SCHOOL OF ENGINEERING

AND

TECHNOLOGY

Department of Computer Science & Engineering

M.Tech (Computer Science & Engineering)
Full Time Postgraduate Course

2021-23

M.Tech (Computer Science & Engineering)
Part Time Postgraduate Course

2021-24

PREFACE

K.R. Mangalam University is in the process of transforming to National Educational Policy 2021. In consultation with Deans, Faculty Members, Industry Experts, and University Alumni, the Academic council constituted department-wise committees to draft the model curriculum of postgraduate engineering courses. Realizing the need for post-graduation in engineering, the curriculum committee decided to implement Model Curriculum for Post Graduate Degree course in Computer Science & Engineering proposed by AICTE. The total number of credits in M.Tech. Computer Science & Engineering (Full Time) is 73. The total number of credits in M.Tech. Computer Science & Engineering (Part Time-Software Engineering/Cyber Security) is 97.

Full time M.Tech. (CSE) course is spread over two years in four semesters and includes mini-project, audit courses, open electives, and dissertation. Part time M.Tech (Cyber Security) aim to fulfill the requirement of skilled manpower in area of Information Security. The course is spread over three years in six semesters and includes audit courses, departmental electives, and dissertation. Part time M.Tech (Software Engineering) course is spread over three years in six semesters and includes audit courses, departmental electives, and dissertation. Emphasis is made to have all the significant areas that affect product lifecycle. The dissertation is for one year and distributed over two semesters. The students and faculty members can design the research project in consultation with industry experts.

The course is designed to retain the undergraduate students going for higher studies but also to attract international students making K.R. Mangalam University a global place of higher learning and research in engineering and technology.

1. Introduction

The K.R. Mangalam Group has made a name for itself in the field of education. Over a period of time, the various educational entities of the group have converged into a fully functional corporate academy. Resources at KRM have been continuously upgraded to optimize opportunities for the students. Our students are groomed in a truly inter-disciplinary environment wherein they develop integrative skills through interaction with students from engineering, management, journalism and media study streams.

The K.R. Mangalam story goes back to the chain of schools that offered an alternative option of world-class education, pitching itself against the established elite schools, which had enjoyed a position of monopoly till then. Having blazed a new trail in school education, the focus of the group was aimed at higher education. With the mushrooming of institutions of Higher Education in the National Capital Region, the university considered it very important that students take informed decisions and pursue career objectives in an institution, where the concept of education has evolved as a natural process.

K.R. Mangalam University was founded in the year 2013 by Mangalam Edu Gate, a company incorporated under Section 25 of the Companies Act, 1956.

K. R. Mangalam University is unique because of its

i. Enduring legacy of providing education to high achievers who demonstrate leadership in diverse fields.
ii. Protective and nurturing environment for teaching, research, creativity, scholarship, social and economic justice.

Objectives

i. To impart undergraduate, post-graduate and Doctoral education in identified areas of higher education.
ii. To undertake research programmes with industrial interface.
iii. To integrate its growth with the global needs and expectations of the major stake holders through teaching, research, exchange & collaborative programmes with foreign, Indian Universities/Institutions and MNCs.
iv. To act as a nodal center for transfer of technology to the industry.
v. To provide job oriented professional education to the pecia student community with particular focus on Haryana.

2. About School

The School of Engineering and Technology offers three undergraduate Programmes: four years B. Tech, three years BCA, B. Sc. in four specialization courses (Electronics Science/Computer Science/Data Sciences/Cyber Security) and postgraduate Programme: M.Tech. in various disciplines. These Engineering programs have the distinct objective of equipping the students with knowledge, skills, and attitude in engineering and technology to make them capable of successfully meeting the present requirements and future challenges in the engineering profession. SOET brings together outstanding academics, industry professionals, experienced researchers to deliver a unique hands-on and multi-disciplinary learning experience.

The curriculum of programs has been designed to cater to the industry's ever-changing needs and demands. The syllabus and curriculum are regularly updated. The school has the best infrastructure, including domain-specific labs. SOET aims to provide exposure to the principles and practices of Design / Developments and Projects in engineering. SOET is offering Ph.D. programs also.

School Vision

Aspires to become an internationally recognized School through excellence in interdisciplinary education, research and innovation, preparing socially responsible life-long learners contributing to nation building.

School Mission

- Foster employability and entrepreneurship through interdisciplinary curriculum and progressive pedagogy with cutting-edge technology.
- Instill notion of lifelong learning through stimulating research, Outcomes-based education and innovative thinking.
- Integrate global needs and expectations through collaborative programs with premier universities, research centers, industries and professional bodies
- Enhance leadership qualities among the youth having understanding of ethical values and environmental realities
- Developing active leadership skills, ethical values, and environmental responsibility.
- Foster employability and entrepreneurship through futuristic curriculum and progressive pedagogy with cutting-edge technology.
- Instill notion of lifelong learning through stimulating research, Outcomes-based education, and innovative thinking.

- Integrate global needs and expectations through collaborative programs with premier universities, research centers, industries, and professional bodies
- Enhance leadership qualities among the youth understanding ethical values and environmental reality.

3. Programmes offered by the School

School offers undergraduate B.Tech Programme, B.Sc. (Hons) Programmes, postgraduate M.Tech Programmes and Doctoral Programmes. All these programmes are designed to impart scientific knowledge to the students and will provide theoretical as well as practical training in their respective fields.

3.1 Department of Computer Science & Engineering

The Department of Computer Science & Engineering administers bachelors, masters and doctoral degree programs in Computer Science & Engineering. The department is committed to provide quality, cutting-edge educational experiences that give students a holistic view of the engineering education and prepare them to take up their career in wide range of industries or establishing startup companies. Core strength of the department lays in its experienced and extremely competent faculty, advanced computing facilities, good placements, ever growing alumni network, emphasis on developing students' skill set while focusing on leadership and ethics in parallel.

Programme Outcome

PO 1 Engineering Knowledge: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PO 2 Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering employability.

PO 7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects through entrepreneurship skills and in multidisciplinary environments.

PO 12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change through skill development.

3.1.1 M.Tech. Computer Science & Engineering

This programme is aimed to exhibit analytical decision making and problem-solving skills by applying research principals for handling real life problems with realistic constraints.

Eligibility Criteria: - The student has passed B. Tech in computer science & engineering/ MCA from recognized central or state university with an overall minimum aggregate of 50% or more.

Course Outline:- Advance Algorithms / Machine Learning / Data Science/Soft Computing/ Digital Forensics/ Artificial Intelligence.

Career Options:- Opportunities are there in the field of IT Consulting, Solution Development, Design Engineering, Network Administrator, IT Manager, Hardware and Software Domains, PSUs, Defense & Civil Services, Research.

3.1.2 M.Tech. Computer Science & Engineering - Part time (Software Engineering / Cyber Security)

This programme is aimed to exhibit analytical decision making and problem-solving skills by applying research principals for handling real life problems with realistic constraints.

Eligibility Criteria: - The student has passed B. Tech in computer science & engineering/ MCA from recognized central or state university with an overall minimum aggregate of 50% or more.

Course Outline:- Software Testing / Object oriented software engineering/ Agile Methodology/ Machine Learning / Data Science/Soft Computing/ Digital Forensics/ Artificial Intelligence./ Penetration Testing / Malware Analysis/ Cyber Law/ Cyber Forensics.

Career Options:- Opportunities are there in the field of IT Consulting, Solution Development, Design Engineering, Network Administrator, IT Manager, Hardware and Software Domains, PSUs, Defense & Civil Services, Research.

Programme Specific Outcome: M.Tech. Computer Science & Engineering

PSO1. Application of Concepts: Ability to apply key principles and practices of computing to design and implement practical systems by actively getting engaged into learning, understanding, and applying new ideas and technologies as the field evolves.

PSO2. Research Orientated: Able to carry out research and intellectual endeavours of the highest standards that advances the theoretical knowledge and are of immediate and long-range practical significance.

PSO3. Global Perspective: Exposed to global view so that they can appreciate diversity in the world and in intellectual pursuits which will be attained by inculcating in them an understanding of the human, social and business context in which they will utilize their engineering skills.

PSO4. Reasoning and Communication Skills: Develop strong reasoning skills and communication skills so that they are able to express ideas clearly and persuasively.

4. Program Duration:

The maximum completion period of the full time M.Tech. (CSE) Programme offered by the University shall be two years. The maximum completion period of the part time M.Tech. (Software Engineering/Cyber Security) Programme offered by the University shall be three years.

5. Class Timings

The classes will be held from Monday to Friday from 09:10 am to 04:00 pm..

6. Syllabi

The syllabi of M.Tech. (CSE) program for all semester is given in the following pages. These are arranged as semester-wise.

For each course, the first line contains; Course Code and Credits (C) of the course.

This is followed by the course objectives, course outcome and the syllabus (Unit I to IV), Text book and reference books.

Two Years M.Tech (CSE)-Full Time course at glance

	Semester I	Semester II	Semester III	Semester IV	Total
Course	7	7	3	1	18
Credit	20	20	17	16	73

Three Years M.Tech (CSE) with specialization software engineering - Part Time course at glance

	Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI	Total
Course	7	6	5	5	4	1	28
Credit	14	14	17	17	19	16	97

Three Years M.Tech (CSE) with specialization cyber security - Part Time course at glance

	Semester I	Semester II	Semester III	Semester IV	Semester V	Semester VI	Total
Course	6	6	5	5	4	1	27
Credit	14	14	17	17	19	16	97

6.1 Scheme of studies- M.Tech(CSE) Full Time:

SEMESTER I

S No	Course Code	Course Title	L	T	P	C
1	ETCS 601A	Mathematical foundations of Computer Science	3	1	-	4
2	ETCA802A	Data Structures and Algorithms	3	1	-	4
3	ETMC 674A	Research Methodology and IPR	2	-	-	2
4	**Departmental Electives (without lab) - I**					
i	ETCS 605A	Machine Learning	3	1	-	4
ii	ETCS 607A	Wireless Sensor Networks	3	1	-	4
iii	ETCS 609A	Introduction to Intelligent Systems	3	1	-	4
5	**Departmental Electives (with lab) - II**					
i	ETCS 611A	Data Science	3	1	-	4
	ETCS 653A	Data Science Lab	0	-	2	1
ii	ETCS 613A	Distributed Systems	3	1	-	4
	ETCS 655A	Distributed Systems Lab	0	-	2	1
iii	ETCS 615A	Advanced Wireless and Mobile Networks	3	1	-	4
	ETCS 657A	Advanced Wireless and Mobile Networks Lab	0	-	2	1
6	ETCA 852A	Data Structures and Algorithms Lab	-	-	2	1
7		Audit Course - I *	2	-	-	-
TOTAL			**16**	**4**	**4**	**20**

SEMESTER II

S No	Course Code	Course Title	L	T	P	C
1	ETCS 602A	Advance Algorithms	3	1	-	4
2	ETCS 604A	Soft Computing	3	1	-	4
3	**Departmental Electives (with lab) - III**					
i	ETCS 606A	Data Preparation and Analysis	3	1	-	4
	ETCS 652A	Data Preparation and Analysis Lab	0	-	2	1
ii	ETCS 608A	Secure Software Design & Enterprise Computing	3	1	-	4
	ETCS 654A	Secure Software Design & Enterprise Computing Lab	0	-	2	1
iii	ETCS 610A	Computer Vision	3	1	-	4
	ETCS 656A	Computer Vision Lab	0	-	2	1
4	**Departmental Electives (without lab) - IV**					
i	ETCS 612A	Human and Computer Interaction	3	1	-	4
ii	ETCS 614A	GPU Computing	3	1	-	4
iii	ETCS 616A	Digital Forensics	3	1	-	4
5	ETCS 658A	Soft Computing Lab	0	-	2	1
6	ETCS 660A	Mini Project with Seminar	2	-	-	2
7		Audit Course - II *	2	-	-	-
TOTAL			**16**	**4**	**4**	**20**

SEMESTER III

S No	Course Code	Course Title	L	T	P	C
1	**Departmental Electives (without lab) - V**					
i	ETCS 617A	Mobile Applications and Services	3	1	-	4
ii	ETCS 619A	Compiler for HPC	3	1	-	4
iii	ETCS 621A	Optimization Techniques	3	1	-	4
2	**Open Electives**					
i	ETMC 675A	Business Analytics	3	-	-	3
ii	ETME 817A	Industrial Safety	3	-	-	3
iii	ETMA 676A	Operations Research	3	-	-	3
iv	ETMC 677A	Cost Management of Engineering Projects	3	-	-	3
v	ETME 819A	Composite Materials	3	-	-	3
vi	ETME821 A	Waste to Energy	3	-	-	3
3	ETCS 659A	Dissertation-I /Industrial Project	0	-	-	10
TOTAL			**6**	**1**	**0**	**17**

SEMESTER IV

SNo	Course Code	Course Title	L	T	P	C
1	ETCS 662A	Dissertation-II	-	-	-	16
TOTAL			**0**	**0**	**0**	**16**
Total Hours: Lect [L]+Prac [P]+Tut [T]			**55**			
Total Credits [C]			**73**			

AUDIT COURSES

SEMESTER I

SNo	Course Code	Course Title	L	T	P	C
1	ETEL 402A	English for Research Paper Writing	2	-	-	-
2	ETCE 601A	Disaster Management	2	-	-	-
3	SEED 545A	Value Education	2	-	-	-

SEMESTER II

SNo	Course Code	Course Title	L	T	P	C
1	ETLS 601A	Constitution of India	2	-	-	-
2	SEED 546A	Pedagogy Studies	2	-	-	-
3	ETMC 678A	Stress Management by Yoga	2	-	-	-
4	ETMC 679A	Personality Development through Life Enlightenment Skills.	2	-	-	-

		L	T	P	C
ETCS 601A	**Mathematical Foundations of Computer Science**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Probability and Set Theory				
Co-requisites	--				

Course Objectives

1. To understand the mathematical fundamentals that is prerequisites for a variety of courses like Data Mining, Network protocols, Analysis of Web Traffic, Computer Security, Software Engineering, Computer Architecture, Operating Systems, Distributed Systems, Bioinformatics, and Machine Learning.
2. To develop the understanding of the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.
3. To study various sampling and classification problems.

Course Outcomes

On completion of this course, the students will be able to

CO1. To understand the basic notions of discrete and continuous probability.
CO2. To understand the methods of statistical inference, and the role that sampling Distribution play in those methods.
CO3. To be able to perform correct and meaningful statistical analyses of simple to Moderate Complexity.
CO4. To be able to apply basic principles of graph theory to solve real-time problems.

Catalog Description

This course imparts the basic concepts of probability theory and statistics to gain insight into real, everyday statistical problems and solutions. The main objective is to develop an intuitive understanding of statistical procedures and strategies most often used by practicing engineers and scientist.

Course Content

Unit I: **14 lecture hours**

Probability mass, density, and cumulative distribution functions, parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central

Limit Theorem, Probabilistic inequalities, Markov chains, Random samples, sampling distributions of estimators.

Unit II: **8 lecture hours**

Methods of Moments and Maximum Likelihood. Statistical inference**,** Introduction to multivariate statistical models: regression and classification problems, principal components analysis**,** the problem of over-fitting model assessment.

Unit III: **8 lecture hours**

Graph Theory: Isomorphism, Planar graphs, graph colouring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems.

Unit IV: **10 lecture hours**

Computer science and engineering applications, Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning. Recent Trends in various distribution functions in mathematical field of computer science for varying fields like bioinformatics, soft computing, and computer vision.

Text Books

1. John Vince, "Foundation Mathematics for Computer Science", Springer.

2. K. Trivedi, "Probability and Statistics with Reliability, Queuing, and Computer Science Applications", Wiley
3. Alan Tucker. "Applied Combinatorics", Wiley

Reference Books/Materials

1. Sheldon M. Ross, "Probability and Statistics for Engineers and Scientist", Elsevier Academic Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the basic notions of discrete and continuous probability.	**PO1**
CO2	To understand the methods of statistical inference, and the role that sampling distribution play in those methods.	**PO2**
CO3	To be able to perform correct and meaningful statistical analyses of simple to moderate complexities.	**PO4**
CO4	To be able to apply basic principles of graph theory to solve real-time problems.	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 601A	Mathematical Foundations For Computer Science	3	3	3	3									3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCA802A	**Data Structures and Algorithms**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of programming				
Co-requisites	--				

Course Objectives

1. To understand the abstract data types stack, queue, dequeue, and list.
2. To be able to implement the ADTs stack, queue, and deque.
3. To understand the performance of the implementations of basic linear data structures.
4. To be able to recognize problem properties where stacks, queues, and deques are appropriate data structures.
5. To expose the student to the algorithm analysis techniques, to the theory of reductions, and to the classification of problems into complexity classes like NP.

Course Outcomes

On completion of this course, the students will be able to

CO1. Formulate and apply object oriented programming as a modern tool to solve engineering problems.

CO2. Demonstrate an understanding of basic data structures and algorithms.

CO3. Demonstrate the ability to analyze, design, apply and use data structures and algorithms to solve engineering problems and evaluate their solutions.

CO4. Demonstrate an understanding of analysis of algorithms.

Catalog Description

The aim of the course is to introduce basic data structures and algorithms. This course covers the design, analysis, and implementation of data structures and algorithms to solve engineering problems using an object-oriented programming language. Topics include elementary data structures, (including arrays, stacks, queues, and lists), advanced data structures (including trees and graphs), the algorithms used to manipulate these structures, and their application to solving practical engineering problems.

Course Content

Unit I: **10 lecture hours**

Python: types, expressions, strings, lists, tuples; Python memory model: names, mutable and immutable values; List operations: slices etc - Binary search; Inductive function definitions: numerical and structural induction; Elementary inductive sorting: selection and insertion sort; In-place sorting.

Basic algorithmic analysis input size, asymptotic complexity, O() notation ; Arrays vs lists; ; Merge sort ; Quick sort ; Stable sorting.

Unit II: **8 lecture hours**

Dictionaries; More on Python functions: optional arguments, default values; Passing functions as arguments; Higher order functions on lists: map, lter, list comprehension.
Exception handling; Basic input/output; Handling Files; String processing.

Unit III: **10 lecture hours**

Backtracking: N Queens, recording all solutions; Scope in Python: local, global, nonlocal names; Nested functions; Data structures: stack, queue; Heaps.
Abstract data types; Classes and objects in Python; "Linked" lists: find, insert, delete; Binary search trees: find, insert, delete; Height-balanced binary search trees.

Unit IV: **12 lecture hours**

Efficient evaluation of recursive definitions: memorization | Dynamic programming: examples | Other programming languages: C and manual memory management | Other programming paradigms: functional programming.

Text Books

1. Narasimha Karumanchi, Data Structures and Algorithms, Carrer Monk Publications
2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, Clifford Stein, “Introduction to Algorithms”, 2nd Ed., PHI

Reference Books/Materials

1. Ellis Horowitz and SartazSahani, “Computer Algorithms”, Galgotia Publications.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Formulate and apply object-oriented programming as a modern tool to solve engineering problems.	**PO1**
CO2	Demonstrate an understanding of basic data structures and algorithms.	**PO3**
CO3	Demonstrate the ability to analyze, design, apply and use data structures and algorithms to solve engineering problems and evaluate their solutions.	**PO2**
CO4	Demonstrate an understanding of analysis of algorithms.	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCA 802A	Data Structures and Algorithms	3	3	3										3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETMC674A	Research Methodology And Ipr	L	T	P	C
Version 1.0		2	0	0	2
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

1. To be able to formulate research problem from real life problems.
2. To learn ecosystem to conduct a research.
3. To inculcate research ethics in a researcher throughout conduction of research.
4. To develop sense of thinking out of the box to frame a novel research idea by analysing the available literature.
5. To make learner sensitive toward Intellectual Property Right (IPR) to enhance their growth of expansion in various band like socio-economic growth, Research and development growth.

