S-7	SLO-1	Strategic Planning	PDSA Cycle	Stratification	Improvement Needs	Pharmacy Council Of India
	SLO-2	Strategic Planning	PDSA Cycle	Stratification	Improvement Needs	Pharmacy Council Of India
S-8	SLO-1	Deming Philosophy	Kaizen	Six sigma	FMEA	Indian Nursing Council
	SLO-2	Deming Philosophy	Kaizen	Six sigma	FMEA	Indian Nursing Council
S-9	SLO-1	Barriers to TQM Implementation	5S	Six sigma	Stages of FMEA	Dental Council of India
	SLO-2	Barriers to TQM Implementation	5S	Six sigma	Stages of FMEA	Homeopathy Central Council

Learning Resources	1. Rose J.E, Total Quality Management, Kogan Page Ltd., 1993 2. Cesar A. Cacere, Albert Zana,The Practise of clinical Engineering, Academic Press,1997 3. Greg Bounds, Beyond Total Quality Management-Toward the emerging paradigm, McGraw Hill, 2013	4. Joseph J.Carr, Elements of Electronics Instrumentation and Measurement, 2nd ed., Pearson Education, 2003 5. Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
Level 2	Apply Analyze	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
Level 3	Evaluate Create	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	1. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	1. Dr. D. Kathirvelu, SRMIST
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	2. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	2. Dr. D. Ashok Kumar, SRMIST

Course Code	18ECO131J	Course Name	VIRTUAL INSTRUMENTATION		Course Category	O	Open Elective	L	T	P	C
								2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil	
Course Offering Department		Electronics and Communication		Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:		Learning			Program Learning Outcomes (PLO)															

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	To study the concepts of Virtual instrumentation and to learn the programming concepts in VI.																		
CLR-2 :	To study about the various real time data acquisition methods.																		
CLR-3 :	To study about thevarious Instrument Interfacing concepts.																		
CLR-4 :	To study the programming techniques for various control techniques using VI software																		
CLR-5 :	To study various analysis toolsfor Process control applications.																		
CLR-6 :	To study various real time measurement systems																		

Column headers (PLO): Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	An ability to understand the purpose of virtual instrumentation and understand the construction of VI	2	80	70	H													H	
CLO-2 :	An ability to understand and apply various data acquisition methods.	2	85	75	H													H	H
CLO-3 :	An ability to understand and implement the available interfacing instruments	2	75	70	H	H	H	H	H									H	H	H
CLO-4 :	An ability to understand and implement various control techniques using VI software	3	85	80	H	H	H	H	H									H		H
CLO-5 :	An ability to understand and develop a program foran engineering application.	3	85	75	H	H	H	H	H				H	H	H	H	H	H	
CLO-6 :	An ability to understand and implement various measurement systems	3	80	70	H	H	H	H	H				H	H	H	H	H	H	

Duration (hour)		12	12	12	12	12
S-1	SLO-1	Historical perspective,Need of VI,Advantages of VI,Virtual Instruments versus Traditional Instruments	A/D Converters, Organization of the DAQ VI system -	Introduction to PC Buses	Introduction to Non continuous controllers in LabVIEW	PC based digital storage oscilloscope
	SLO-2	Review of software in Virtual Instrumentation ,Software environment Architecture of VI,Introduction to the block diagram and Front panel Pallets	D/A Converters, Types of D/A	Local Buses-ISA, PCI,	Introduction to continuous controllers in LabVIEW	Sensor Technology
S-2	SLO-1	Creating and saving a VI, Front Panel Tool Bar, Block diagram Tool Bar, Palettes	plug-in Analog Input/Output cards - Digital Input and Output Cards,	RS232, RS422	Design of ON/OFF controller	Applications of sensor Technology
	SLO-2	Creating sub VI, Creating an ICON, Building a connector pane, Displaying VI'S Placing and Saving Sub VI'S on block diagram Example of full adder circuit using half adder circuit	Organization of the DAQ VI system -	RS485	Proportional controller for a mathematically described processes using VI software	Signal processing Techniques
S 3-4	SLO-1	Front Panel controls and Indicator Verification of Arithmetic Operations	Measurement of diode I-V characteristics using LabVIEW	Load cell Data acquisition using RS232	On-off temperature controller using LabVIEW	Design of DSO
	SLO-2	Verification of Half Adder Verification of Full adder.	Temperature measurement using LabVIEW and DAQ hardware.	Load cell Data acquisition using RS422	Continous Control of temperature using LabVIEW	Analysis of different signal Filters using LabVIEW
S-5	SLO-1	Loops-For Loop,	Opto Isolation need	Interface Buses-USB,PXI	Modeling of level process	Spectrum Analyser
	SLO-2	While Loop	Performing analog input and analog output	VXI,	Basic control of level process in LabVIEW	Waveform Generator
S-6	SLO-1	Arrays,	Scanning multiple analog channels	SCXI	Modeling of Reactor Processes	Data visualization from multiple locations