Course Outcomes

On completion of this course, the students will be able to

CO1.Understand research problem formulation.

CO2.Analysis research related information

CO3.Follow research ethics

CO4. Understand that today's world is controlled by Computer, Information, Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

CO5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about
Intellectual Property Right to be promoted among students in general &
engineering in particular.

CO6. Understand that IPR protection provides an incentive to inventors for further
research work and investment in R & D, which leads to creation of new and
better products, and in turn brings about, economic growth and social benefits.

Catalog Description

This course imparts the basic concepts of research methodology and Intellectual Property Right. It enables them to understand flow of research starting from novel idea till ethically completion of the work. The course of Research Methodology and IPR help organizing the steps to be carried out during research to solve the problem efficiently. The course introduces the basic concepts about meaning and feature of good research problem, literature survey and writing an article. It also discusses about IPR and Patents.

Course Content

Unit I: **10 lecture hours**

Nature of research problem: Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit II: **8 lecture hours**

Literature Survey: Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Unit III: **8 lecture hours**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit IV: **8 lecture hours**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Text Books

Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & engineering students’”

Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”

Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners”

Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.

Reference Books/Materials

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand research problem formulation.	**PO2**
CO2	Analyses research related information	**PO2**
CO3	Follow research ethics	**PO8**
CO4	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.	**PO10**
CO5	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.	**PO3**
CO6	Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETMC 674A	RESEARCH METHODOLOGY AND IPR		3	3			2		2		2					3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS605A	Machine Learning	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Learn the concept of how to learn patterns and concepts from data without being explicitly programmed in various IOT nodes.
2. Design and analyse various machine learning algorithms and techniques with a modern outlook focusing on recent advances.
3. Explore supervised and unsupervised learning paradigms of machine learning.
4. Explore Deep learning technique and various feature extraction strategies.

Course Outcomes

On completion of this course, the students will be able to

CO1. Develop an appreciation for what is involved in learning from data.

CO2. Understand a wide variety of learning algorithms.

CO3. Understand how to apply a variety of learning algorithms to data.

CO4. Understand how to perform evaluation of learning algorithms and model selection.

Catalog Description

Machine Learning is a key to develop intelligent systems and analyze data in science and engineering. Machine learning engines enable intelligent technologies such as Siri, Kinect or Google self-driving car, to name a few. At the same time machine learning methods help unlocking the information in our DNA and make sense of the flood of information gathered on the web, forming the basis of a new Science of Data. This course introduces the fundamental methods at the core of modern machine learning. It covers theoretical foundations as well as essential algorithms for supervised and unsupervised learning. Classes on theoretical and algorithmic aspects are complemented by practical lab sessions.

Course Content

UNIT I **8 lecture hours**

Supervised Learning (Regression/Classification): Basic methods: Distance-based methods, Nearest-Neighbours, Decision Trees, Naive Bayes.

Linear models: Linear Regression, Logistic Regression, Generalized Linear, Models, Support Vector Machines, Nonlinearity and Kernel Methods, Beyond Binary Classification: Multi-class/Structured Outputs, Ranking

UNIT II **12 lecture hours**

Unsupervised Learning: Clustering: K-means/Kernel K-means, Dimensionality Reduction: PCA and kernel PCA, Matrix Factorization and Matrix Completion, Generative Models (mixture models and latent factor models).

UNIT III **12 lecture hours**

Evaluating Machine Learning algorithms and Model Selection, Introduction to Statistical Learning Theory, Ensemble Methods (Boosting, Bagging, and Random Forests). Sparse Modeling and Estimation, Modeling Sequence/Time-Series Data, Deep Learning and Feature Representation Learning.

UNIT IV **8 lecture hours**

Scalable Machine Learning (Online and Distributed Learning): A selection from some other advanced topics, e.g., Semi-supervised Learning, Active Learning, Reinforcement Learning, Inference in Graphical Models, Introduction to Bayesian Learning and Inference.

Recent trends in various learning techniques of machine learning and classification methods for IOT applications. Various models for IOT applications.

Text Books

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009 (freely available online)
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

Reference Books/Materials

1. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media

2. AurélienGéron, "Hands-On Machine Learning with Scikit-Learn and Tensor Flow:

Concepts, Tools, and Techniques to Build Intelligent Systems", 1st Edition, O'Reilly Media

3. Jain V.K., "Data Sciences", Khanna Publishing House, Delhi.

4. Jain V.K., "Big Data and Hadoop", Khanna Publishing House, Delhi.

5. Jeeva Jose, "Machine Learning", Khanna Publishing House, Delhi.

6. Chopra Rajiv, "Machine Learning", Khanna Publishing House, Delhi.

7. Ian Goodfellow, YoshuaBengio and Aaron Courville, "Deep Learning", MIT Press

http://www.deeplearningbook.org

8. Jiawei Han and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Morgan

Kaufmann Publisher

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop an appreciation for what is involved in learning from data.	**PO1**
CO2	Understand a wide variety of learning algorithms.	**PO4**
CO3	Understand how to apply a variety of learning algorithms to data.	**PO5**
CO4	Understand how to perform evaluation of learning algorithms and model selection	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS605 A	Machine Learning	2	2		3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS607A	**Wireless Sensor Networks**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Advanced of Computer communication				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to:-

1. Architect sensor networks for various application setups.
2. Devise appropriate data dissemination protocols and model links cost.
3. Understand the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers.
4. Evaluate the performance of sensor networks and identify bottlenecks.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Describe and explain radio standards and communication protocols for wireless sensor networks.

CO 2 Explain the function of the node architecture and use of sensors for various applications.

CO3 Be familiar with architectures, functions and performance of wireless sensor networks System and platforms.

Catalog Description

This course will also provide a systematic explanation of mobile computing as a discrete discipline and will provide an in-depth coverage of mobile systems and devices, mobile operating systems used for application development, mobile databases, client-server computing agents, application servers, security protocols, and mobile Internet, and ad-hoc and sensor networks.

Course Content

Unit I: **12 lecture hours**

Introduction to Wireless Sensor Networks: Course Information, Introduction to Wireless Sensor Networks: Motivations, Applications, Performance metrics, History and Design factors.

Network Architecture: Traditional layered stack, Cross-layer designs, Sensor Network Architecture.

Unit II: **8 lecture hours**

Hardware Platforms: Motes, Hardware parameters.

Introduction to ns-3: **I**ntroduction to Network Simulator 3 (ns-3), Description of the ns-3 core module and simulation example.

Medium Access Control Protocol design: Fixed Access, Random Access, WSN protocols: synchronized, duty-cycled

Unit III: **12 lecture hours**

Introduction to Markov Chain: Discrete time Markov Chain definition, properties, classification and analysis.

MAC Protocol Analysis: Asynchronous duty-cycled. X-MAC Analysis (Markov Chain).

Security: Possible attacks, countermeasures, SPINS, Static and dynamic key distribution.

Unit IV: **8 lecture hours**

Routing protocols: Introduction, MANET protocols

Routing protocols for WSN: Resource-aware routing, Data-centric, Geographic Routing, Broadcast, Multicast **Opportunistic Routing Analysis**: Analysis of opportunistic routing (Markov Chain), advanced topics in wireless sensor networks.

Recent development in WSN standards, software applications.

Text Books

1. W. Dargie and C. Poellabauer, "Fundamentals of Wireless Sensor Networks –Theory and Practice", Wiley 2010
2. KazemSohraby, Daniel Minoli and TaiebZnati, "wireless sensor networks -Technology, Protocols, and Applications", Wiley Interscience 2007

Reference Books/Materials

1. Wireless Communications and Networking, Vijay Garg, Elsevier

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Describe and explain radio standards and communication protocols for wireless sensor networks.	**PO1, PO2**
CO2	Explain the function of the node architecture and use of sensors for various applications.	**PO3, PO4**
CO3	Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.	**PO10, PSO1, PSO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 607A	Wireless Sensor Networks	2	2	2	2						3			3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS609A	Introduction To Intelligent Systems	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Computer Programming				
Co-requisites	--				

Course Objectives

1. The aim of the course is to introduce to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach.
2. It explores the essential theory behind methodologies for developing systems that demonstrate intelligent behaviour including dealing with uncertainty, learning from experience and following problem solving strategies found in nature.

Course Outcomes

On completion of this course, the students will be able to

CO1. Will gain deep understanding of the basic artificial intelligence techniques

CO2. Apply knowledge to design solutions to different problems and will gain the ability to design and develop an intelligent system for a selected application.

CO3. Apply artificial intelligence techniques to solve different problems.

CO4. Apply different learning and evolutionary algorithms to enhance the AI applications.

Catalog Description

This course introduces students to the field of Artificial Intelligence (AI) with emphasis on its use to solve real world problems for which solutions are difficult to express using the traditional algorithmic approach. It explores the essential theory behind methodologies for developing systems that demonstrate intelligent behavior including dealing with uncertainty, learning from experience and following problem solving strategies found in nature.

Course Content

Unit I: **12 lecture hours**

Biological foundations to intelligent systems I: Artificial neural networks, Back-propagation networks, Radial basis function networks, and recurrent networks.

Biological foundations to intelligent systems II: Fuzzy logic, knowledge Representation and inference mechanism, genetic algorithm, and fuzzy neural networks.

Unit II: **8 lecture hours**

Search Methods Basic concepts of graph and tree search. Three simple search methods: breadth-first search, depth-first search, iterative deepening search. Heuristic search methods: best-first search, admissible evaluation functions, hill-climbing search. Optimisation and search such as stochastic annealing and genetic algorithm

Unit III: **12 lecture hours**

Knowledge representation and logical inference Issues in knowledge representation. Structured representation, such as frames, and scripts, semantic networks and conceptual graphs. Formal logic and logical inference. Knowledge-based systems structures, its basic components. Ideas of Blackboard architectures.

Unit IV: **8 lecture hours**

Reasoning under uncertainty and Learning Techniques on uncertainty reasoning such as Bayesian reasoning, Certainty factors and Dempster-Shafer Theory of Evidential reasoning, A study of different learning and evolutionary algorithms, such as statistical learning and induction learning.

Recent trends in Fuzzy logic, Knowledge Representation

Text Books

1. Luger G.F. and Stubblefield W.A. (2008). Artificial Intelligence: Structures and strategies for Complex Problem Solving. Addison Wesley, 6th edition.
2. Russell S. and Norvig P. (2009). Artificial Intelligence: A Modern Approach. Prentice-Hall, 3rd edition.

Reference Books/Materials

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Will gain deep understanding of the basic artificial intelligence techniques.	**PO1, PO2**
CO2	Apply knowledge to design solutions to different problems and will gain the ability to design and develop an intelligent system for a selected application	**PO3, PO4**
CO3	Apply artificial intelligence techniques to solve different problem	**PO10, PSO1, PSO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
ETCS609 A	Introduction To Intelligent Systems	2	2	2	2						3			3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS611A	**Data Science**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Discrete Mathematics and Statistics				
Co-requisites	--				

Course Objectives

1. Provide students with the knowledge and expertise to become a proficient data scientist.
2. Demonstrate an understanding of statistics and machine learning concepts that are vital for data science.
3. Produce Python code to statistically analyse a dataset.
4. Critically evaluate data visualisations based on their design and use for communicating Stories from data.

Course Outcomes

On completion of this course, the students will be able to

CO1. Abstract thinking: Ability to understand the abstract concepts that lead to various data science theories in Mathematics, Statistics and Computer science.

CO2. Modern software tool usage: Acquire the skills in handling data science programming tools towards problem solving and solution analysis for domain specific problems.

CO3. Ability to identify analyze and design solutions for data science problems using fundamental principles of mathematics, Statistics, computing sciences, and relevant domain disciplines.

CO4. Design application using data science and basic machine learning techniques.

Catalog Description

This course introduces the basic notions and definitions used in data analysis, machine learning. The course will enable the students to formulate the problem of knowledge extraction as combinations of data filtration, analysis and exploration methods and translate a real-world problem into mathematical terms.

The students will be able to develop complex analytical reasoning and apply the algorithms on real world problems.

Course Content

Unit I: **10 lecture hours**

Introduction to core concepts and technologies: Introduction, Terminology, data science process, data science toolkit, Types of data, Example applications.

Data collection and management: Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management, using multiple data sources.

Unit II: **10 lecture hours**

Data analysis: Introduction, Terminology and concepts, Introduction to statistics, Central tendencies and distributions, Variance, Distribution properties and arithmetic, Samples/CLT, Basic machine learning algorithms, Linear regression, SVM, Naive Bayes.

Unit III: **10 lecture hours**

Data visualization: Introduction, Types of data visualization, Data for visualization: Data types, Data encodings, Retinal variables, mapping variables to encodings, Visual encodings.

Unit IV: **10 lecture hours**

Applications of Data Science, Technologies for visualization, Bokeh (Python).

Recent trends in various data collection and analysis techniques, various visualization techniques, application development methods of used in data science.

Text Books

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from the Frontline. O'Reilly.

Reference Books/Materials

1. Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Abstract thinking: Ability to understand the abstract concepts that lead to various data science theories in Mathematics, Statistics and Computer science	**PO1**
CO2	Modern software tool usage: Acquire the skills in handling data science programming tools towards problem solving and solution analysis for domain specific problems	**PO5**
CO3	Ability to identify analyze and design solutions for data science problems using fundamental principles of mathematics, Statistics, computing sciences, and relevant domain disciplines	**PO2**
CO4	Design application using data science and basic machine learning techniques	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS611A	Data Science	2	3	3		3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS653A	**Data Science Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Prior coding in Python/R				
Co-requisites	--				

Course Objectives

1. Understanding of the Python Programming Language.
2. Exposure on solving of data science problems.
3. Understand and implement the classification and Regression Model.
4. Understand and implement the clustering models.

Course Outcomes

On completion of this course, the students will be able to

CO1. Develop solutions to simple computational problems using python.

CO2. Solve problems of regression and correlation using python.

CO3. Design and solve problems of classification using python.

CO4. Design and solve problems of clustering using python.

Catalog Description

Data Science Lab is designed to not only facilitate students to practice basic programming in Python/R; but also learn advanced technologies of computer science such as Machine Learning, Artificial Intelligence and Data Mining. Each lab sessions is aimed to translate the theory lectures into practical implementation through programming paradigms and tools, platforms provided in the data science lab. Data Science Lab helps students to design solutions to data mining and machine learning problems arising in numerous application areas involving data analytics.

Course Content

LIST OF EXPERIMENTS

1. Introduction to Python/R tool for data analytics science.
2. Basic Statistics and Visualization in Python/R.
3. Implementation of K-means Clustering.
4. Implementation of Association Rules.
5. Implementation of Linear Regression.

6. Implementation of Logistic Regression.
7. Implementation of Naive Bayesian Classifier.
8. Implementation of Decision Trees.
9. Simulate Principal component analysis.
10. Simulate Singular Value Decomposition.

Text Books

- Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from the Frontline. O'Reilly.

Reference Books/Materials

1. Jure Leskovek, AnandRajaraman and Jeffrey Ullman. Mining of Massive Datasets. v2.1, Cambridge University Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop solutions to simple computational problems using python.	**PO3**
CO2	Solve problems of regression and correlation using python	**PO4**
CO3	Design and solve problems of classification using python	**PO2**
CO4	Design and solve problems of clustering using python	**PO3**

Course Code	Course Title	Engineering Knowledge PO1	Problem analysis PO2	Design/development of solutions PO3	Conduct investigations of complex problems PO4	Modern tool usage PO5	The engineer and society PO6	Environment and sustainability PO7	Ethics PO8	Individual or team work PO9	Communication PO10	Project management and finance PO11	Life-long Learning PO12	Application of Concepts PSO1	Research Orientated PSO2	Global Perspective PSO3	Reasoning and Communication Skills PSO4
ETCS653A	Data Science Lab		3	2	3									3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS613A	**Distributed Systems**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Data base				
Co-requisites	--				

Course Objectives

1. Uunderstand the fundamental concepts and issues of managing large volume of shared data in a parallel and distributed environment, and to provide insight into related research problems.
2. Design trends in distributed systems

Course Outcomes

On completion of this course, the students will be able to

CO1. To provide hardware and software issues in modern distributed systems.

CO2. To get knowledge in distributed architecture, naming, synchronization, consistency and replication, fault tolerance, security, and distributed file systems.

CO3. Understand the concepts and issues related to distributed systems.

CO4. Design and develop the programs for distributed environment.

CO5. Manage performance, reliability and other issues while designing in distributed

environment.

CO6. To expose students to both the abstraction and details of file systems.

CO7. To provide students with contemporary knowledge in parallel and distributed computing.

CO8. Introduce a variety of methodologies and approaches for reasoning about concurrent and

distributed programs

Catalog Description

This course provides an introduction to the fundamentals of distributed computer systems, assuming the availability of facilities for data transmission. The structure of distributed systems using multiple levels of software is emphasized. Specific topics include: distributed algorithms, distributed file systems, distributed databases, security and protection of distributed services such as the world-wide web, and examples of research and commercial distributed systems

Course Content

Unit I: **12 lecture hours**

INTRODUCTION: Distributed data processing; What is a DDBS; Advantages and disadvantages of DDBS; Problem areas; Overview of database and computer network concepts.
DISTRIBUTED DATABASE MANAGEMENT SYSTEM ARCHITECTURE: Transparencies in a distributed DBMS; Distributed DBMS architecture; Global directory issues.

Unit II: **8 lecture hours**

DISTRIBUTED DATABASE DESIGN: Alternative design strategies; Distributed design issues; Fragmentation; Data allocation.

SEMANTICS DATA CONTROL: View management; Data security; Semantic Integrity Control.

QUERY PROCESSING ISSUES: Objectives of query processing; Characterization of query processors; Layers of query processing; Query decomposition; Localization of distributed data.

Unit III: **12 lecture hours**

DISTRIBUTED QUERY OPTIMIZATION: Factors governing query optimization; Centralized query optimization; Ordering of fragment queries; Distributed query optimization algorithms.

TRANSACTION MANAGEMENT: The transaction concept; Goals of transaction management; Characteristics of transactions; Taxonomy of transaction models.

CONCURRENCY CONTROL:
Concurrency control in centralized database systems; Concurrency control in DDBSs; Distributed concurrency control algorithms; Deadlock management.

Unit IV: **8 lecture hours**

RELIABILITY: Reliability issues in DDBSs; Types of failures; Reliability techniques; Commit protocols; Recovery protocols.

PARALLEL DATABASE SYSTEMS: Parallel architectures; parallel query processing and optimization; load balancing.

ADVANCED TOPICS: Mobile Databases, Distributed Object Management, Multi-databases

Text Books

1. Principles of Distributed Database Systems, M.T. Ozsu and P. Valduriez, Prentice-Hall, 1991.
2. Distributed Database Systems, D. Bell and J. Grimson , Addison-Wesley, 1992.

Reference Books/Materials

1. J. Han and M. Kamber, Data Mining - Concepts and Techniques, Morgan-Kaufman, 2001.
2. Distributed Database Management Systems: A Practical Approach, Author(s): Saeed K. RahimiFrank S. Haug
3. Principles of Distributed Database Systems, Fourth Edition, M. Tamer Özsu, Patrick Valduriez

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To provide hardware and software issues in modern distributed systems.	**PO2**
CO2	To get knowledge in distributed architecture, naming, synchronization, consistency and replication, fault tolerance, security, and distributed file systems.	**PO3**
CO3	Understand the concepts and issues related to distributed systems.	**PO4**
CO4	Design and develop the programs for distributed environment.	**PO5**
CO5	Manage performance, reliability and other issues while designing	**PO4**

	in distributed environment.	
CO6	To expose students to both the abstraction and details of file systems.	**PO4**
CO7	To provide students with contemporary knowledge in parallel and distributed computing.	**PO9**
CO8	Introduce a variety of methodologies and approaches for reasoning about concurrent and distributed programs	**PSO1**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3	PSO 4
ETCS613A	Distributed Systems		2	3	3	3				3				3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS655A	Distributed Systems Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning				
Co-requisites	--				

Course Objectives

1. To expose students to both the abstraction and details of file systems.
2. 2. To introduce concepts related to distributed computing systems.
3. 3. To focus on performance and flexibility issues related to systems design decisions

Course Outcomes

On completion of this course, the students will be able to

CO1. To understand the Distributed Systems and will be able to describe the problems and challenges associated with these principles.

CO2. To Understand Distributed Computing techniques, Synchronous and Processes.

CO3. To be able to design a distributed system that fulfills requirements with regards to key distributed systems properties with understanding of Distributed File Systems and Distributed Shared Memory.

Catalog Description

This course introduces the main principles underlying distributed systems: processes, communication, naming, synchronization, consistency, fault tolerance, and security. Students will be familiar with some of the main paradigms in distributed systems: object-based systems, file systems, web-based and coordination-based systems. On the completion of the unit, students will understand the fundamentals of distributed computing and be able to design and develop distributed systems and applications.

Course Content

1	Implement concurrent echo client-server application.	**2 lab hours**
2	Implement concurrent day-time client-server application.	**2 lab hours**
3	Configure following options on server socket and tests them:	**2 lab hours**

	SO_KEEPALIVE, SO_LINGER, SO_SNDBUF, SO_RCVBUF, and TCP_NODELAY.	
4	Incrementing a counter in shared memory.	**2 lab hours**
5	Create CORBA based server-client application.	**2 lab hours**
6	Design XML Schema and XML instance document.	**4 lab hours**
7	WSDL based: Implement Arithmetic Service that implements add, and subtract operations / Java based: Implement Trigonometric Service that implements sin, and cos operations.	**4 lab hours**
8	Configuring reliability and security options.	**2 lab hours**
9	Monitor SOAP request and response packets. Analyze parts of it and compare them with the operations (java functions) headers.	**2 lab hours**
10	Design and test BPEL module that composes Arithmetic Service and Trigonometric Service.	**2 lab hours**
11	Test open source ESB using web service.	**2 lab hours**
12	Implementing Publish/Subscribe Paradigm using Web Services, ESB and JMS.	**2 lab hours**
13	Implementing Stateful grid services using Globus WS-Core-4.0.3.	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the Distributed Systems and will be able to describe the problems and challenges associated with these principles.	**PO2**
CO2	To Understand Distributed Computing techniques, Synchronous and Processes.	**PO3**
CO3	To be able to design a distributed system that fulfills requirements with regards to key distributed systems properties with understanding of Distributed File Systems and Distributed Shared Memory.	**PO5, PSO1, PO9**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
ETCS655 A	Distributed Systems Lab		2	3		3				3				3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS615A	Advanced Wireless And Mobile Networks	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Get familiar with the wireless/mobile market and the future needs and challenges.

2. Get familiar with key concepts of wireless networks, standards, technologies and their basic operations.

3. To learn how to design and analyse various medium access.

4. To learn how to evaluate MAC and network protocols using network simulation software tools.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand fundamentals of wireless communications.

CO2. Analyse security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.

CO3. Demonstrate basic skills for cellular networks design.

CO4. Apply knowledge of TCP/IP extensions for mobile and wireless networking.

Catalog Description

This course will cover the fundamental aspects of wireless networks, with emphasis on current and next-generation wireless networks. Various aspects of wireless networking will be covered including: fundamentals of cellular communication, mobile radio propagation, multiple access techniques, and mobility support, channel allocation, Wireless PAN/LAN/MAN standards, mobile ad-hoc networks, wireless sensor networks, and routing in wireless and mobile networks. The goal of this course is to introduce the students to state-of-the-art wireless network protocols and architectures. We will introduce the students to wireless networking research and guide them to investigate novel ideas in the area via semester-long research projects. We will also look at industry trends and discuss some innovative ideas that have recently been developed. Some of the course material will be drawn from research papers, industry white papers and Internet RFCs.

The course should provide the students with a good understanding of the wireless networking concepts and research directions.

Course Content

UNIT I **8 lecture hours**

INTRODUCTION: Wireless Networking Trends, Key Wireless Physical Layer Concepts, Multiple Access Technologies -CDMA, FDMA, TDMA, Spread Spectrum technologies, Frequency reuse, Radio Propagation and Modelling, Challenges in Mobile Computing: Resource poorness, Bandwidth, energy etc.

WIRELESS LOCAL AREA NETWORKS: IEEE 802.11 Wireless LANs Physical & MAC layer, 802.11 MAC Modes (DCF & PCF) IEEE 802.11 standards, Architecture & protocols, Infrastructure vs. Adhoc Modes, Hidden Node & Exposed Terminal Problem, Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues.

UNIT II **12 lecture hours**

WIRELESS CELLULAR NETWORKS: 1G and 2G, 2.5G, 3G, and 4G, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks, Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity in cellular systems, Spread spectrum Technologies.

UNIT III **12 lecture hours**

WiMAX (Physical layer, Media access control, Mobility and Networking), IEEE 802.22
Wireless Regional Area Networks, IEEE 802.21 Media Independent Handover Overview

WIRELESS SENSOR NETWORKS: Introduction, Application, Physical, MAC layer and Network Layer, Power Management, Tiny OS Overview.

UNIT IV **8 lecture hours**

WIRELESS PANs: Bluetooth AND ZigBee, Introduction to Wireless Sensors.

SECURITY: Security in wireless Networks Vulnerabilities, Security techniques, Wi-Fi Security, Dos in wireless communication.

ADVANCED TOPICS: IEEE 802.11x and IEEE 802.11i standards, Introduction to Vehicular Adhoc Networks.

Text Books

1. Schiller J., Mobile Communications, Addison Wesley 2000
2. Stallings W., Wireless Communications and Networks, Pearson Education 2005
3. Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc 2002.
4. Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc 2000.
5. Pandya Raj, Mobile and Personal Communications Systems and Services, PHI 2000.

Reference Books/Materials

1. William Stallings, "Wireless Communications & Networks", 2/E, Pearson Education India, Reprint 2007.
2. Jochen Schiller, "Mobile Communications", 2/E, Pearson Education India, reprint 2007.
3. Sandeep Singhal, "The Wireless Application Protocol" , Addison Wesley, India, reprint 2001
4. T S Rappaport, "Wireless Communications: Principles & Practice", 2/E, Pearson Education, 2002.
5. C E Perkins, "Ad Hoc Networking", Addison Wesley, 2000. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand fundamentals of wireless communications.	**PO1**
CO2	Analyse security, energy efficiency, mobility, scalability, and their unique characteristics in wireless networks.	**PO4**

CO3	Demonstrate basic skills for cellular networks design.	**PO5**
CO4	Apply knowledge of TCP/IP extensions for mobile and wireless networking.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
ETCS615 A	Advanced Wireless And Mobile Networks	2	2		3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 657A	**Advanced Wireless And Mobile Networkslab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. To know about Second Generation, Third Generation Cellular technologies.
2. To study the Evolution Generation (2.5G) technology platforms.
3. To study various 4G technologies like OFDM, MC-CDMA etc.
4. To understand General Packet Radio Receiver.

Course Outcomes

On completion of this course, the students will be able to

CO1. Explain and compare Second and Third Generation technologies, their architectures.

CO2. Describe improved version of 2G technology i.e., evolution Generation (2.5G).

CO3. Define 4G technologies, their applications in modern wireless communication systems.

CO4. Explain working of General Packet Radio Receiver.

Catalog Description

Machine Learning is concerned with computer programs that automatically improve their performance through experience. This course covers the theory and practical algorithms for machine learning from a variety of perspectives. We cover topics such as FIND-S, Candidate Elimination Algorithm, Decision tree (ID3 Algorithm), Backpropagation Algorithm, Naïve Bayesian classifier, Bayesian Network, k-Means Algorithm, k-Nearest Neighbor Algorithm, Locally Weighted Regression Algorithm.

List of Experiments (Indicative)

1	To understand the Basic circuit of Mobile phone(Transmitter, Receiver and Base band control Section).	**2 lab hours**

2	To study working of SIMcard in GSM handset SIM card detection.	**2 lab hours**
3	To Study and observe Transmitted/Received RF signal.	**2 lab hours**
4	Study and observe Transmitted (I & Q) /Received (I & Q)signals constellations.	**2 lab hours**
5	Study and analyze the Buzzer in 4G LTE Smart Phone TechBook.	**2 lab hours**
6	To study and Analyze the Vibrator in 4G LTE smart phone Tech book.	**4 lab hours**
7	Study of switch faults in User Interface Section of 4G LTE Smart PhoneTechBook.	**4 lab hours**
8	Study and analyze the Power Management Unit in 4G LTE Smart Phone TechBook.	**4 lab hours**
9	To study AT commands using GSM trainer module10	**4 lab hours**
10	To study General Packet Radio Receiver.	**4 Lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Explain and compare Second and Third Generation technologies, their architectures.	**PO2**
CO2	Describe improved version of 2G technology i.e., evolution Generation (2.5G).	**PO3**
CO3	Define 4G technologies, their applications in modern wireless communication systems.	**PO5**
CO4	Explain working of General Packet Radio Receiver.	**PO8**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS657A	Advanced Wireless And Mobile Networks Lab		3	3		2			2					3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCA852A	**Data Structures and Algorithms Lab**	L	T	P	C
Version 1.0		-	-	2	1
Pre-requisites/Exposure	Basics of programming				
Co-requisites	--				

Course Objectives

1. To understand and remember algorithms and its analysis procedure.
2. Introduce the concept of data structures through ADT including List, Stack, Queues .
3. To design and implement various data structure algorithms.
4. To introduce various techniques for representation of the data in the real world.
5. To develop application using data structure algorithms.
6. To compute the complexity of various algorithms.

Course Outcomes

On completion of this course, the students will be able to

CO1. Design and analyze the time and space efficiency of the data structure.

CO2. Identity the appropriate data structure forgiven problem.

CO3. Analyze algorithms and algorithm correctness.

CO4. Have practical knowledge on the applications of data structures.

Catalog Description

The course is designed to develop skills to design and analyze simple linear and non-linear data structures. It strengthen the ability of the students to identify and apply the suitable data structure for the given real world problem. It enables them to gain knowledge in practical applications of data structure.

Course Content

LIST OF EXPERIMENTS

Topic 1: Sorting – Searching

- Write a program to implement Bubble Sort.
- Write a program to implement Selection sort.
- Write a program to implement Quick Sort.
- Write a program to implement Insertion Sort.

- Write a program to implement Merge Sort.
- Write a program to implement Binary Search.

Topic 2: Arrays –Stacks-Recursion

- Write a program that finds the transposes a given square matrix.
- Write a recursive program that prints all the permutations of the first n characters of a string.
- Write a program to implement a stack of strings (illustrate the operations push (), pop(), size(), empty() and top()).
- Write a program to show the linked implementation of the Stack class.
- Write a program to covert infix to postfix.
- Write a program to implement Towers of Hanoi using Stack and Queues-Linked-Lists.
- Write a program to implement a linear list and perform the operation such as insert(), search() and delete().
- Write a program to implement a queue by adding the functions such as (i) Determine the size (ii) input queue (iii) output a queue (iv) split a queue into two queues

Topic 3: Binary Trees - Binary Tree Traversal

- Write a program to implement Binary Search Tree.
- Write a program to implement Binary Search Trees using Priority queue.
- Write a program to create a binary tree and find the height of a binary tree.
- Write a program to perform the binary tree traversals.
- Write a program to perform a deletion from a Binary Tree (using a delete () function).

Topic 4: Graphs

- Write a program to implement DFS traversal of a graph.
- Write a program to implement BFS traversal of a graph

<u>Text Books</u>

1. Narasimha Karumanchi, Data Structures and Algorithms, CarrerMonk Publications

2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, Clifford Stein, “Introduction to Algorithms”, 2nd Ed., PHI

Reference Books/Materials

1. Ellis Horowitz and Sartaz Sahani, "Computer Algorithms", Galgotia Publications.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Design and analyze the time and space efficiency of the data structure.	**PO3**
CO2	Identity the appropriate data structure for given problem.	**PO4**
CO3	Analyze algorithms and algorithm correctness.	**PO2**
CO4	Have practical knowledge on the applications of data structures	**PO1**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCA 852A	Data Structures and Algorithms Lab	3	3	3	3									3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS602A	Advance algorithms	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Advanced Computer Programming				
Co-requisites	--				

Course Objectives

1. The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
2. Students should be able to understand the necessary divide and conquer algorithms.
3. To familiarize students with greedy and dynamic programming concepts
4. Student should be able to come up with analysis of efficiency and proofs of correctness.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Acquire knowledge of advanced algorithm design techniques such as dynamic programming, greedy algorithms, divide and conquer, approximation algorithms, and randomized algorithms.

CO 2 Understand advanced algorithmic problems, their relationships, variations, and practical applications.

CO 3 Comprehend Graph algorithms, Matrix operations, FFT, Number-theoretic algorithms, and String matching with in-depth analysis.

CO 4 Grasp the theory of NP, NP-completeness, and their relevance to complex algorithmic problems and real-world scenarios.

Catalog Description

This course imparts the basic concepts of advance data structures and algorithms. It enables them to write algorithms for solving problems with the help of fundamental data structures. The course of data structures help organizing the data in variety of ways to solve the problem efficiently. The objective of this course is to study paradigms and approaches used to design and analyze algorithms and to appreciate the impact of algorithm design in practice.

Course Content

Unit I: **10lecture hours**

Graph Algorithms: Shortest path by BFS, shortest path in edge-weighted case (Dijkasra's), depth-first search and computation of strongly connected components. Emphasis on correctness proof of the algorithm and time/space analysis, example of amortized analysis.

Greedy Algorithms: Huffman Code, Knapsack problem, Dijkstra's Algorithm and more examples of greedy algorithms.

Unit II: 10 lecture hours

Divide and conquer and Dynamic Programing: Introduction to dynamic programming and Divide and Conquer paradigm. Strassen's multiplication, LU Decomposition, PLU decomposition and solving linear system of equations. Floyd-Warshall algorithm and more examples of dynamic programming.

String Matching: KMP(Knuth-Morris-Pratt) and Boyer-Moore Algorithms

Matroids: Algorithm to compute a maximum weight maximal independent set. Applications to MST: Prim's and Kruskal's algorithms

Unit III: 12 lecture hours

Number Theoretic algorithms: Euclid's GCD algorithm, Chinese remainder theorem, RSA Public-key cryptosystem.

Discrete Fourier Transform (DFT): In complex field, DFT in modulo ring, Fast Fourier Transform algorithm. Schönhage-Strassen Integer Multiplication algorithm.

Graph Matching: Algorithm to compute maximum matching. Characterization of maximum matching by augmenting paths, Edmond's Blossom algorithm to compute augmenting path.

Backtracking, Branch and Bound: Assignment problem, TSP.

Unit IV: 8 lecture hours

NP-Completeness: 3-CNF Satisfiability, Clique problem, Vertex-cover problem, Subset-sum problem, The Hamilton-Cycle problem.

Sorting Networks: Bitonic Sorting Algorithm, Recent Trends in problem solving paradigms using recent searching and sorting techniques by applying recently proposed data structures.

Text Books

1. "Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.

2. "The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.

3. "Algorithm Design" by Kleinberg and Tardos.

Reference Books/Materials

- Schaum's outline series, "Data Structure", McGraw Hills.
- Y. Langsamet. al., "Data Structures using C and C++", PHI.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Acquire knowledge of advanced algorithm design techniques such as dynamic programming, greedy algorithms, divide and conquer, approximation algorithms, and randomized algorithms.	**PO1**
CO2	Understand advanced algorithmic problems, their relationships, variations, and practical applications.	**PO4**
CO3	Comprehend Graph algorithms, Matrix operations, FFT, Number-theoretic algorithms, and String matching with in-depth analysis.	**PO5**
CO4	Grasp the theory of NP, NP-completeness, and their relevance to complex algorithmic problems and real-world scenarios.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 602A	Advance algorithms	1	3		2	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS604A	Soft Computing	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Algorithms, Programming Skill in C/C++/ JAVA, MATLAB				
Co-requisites	Basic Mathematics				

Course Objectives

Help in understanding principle component of fuzzy logic, neural network and genetic algorithm as a part of Artificial Intelligence and integrating the techniques to solve problems efficiently.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
CO2. Implement soft computing based solutions for real-world problems.
CO3. Showcase knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, and genetic algorithms.
CO4. Application of ANN training algorithms for real life problem solving
C05. Understanding fundamental and operational feature of deep learning and genetic Algorithms.

Catalog Description

Through this subject, student will be able to understand the coarse grained aspects of Artificial Intelligence and its branches. Student will understand the applications of artificial network and its working in real life problems. The internals of framework and working will be discussed throughout the course duration.

Course Content

Unit I: **10 lecture hours**

Introduction To Soft Computing And Neural Networks: Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics.

Fuzzy Logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.

Unit II: 10 lecture hours

NEURAL NETWORKS: Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, Radial Basis Function Networks : Reinforcement Learning, Unsupervised Learning Neural Networks, Adaptive Resonance architectures, Advances in Neural networks.

Unit III: 10 lecture hours

GENETIC ALGORITHMS: Introduction to Genetic Algorithms (GA), Applications of GA in Machine Learning : Machine Learning Approach to Knowledge Acquisition.

Matlab/Python Lib: Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic.

Unit IV: 8 lecture hours

Recent Trands in deep learning, various classifiers, neural networks and genetic algorithm. Implementation of recently proposed soft computing techniques.

Text Books

1. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro:Fuzzy and Soft Computing,Prentice:Hall of India, 2003.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic:Theory and Applications, Prentice Hall, 1995.