	SLO-2	Clusters,plotting data	Issues involved in selection of Data acquisition cards	PCMCIA	Basic control of Reactor process in LabVIEW	Distributed monitoring and control
S 7-8	SLO-1	Program to find Addition of First n natural numbers using for loop Program to find Addition of First n odd numbers using while loop.	Flow measurement in water using LabVEW and DAQ hardware.	DC motor control using VXI	On-off Level controller using LabVIEW	Real time spectrum analysis using LabVIEW
	SLO-2	Implementation of Array functions. Calculation of BMI using cluster	Level measurement in water using LabVEW and DAQ hardware	GPIB with VISA functions	Continuous Control of pressure controller using LabVIEW	Arbitratory Waveform Generator using LabVIEW
S-9	SLO-1	Charts	Data acquisition modules with serial communication	Instrumentation Buses - Modbus and GPIB	Case studies on development of HMI in VI	Vision and Motion Control
	SLO-2	Graphs	Design of digital voltmeters with transducer input	Networked busses – ISO/OSI	Case studies on development of HMI in VI	Examples on Integrating Measurement with vision and motion
S-10	SLO-1	Case and Sequence Structures	Timers and Counters	Reference model,	Case studies on development of SCADA in VI	NI Motion control
	SLO-2	Formula nodes, String and File Input/Output.	Timers and Counters	Ethernet and TCP / IP Protocols	Case studies on development of SCADA in VI	Speed control system
S 11-12	SLO-1	Monitoring of temperature using Charts and Graphs. Program for implementing Seven segment display..	Design of digital voltmeters with transducer input using LabVIEW	Online temperature control using LabVIEW using TCP/IP	On-off pressure controller using LabVIEW	Minor Project
	SLO-2	Program to perform Traffic light control	Pressure measurement usingLabVEW and DAQ hardware DAQ.	Online temperature control using Webpublishing tool	Continuous Control of pressure controller using LabVIEW	Minor Project

Learning Resources	1. Nadovich, C., Synthetic Instruments Concepts and Applications, Elsevier, 2005 2. Bitter, R., Mohiuddin, T. and Nawrocki, M., Labview Advanced Programming Techniques, 2nd ed., CRC Press, 2007 3. Gupta, S. and Gupta, J. P., PC Interfacing for Data Acquisition and Process Control", 2nd ed., Instrument Society of America, 1994	4. Jamal, R., Picklik, H., Labview – Applications and Solutions, National Instruments Release. 5. Johnson, G., Labview Graphical programming, McGraw-Hill, 1997 6. Wells, L.K., Travis, J., Labview for Everyone, Prentice Hall, 1997 7. Buchanan, W., Computer Busses, CRC Press, 2000

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember Understand	20%	20%	15%	15%	15%	15%	15%	15%	15%	15%
Level 2	Apply Analyze	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Level 3	Evaluate Create	10%	10%	15%	15%	15%	15%	15%	15%	15%	15%
	Total	100 %		100 %		100 %		100 %		100 %	

 # CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. D. Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	1. Dr. K. A. Sunitha, SRMIST
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	2. Mrs. A. Brindha, SRMIST