Reference Books/Materials

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.	**PO1**
CO2	Implement soft computing based solutions for real-world problems.	**PO2, PO3**
CO3	Showcase knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, and genetic algorithms.	**PO2**
CO4	Application of ANN training algorithms for real life problem solving.	**PO4**
CO5	Understanding fundamental and operational feature of deep learning and genetic Algorithms.	**PO1, PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 604A	Soft Computing	3	3	3	2									3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS606A	Data Prepration and Analysis	L	T	P	C
Version 1.0		3	1	-	4
Pre-requisites/Exposure	Basics of Python/R				
Co-requisites	--				

Course Objectives

Upon the completion of this course the students:-

1. Will learn how to prepare data for analysis
2. Will perform exploratory data analysis.
3. Will develop meaningful data visualizations.
4. Will work on a variety of real world datasets.

Course Outcomes

On completion of this course, the students will be able to

CO1. Design an approach to leverage data using the steps in the machine learning process.

CO2. Apply machine learning techniques to explore and prepare data for modeling.

CO3. Identify the type of machine learning problem in order to apply the appropriate set of techniques.

CO4. Construct models that learn from data using widely available open source tools.

Catalog Description

This course surveys industrial and scientific applications of data analytics, with case studies. Students will learn to prepare data for analysis, perform exploratory data analysis and develop meaningful data visualizations. Thy will work with variety of real world datasets and learn how to prepare datasets for analysis by cleaning and reformatting. Students will also learn to apply a variety of different data exploratory techniques and visualization methods.

Course Content

Unit I **10 lecture hours**

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.

Unit II **10 lecture hours**

Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.

Unit III **10 lecture hours**

Exploratory Data Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation.

Unit IV **10 lecture hours**

Visualization: Designing visualizations, Time series, Geo-located data, Correlations and connections, Hierarchies and networks, interactivity.

Text Books

1. Glenn J. Myatt, Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publishers, 2007.

Reference Books/Materials

1. Daniel T. Larose, "Data Mining and Predictive Analytics (Wiley Series on Methods and Applications in Data Mining) 2nd Edition", Wiley.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Design an approach to leverage data using the steps in the machine learning process.	**PO3**
CO2	Apply machine learning techniques to explore and prepare data for modeling.	**PO4**
CO3	Identify the type of machine learning problem in order to apply the appropriate set of techniques	**PO2**
CO4	Construct models that learn from data using widely available open source tools.	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 606A	Data Preparation and Analysis		3	3	2	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS652A	Data Preparation and Analysis Lab	L	T	P	C
Version 1.0		-	-	2	1
Pre-requisites/Exposure	Basics of python programming				
Co-requisites	--				

Course Objectives

The course should enable the students to:

1. Learn pre-processing method for multi-dimensional data
2. Practice on data cleaning mechanisms
3. Learn various data exploratory analysis
4. Develop the visualizations for clusters or partitions.

Course Outcomes

On completion of this course, the students will be able to

CO1. Apply pre-processing methods on various datasets as per the problem specific requirement.

CO2. Apply exploratory data analysis on the datasets.

CO3. Apply various data integration and cleaning techniques.

CO4. Apply various data visualization techniques on the datasets.

Catalog Description

This course surveys industrial and scientific applications of data analytics, with case studies. Students will learn to prepare data for analysis, perform exploratory data analysis and develop meaningful data visualizations. Thy will work with variety of real world datasets and learn how to prepare datasets for analysis by cleaning and reformatting. Students will also learn to apply a variety of different data exploratory techniques and visualization methods.

Course Content

LIST OF EXPERIMENTS

S.No	Experiment	No of hours
1	Data pre processing methods on student and labor datasets Implement data cube for data warehouse on 3-dimensional data.	2

2	Implement various missing handling mechanisms, Implement various noisy handling mechanisms.	4
3	Develop k-means and MST based clustering techniques, Develop the methodology for assessment of clusters for given dataset.	4
4	Design algorithms for association rule mining algorithms.	2
5	Derive the hypothesis for association rules to discovery of strong association rules; Use confidence and support thresholds.	2
6	Construct Haar wavelet transformation for numerical data, Construct principal component analysis (PCA) for 5-dimensional data.	2
7	Implement binning visualizations for any real time dataset, Implement linear regression techniques.	2
8	Visualize the clusters for any synthetic dataset, Implement the program for converting the clusters into histograms.	2
9	Write a program to implement agglomerative clustering technique.	2
10	Write a program to implement divisive hierarchical clustering technique.	4
11	Develop scalable clustering algorithms.	2
12	Develop scalable a priori algorithm.	4

Text Books

1. Glenn J. Myatt, Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publishers, 2007.

Reference Books/Materials

1. Daniel T. Larose, "Data Mining and Predictive Analytics (Wiley Series on Methods and Applications in Data Mining) 2nd Edition", Wiley.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Apply pre-processing methods on various datasets as per the problem specific requirement.	**PO3**
CO2	Apply exploratory data analysis on the datasets.	**PO4**
CO3	Apply various data integration and cleaning techniques	**PO2**
CO4	Apply various data visualization techniques on the datasets.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 652A	Data Preparation and Analysis Lab		3	3	3									3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 608A	**Secure Software Design &Enterprise Computing**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Software Engineering				
Co-requisites	--				

Course Objectives

1. Fix software flaws and bugs in various software.
2. Identify various issues like weak random number generation, information leakage, poor usability, and weak or no encryption on data traffic
3. Identify techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Differentiate between various software vulnerabilities

CO2. Identify software process vulnerabilities for an organization

CO3. Monitor resources consumption in a software

CO4. Interrelate security and software development process

Catalog Description

This course make helps understand how the security aspects of software development are embedded into the system to be developed. It includes secure architecture design, secure coding, secure deployment and secure software development methodologies.

Course Content

Unit I: **8 lecture hours**

Secure Software Design

Identify software vulnerabilities and perform software security analysis, Master security programming practices, Master fundamental software security design concepts, Perform security testing and quality assurance.

Unit II: **12 lecture hours**

Enterprise Application Development

Describe the nature and scope of enterprise software applications, Design distributed N-tier software application, Research technologies available for the presentation, business and data tiers of an enterprise software application, Design and build a database using an enterprise database system, develop components at the different tiers in an enterprise system, Design and develop a multi-tier solution to a problem using technologies used in enterprise system,

Present software solution.

Unit III: **8 lecture hours**

Enterprise Systems Administration

Design, implement and maintain a directory-based server infrastructure in a heterogeneous systems environment, monitor server resource utilization for system reliability and availability, Install and administer network services(DNS/DHCP/Terminal Services/Clustering/Web/Email).

Unit IV: **12 lecture hours**

Obtain the ability to manage and troubleshoot a network running multiple services, Understand the requirements of an enterprise network and how to go about managing them. Handle insecure exceptions and command/SQL injection, defend web and mobile applications against attackers, software containing minimum vulnerabilities and flaws.

Case study of DNS server, DHCP configuration and SQL injection attack.

Text Books

1. Theodor Richardson, Charles N Thies, Secure Software Design, Jones & Bartlett
2. Kenneth R. van Wyk, Mark G. Graff, Dan S. Peters, Diana L. Burley, Enterprise Software Security, Addison Wesley.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Differentiate between various software vulnerabilities	**PO2**
CO2	Identify software process vulnerabilities for an organization	**PO1, PO2**
CO3	Monitor resources consumption in a software	**PO4**
CO4	Interrelate security and software development process	**PO3, PO5**

Course Code	Course Title	Engineering Knowledge PO1	Problem analysis PO2	Design/development of solutions PO3	Conduct investigations of complex problems PO4	Modern tool usage PO5	The engineer and society PO6	Environment and sustainability PO7	Ethics PO8	Individual or team work PO9	Communication PO 10	Project management and finance PO11	Life-long Learning PO12	Application of Concepts PSO1	Research Oriented PSO2	Global Perspective PSO3	Reasoning and Communication Skills PSO4
ETCS 608A	Secure Software Design & Enterprise Computing	2	3	3	3	2								3	3	1	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 654A	**Secure Software Design & Enterprise Computing Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Software Engineering				
Co-requisites	--				

Course Objectives

1. Fix software flaws and bugs in various software.
2. Identify various issues like weak random number generation, information leakage, poor usability, and weak or no encryption on data traffic
3. Identify techniques for successfully implementing and supporting network services on an enterprise scale and heterogeneous systems environment.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Differentiate between various software vulnerabilities

CO2. Identify software process vulnerabilities for an organization

CO3. Monitor resources consumption in a software

CO4. Interrelate security and software development process

Catalog Description

Based on theory subject **ETCS 654A**, the following experiments are to be performed. It enables students to understand the use the Secure Software Design & Enterprise Computing concept and use them practically to secure enterprise systems.

List of Experiments (Indicative)

1	Study of Network Security fundamentals -Ethical Hacking, Social Engineering practices.	**2 lab hours**
2	Study of System threat attacks -Denial of Services.	**2 lab hours**
3	Study of Sniffing and Spoofing attacks, Study of Techniques uses for Web Based Password Capturing.	**4 lab hours**
4	Study of Different attacks causes by Virus and Trojans.	**2 lab hours**
5	Study of Anti-Intrusion Technique –Honey pot.	**4 lab hours**
6	Study of Symmetric Encryption Scheme –RC4.	**4 lab hours**

7	Implementation of S-DES algorithm for data encryption.	**4 lab hours**
8	Implementation of Asymmetric Encryption Scheme –RSA.	**4 lab hours**
9	Study of IP based Authentication.	**2 lab hours**
10	Design a security model for an enterprise.	**4 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Differentiate between various software vulnerabilities	**PO2**
CO2	Identify software process vulnerabilities for an organization	**PO1, PO2**
CO3	Monitor resources consumption in a software	**PO4**
CO4	Interrelate security and software development process	**PO3, PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 654A	Secure Software Design & Enterprise Computin g Lab	2	3	3	3	2								3	3	1	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 610A	**COMPUTER VISION**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of image processing				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to:-

1. To introduce students the fundamentals of image formation;

2. To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition;

3. To develop an appreciation for various issues in the design of computer vision and object recognition systems; and

4. To provide the student with programming experience from implementing computer vision and object recognition applications.

Course Outcomes

On completion of this course, the students will be able to:-

CO1.Understand and master basic knowledge, theories and methods in image processing and computer vision.

CO2. Identify, formulate and solve problems in image processing and computer vision.

CO3.Implement and test some fundamental computer vision algorithms e.g. image filtering, restoration, image segmentation, camera calibration.

CO4. Design and demonstrate a working computer vision system through team research project, and project report, presentation.

CO5.Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.

Catalog Description

This course introduces students to fundamental problems in image processing and computer vision, as well as their state-of-the-art solutions. Topics covered in detail include: image formation, image filtering, camera geometry, thres holding and image segmentation, edge, point and feature detection, geometric frameworks for vision, 3D visual reconstruction etc. The course features extensive practical components including computer labs and Term Research projects that provide students with the opportunity to practice and refine their skills in image processing and computer vision.

Course Content

Unit I: **8 lecture hours**

Overview, computer imaging systems, lenses, Image formation and sensing, Image analysis, pre-processing and Binary image analysis. Edge detection, Edge detection performance, Hough transform, corner detection

Unit II: **12 lecture hours**

Segmentation, Morphological filtering, Fourier transforms. Feature extraction, shape, histogram, colour, spectral, texture, using CVIP tools, Feature analysis, feature vectors, distance /similarity measures, data pre-processing.

Unit III: **12 lecture hours**

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians Classification: Discriminant Function, Supervised, Un-supervised, Semi supervised Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA,ICA, and Non-parametric methods.

Unit IV: **8 lecture hours**

Recent trends in Activity Recognition, computational photography, Biometrics.

Text Books

1. Computer Vision: Algorithms and Applications by Richard Szeliski.

Reference Books/Materials

1. Deep Learning, by Good fellow, Bengio, and Courville.
2. Dictionary of Computer Vision and Image Processing, by Fisher et al.
3. Haralick & Shapiro, “Computer and Robot Vision”, Vol II
4. EmanueleTrucco and AllessandroVerri “Introductory Techniques for 3-D Computer Vision”, Prentice Hall, 1998.
5. Olivier Faugeras, “Three-Dimensional Computer Vision”, The MIT Press, 1993.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Explain in detail DBMS architecture.	**PO1**
CO2	Explain in detail query processing and techniques involved in query optimization	**PO4**
CO3	Explain the principles of concurrency control.	**PO5**
CO4	Explain the principles of recovery management.	**PO2**
CO5	Know recent developments and active research topics in database.	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 610A	COMPUTER VISION	2	2		3	3	3							3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS656A	**COMPUTER VISION LAB**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning of Image Processing & Computer Vision				
Co-requisites	--				

Course Objectives

The students will be able to get an idea on:

1. To introduce students the fundamentals of image formation;
2. To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition;
3. To develop an appreciation for various issues in the design of computer vision and object recognition systems; and
4. To provide the student with programming experience from implementing computer vision and object recognition applications.

Course Outcomes

Upon completion of the course the students will be able to:

CO1.Understand and master basic knowledge, theories and methods in image processing and computer vision.

CO2. Identify, formulate and solve problems in image processing and computer vision.

CO3.Implement and test some fundamental computer vision algorithms e.g. image filtering, restoration, image segmentation, camera calibration.

CO4. Design and demonstrate a working computer vision system through team research project, and project report, presentation.

CO5.Describe basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition.

Catalog Description

This course introduces students to fundamental problems in image processing and computer vision, as well as their state-of-the-art solutions. Topics covered in detail include: image formation, image filtering, camera geometry, thresholding and image segmentation, edge, point and feature detection, 3D visual reconstruction etc. The course features extensive practical components including computer labs and term

Research projects that provide students with the opportunity to practice and refine their skills in image processing.

Course Content

1	Write a program for image enhancement.	**2 lab hours**
2	Write a program for image compression.	**2 lab hours**
3	Write a program for color image processing.	**2 lab hours**
4	Write a program for image segmentation.	**2 lab hours**
5	Write a program for image morphology.	**2 lab hours**
6	Write a program for Image Restoration.	**4 lab hours**
7	Write a program for Edge detection.	**4 lab hours**
8	Write a program for Blurring 8 bit color versus monochrome.	**4 lab hours**
9	Write a Program with illustration of Line Detection Using Hough Lines.	**4 lab hours**
10	Write a program for Image Restoration.	**4 lab hours**
11	To create a program for segmentation of an image using watershed transforms.	

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand and master basic knowledge, theories and methods in image processing and computer vision.	**PO1**
CO2	Identify, formulate and solve problems in image processing and computer vision.	**PO4**
CO3	Implement and test some fundamental computer vision algorithms e.g. image filtering, restoration, image segmentation, camera calibration.	**PO5, PSO2, PO9,PSO1**
CO4	Design and demonstrate a working computer vision system through team research project, and project report, presentation.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 656A	Computer Vision Lab	2	2		3	3				3				3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS612A	**Human and Computer Intraction**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

1. Learn the foundations of Human Computer Interaction.

2. Familiar with the design technologies for individuals and persons with disabilities.

3. Aware of mobile Human Computer interaction.

Course Outcomes

Upon completion of the course, students should be able to:

CO1. Explain the capabilities of both humans and computers from the viewpoint of human information processing.

CO2. Describe typical human–computer interaction (HCI) models and styles, as well as various historic HCI paradigms.

CO3. Apply an interactive design process and universal design principles to designing HCI systems.

CO4. Describe and use HCI design principles, standards and guidelines.

CO5. Analyze and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems.

CO6. Discuss tasks and dialogs of relevant HCI systems based on task analysis and dialog design.

CO7. Analyze and discuss HCI issues in groupware, ubiquitous computing, virtual reality, multimedia, and Word Wide Web-related environments.

Catalog Description

This course teaches students to design user interfaces based on the capabilities of computer technology and the needs of human factors. Students design a user interface for a system and implement a prototype from a list of informal requirements. The project is developed over three assignments by a design process based on current human–computer interaction principles.

Course Content

Unit I: **8 lecture hours**

Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.

Unit II: **12 lecture hours**

Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

Unit III: **12 lecture hours**

Cognitive models –Socio-Organizational issues and stake holder requirements –Communication and collaboration models-Hypertext, Multimedia and WWW.

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Unit IV: **8 lecture hours**

Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.

Recent Trends: Speech Recognition and Translation, Multimodal System.

TEXT BOOKS:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004 (UNIT I , II & III)

2. Brian Fling, "Mobile Design and Development", First Edition , O□Reilly Media Inc., 2009 (UNIT – IV)

3. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O□Reilly, 2009.(UNIT-V)

Reference Books/Materials

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Explain the capabilities of both humans and computers from the viewpoint of human information processing.	**PO1**
CO2	Describe typical human–computer interaction (HCI) models and styles, as well as various historic HCI paradigms.	**PO4**
CO3	Apply an interactive design process and universal design principles to designing HCI systems.	**PO5**
CO4	Describe and use HCI design principles, standards and guidelines.	**PO2**
CO5	Analyze and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems.	**PO3**
CO6	Discuss tasks and dialogs of relevant HCI systems based on task analysis and dialog design.	**PSO3**
CO7	Analyze and discuss HCI issues in groupware, ubiquitous computing, virtual reality, multimedia, and Word Wide Web-related environments.	**PSO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 612A	Human and Computer Interaction	1	1	2	3	2										2	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS614A	**GPU Computing**	L	T	P	C
Version 1.0		3	1	-	4
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

To learn parallel programming with Graphics Processing Units (GPUs)

Course Outcomes

On completion of this course, the students will be able to

1. Learn concepts in parallel programming
2. Implementation of programs on GPUs
3. Analyze an algorithms to provide parallel solutions to computationally challenging problems.
4. Debug and Profiling parallel programs

Catalog Description

This course will introduce parallel computing paradigms with focus on GPU programming to harness the massively parallel GPU architecture in solving computationally demanding tasks. The NVIDIA CUDA and industry standard Open CL frameworks will be introduced and used with most of the labs. This is a project based course where the students will work on scientific computational problems.

Course Content

Unit I: 13 lecture hours

Introduction: History, Graphics Processors, Graphics Processing Units, GPGPUs. Clock speeds, CPU / GPU comparisons, Heterogeneity, Accelerators, Parallel programming, CUDA Open CL / Open ACC, Hello World Computation Kernels, Launch parameters, Thread hierarchy, Warps /Wave fronts, Thread blocks / Workgroups, Streaming multiprocessors, 1D / 2D /3D thread mapping, Device properties, Simple Programs

Unit II: 7 lecture hours

Memory: Memory hierarchy, DRAM / global, local / shared, private / local, textures, Constant Memory, Pointers, Parameter Passing, Arrays and dynamic Memory, Multi-dimensional Arrays, Memory Allocation, Memory copying across devices, Programs with matrices, Performance evaluation with different memories.

Unit III: **10 lecture hours**

Synchronization: Memory Consistency, Barriers (local versus global), Atomics, Memory fence. Prefix sum, Reduction. Programs for concurrent Data Structures such as Work lists, Linked-lists. Synchronization across CPU and GPU **Functions**: Device functions, Host functions, Kernels functions, Using libraries(such as Thrust), and developing libraries.

Unit IV: **10 lecture hours**

Support: Debugging GPU Programs. Profiling, Profile tools, Performance aspects

Streams: Asynchronous processing, tasks, Task-dependence, Overlapped data transfers, Default Stream, Synchronization with streams. Events, Event-based-Synchronization - Overlapping data transfer and kernel execution, pitfalls.

Case Studies: Image Processing, Graph algorithms, Simulations, Deep Learning.

Advanced topics: Dynamic parallelism, Unified Virtual Memory, Multi-GPU processing, Peer access, Heterogeneous processing.

Text Books

1. Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-meiHwu; Morgan Kaufman; 2010 (ISBN: 978-0123814722)
2. CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012 (ISBN: 978-0124159334)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn concepts in parallel programming	**PO1**
CO2	Implementation of programs on GPUs	**PO3; PO5**
CO3	Analyze an algorithms to provide parallel solutions to computationally challenging problems.	**PO2**
CO4	Profiling parallel programs	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 614A	GPU Computing	3	3	3	3	3								3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 616A	**Digital Forensics**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Concepts of Security				
Co-requisites	--				

Course Objectives

1. Provides an in-depth study of the rapidly changing and fascinating field of computer forensics.

2. Combines both the technical expertise and the knowledge required to investigate, detect, and prevent digital crimes.

3. Have knowledge on digital forensics legislations, digital crime, forensics processes and procedures, data acquisition and validation, e-discovery tools.

4. Students will learn different techniques and procedures that enable them to perform a digital investigation.

Course Outcomes

On completion of this course, the students will be able to

CO1. Explain the origins of forensic science.

CO2. Identify the process in taking digital evidence.

CO3. Describe how to conduct an investigation using methods of memory, operating system, network and email forensics.

CO4. Assess the different forensics tools.

CO5. Differentiate among different types of security attacks.

CO6. Describe the concept of ethical hacking.

Catalog Description

The aim of this course is to equip you with the knowledge and techniques to computer forensics practices and evidence analysis. It prepares you to use various forensic investigation approaches and tools necessary to start a computer forensics investigation. It also aims at increasing the knowledge and understanding in cyber security and ethical hacking.

Course Content

Unit I: **12 lecture hours**

Digital Forensics Science: Forensics science, computer forensics, and digital forensics.
Computer Crime: Criminalistics as it relates to the investigative process, analysis of cyber-criminalistics area, holistic approach to cyber-forensics.

Unit II: **12 lecture hours**

Cyber Crime Scene Analysis: Discuss the various court orders etc., methods to search and seizure electronic evidence, retrieved and un-retrieved communications, Discuss the importance of understanding what court documents would be required for a criminal investigation.

Unit III: **10 lecture hours**

Evidence Management & Presentation: Create and manage shared folders using operating system, importance of the forensic mindset, define the work load of law enforcement, Explain what the normal case would look like, Define who should be notified of a crime, parts of gathering evidence, Define and apply probable cause.

Unit IV: **8 lecture hours**

Computer Forensics: Prepare a case, Begin an investigation, Understand computer forensics workstations and software, Conduct an investigation, Complete a case, Critique a case.
Network Forensics: open-source security tools for network forensic analysis, requirements for preservation of network data.
Mobile Forensics: mobile forensics techniques, mobile forensics tools.
Legal Aspects of Digital Forensics: IT Act 2000, amendment of IT Act 2008.

Text Books

1. John Sammons, The Basics of Digital Forensics, Elsevier

Reference Books/Materials

1. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Explain the origins of forensic science	**PO2**
CO2	Identify the process in taking digital evidence.	**PO2**
CO3	Describe how to conduct an investigation using methods of memory, operating system, network and email forensics.	**PO2**
CO4	Assess the different forensics tools.	**PO5**
CO5	Differentiate among different types of security attacks.	**PO4**
CO6	Describe the concept of ethical hacking.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 616A	Digital Forensics		3		3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS658A	Soft Computing Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Algorithms, Programming Skill in C/C++/ JAVA, MATLAB				
Co-requisites	Basic Mathematics				

Course Objectives

- Learn basic concepts of Soft Computing and fuzzy logic as a part of artificial intelligence.
- Provides a practical approach to fuse real life approach with techniques of genetic algorithm and fuzzy logic.

Course Outcomes

On completion of this course, the students will be able to

CO1.Understand the structure and organization of neural network.

CO2.Execute and evaluate the performance of network using fuzzy operations.

CO3.Demonstrate and measure correlation using datasets

CO4.Demonstrate fundamental and operational feature of deep learning and genetic Algorithms

Catalog Description

This course complements ETCS604A. It enables them to select and design network for solving real life problem with optimal solution(s). The list of experiments helps to understand details of component of network.

List of Experiments (Indicative)

1	Create a perception with appropriate number of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weight.	**2 lab hours**
2	Write a program to implement artificial neural network without back propagation.	**2 lab hours**
3	Write a program to implement artificial neural network with back propagation.	**2 lab hours**
4	Implement Union, Intersection, Complement and Difference	**2 lab hours**

	operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.	
5	Implement travelling sales person problem (TSP) using genetic algorithms.	**2 lab hours**
6	Plot the correlation plot on dataset and visualize giving an overview of relationships among data on soya bins data. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.	**2 lab hours**
7	Implement linear regression and multi-regression for a set of data points.	**2 lab hours**
8	Implement crisp partitions for real-life iris dataset.	**2 lab hours**
9	Write a program to implement Hebb's rule.	**2 lab hours**
10	Write a program to implement Delta rule.	**2 lab hours**
11	Write a program to implement logic gates.	**2 lab hours**
12	Implement SVM classification by fuzzy concepts.	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the structure and organization of neural network.	**PO1, PO2**
CO2	Execute and evaluate the performance of network using fuzzy operations.	**PO3, PO4**
CO3	Demonstrate and measure correlation plot on dataset	**PO5**
CO4	Demonstrate fundamental and operational feature of deep learning and genetic Algorithms	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 658A	Soft Computer Lab	2	3	3	2	2								3	3	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS660A	Mini Project With Seminar	L	T	P	C
Version 1.0		2	-	-	2
Pre-requisites/Exposure	--				
Co-requisites	--				

The course is designed to provide an opportunity to students to demonstrate the ability to devise, select and use a range of methodologies and tools to the Chosen/Given project, applying the theoretical knowledge to a real life situation. Experiential Learning outside classroom through self-exploration, practical experience, Industry, field experience, live experience, research, design projects etc.

The learning process in the Project seeks out and focuses attention on many latent attributes, which do not surface in the normal class room situations. These experiential learning attributes through project includes Intellectual ability, Professional judgment and decision making ability, Inter-disciplinary approach, Skills for data handling, Ability in written and oral presentation, Sense of responsibility Developing professional Skills Application of theory, concepts in given industry /practical / field scenario.

Course Outcomes

On completion of this course, the students will be able to

CO1. Use applied scientific knowledge to identify and implement relevant principles of mathematics and computer science.

CO2. Use the relevant tools necessary for engineering practice.

CO3. Define overall needs and constraints to solve a problem and develop/ design a prescribed engineering sub-system.

CO4. Communicate effectively and learn to be a team player.

Catalog Description

Students are expected make a project based on the latest advancements related to the parent branch of Engineering. Students may opt for an in-disciplinary project (if feasible).

The project may be a complete hardware or a combination of hardware and software under the guidance of a Supervisor from the Department. This is expected to provide a good training for the student(s) in technical aspects

Student will be continuously evaluated during the semester in form of Project Progress Seminars. At the end of the semester, assessment of the research/project work of each student will be made by the board of examiners including supervisors on the basis of a viva-voce examination and the report submitted by the student.

Course Content

The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic.
2. Preparing an Action Plan for conducting the investigation, including team work.
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
4. Final development of product/process, testing, results, conclusions and future directions.
5. Preparing a report in the standard format for being evaluated by the Department.
6. Final project presentation before a Departmental Committee.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Use applied scientific knowledge to identify and implement relevant principles of mathematics and computer science.	**PO3**
CO2	Use the relevant tools necessary for engineering practice.	**PO5**

CO3	Define overall needs and constraints to solve a problem and develop/ design a prescribed engineering sub-system.	**PO2**
CO4	Communicate effectively and learn to be a team player.	**PO10**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 660A	Mini Project with Seminar		3	3		3					3			3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS617A	Mobile Applications and Services	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Wireless Communication and Mobile Computing				
Co-requisites	Java Programming / KOTLIN				

Course Objectives

1. This course present the mobile platforms and their ecosystems
2. It explores emerging technologies and tools used to design and implement feature-rich mobile applications for smart phones and tablets.
3. It also take into account both the technical constraints relative to storage capacity, processing capacity, display screen, communication interfaces, and the user interface, context and profile.

Course Outcomes

On completion of this course, the students will be able to

CO1. Identify the target platform and users and be able to define and sketch a mobile application.

CO2. Understand the fundamentals, frameworks, and development lifecycle of mobile application platforms

CO3. Design and develop a mobile application prototype

CO4. Exposed to technology and business trends impacting mobile applications

Catalog Description

The main objective of this part is to give students an introduction to programming on the Android platform and help them build skills needed for approaching and solving coding problems on limited devices. Ergonomic user interface and efficient resource usage (memory, CPU, battery, network, physical disks, etc.) in achieving mobile tasks will be discussed in details.

Course Content

Unit I: 8 lecture hours

Introduction: Introduction to Mobile Computing, Introduction to Android Development Environment, Factors in Developing Mobile Applications, Mobile Software Engineering, Frameworks and Tools, Generic UI Development Android User.

Unit II: 8 lecture hours

More on Uis: VUIs and Mobile Apps, Text-to-Speech Techniques, Designing the Right UI, Multichannel and Multimodal Uis, Storing and Retrieving Data, Synchronization and Replication of Mobile Data, Getting the Model Right, Android Storing and Retrieving Data, Working with a Content Provider.

Unit III: 10 lecture hours

Communications via Network and the Web: State Machine, Correct Communications Model, Android Networking and Web, Telephony Deciding Scope of an App, Wireless Connectivity and Mobile Apps, Android Telephony Notifications and Alarms: Performance, Performance and Memory Management, Android Notifications and Alarms, Graphics, Performance and Multithreading, Graphics and UI Performance, Android Graphics.

Unit IV: 14 lecture hours

Putting It All Together: Packaging and Deploying, Performance Best Practices, Android Field Service App, Location Mobility and Location Based Services Android Multimedia: Mobile Agents and Peer-to-Peer Architecture, Android Multimedia.

Platforms and Additional Issues: Development Process, Architecture, Design, Technology Selection, Mobile App Development Hurdles, Testing, Security and Hacking, Active Transactions, More on Security, Hacking Android.

Recent trends in Communication protocols for IOT nodes, mobile computing techniques in IOT, agents based communications in IOT.

Text Books

1. Wei-Meng Lee, Beginning Android™ 4 Application Development, 2012 by John Wiley & Sons

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the target platform and users and be able to define and sketch a mobile application.	**PO5**
CO2	Understand the fundamentals, frameworks, and development lifecycle of mobile application platforms .	**PO3**
CO3	Design and develop a mobile application prototype	**PO7**
CO4	Exposed to technology and business trends impacting mobile applications	**PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS617A	Mobile Applications and Services			2		2		2					2	3		2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS619A	**Compiler for HPC**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Computer Organization and Architecture, Basics of Compiler Design				
Co-requisites	--				

Course Objectives

1. Introduce structure of compilers and high-performance compiler design for students.
2. Concepts of cache coherence and parallel loops in compilers are included.
3. Know the most common machine independent optimizations.
4. Know scheduling techniques and register allocation for exploiting Instruction Level Parallelism
5. Know the most common memory locality optimizations.

Course Outcomes

On completion of this course, the students will be able to

CO1.Be familiar with the structure of compiler.

CO2. Understand the performance characteristics of modern processors.

CO3. Have experience with algorithms for automatically taking advantage of SIMD, SIMT, and MIMD parallelism design, formulate, solve and implement high performance versions of standard.

Course Overview:

Optimizing compilers play a critical role in modern computer systems ranging from mobile devicesto supercomputers. Compilers can optimize for performance, power consumption and/or code size. Practically all computer scientists and engineers may benefit for a deep knowledge of compiler optimizations: programmers hardware features that are easy to use by compilers, and finally compiler writers develop new compiler optimizations. This course covers optimizations and aspects of the compiler back-end and middle-end such as: data-flow analysis, control Flow analysis, instruction level parallelism, memory hierarchy optimizations, data level parallelism and thread level parallelism.

Course Content

Unit I: **8 lecture hours**

High Performance Systems, Structure of a Compiler, Programming Language Features, Languages for High Performance.

Data Dependence: Data Dependence in Loops, Data Dependence in Conditionals, Data Dependence in Parallel Loops, Program Dependence Graph.

Scalar Analysis with Factored Use-Def Chains: Constructing Factored Use-Def Chains, FUD Chains for Arrays, Induction Variables Using FUD Chains, Constant Propagation with FUD Chains, Data Dependence for Scalars. Data Dependence Analysis for Arrays.

Unit II: **12 hours**

Array Region Analysis, Pointer Analysis, I/O Dependence, Procedure Calls, Inter-procedural Analysis.

Loop Restructuring: Simple Transformations, Loop Fusion, Loop Fission, Loop Reversal, Loop Interchanging, Loop Skewing, Linear Loop Transformations, Strip-Mining, Loop Tiling, Other Loop Transformations, and Inter-procedural Transformations.

Optimizing for Locality: Single Reference to Each Array, Multiple References, General Tiling, Fission and Fusion for Locality.

Unit III: **12 hours**

Concurrency Analysis: Concurrency from Sequential Loops, Concurrency from Parallel Loops, Nested Loops, Round off Error, Exceptions and Debuggers.

Vector Analysis: Vector Code, Vector Code from Sequential Loops, Vector Code from For all Loops, Nested Loops, Round off Error, Exceptions, and Debuggers, Multi-vector Computers.

Unit IV: **8 hours**

Message-Passing Machines: SIMD Machines, MIMD Machines, Data Layout, Parallel Code for Array Assignment, Remote Data Access, Automatic Data Layout, Multiple Array Assignments, Other Topics.

Scalable Shared-Memory Machines: Global Cache Coherence, Local Cache Coherence, Latency Tolerant Machines.

Recent trends in compiler design for high performance computing and message passing machines and scalable shared memory machines.

TEXTBOOKS:

1. Michael Wolfe, High-Performance Compilers for Parallel Computing, Pearson.

REFERENCES BOOKS:

1. Georg Hager, Gerhard Wellein, Introduction to High Performance Computing for Scientists and Engineers, Chapman & Hall / CRC Computational Science series, 2011

2. Charles Severance, Kevin Dowd, High Performance Computing, O'Reilly Media, 2nd Edition,1998.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Be familiar with the structure of compiler.	**PO1**
CO2	Understand the performance characteristics of modern processors.	**PO2, PO4**
CO3	Have experience with algorithms for automatically taking advantage ofSIMD, SIMT, and MIMD parallelism design, formulate, solve and implement high performance versions of standard.	**PO3, PO5**

Course Code	Course Title	Engineering Knowledge PO1	Problem analysis PO2	Design/development of solutions PO3	Conduct investigations of complex problems PO4	Modern tool usage PO5	The engineer and society PO6	Environment and sustainability PO7	Ethics PO8	Individual or team work PO9	Communication PO10	Project management and finance PO11	Life-long Learning PO12	Application of Concepts PSO1	Research Orientated PSO2	Global Perspective PSO3	Reasoning and Communication Skills PS04
ETCS 619A	Compiler for HPC	2	2	2	3	3								3		1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 621A	**OPTIMIZATION TECHNIQUES**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basic knowledge in optimization techniques				
Co-requisites	--				

Course Objectives

1. Insight into the mathematical formulation of real-world problems.

2. Optimize these mathematical problems using nature-based algorithms. And the solution is useful specially for NP-Hard problems.

3. To Create an Engineering design methodology using a mathematical formulation of a design problem to support selection of the optimal design among alternatives.

4. The goal is to provide students with solid foundations to deal with a wide variety of optimization problems that arise in multiple areas of science, engineering and business, and to provide a thorough knowledge of the most common algorithms.

Course Outcomes

On completion of this course, the students will be able to

CO1. Ability to apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.

CO2. Ability to go in research by applying optimization techniques in problems of Engineering and Technology.

CO3. Ability to solve the mathematical results and numerical techniques of optimization theory to concrete Engineering problems by using computer software.

CO4. Cast engineering minima/maxima problems into optimization framework.

CO5. An ability to apply design and development principles in the construction and implementation of software systems of varying complexity to meet desired needs.

CO6. An ability to continue to learn and use new techniques, skills, and engineering and scientific tools for research in electrical engineering and computer science.

CO7. A dedication to advance engineering research to discover new knowledge, develop new methodologies, promote innovative thinking, and research output in engineering and science.

CO8. Learn efficient Genetic Algorithm procedures to solve optimization problems.

Catalog Description

The purpose of this course is to develop a knowledge in the field of optimization techniques their basic concepts,principles. linear programming and queuing theory. The course introduces theory and numerical methods for continuous multivariate optimization (constrained and unconstrained). The goal is to provide students with solid foundations to deal with a wide variety of optimization problems that arise in multiple areas of science, engineering, and business, and to provide a thorough knowledge of the most common algorithms.

Course Content

Unit I: **12 lecture hours**

Engineering application of Optimization, Formulation of design problems as mathematical programming problems. General Structure of Optimization Algorithms, Constraints, The Feasible Region.

Unit II: **8 lecture hours**

Branches of Mathematical Programming: Optimization using calculus, Graphical Optimization, Linear Programming, Quadratic Programming, Integer Programming, Semi Definite Programming.

Unit III: **10 lecture hours**

Optimization Algorithms like Genetic Optimization, Particle Swarm Optimization, Ant Colony Optimization etc.Real life Problems and their mathematical formulation as standard programming problems.

Unit IV: **10 lecture hours**

Recent trends: Applications of ant colony optimization, genetics, and linear and quadratic programming in real world applications.

Text Books

1. Laurence A. Wolsey (1998). Integer programming. Wiley. ISBN 978-0-471-28366-9.
2. Practical Optimization Algorithms and Engineering Applications Andreas Antoniou.

3. An Introduction to Optimization Edwin K., P. Chong & Stanislaw h. Zak.
4. Dimitris Bertsimas; Robert Weismantel (2005). Optimization over integers. Dynamic Ideas. ISBN 978-0-9759146-2-5.

Reference Books/Materials

Sheldon M. Ross, “Probability and Statistics for Engineers and Scientist”, Elsevier Academic Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz I	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Ability to apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems.	**PO1**
CO2	Ability to go in research by applying optimization techniques in problems of Engineering and Technology.	**PO2**
CO3	Ability to solve the mathematical results and numerical techniques of optimization theory to concrete Engineering problems by using computer software.	**PO4**
CO4	Cast engineering minima/maxima problems into optimization framework.	**PO3**
CO5	An ability to apply design and development principles in the construction and implementation of software systems of varying complexity to meet desired needs.	**PO2**
CO6	An ability to continue to learn and use new techniques, skills, and engineering and scientific tools for research in electrical engineering and computer science.	**PO5**
CO7	A dedication to advance engineering research to discover new knowledge, develop new methodologies, promote innovative thinking, and research output in engineering and science.	**PO3**

CO8	Learn efficient Genetic Algorithm procedures to solve optimization problems.	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 621A	Optimization Techniques	3	3	3	3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETMC 675A	**Business Analytics**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Probability and Set Theory				
Co-requisites	--				

Course Objectives

1. Understand and critically apply the concepts and methods of business analytics
2. Identify, model and solve decision problems in different settings
3. Interpret results/solutions and identify appropriate courses of action for a given managerial situation whether a problem or an opportunity
4. Create viable solutions to decision making problems

Course Outcomes

` On completion of this course, the students will be able to

CO1. Enable all participants to recognise, understand and apply the language, theory and models of the field of business analytics

CO2. Foster an ability to critically analyse, synthesise and solve complex unstructured business problems

CO3. Encourage an aptitude for business improvement, innovation and entrepreneurial action

CO4. Encourage the sharing of experiences to enhance the benefits of collaborative learning

CO5. Instil a sense of ethical decision-making and a commitment to the long-run welfare of both organisations and the communities they serve

Catalog Description

The problems faced by decision makers in today's competitive business environment are often extremely complex and can be addressed by numerous possible courses of action. Evaluating these alternatives and gaining insight from past performance is the essence of business analytics. This course is designed as an introduction to Business Analytics, an area of business administration that considers the extensive use of data, methods, and fact-based management to support and improve decision making. While business intelligence focuses on data handling, queries and reports to discover patterns and generate information associated with products, services and customers, business analytics uses data and models to explain the performance of a business and how it can be improved. This course discusses the benefits of employing analytics and a structured approach to problem-solving in management situations.