Course Code	18ECO132T	Course Name	ANALYTICAL INSTRUMENTATION	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Electronics and Communication		Data Book / Codes/Standards	Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)														
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Understand the principle and theory of analytical instruments																		
CLR-2 :	Understand the quantitative analysis of dissolved components																		
CLR-3 :	Study the concept of separation science and its applications																		
CLR-4 :	Study the various spectroscopic techniques and its instrumentation																		
CLR-5 :	Identify and solve engineering problems associated with Radiation Techniques																		
CLR-6 :	Understand the working of Analytical Instrument and their importance in industries	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:																		
CLO-1 :	Apply the principles and theory of instrumental analysis	2	80	70	H	H	L	L	H	H	H	-	-	-	-	-	-	H	H	L
CLO-2 :	Apply the principles of various chemical analysis instruments in industries	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	-	H	H	L
CLO-3 :	Analyze and understand the operation of various radio chemical methods of analysis	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	-	H	H	L
CLO-4 :	To analyze and understand the operation of instruments based on optical properties	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	-	H	H	L
CLO-5 :	To identify and solve engineering problems associated with Radiation Techniques	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	-	H	H	L
CLO-6 :	To understand the working of analytical Instruments in industries	2	80	70	H	H	L	L	H	H	-	-	-	-	-	-	-	H	H	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to Chemical instrumental analysis	Dissolved oxygen analyzer, Importance of measuring dissolved oxygen in Industry, Principle working	Chromatography, Importance, Basic working of Chromatography	Spectral methods of analysis- Properties or parameters of electromagnetic radiation	NMR spectrometers ,Importance and basic working of NMR Spectroscopy
	SLO-2	Spectral method of analysis	Working of Dissolved oxygen analyzer	Gas chromatography Instrumentation	Electromagnetic spectrum Types of spectrometers	Magnetic assembly, Probe unit, Instrument stabilization
S-2	SLO-1	Electro analytical and seperative methods	sodium analyzer, Importance of measuring sodium in Industry, Principle working	Basic parts of a gas chromatography	Beer's law UV-visible spectrophotometers Transmittance and absorbance	Types of NMR spectrometer, Minimal type
	SLO-2	Instrumental methods of analysis-basic components and their classification	Working of sodium analyzer	Carrier gas supply Sample injection system	Beer's law Application of beer's law	Multipurpose NMR,Wideline
S-3	SLO-1	Sampling systems	Silica analyzer, Importance of measuring Silica in Industry, Principle working	Chromatographic column, Selection of column	Derivations of beer's law	Applications of NMR Spectrometer
	SLO-2	Importance of Sampling system in chemical Industries and Safety aspects	Working of Silica Analyzer	Thermal compartment Detection system Recording system	Single beam and double beam instruments	Mass Spectrometers, Basic working and Importance
S-4	SLO-1	PH Measurement, Principle of PH measurement &Importance of PH measurement in Industries	Moisture measurement Importance of Moisture measurement	Liquid chromatography-Principles, types and applications	IR spectrophotometers Instruments of IR	Components of Mass Spectrometers
	SLO-2	Types of Electrodes, Reference Electrodes and types	Types of Moisture measurement	High pressure liquid chromatography	Types of IR Components required for three types of IR	Types of Mass spectrometers Magnetic Sector analyzer ,Double focusing spectrometers
S-5	SLO-1	Secondary Electrodes and Types	Oxygen analyzer Methods of oxygen analyzers and importance	Instrumentation or basic component of HPLC	Instruments of dispersive instrument , IR Radiation Sources and types	Time of flight analyzers, Quadrupole Mass analyzers

	SLO-2	Indicator electrodes	Paramagnetic oxygen analyzer Electro analytical method	Solvent reservoir and its treatment system	Importance of Monochromators and types of Monochromators	Application of mass spectrophotometers
S-6	SLO-1	pH meters direct reading type pH meter null detector type pH meter	CO monitor,Importance of measuring CO	Pumping system, Types of working systems and Importance	Samples And Sample Cells detectors	nuclear radiation detectors, importance of measurement
	SLO-2	ion selective electrodes Types of ion selective electrodes Glass membrane electrodes Liquid membrane electrodes Solid membrane Electrodes	Types of CO monitor	Pulse dampers	FTIR spectrometers Main components Advantages disadvantages	GM counter
S-7	SLO-1	Features of Biosensor Block diagram of bio sensor	$NO2$ analyzer, Importance of NO_2 measurement	Sample injection system and types	Types of sources Selection factors	Working setup, advantages of GM Counter
	SLO-2	Applications of Biosensors in industries	Types of NO_2 measurement	Liquid chromatographic column working , Types of Column thermostats	Types of detectors Selection factors	proportional counter, Basic Principle
S-8	SLO-1	conductivity meters ,Importance in Chemical Industries	H_2S analyzer, Importance of $H_2 S$ Measurement	Detection system types	atomic absorption spectrophotometer instruments for atomic absorption spectroscopy	Working setup, advantages of GM Counter
	SLO-2	Types of Conductivity meters	Types of H_2S measurement	Types of Recording system	radiation source chopper	solid state detectors, Basic Principle
S-9	SLO-1	Air pollution Monitoring Instruments	Dust and smoke measurement- dust measurement and Importance Types of dust measurement	Application of HPLC, Advantages of HPLC over gas chromatography	production of atomic vapor by flame, Parts by flame photometer Emission system	Working setup, advantages of Solid state detectors
	SLO-2	Estimation of Air pollution	Thermal analyzer , Importance of Thermal analyzers, Types of Thermal analyzer	Detectors types, Factors Influencing the Selection of Detectors	Monochromators And types, Types of Detectors and recording systems and their selection criteria	scintillation counter, Basic principle

Learning Resources	1. Khandpur. R.S, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2006 2. Bella. G, Liptak, "Process Measurement and analysis"., CRC press LLC.,2003. 3. Francis Rousseau and Annick Rouesssac "Chemical analysis Modern Instrumentation Methods and Techniques", John wiley & sons Ltd.2007.	4. James W.Robinson,"Undergraduate Instrumental Analysis", Marcel Dekker., 2005. 5. Dwayne Heard, "Analytical Techniques for atmospheric measurement", Blackwell Publishing, 2006.

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
		CLA – 1 (10%)		CLA – 2 (15%)		CLA – 3 (15%)		CLA – 4 (10%)#			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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Course Designers		
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1. D.Karthikeyan, Controlsoft Engineering India Pvt Ltd, karthikeyan.d@controlsoftengg.in	1. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	1. Dr. K. A. Sunitha, SRMIST
2. V. Venkateswaran, Instrumentation Consultant, vvenkat99@gmail.com	2. Dr. D. Nedumaran, Madras University, dnmaran@gmail.com	2. Mrs. A. Brindha, SRMIST

Course Code	18ECO133T	Course Name	SENSORS AND TRANSDUCERS	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Electronics and Communication	Data Book / Codes/Standards	Nil	

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Learning			Program Learning Outcomes (PLO)

		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLR-1 :	Gain knowledge on classification, and characteristics of transducers																		
CLR-2 :	Acquire the knowledge of different types of inductive and capacitive sensors																		
CLR-3 :	Acquire the knowledge of different types of thermal and radiation sensors																		
CLR-4 :	Acquire the knowledge of different types of magnetic sensors																		
CLR-5 :	Acquire the knowledgeof different types of sensors measuring non-Electrical quantity																		
CLR-6 :	Locate the Applications of sensors in industries and home appliances																		

Course Learning Outcomes (CLO):	At the end of this course, learners will be able to:	Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO - 1	PSO - 2	PSO – 3
CLO-1 :	To demonstrate the various types of basic sensors.	3	80	75	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-
CLO-2 :	Understand the inductive and capacitive sensors which are used for measuring various parameters.	3	80	75	H	-	-	H	-	H	-	-	-	-	-	H	-	H	-
CLO-3 :	Understand the thermal and radiation sensors	3	80	75	-	-	-	-	-	H	-	-	H	H	-	-	H	-	-
CLO-4 :	Have an adequate knowledgeon the various magnetic sensors	3	80	75	-	H	H	-	-	-	-	-	-	-	-	-	-	H	-
CLO-5 :	To demonstrate the various types of basic sensors measuring non electrical quantity	3	80	75	-	-	H	-	H	-	-	-	-	-	-	H	-	-	H
CLO-6 :	Select the right transducer for the given application	3	80	75	H	-	H	-	-	H	H	H	-	-	-	H	H	-	-