Course Content

UNIT I **8 hours**

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II **8 hours**

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for
Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.

UNIT III **7 hours**

Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

UNIT IV **7 hours**

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making. Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

TEXT BOOKS:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Enable all participants to recognise, understand and apply the language, theory and models of the field of business analytics	**PO1**
CO2	Foster an ability to critically analyse, synthesise and solve complex unstructured business problems	**PO2, PO4**
CO3	Encourage an aptitude for business improvement, innovation and entrepreneurial action	**PO7**
CO4	Encourage the sharing of experiences to enhance the benefits of collaborative learning	**PO9**
CO5	Instil a sense of ethical decision-making and a commitment to the long-run welfare of both organisations and the communities they serve.	**PO8**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 675A	Business Analytics	3	3		3			3	3	3				3	3	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETME 817A	INDUSTRIAL SAFETY	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basics knowledge of industrial engineering				
Co-requisites	--				

Course Objectives:

Upon completion of the course the students will be able to:

1. Familiar with standard workplace hazard/warning signs and labels.
2. Familiar with standard categories of hazardous materials.
3. Understand the documentation used with hazardous materials, such as the MSDS.
4. Describe the different levels of danger that exist with electrical shock.
5. Describe several appropriate actions to take in the event of an electrical accident.

Course Outcomes:

Upon the completion of this course the students will be able to:

1. Analyze the effect of release of toxic substances
2. Understand the industrial laws, regulations, and source models.
3. Apply the methods of prevention of fire and explosions.
4. Understand the relief and its sizing methods and methods of hazard identification and preventive measures& types.

Catalog Description

The basic purpose of this course is to deal with the safety practices in the electronics industry which includes electrical safety, HAZMAT, flammable and combustible liquids, safe handling of electronic components in the manufacturing environment including ESD control, product testing/certification, blood borne pathogens, fire safety, laser, and radiation safety. Audit available.

Course Content

Unit I: **12 lecture hours**

Industrial safety**:** Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, washrooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety colour codes. Fire prevention and fire fighting, equipment, and methods.

Unit II: **12 lecture hours**

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relationship with replacement economy, Service life of equipment. Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods.

Unit III: **8 lecture hours**

Lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle, and factors affecting the corrosion. Types of corrosion, corrosion prevention methods. Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree.

Unit IV: **8 lecture hours**

Draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal, and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes. Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning, and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps, and advantages of preventive maintenance.

TEXTBOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand, and Company.
3. Pump-hydraulic Compressors, Aludels, McGraw Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Analyze the effect of release of toxic substances	**PO1**
CO2	Understand the industrial laws, regulations, and source models.	**PO2**
CO3	Apply the methods of prevention of fire and explosions.	**PO3**
CO4	Understand the relief and its sizing methods and methods of hazard identification and preventive measures& types.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETME 817A	Industrial Safety	2	2	2	3									3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETMA 676A	**Operations Research**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. Describe the linear programming duality. and the simplex and revised simplex algorithms
2. Describe the linear programming applications and formulations
3. Describe the transportation problem and its application
4. Describe the Network Analysis
5. To acquaint the students with the use of quantitative models in game theory

Course Outcomes

On completion of this course, the students will be able to

CO1- Understand the origin and development of Operations Research

CO2- Analyze the real life systems with limited constraints

CO3-Identify a problem in your locality, formulate it as an LPP and solve

CO4- Understanding the various laws and theorems related to electric networks

CO5The students will be able to recognize strategic environments and to use Game Theory.

Catalog Description

This course covers some core areas of Operational Research, namely Linear programming,, Transportation problem network analysis and Game Theory. Emphasis will be placed both on the mathematical techniques and on problem formulation through examples from applications.

Course Content

Unit I: **14 lecture hours**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

Unit II: **8 lecture hours**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming.
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

Unit III: **11 lecture hours**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Unit IV: **12 lecture hours**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

Text Books

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008.
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the origin and development of Operations Research	**PO1, PO2**
CO2	Analyze the real life systems with limited constraints	**PO12**
CO3	Identify a problem in your locality, formulate it as an LPP and solve	**PO4, PO2**
CO4	Understanding the various laws and theorems related to electric networks	**PO3**
CO5	The students will be able to recognize strategic environments and to use Game Theory	**PO5, PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 676A	Operations Research	3	2	3	3	2								3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETMC 677A	Cost Management Of Engineering Projects	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

The objective of this course is to help you in developing your knowledge and understanding of Cost Management Principles.

1. Recognize and apply appropriate theories, principles and concepts relevant to cost management.
2. Exercise appropriate judgment in selecting and presenting information using various methods relevant to cost management.
3. Plan, design and execute practical activities using techniques and procedures appropriate to cost management.
4. Respond to change within the external and internal business environments and its effect on cost management.
5. Develop appropriate effective written and oral communication skills relevant to cost management.
6. Use organization skills (including task and time management) relevant to cost management both individually and in a group situation.
7. Solve problems relevant to cost management using ideas and techniques some of which are at the forefront of the discipline.

Course Outcomes

On completion of this course, the students will be able to

CO1. To appreciate the use of different costs for different purposes.

CO2.Explain traditional and contemporary approaches to cost allocation.

CO3. Describe different product costing scenarios in job-order and process environments.

CO4. Identify relevant information for decision making purposes in order to produce financial analyses for a range of decisions such as product-mix, pricing, outsourcing and special orders.

CO5. Use standard costs to prepare budgets for planning and control purposes.

Catalog Description

The Cost Management course addresses the identification, elaboration, planning, and management of the project budget. Including selected processes from the PMI Integration, Cost, Scope and Risk Knowledge

Areas, this class addresses the development of a Project Cost Estimate, Project Budget, and the Project Budget Baseline. In addition it addresses the preparation of a spending profile that supports variance analysis and corrective action using Earned Value Management. Using a combination of theory based lecture and hands on exercises, students are provided with an effective skill set for developing and controlling the project budget baseline.

Course Content

UNIT I **8 hours**

Introduction and Overview of the Strategic Cost Management Process

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control;

UNIT II **8 hours**

Provision of data for Decision-Making Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance.

UNIT III **7 hours**

Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing,

Life Cycle Costing. Costing of service sector.

UNIT IV **7 hours**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

TEXT BOOKS:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To appreciate the use of different costs for different purposes.	**PO1**
CO2	Explain traditional and contemporary approaches to cost allocation	**PO4**
CO3	Describe different product costing scenarios in job-order and process environments.	**PO7**
CO4	Identify relevant information for decision making purposes in order to produce financial analyses for a range of decisions such as product-mix, pricing, outsourcing and special orders.	**PO11**
CO5	Use standard costs to prepare budgets for planning and control purposes.	**PO3, PO5**

Course Code	Course Title	Engineering Knowledge PO1	Problem analysis PO2	Design/development of solutions PO3	Conduct investigations of complex problems PO4	Modern tool usage PO5	The engineer and society PO6	Environment and sustainability PO7	Ethics PO8	Individual or team work PO9	Communication PO10	Project management and finance PO11	Life-long Learning PO12	Application of Concepts PSO1	Research Oriented PSO2	Global Perspective PSO3	Reasoning and Communication Skills PSO4
ETMC 677A	COST MANAGEMENT OF ENGINEERING PROJECTS	3		3	3	3		3				3		3	2	3	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETME 821A	**Waste To Energy**	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Basics of waste and energy				
Co-requisites	--				

Course Objectives:

The subject expects students to achieve the following objectives.

1. Understand of the concept of Waste to Energy.
2. Link legal, technical and management principles for production of energy form waste.
3. Learn about the best available technologies for waste to energy.
4. Analyse of case studies for understanding success and failures.
5. Facilitate the students in developing skills in the decision-making process.

Course Outcomes:

Upon the completion of this course the students will be able to:

CO1.Apply the knowledge about the operations of Waste to Energy Plants.

CO2.Analyse the various aspects of Waste to Energy Management Systems.

CO3.Carry out Techno-economic feasibility for Waste to Energy Plants.

CO4. Apply the knowledge in planning and operations of Waste to Energy plants.

Catalog Description

This course gives introductory knowledge about Waste to Energy conversion system,and utilization in various field. It enables the students to understand the waste to energy management system systems. This course is also helping students to answer fundamental questions of waste To Energy at the time of the interview.

Course Content

Unit I: **08 lecture hours**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Unit II: **12 lecture hours**

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit III: **06 lecture hours**

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction, and operation - Operation of all the above biomass combustors.

Unit IV: **12 lecture hours**

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy program in India.

TEXTBOOKS:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Handbook - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

REFERENCE BOOKS:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.

2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Apply the knowledge about the operations of Waste to Energy Plants.	**PO1**
CO2	Analyze the various aspects of Waste to Energy Management Systems.	**PO4**
CO3	Carry out Techno-economic feasibility for Waste to Energy Plants.	**PO2**
CO4	Apply the knowledge in planning and operations of Waste to Energy plants.	**PO7**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETME 821A	Waste to Energy	2	3		3			3						3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS659A	**Dissertation-I/Industrial Project**	L	T	P	C
Version 1.0		0	-	0	10
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
3. To learn the art of technical report writing
4. To learn the art of verbal communication with the help of modern presentation techniques

Course Outcomes

On completion of this course, the students will be able to

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Have practical knowledge on the applications of topic of study on society.

Catalog Description

This is the first part of the major dissertation/industrial project wherein every student shall be expected to contribute to domain knowledge incrementally. It is expected that the research/project work should be focused in a particular area for concept, design, implementation and/or analysis. Each student will have to undertake a research/project work under a supervisor. Research/project work may be carried out within department or in any other academic / research / industrial / commercial organization under the guidance of the thesis supervisor who must be a faculty member of the department or under a joint supervision including at least one such faculty member. The work will have to be carried out during the 5th semester of study. The student will have to submit a typewritten or printed report on the work done by him / her according to a schedule to be announced by the department. The project-report should be duly approved by the supervisor concerned and should embody results of research / development work carried out by the student.

Student will be continuously evaluated during the semester in form of Dissertation/project Progress Seminars. At the end of the semester, assessment of the research/project work of each student will be made by the board of examiners including supervisors on the basis of a viva-voce examination and the report submitted by the student.

Course Content

The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic.
2. Preparing an Action Plan for conducting the investigation, including team work.
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
4. Final development of product/process, testing, results, conclusions and future directions.
5. Preparing a report in the standard format for being evaluated by the Department.
6. Final Dissertation Presentation before a Departmental Committee.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Carry out the extensive literature survey.	PO2
CO2	Learn to write and present technical reports/articles.	PO5

CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	**PO2**
CO4	Have practical knowledge on the applications of topic of study on society.	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 659A	Dissertation-I/Industrial Project		3			3	3							3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS662A	**Dissertation-II**	L	T	P	C
Version 1.0		-	-	32	16
Pre-requisites/Exposure	Dissertation-I				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
3. To learn the art of technical report writing
4. To learn the art of verbal communication with the help of modern presentation techniques.

Course Outcomes

On completion of this course, the students will be able to

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.

Catalog Description

This will be culmination of Dissertation I of semester V. Research work may be carried out with in department or in any other academic / research / industrial / commercial organization under the guidance of the thesis supervisor who must be a faculty member of the depart mentor under a joint supervision including at least one such faculty member. The student will have to submit typewritten or printed report on the work done by him / her according to a schedule
to be announced by the department. The project-report should be duly approved by the supervisor concerned and should embody results of research / development work carried out
by the student.

Student will be continuously evaluated during the semester in form of Dissertation Progress Seminars. At the end of the semester, assessment of the research work of each student will be made by the board of examiners including supervisors on the basis of a viva-voce examination and the report submitted by the student.

Students are required to publish their research work in form of research publication. The
result will be declared only after acceptance or publication of full length paper in peer reviewed Conference or Journal.

Course Content

The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic.
2. Preparing an Action Plan for conducting the investigation, including team work.
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
4. Final development of product/process, testing, results, conclusions and future directions.
5. Preparing a report in the standard format for being evaluated by the Department.
6. Final Dissertation Presentation before a Departmental Committee.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Carry out the extensive literature survey.	PO2
CO2	Learn to write and present technical reports/articles.	PO5

CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	**PO2**
CO4	Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 662A	Dissertation-II		3			3	3							3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

6.2 Scheme of studies- M.Tech(CSE) with specialization software engineering- Part Time:

Semester I

SNo	Course Code	Course Title	L	T	P	C
1	ETCS 601P	Design and Analysis of Algorithms	3	1	-	4
2	ETCS 627P	Advanced Software Engineering	3	1	-	4
3	ETCS 629P	Software Measurements and Metrics	3	1	-	4
4	ETCS 651P	Design and Analysis of Algorithms Lab	-	-	2	1
5	ETCS 669P	Advanced Software Engineering Lab	-	-	2	1
6		Audit Course - I *	2	-	-	-
TOTAL			**11**	**3**	**4**	**14**

SEMESTER II

SNo	Course Code	Course Title	L	T	P	C
1	ETCS 620P	Object Oriented Software Engineering	3	1	-	4
2	ETCS 622P	Software Architecture and Design Patterns	3	1	-	4
3	ETCS 624P	Software Testing Techniques	3	1	-	4
4	ETCS 664P	Object Oriented Software Engineering Lab	-	-	2	1
5	ETCS 666P	Software Testing Techniques Lab	-	-	2	1
6		Audit Course - II*	2	-	-	-
TOTAL			**11**	**3**	**4**	**14**

SEMESTER III

SNo	Course Code	Course Title	L	T	P	C
1	ETCS 631P	Software Requirement and Estimation	3	1	-	4
2	ETCS 633P	Software Quality Assurance	3	1	-	4
3	ETCS 635P	Service Oriented Architecture	3	1	-	4
4	**Departmental Electives (with lab)**					
i	ETCS 613P	Advanced Data Base Management System	3	1	-	4
	ETCS 655P	Advanced Data Base Management System Lab	-	-	2	1
ii	ETCS 615P	Soft Computing	3	1	-	4
	ETCS 657P	Soft Computing Lab	-	-	2	1
iii	ETCS 617P	Data Preparation and Analysis	3	1	-	4
	ETCS 659P	Data Preparation and Analysis Lab	-	-	2	1
TOTAL			**12**	**4**	**2**	**17**

SEMESTER IV

SNo	Course Code	Course Title	L	T	P	C
1	ETCS 626P	Software Reliability and Reuse	4	-	-	4
2	ETCS 628P	Software Reverse Engineering	4	-	-	4
3	ETCS 630P	Software Security	4	-	-	4
4	**Departmental Electives (with lab)**					
i	ETCS 614P	Android Security	3	1	-	4
	ETCS 656P	Android Security Lab	-	-	2	1
ii	ETCS 616P	Formal Methods for Security	3	1	-	4
	ETCS 658P	Formal Methods for Security Lab	-	-	2	1
iii	ETCS 618P	Blockchain Technology	3	1	-	4
	ETCS 660P	Blockchain Technology Lab	-	-	2	1
TOTAL			**15**	**1**	**2**	**17**

SEMESTER V

SNo	Course Code	Course Title	L	T	P	C
1	ETCS 637P	Agile Software Engineering	3	1	-	4
2	**Departmental Electives (with lab)**					
i	ETCS 621P	Cloud Computing and Security	3	1	-	4
	ETCS 661P	Cloud Computing and Security Lab	-	-	2	1
ii	ETCS 623P	Internet of Things and Security	3	1	-	4
	ETCS 663P	Internet of Things and Security Lab	-	-	2	1
iii	ETCS 625P	Big Data Analytics	3	1	-	4
	ETCS 665P	Big Data Analytics Lab	-	-	2	1
3	ETCS 667P	Dissertation-I	-	-	20	10
TOTAL			**6**	**2**	**22**	**19**

SEMESTER VI

1	ETCS 662P	Dissertation-II	-	-	32	16
TOTAL			**0**	**0**	**32**	**16**

ETCS601P	**Design and analysis of algorithms**	L	T	P	C

Version 1.0		3	1	0	4
Pre-requisites/Exposure	Advanced Computer Programming				
Co-requisites	--				

Course Objectives

1. The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
2. Students should be able to understand the necessary divide and conquer algorithms.
3. To familiarize students with greedy and dynamic programming concepts
4. Student should be able to come up with analysis of efficiency and proofs of correctness.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the implementation of symbol table using hashing techniques.
CO 2 Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
CO 3 Understanding the concept and usage of greedy and dynamic programming
CO 4 Understanding the concept of backtracking, branch and bound technique.

Catalog Description

This course imparts the basic concepts of advance data structures and algorithms. It enables them to write algorithms for solving problems with the help of fundamental data structures. The course of data structures help organizing the data in variety of ways to solve the problem efficiently. The objective of this course is to study paradigms and approaches used to design and analyze algorithms and to appreciate the impact of algorithm design in practice.

Course Content

Unit I: 8 lecture hours

Introduction to Algorithms: Algorithms and their Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notations

Divide and Conquer Algorithms: General Method, Analyzing Divide and Conquer Algorithms, Applications - Binary Search, Merge Sort, Heap Sort, Priority Queues, Quick Sort, Strassen's Matrix Multiplication.

Unit II: 12 lecture hours

Advanced Analysis Techniques: Probabilistic Analysis, Amortized Analysis.

Review of Data Structures: Stacks, Queues, Trees, Binary Trees, Binary Search Trees, Graphs – Representation and Traversal, B-Trees, Data Structures for Disjoint Sets.

Advanced Data Structures: Splay Trees, Binomial Heaps, Fibonacci Heaps

Unit III: 12 lecture hours

Greedy Programming: Fractional Knapsack Problem, Minimum Spanning Tree, Task Scheduling, Activity Selection Problem, Single Source Shortest Path.

Dynamic Programming: Longest Common Subsequence, 0-1 Knapsack Problem, Shortest Path Problems (Single-Source and All-Pair), Travelling Salesperson problem.

Unit IV: 8 lecture hours

Backtracking: General Method, N-queens Problem, Sum of Subset Problem, Graph Colouring, Longest Common Subsequence

Branch and Bound Technique: General Method, 0/1 Knapsack problem, Travelling Salesperson problem.

Max-flow: Flow Networks, Ford-Fulkerson Method, Bipartite Matching

Polynomials and FFT: Representation of Polynomials, DFT and FFT, Efficient FFT

Implementations

Text Books

1. 1 T H Cormen, C E Leiserson, and R L Rivest, Introduction to Algorithms, Pearsons.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

Reference Books/Materials

1. Schaum's outline series, "Data Structure", McGraw Hills.

2. Y. Langsamet. al., "Data Structures using C and C++", PHI.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the implementation of symbol table using hashing techniques.	**PO1**
CO2	Develop and analyze algorithms for red-black trees, B-trees and Splay trees.	**PO4**
CO3	Understanding the concept and usage of greedy and dynamic programming	**PO5**
CO4	Understanding the concept of backtracking, branch and bound technique.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 601P	Design and analysis of algorithms	2	2		3	3								3	2	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 627P	**Advance Software Engineering**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Software Engineering				
Co-requisites	--				

Course Objectives

1. To understand Software Engineering Lifecycle Models
2. To do project management and cost estimation
3. To gain knowledge of the System Analysis and Design concepts.
4. To understand software testing approaches

Course Outcomes

On completion of this course, the students will be able to:

CO1. Understand the advantages of various Software Development Lifecycle Models

CO2. Gain knowledge on project management approaches as well as cost and schedule estimation strategies

CO3. Perform formal analysis on specifications

CO4. Architect and design using architectural styles and design patterns

CO5. Understand software testing approaches and maintenance process

Catalog Description

This course exposes students to the advanced problems of software engineering. After mastering the basics of requirements engineering, design, and testing, we explore maintenance and evolution, project and quality management, as well as the engineering for distinct quality characteristics

Course Content

Unit I: **10 lecture hours**

Introduction: Software Crisis, Software Processes & Characteristics, Software life cycle models, Waterfall, Prototype, Evolutionary and Spiral Models, Overview of Quality Standards like ISO 9001, SEI – CMM.

Software Requirements analysis & specifications: Requirement engineering, requirement elicitation techniques like FAST, QFD & Use case approach, requirements analysis using DFD, Data dictionaries & ER Diagrams, Requirement’s documentation, Nature of SRS, Characteristics & organization of SRS.

Unit II: **12 lecture hours**

Software Architecture: Role of Software Architecture, Architecture views, Component and Connector view: Components, Connectors, Architecture style for C and C view: pipe and filter, shared data style, client server style, Evaluating Architecture.

Software Project Planning: Size Estimation like lines of Code & Function Count, Cost Estimation Models, Static single & Multivariable Models, COCOMO, COCOMO-II, Putnam resource allocation model, Risk Management.

Unit III: **10 lecture hours**

Software Design: Cohesion & Coupling, Classification of Cohesiveness & Coupling, Function Oriented Design, Object Oriented Design, User Interface Design.

Software Maintenance: Management of Maintenance, Maintenance Process, Maintenance Models, Reverse Engineering, Software Re-engineering, Configuration Management, Documentation.

Software Metrics: Software measurements: What & Why, Token Count, Halstead Software Science Measures, Design Metrics, Data Structure Metrics, Information Flow Metrics

Unit IV: **8 lecture hours**

Software Testing: Testing process, Design of test cases, functional testing: Boundary value analysis, Equivalence class testing, Decision table testing, Cause effect graphing, Structural testing, Path Testing, Data flow and mutation testing, Unit Testing, Integration and System Testing, Debugging, Alpha & Beta Testing, Regression Testing, Testing Tools & Standards.

Software Reliability: Importance, Hardware Reliability & Software Reliability, Failure and Faults, Reliability Models, Basic Model, Logarithmic Poisson Model, Calendar time Component.

Text Books

1. K. K. Aggarwal & Yogesh Singh, "Software Engineering", New Age International.
2. R. S. Pressman, "Software Engineering – A practitioner's approach", McGraw Hill Int. Ed..

Reference Books/Materials

1 Stephen R. Schach, "Classical &Object Oriented Software Engineering", IRWIN, TMH.
2 James Peter, W. Pedrycz, "Software Engineering: An Engineering Approach", John Wiley & Sons.
3 Sommerville, "Software Engineering", Addison Wesley.

4 K. Chandrasehakhar, “Software Engineering & Quality Assurance”, BPB.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the advantages of various Software Development Lifecycle Models	**PO1**
CO2	Gain knowledge on project management approaches as well as cost and schedule estimation strategies	**PO2**
CO3	Perform formal analysis on specifications	**PO3**
CO4	Architect and design using architectural styles and design patterns	**PO4**
CO5	Understand software testing approaches and maintenance process	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 627P	Advance Software Engineering	2	2	3	3	3								3	2	3	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS629P	**Software Measurements And Metrics**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Software Engineering				
Co-requisites	--				

Course Objectives

1. To get an overview of Measurement theory (overview of software metrics, basics of measurement theory, goal-based framework for software measurement, empirical investigation in software engineering)
2. To provide a solid background knowledge about software metrics.
3. To educate various metrics and models to assess software.
4. To provide hands on experience on using and implementing metrics.
5. To provide the idea of decomposing the given problem into Analysis, Design, Implementation, Testing and Maintenance phases.
6. To provide an idea of using various process models in the software industry according to given circumstances.
7. To study about Measurement management

Course Outcomes

On completion of this course, the students will be able to

CO1. To acquire knowledge about software metrics.

CO2.To assess software using various metrics and models.

CO3.To use and implement different metrics.

CO4.Apply analysis and design principles at various levels and various views in different domains of software systems.

CO5.To represent engineering problems graphically by drawing all UML diagrams.

CO6.To be able to decompose the given project in various phases of a lifecycle.

CO7.To be able to choose appropriate process model depending on the user requirements.

CO8. To be able to apply various life cycle activities like Analysis, Design, Implementation, Testing and Maintenance.

Catalog Description

This course is a step by step description of the software metrics. It includes introduction to foundations of measurement theory, models of software engineering measurement, software products metrics, software process metrics and measuring management.

Course Content

Unit I: **12 lecture hours**

Measurement and Basics of Measurement - Measurement in Everyday Life, Measurement in Software Engineering, Scope of Software Metrics, Representational Theory of Measurement, Measurement and Models, Measurement Scales and Scale Types.

Unit II: **8 lecture hours**

Goal-Based Frame Work for Software Measurement - Classifying Software Measures, Determining what to measure, Applying Frame Work, Software Measurement Validation Software Metrics Data Collection - Good Data, Definition of Data, Collecting, Storing and Extracting Data.

Measuring Internal Product Attributes – Size - Aspects of software size, Length, Reuse, Functionality, Complexity.

Measuring External Product Attributes - Modeling Software Quality, Measuring Aspects of Quality

Unit III: **12 lecture hours**

Structure - Types of structural measures, Control-flow structure, Modularity and information flow attributes.

Object-Oriented Metrics - Object-Oriented Concepts and Constructs, Design and Complexity metrics, Productivity Metrics, Quality and Quality Management Metrics.

Unit IV: **8 lecture hours**

Software Quality Metrics Overview - Product Quality Metrics, In-Process Quality Metrics,

Metrics for Software Maintenance, Examples of Metrics Programs-Motorola, HP, IBM, Collecting Software Engineering Data, Applying the Seven Basic Quality Tools in Software Development.

Text Books

1. Fenton, Pfleeger, “Software Metrics,” 2nd Edition, Thomson, 2005.

Reference Books/Materials

1. Stephen H. Kan, “Metrics and Models in Software Quality Engineering,” 2nd Edition, Addison Wesley, 2011.
2. C RavindranathPandian, Software Metrics: A Guide to planning, Analysis, and Application, Auerbach , 2011

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To acquire knowledge about software metrics.	**PO2**
CO2	To assess software using various metrics and models.	**PO3**
CO3	To use and implement different metrics.	**PO4**
CO4	Apply analysis and design principles at various levels and various views in different domains of software	**PO5**

	systems.	
CO5	To represent engineering problems graphically by drawing all UML diagrams.	**PO4,PSO2**
CO6	To be able to decompose the given project in various phases of a lifecycle.	**PO4, PSO3**
CO7	To be able to choose appropriate process model depending on the user requirements.	**PO9**
CO8	To be able to apply various life cycle activities like Analysis, Design, Implementation, Testing and Maintenance.	**PSO1**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 629P	SOFTWARE MEASUREMENTS AND METRICS		2	3	3	3				3				3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS651P	**Design and analysis of algorithms Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning				
Co-requisites	--				

Course Objectives

1. To understand concept of different sorting algorithms.
2. To understand the concept of dynamic programming.
3. To understand concept of divide and conquer.
4. To understand Dictionary (ADT)
5. To understand concept of greedy algorithms.
6. To understand concept & features like max heap, min heap

Course Outcomes

On completion of this course, the students will be able to

CO 1 Student will be able to implement optimal solution for various dynamic problems.

CO 2 To understand various sorting techniques.

CO 3 Analyze working of various operations on graphs.

CO 4 To understand concept of string matching in data structure

Course Content

List of Experiments

1	To analyze time complexity of insertion sort	**2 lab hours**
2	To analyze time complexity of Quick sort	**2 lab hours**
3	To analyze time complexity of merge sort	**2 lab hours**
4	Implement Largest Common Subsequence.	**2 lab hours**
5	To Implement Optimal Binary Search Tree.	**2 lab hours**
6	To Implement Matrix Chain Multiplication.	**2 lab hours**

7	To Implement Strassen's matrix multiplication Algorithm.	**2 lab hours**
8	To implement Knapsack Problem.	**2 lab hours**
9	To implement Activity Selection Problem.	**2 lab hours**
10	To implement Dijkstra's Algorithm.	**2 lab hours**
11	To implement Warshall's Algorithm.	**2 Labs**
12	To implement Bellman Ford's Algorithm.	**2 Labs**
13	To implement Depth First Search Algorithm.	**1 Lab**
14	To implement BreadthFirst Search Algorithm.	**1 Lab**
15	To implement NaïveString MatchingAlgorithm.	**1 Lab**
16	To implement Rabin Karp String MatchingAlgorithm	**1 Lab**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the implementation of symbol table using hashing techniques.	**PO1**
CO2	Develop and analyze algorithms for red-black trees, B-trees and Splay trees.	**PO4**
CO3	Understanding the concept and usage of greedy and dynamic programming	**PO5**
CO4	Understanding the concept of backtracking, branch and bound technique.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 651P	Design and analysis of algorithms Lab	2	2		3	3								3	2		2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 669P	ADVANCE SOFTWARE ENGINEERING LAB	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Software Engineering				
Co-requisites	--				

Course Objectives

1. To understand Software Engineering Lifecycle Models
2. To do project management and cost estimation
3. To gain knowledge of the System Analysis and Design concepts.
4. To understand software testing approaches

Course Outcomes

On completion of this course, the students will be able to:

CO1. Understand the advantages of various Software Development Lifecycle Models

CO2. Gain knowledge on project management approaches as well as cost and schedule estimation strategies

CO3. Perform formal analysis on specifications

CO4. Architect and design using architectural styles and design patterns

CO5. Understand software testing approaches and maintenance process

Catalog Description

Based on theory subject **ETCS 627P**, the following experiments are to be performed. It enables students to understand the use the software engineering concept and use them practically to develop quality software.

List of Experiments (Indicative)

1	Prepare the Software Requirement Specification (SRS), High Level Design (HLD) and Detailed Design (DD) for Employee Information System **Note:** For the reference of SRS, HLD and DD templates refer	**4 lab hours**

	department manual anduse any opensource Requirement documentation tool	
2	Prepare the Software Requirement Specification (SRS), High Level Design (HLD) and Detailed Design (DD) for Online Airline Reservation **Note:** For the reference of SRS, HLD and DD templates refer department manual anduse any open source Requirement documentation tool	**4 lab hours**
3	Estimate project parameters such as size, effort and time for development for aLibrary Information system using Basic COCOMO model.	**4 lab hours**
4	Model UML Use case, Sequence, Collaboration and Component diagrams using Argo UML tool for Students Marks Analyzing System.	**4 lab hours**
5	Model UML Use case, Sequence, Collaboration and Component diagrams using Argo UML tool for Course Registration System.	**4 lab hours**
6	Study and prepare a report for Raptor-Flowchart based programming tool.	**4 lab hours**
7	Study and prepare a report for Visio 2010programing tool.	**4 lab hours**
8	Study and prepare a report for Jenkins programming tool.	**4 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the advantages of various Software Development Lifecycle Models	**PO1**
CO2	Gain knowledge on project management approaches as well as cost and schedule estimation strategies	**PO2**
CO3	Perform formal analysis on specifications	**PO3**
CO4	Architect and design using architectural styles and design patterns	**PO4**
CO5	Understand software testing approaches and maintenance process	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 669P	Advance Software Engineering Lab	2	2	3	3	3								3	2	3	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 620P	**Object Oriented Software Engineering**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Software Engineering				
Co-requisites	--				

Course Objectives

1. Understand the fundamental phases of software development and the principles underlying object-oriented software design.
2. Understand modeling various Models in UML
3. Learning about various object-oriented software engineering testing techniques

Course Outcomes

On completion of this course, the students will be able to:

CO1. Learn various concepts under object-oriented design.

CO2. To learn various modeling techniques to model different perspectives of object-oriented software design (UML)

CO3. Ability to abstract object-based views for generic software systems

CO4. Develop error identification and testing strategies for code development.

Catalog Description

Introduction to the advanced techniques for designing, implementing, and testing computer software with a particular focus on using object-oriented design, analysis and programming to produce high quality computer programs that solve non-trivial problems.

Course Content

Unit I: 10 lecture hours

Object Oriented Concepts and Modeling: Introduction to class, Object, inheritance, polymorphism, Importance of Modeling, Object Oriented Modeling, Object oriented system development, Function/data methods, Object oriented analysis, Object oriented construction, Object oriented testing, Identifying the elements of an object model, Identifying classes and objects, Specifying the attributes, Defining operations, Finalizing the object definition

Introduction to UML: Overview of UML, Conceptual Model of UML, Architecture, Basic Structural Modeling, UML Diagrams, Software Development Life Cycle

Unit II: 10 lecture hours

Basic and Advanced Structural Modeling: Classes Relationship, Common mechanism, Class diagram, Advanced classes, Advanced Relationship, Interface, Types and Roles, Packages, Object Diagram

Basic Behavioral Modeling: Interactions, Use cases, Use Case Diagram, Interaction Diagram, Activity Diagram, State chart Diagram

Unit III: 8 lecture hours

Architectural Modeling: Component, Components Diagram, Deployment Diagram

Object Oriented Design: Generic components of OO Design model, System Design process: Partitioning the analysis model, Concurrency and subsystem allocation, Task Management component, Data Mgmt component, Resource Mgmt component, Inter sub-system communication, Object Design process

Unit IV: 12 lecture hours

Testing Object Oriented Systems: Overview of Testing and object-oriented Testing, Types of Testing, Object oriented Testing strategies, Test case design for OO software, Inter class test case design, State Based testing and Data flow testing for Classes, Component Based Computing,

Fundamentals: Definition and nature of components, components and interfaces, Interfaces as contracts, the benefits of components.
Basic Techniques: component design and assembly, Relationship with the client-server model and with patterns, Use of objects and object lifecycle services, use of object brokers

Text Books

1. Booch, Rumbaugh & Jacobson "The Unified Modeling Language User Guide", Addison-Wesley

2. Ivar Jacobson "Object Oriented Software Engineering: A Use Case Driven Approach", Addison-Wesley
3. Grady Booch "Object-Oriented Analysis and Design with Applications", 2/E, Addison-Wesley Professional.

Reference Books/Materials

1. R. S. Pressman, "Software Engineering – A practitioner's approach", McGraw Hill Int. Ed.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn various concepts under object-oriented design.	**PO1**
CO2	To learn various modeling techniques to model different perspectives of object-oriented software design (UML)	**PO3, PO5**
CO3	Ability to abstract object-based views for generic software systems	**PO1**
CO4	Develop error identification and testing strategies for code development.	**PO2, PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 620P	Object Oriented Software Engineering	2	2	3	3	3								3	2	3	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 622P	Software Architecture And Design Patterns	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Software Engineering				
Co-requisites	--				

Course Objectives

1. Understand the creational and structural patterns.
2. Be capable of applying his knowledge to create an architecture for given application.
3. Be able to explain the role of analyzing architectures.
4. Be able to identify different structural patterns.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand the architecture, creating it and moving from one to any, different structural patterns.
CO2. Analyze the architecture and build the system from the components.
CO3. Design creational and structural patterns.
CO4. Learn about behavioral patterns.
CO5. Do a case study in utilizing architectural structures.

Catalog Description

This is a project-oriented course intended to give students hands-on experience in using a variety of analysis techniques to evaluate cryptographic protocols and other security mechanisms. A network protocol such as SSL (Secure Sockets Layer) may fail in three ways: the protocol design may be flawed, the cryptography may be inadequate, or the implementation may be buggy. This course is primarily concerned with techniques for identifying design flaws, but we will also talk about cryptography and secure implementation to the extent that they affect protocol design.

Course Content

Unit I: **12 lecture hours**

Introduction to Software Architecture, Software Processes and the ABC, Architectural Patterns, Reference Model and Reference Architecture.

Unit II: **10 lecture hours**

Understanding the Requirements: Functionality and Architecture, Architecture and Quality Attributes (QA), System QAs, QA Scenarios in Practice, Business and Architecture Qualities, Achieving Qualities.

Designing the Architecture: Architecture in the Life Cycle, Attribute Driven Design (ADD).

Documenting Software Architectures: Uses of Architectural Documentation, Views.

Reconstructing Software Architectures: Information Extraction, Database Construction, View Fusion and Reconstruction.

Unit III: **10 lecture hours**

Evaluating the Architecture: The ATAM, The CBAM. The World Wide Web-A Case Study in Interoperability

Moving From one System to Many: Software Product Lines, Celsius Tech- A Case Study in Product Line Development, Building Systems from off the shelf components, Software Architecture in the future.

Unit IV: **8 lecture hours**

Introduction to Design Patterns: Design Patterns in Smalltalk MVC, Describing DPs, The Catalog of DPs, Organizing the Catalog, Design Pattern to Solve Design Problem, Select and use of a DP.

Creational Patterns: Abstract Factory, Builder, Factory Method, Prototype.

Structural Patterns: Adapter, Composite, Decorator, Flyweight.

Behavioral patterns: Command, Iterator, Mediator, Observer, State.

Text Books

1. Len Bass, Paul Clements and Rick Kazman, "Software Architecture in Practice," Addison-Wesley.

Reference Books/Materials

1. Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides"Design Patterns: Elements of Reusable Object-Oriented Software," Pearson Education.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the architecture, creating it and moving from one to any, different structural patterns.	**PO2**
CO2	Analyze the architecture and build the system from the components.	**PO2**
CO3	Design creational and structural patterns.	**PO3**
CO4	Learn about behavioral patterns.	**PO12**
CO5	Do a case study in utilizing architectural structures.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 622P	Security Analysis of Protocols		3	3	3								3	3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 664P	**Object Oriented Software Engineering Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Software Engineering				
Co-requisites	--				

Course Objectives

1. Understand the fundamental phases of software development and the principles underlying object-oriented software design.
2. Understand modeling various Models in UML
3. Learning about various object-oriented software engineering testing techniques

Course Outcomes

On completion of this course, the students will be able to:

CO1. Learn various concepts under object-oriented design.