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Introduction to sensors/ transducers, Principles	Introduction to Inductive sensor	Thermal sensors: Introduction	Magnetic sensors: Introduction	Measurement of Non-Electrical quantity: Introduction
	SLO-2	Classification based on different criteria	Sensitivity and linearity of the sensor	Thermal Expansion type.	Villari effect	Flow Measurement – Introduction.
S-2	SLO-1	Characteristics of measurement systems	Transformer type transducer	Acoustics temperature sensors.	Wiedmann effect	Ultrasonic Flow Meters.
	SLO-2	Static characteristics Accuracy, Precision, Resolution, Sensitivity	Electromagnetic transducer	Thermo-emf sensor.	Hall effect	Hot Wire Anemometers.
S-3	SLO-1	Dynamic characteristics.	Magnetosrtictive transducer	Materials for thermos-emf sensors.	Construction,	Electromagnetic Flow meters.
	SLO-2	Environmental Parameters	Materials used in inductive sensor	Thermocouple construction	performance characteristics,	Principle and types.
S-4	SLO-1	Characterization and its type	Mutual Inductance change type	Types.	and its Application	Measurement of Displacement.
	SLO-2	Electrical characterization.	LVDT: Construction.	Thermo-sensors using semiconductor device	Introduction to smart sensors	Introduction and types.
S-5	SLO-1	Mechanical Characterization.	Material, input output relationship,	Pyroelectric thermal sensors	Film sensors: Introduction	Measurement of Velocity/ Speed.
	SLO-2	Thermal Characterization	Synchros-Construction	Introduction	Thick film sensors	Introduction and types.

S-6	SLO-1	Optical Characterization.	Capacitive sensor: Introduction	characteristics	Microelectromechanical systems	Measurement of Liquid Level.
	SLO-2	Errors and its classification.	Parallel plate capacitive sensor	Application	Micromachining.	Introduction and types.
S-7	SLO-1	Selection of transducers.	Variable thickness dielectric capacitive sensor	Radiation sensors	Nano sensors	Measurement of Pressure.
	SLO-2	Introduction to mechanical sensors	Electrostatic transducer	Introduction	Applications: Industrial weighing systems: Link–lever mechanism.	Introduction and types.
S-8	SLO-1	Resistive potentiometer and types	Piezoelectric elements	Characteristics	Load cells – pneumatic, elastic and their mounting.	Measurement of Vibration.
	SLO-2	Strain gauge: Theory, type, design consideration, sensitivity.	Ultrasonic Sensors	Geiger counters	different designs of weighing systems.	Introduction and types.
S-9	SLO-1	Resistive transducer: RTD, materials used in RTD	Calculation of sensitivity.	Scintillation detectors	conveyors type.	Application of sensors in industries
	SLO-2	Thermistor: thermistor material, shape	Capacitor microphone, response characteristics	Application on radiation sensors	weighfeeder type.	Application of sensors in home appliances

Learning Resources	1. Patranabis, D., "Sensors and Transducers", 2nd Edition, Prentice Hall India Pvt. Ltd, 2010 2. Doeblin, E.O., "Measurement Systems: Applications and Design", 6thEdition, Tata McGraw-Hill Book Co., 2011 3. Bentley, J. P., "Principles of Measurement Systems", 4th Edition, Addison Wesley Longman Ltd., UK, 2004.	4. Murthy, D.V.S., "Transducers and Instrumentation", Prentice Hall of India Pvt. Ltd., New Delhi, 2010 5. Neubert H.K.P., "Instrument Transducers – An Introduction to their performance and Design", Oxford University Press, Cambridge, 2003

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (50% weightage)								Final Examination (50% weightage)	
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Level 1	Remember	40 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Understand										
Level 2	Apply	40 %	-	40 %	-	40 %	-	40 %	-	40%	-
	Analyze										
Level 3	Evaluate	20 %	-	30 %	-	30 %	-	30 %	-	30%	-
	Create										
	Total	100 %		100 %		100 %		100 %		100 %	

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2. Mr. Prasad, KCP Sugar & Industries, kcpengineering@gmail.com	2. Mr. Prashanth Ravi, NTU, prashantrar@gmail.com	2. Dr. G.JoselinRetna Kumar, SRMIST

Course Code	18ECO134T	Course Name	INDUSTRIAL AUTOMATION	Course Category	O	Open Elective	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication	Data Book / Codes/Standards	Nil		

Course Learning Rationale (CLR): The purpose of learning this course is to:

- CLR-1 : Understand basic components of PLC
- CLR-2 : Understand the use of timers and counters in process automation
- CLR-3 : Understand DCS architecture
- CLR-4 : Understand operator and engineering interface in DCS
- CLR-5 : Understand HART signal standard and Field bus
- CLR-6 : Understand Field bus signal standard.

Course Learning Outcomes (CLO): At the end of this course, learners will be able to:

		Level of Thinking (Bloom)	Expected Proficiency (%)	Expected Attainment (%)	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Society & Culture	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
		1	2	3	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CLO-1 :	Select PLC based on I/O's	3	80	75	H	M	L	-	-	-	-	-	M	-	M	L	M		M
CLO-2 :	Apply timers and counters in process automation	3	80	75	H	H	H	H	H	-	L	-	H	M	L	L	H	H	H
CLO-3 :	Select LCU based on application	3	80	75	H	M	-	-	-	-	-	-	L	-	-	L	M	L	M
CLO-4 :	Analyse data's in Operator displays	3	80	75	H	H	-	H	-	-	-	-	H	M	-	L	H	L	M
CLO-5 :	Interpret industrial data communication modes	3	80	75	H	-	-	-	-	-	-	-	-	L	-	L	H	-	L
CLO-6 :	Gain knowledge on field bus	3	80	75	H	L	-	-	-	-	-	-	-	-	-	L	H	-	L

Duration (hour)		9	9	9	9	9
S-1	SLO-1	Programmable logic controllers	PLC Programming Languages	Evolution of DCS	Operator Interfaces Requirements	Introduction to HART
	SLO-2	PLC vs Computer	Ladder Diagram	Hybrid System Architecture	Process Monitoring	Evolution of Signal standard
S-2	SLO-1	Parts of a PLC	Functional block	Central Computer system Architecture	Process Control	HART Networks: Point-to-Point
	SLO-2	Architecture	Sequential Function Chart	DCS Architecture	Process Diagnostics	Multi-drop
S-3	SLO-1	PLC size and Application.	Instruction List	Comparison of Architecture	Process Record Keeping	Split range control valve
	SLO-2	Fixed and Modular I/O	Structured Text	Local Control Unit Architecture	Low Level Operator Interface	HART Field Controller Implementation
S-4	SLO-1	Discrete Input Modules	Wiring Diagram	Architectural Parameters	High Level Operator Interface	Hart Commends: Universal
	SLO-2	Discrete Output Modules	Ladder logic Program	Comparison Of LCU Architecture	Hardware Elements In The Operator Interface	Common Practice
S-5	SLO-1	Analog Input Modules	On-Delay Timer Instruction	LCU Language Requirements	Operator Input And Output Devices	Device Specific

	SLO-2	Analog Output Modules	Off-Delay Timer Instruction	Function Blocks	Operator Display Hierarchy	Wireless Hart
S-6	SLO-1	Special I/O Modules	Retentive Timer	Function Block Libraries	Plant-Level Display	Field Bus Basics
	SLO-2	High Speed Counter Module	Cascading Timer	Problem-Oriented Language	Area- Level Display	Field Bus Architecture
S-7	SLO-1	Power Supplies	Up-Counter	LCU Process Interfacing Issues	Group- Level Display	Field Bus Standard
	SLO-2	Isolators	Down-Counter	Security Requirements	Loop- Level Display	Field Bus Topology
S-8	SLO-1	Input/output Devices: Switches	Cascading Counters	Security Design Approach	Engineering Interface Requirements	H1 Field Bus
	SLO-2	sensors	Combining Counter And Timer Functions	On-Line Diagnostics	Requirement For Operator Interface Configuration	H2 Field Bus
S-9	SLO-1	Relays	Math Operation	Redundant Controller Design	Low Level Engineering Interface,	Interoperability
	SLO-2	Solenoid valve	Program	One-On-One, One-On-Many Redundancy	High Level Engineering Interfaces	Interchangeability

Learning Resources	1. Frank D. Petruzella, Programmable Logic Controller, Tata McGraw Hill Fifth Edition, 2017 2. Bolton. W, Programmable Logic Controllers, 6th Edition, Elsevier Newnes, Sixth Edition 2016. 3. Krishna Kant, Computer Based Industrial Control, Second edition, Prentice Hall of India, New Delhi,2015	4. Bowten, R HART Application Guide, HART Communication foundation,2015. 5. Berge, J, Field Busses for process control: Engineering, operation, maintenance, ISA press,2015

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