CO2. To learn various modeling techniques to model different perspectives of object-oriented software design (UML)

CO3. Ability to abstract object-based views for generic software systems

CO4. Develop error identification and testing strategies for code development.

Catalog Description

Based on theory subject **ETCS 620P**, the following experiments are to be performed. It enables students to understand the use the Object- Oriented Software Engineering concept and use them practically to develop quality software.

List of Experiments (Indicative)

1	Represent the following concepts of OOSE using suitable UML symbols:Association, Composition, Activity, Classes, Interface etc.	**4 lab hours**
2	Create a Usecase diagram of Airline Reservation System.	**4 lab hours**
3	Create a class diagram of Airline Reservation System or any suitable case study.	**4 lab hours**
4	Create an Activity Diagram for the above problem.	**4 lab hours**

5	Design JUnit test cases to test a given Java code. Test cases should cover checking of boundary value analysis, complete path coverage etc.	**4 lab hours**
6	Execute the test cases written in Experiment 5, above, and determine the code coverage through those test cases.	**4 lab hours**
7	Create Javadoc of a given Java project.	**4 lab hours**
8	Create Javadoc of a given Java project.	**4 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Learn various concepts under object-oriented design.	**PO1**
CO2	To learn various modeling techniques to model different perspectives of object-oriented software design (UML)	**PO3, PO5**
CO3	Ability to abstract object-based views for generic software systems	**PO1**
CO4	Develop error identification and testing strategies for code development.	**PO2, PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 664P	Object Oriented Software Engineering Lab	2	2	3	3	3								3	2	3	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 666P	**SOFTWARE TESTING TECHNIQUES LAB**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Basics of Software Engineering				
Co-requisites	--				

Course Objectives

1. To study fundamental concepts in software testing.

2.To discuss various software testing issues and solutions in software unit test, integration and system testing.

3.To expose the advanced software testing topics, such as object-oriented software testing methods.

4. To gain software testing experience by applying software testing knowledge and methods to practice-oriented software testing projects.

5. To understand software test automation problems and solutions.

6. To learn how to write software testing documents, and communicate with engineers in various forms.

7. To gain the techniques and skills on how to use modern software testing tools to support software testing projects.

Course Outcomes

On completion of this course, the students will be able to

CO1. Have an ability to apply software testing knowledge and engineering methods.

CO2. Have an ability to design and conduct a software test process for a software testing project.

CO3. Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.

CO4. Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.

CO5.Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.

CO6. Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problem.

CO7. Have an ability to use software testing methods and modern software testing tools for their testing projects.

Catalog Description

After completing this course, you will understand the fundamental principles and processes of software testing. You will have actively created test cases and run them using an automated testing tool. You will be being writing and recognizing good test cases, including input data and expected outcomes.

List of Experiments (Indicative)

1	Consider an automated banking application. The user can dial the bank from a personal computer, provide a six-digit password, and follow with a series of keyword commands that activate the banking function. The software for the application accepts data in the following form: Design adhoc test cases to test the system	3 lab hours
2	For the above problem design the test cases to test the system using following Black Box testing technique: BVA, Worst BVA, Robust BVA, Robust Worst BVA and Equivalence class testing (Input/Output domain)	3 lab hours
3	Study of any open source testing tool (Web Performance Analyzer/OSTA/selenium)	3 lab hours
4	Consider an application that is required to validate a number according to the following simple rules: a) A number can start with an optional sign. b) The optional sign can be followed by any number of digits. c) The digits can be optionally followed by a decimal point, represented by a period. d) If there is a decimal point, then there should be two digits after the decimal. e) Any number-whether or not it has a decimal point, should be terminated a blank. Generate test cases to test valid and invalid numbers.	4 lab hours
5	Generate test cases using Black box testing technique to Calculate Standard Deduction on Taxable Income. The standard deduction is higher for tax payers who are 65 or older or blind. Use the method given below to calculate tax.	4 lab hours

<table>
<tr><td></td><td>a) The first factor that determines the standard deduction is the filing status. The basic standard deduction for the various filing status are: Single $4,750, Married, filing a joint return $9,500, Married filing a separate return $7,000.

b) If a married couple is filing separate returns and one spouse is not taking standard deduction, the other spouse also is not eligible for standard deduction.

c) An additional $1,000 is allowed as standard deduction, if either the filer is 65 yrs or the spouse is 65 yrs or older (the latter case applicable when the filing status is “married” and filing “joint”).

d) An additional $1,000 is allowed as standard deduction, if either the filer is blind or the spouse is blind (the latter case applicable when the filing status is “married” and filing “joint”)</td><td></td></tr>
<tr><td>6</td><td>Consider the following program segment:

int max (int i, int j, int k)

{

int max;

if (i>j) then

if (i>k) then max=i;

else max=k;

else if (j > k) max=j

else max=k

return (max);

}

a) Draw the control flow graph for this program segment

b) Determine the cyclomatic complexity for this program

c) Determine the independent paths</td><td>4 lab hours</td></tr>
</table>

7	Consider a program to input two numbers and print them in ascending order given below. Find all du paths and identify those du-paths that are not feasible. Also find all dc paths and generate the test cases for all paths (dc paths and non dc paths).
	
	#include<stdio.h>
	
	#include<conio.h>
	
	void main()
	
	{
	
	int a,b,t;
	
	clrscr();
	
	printf("Enter first number");
	
	scanf("%d",&a);
	
	printf("Enter second number");
	
	scanf("%d",&b);
	
	if(a<b){
	
	t=a;
	
	a=b;
	
	b=t;
	
	}
	
	printf("%d %d",a,b);
	
	getch();
	
	}
		4 lab hours

8	Consider the above program and generate possible program slices for all variables. Design at least one test case from every slice.	4 lab hours

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Projects/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Have an ability to apply software testing knowledge and engineering methods.	**PO1**
CO2	Have an ability to design and conduct a software test process for a software testing project.	**PO3**
CO3	Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.	**PO3**
CO4	Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.	**PO4**
CO5	Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.	**PO4**
CO6	Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problem.	**PO5**
CO7	Have an ability to use software testing methods and modern software testing tools for their testing projects.	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS666P	SOFTWARE TESTING TECHNIQUES LAB	3		3	3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 631P	**Software Requirement and Estimation**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

The main objective of the course is to expose the students to Software requirements and estimation. The courses aims to ensure that student

1.Understand the good practices for requirements engineering.

2.Understand Requirements elicitation, elicitation techniques.

3.Understand analysis models, Software quality attributes.

4.Understand software estimation, size estimation.

5.Understand Effort, Schedule and Cost Estimation.

Course Outcomes

On completion of this course, the students will be able to

1. Gain knowledge about software requirements.
2. Analyze requirement elicitation techniques and prototyping.
3. Gain knowledge about requirement management, their principles and practices.
4. Analyze use case modeling and different data diagrams.
5. Estimating the software in terms of size, cost, effort and schedule.

Catalog Description

In this course students will learn how to capture software requirements and handle difficult situations in gathering data to build systems. Special emphasis is given to working with clients and to learning about the needs of users who interact with a system. The course addresses elicitation, specification, and management of software system requirements. Additionally, the course examines iterative prototyping user interactions for a system.

Course Content

Unit I: **10 lecture hours**

Essential Software requirement, Good practices for requirements engineering, Improving requirements processes, Software requirements and risk management.

Software Requirements Engineering: Requirements elicitation, requirements analysis documentation, review, elicitation techniques, analysis models, Software quality attributes, risk reduction through prototyping, setting requirements priorities, verifying requirements quality.

Unit II: **10 lecture hours**

Requirements management, Principles and Practices, Requirements Attributes, Change Management Process, Requirements Traceability Matrix, Links in requirements chain.

Software Requirements Modeling: Use case modeling, Analysis models, Data flow diagrams, State transition diagrams, Class diagrams, and Object analysis.
Components of Software Estimations, Estimation methods, Problems associated with estimation, Key project factors that influence estimation.

Unit III: **10 lecture hours**

Size Estimation-Two views of sizing, Function Point Analysis, Mark II FPA, Full Function Points, LOC Estimation, and Conversion between size measures.
Introduction to Productivity, Estimation Factors, Approaches to Effort and Schedule Estimation, COCOMO II, Putnam Estimation Model, Algorithmic models, Cost Estimation.

Unit IV: **10 lecture hours**

Benefits of using a requirements management tool, commercial requirements management tool, Rational Requisite Pro, Caliber – RM, Implementing requirements management automation. Desirable features in software estimation tools, IFPUG, USC's COCOMO II, SLIM (Software Life Cycle Management) Tools.

TEXT BOOKS:

1. Karl E. Weigers, "Software Requirements," 2nd Edition, Microsoft Press, 2013.
2. Rajesh Naik and Swapna Kishore, "Software Requirements and Estimation," Tata McGraw Hill, 2001.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Gain knowledge about software requirements.	**PO1**
CO2	Analyze requirement elicitation techniques and prototyping.	**PO2, PO3**
CO3	Gain knowledge about requirement management, their principles and practices	**PO4**
CO4	Analyze use case modeling and different data diagrams.	**PO2, PO6**
CO5	Estimating the software in terms of size, cost, effort and schedule.	**PO11; PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 631P	Software Requirement and Estimation	3	3	2	2	2	3					3		3	2	3	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 633P	**Software Quality Assurance**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Concepts of Software Engineering				
Co-requisites					

Course Objectives

1. To describe the need and knowledge of Software Quality.
2. Describe Software Quality Assurance.
3. Explain Software Quality factors
4. To describe elements of Software Quality Assurance
5. Development and quality plans

Course Outcomes

On completion of this course, the students will be able to

1. Understand general concepts about quality, quality assurance (QA), and software quality engineering
2. Choose appropriate testing strategies and develop test cases
3. Understand how to detect, classify, prevent and remove defects
4. Create control flow and data flow testing by using both control flow (graphs) and data flow diagrams respectively and hence getting a clear insight between control flow and data flow testing.

Catalog Description

The aim and objective of this course is to teach students the concepts and skills needed for SQA and Testing. Software quality assurance (SQA or simply QA) is viewed as an activity that runs through the entire development process. It encompasses activities and related techniques to ensure the implementation of appropriate functionality that satisfy the requirements/needs of its targeted client/users for the intended software system, product, or service as the case may be, both correctly and efficiently.

Course Content

Unit I: **10 lecture hours**

Software Quality, Software Quality Control, Software Quality Assurance, Cost of Quality, Framework and Standards SQA Framework, Formal Inspection and technical review, Inspection Role and steps, Software Reliability, Statistical Quality Assurance, SQA Plan, IEEE standards for SQA Plan Software Quality Assurance, Components of Software Quality Assurance, Software Quality Assurance Plan, Quality Standards: ISO 9000 and Companion ISO Standards, CMM, CMMI, PCMM, Malcolm Bridge, Three- Sigma, Six- Sigma

Unit II: **10 lecture hours**

Software Quality Assurance Metrics and Measurement Software Quality Metrics: Product Quality metrics, In Process Quality Metrics, Metrics for Software Maintenance, Examples of Metric Programs. Software Quality metrics methodology. Establish quality requirements, Identify Software quality metrics. Implement the software quality metrics, analyze software metrics results, and validate the software quality metrics, Software quality indicators.

Unit III: **10 lecture hours**

Quality Assurance Clarification: QA as Dealing with Defects, Defect Prevention- Education and Training, Formal Method, Other defect prevention techniques, Defect Reduction- Inspection Direct default detection and removal, Testing failure observation and fault removal, other techniques and risk identification, Defect Containment.

Unit IV: **10 lecture hours**

Quality Assurance in Context- Handling Discovered defect during QA activities, QA Activities in Software Processes, Verification and Validation Perspectives, Reconciling the Two Views, Quality Engineering in Software Process, Software Inspection, and Formal Verification. Quality Assurance Techniques and Activities, Cost Comparison.

Feedback loop and activities for quantifiable Quality Improvement, Quality Models and Measurements, Defect Classification and Analysis, Risk Identification for Quantifiable Quality Improvement, Software Reliability Engineering.

TEXT BOOKS:

1. Effective Methods for Software Testing, 2nd Edition William E. Perry, Second Edition, Wiley.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand general concepts about quality, quality assurance (QA), and software quality engineering	**PO1**
CO2	Choose appropriate testing strategies and develop test cases	**PO2, PO3**
CO3	Understand how to detect, classify, prevent and remove defects	**PO4**
CO4	Create control flow and data flow testing by using both control flow (graphs) and data flow diagrams respectively and hence getting a clear insight between control flow and data flow testing.	**PO6, PO11**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 633P	Software Quality Assurance	3	3	2	3		3					2		3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 635P	**Service Oriented Architecture**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Concepts of Software Engineering				
Co-requisites					

Course Objectives

1. Perform a service-oriented analysis
2. Model service candidates derived from existing business documentation
3. Design the composition of an SOA
4. Design application services for technology abstraction
5. Design business services for business logic abstraction
6. Design service-oriented business processes

Course Outcomes

On completion of this course, the students will be able to

1. Comprehend the need for SOA and its evolution.
2. Explore various patterns of service design and techniques.
3. Formulate experiments with various levels and factors.
4. Demonstrate applicability of SOA in various domains.

Catalog Description

This course focuses on service-oriented architectural model and the service-orientation design paradigm. It will describe Service Oriented Architecture (SOA) concepts and principles, as well as quality considerations for developing modern software systems from a technical and organizational perspective. The aim of this course is to establish a strong understanding of the concepts needed to have an effective working knowledge of SOA methodologies, and SOA systems design.

Course Content

Unit I: **10 lecture hours**

Introducing SOA: Fundamental SOA, Common Characteristics of Contemporary SOA, Common tangible benefits of SOA, Common pitfalls of adopting SOA.

Web Services and Primitive SOA: The Web Services frame work, Services, Service descriptions, Messaging.

Web Services and Contemporary SOA (Part-I Activity Management and Composition): Message Exchange Patterns, Service Activity, Coordination, Atomic transactions, Business Activities, Orchestration, Choreography.

Unit II: 10 lecture hours

Web Services and Contemporary SOA (Part-II Advanced Messaging, Metadata and Security): Addressing, Reliable messaging, Correlation, Policies, Metadata exchange, Security, Notification and eventing.

Principles of Service-Orientation: Anatomy of SOA, Common principles of Service Orientation, Service Orientation and Object Orientation

Service Layers: Service-Orientation and Contemporary SOA, Service Layer Abstraction, Application Service Layer, Business Service Layer, Orchestration Service Layer, Agnostic Services, Service Layer Configuration Scenarios.

Unit III: 10 lecture hours

SOA Delivery Strategies: SOA delivery lifecycle phases, The Top-down strategy, The bottom-up strategy, The agile strategy.

Analysis Introduction: Introduction to Service Oriented Analysis, Benefits of a Business Centric SOA, Deriving Business Services.

Service Modelling: Service Modelling, Service Modelling guidelines, Classifying Service model logic, Contrasting Service modelling approaches.

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Unit IV: 10 lecture hours

Design Introduction: Introduction to Service-Oriented design, WSDL related XML Schema language basics, WSDL language basics, SOAP language basics, Service interface design tools.

Service Design: Service Design overview, Entity-centric business Service Design, Application Service Design, Task-centric business Service Design, Service Design guidelines.

Business Process Design: WS-BPEL language basics, Service Oriented Business process design.

SOA Platforms: SOA platform basics, SOA Support in J2EE, SOA Support in .NET

TEXT BOOK:

1. Thomas Erl, "Service-Oriented Architecture - Concepts, Technology and Design, "Pearson, 2008.

.Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Comprehend the need for SOA and its evolution.	**PO1, PO2**
CO2	Explore various patterns of service design and techniques.	**PO4**
CO3	Formulate experiments with various levels and factors.	**PO5, PO6**
CO4	Demonstrate applicability of SOA in various domains.	**PO11**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 635P	Service Oriented Architecture	2	3		3	2	2					2		2	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 613P	Advanced Database Management System	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Knowledge of Database Management System				
Co-requisites					

Course Objectives

- To understand the basic concepts and terminology related to DBMS and Relational Database Design
- To the design and implement Distributed Databases.
- To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports

Course Outcomes

On completion of this course, the students will be able to

1. Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.
2. Perform Query Optimization.
3. Have knowledge of Parallel and distributed database systems.
4. Have knowledge of new database architectures and query operators.

Catalog Description

The course presupposes a basic knowledge of conceptual modelling for data base systems and implementation using relational DBMS and SQL. The course aims to a more profound understanding of database theories, models, and methods and an ability to use these in different situations.

Course Content

Unit I: 10 lecture hours

Relational Databases: Integrity Constraints revisited, Extended ER diagram, Relational Algebra & Calculus, Functional, Muilti-valued and Join Dependency, Normal Forms, Rules about functional dependencies.

Query Processing and Optimization: Valuation of Relational Operations, Transformation of Relational Expressions, Indexing and Query Optimization, Limitations of Relational Data Model, Null Values and Partial Information.

Unit II: 10 lecture hours

Deductive Databases: Datalog and Recursion, Evaluation of Datalog program, Recursive queries with negation.

Objected Oriented and Object Relational Databases: Modeling Complex Data Semantics, Specialization, Generalization, Aggregation and Association, Objects, Object Identity, Equality and Object Reference, Architecture of Object Oriented and Object Relational Databases

Parallel and Distributed Databases: Distributed Data Storage – Fragmentation & Replication, Location and Fragment Transparency Distributed Query Processing and Optimization, Distributed Transaction Modeling and concurrency Control, Distributed Deadlock, Commit Protocols, Design of Parallel Databases, Parallel Query Evaluation.

Unit III: 10 lecture hours

Advanced Transaction Processing: Nested and Multilevel Transactions, Compensating Transactions and Saga, Long Duration Transactions, Weak Levels of Consistency, Transaction Work Flows, Transaction Processing Monitors.

Active Database and Real Time Databases: Triggers in SQL, Event Constraint and Action: ECA Rules, Query Processing and Concurrency Control, Compensation and Databases Recovery

Image and Multimedia Databases: Modeling and Storage of Image and Multimedia Data, Data Structures – R-tree, k-d tree, Quad trees, Content Based Retrieval: Color Histograms, Textures, etc., Image Features, Spatial and Topological Relationships, Multimedia Data Formats, Video Data Model, Audio & Handwritten Data, Geographic Information Systems (GIS)

Unit IV: 10 lecture hours

WEB Database: Accessing Databases through WEB, WEB Servers, XML Databases, and Commercial Systems.

Data Warehousing: Data Warehousing Architecture, Multidimensional Data Model, Update Propagation OLAP Queries. Data Mining: Knowledge Representation Using Rules, Association and Classification Rules, Sequential Patterns, Algorithms for Rule Discovery

Case Study: Oracle Xi

TEXT BOOKS:

1. Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4th Edition, Pearson Education, 2007
2. Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson Education, 2007
3. R. Ramakrishnan, "Database Management Systems", McGraw Hill International Editions, 1998

Reference Books:

1. Date, Kannan, Swaminathan, "An Introduction to Database Systems", 8th Edition Pearson Education, 2007
2. Singh S.K., "Database System Concepts, design and application", Pearson Education, 2006.
3. Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6th Edition, 2006
4. D. Maier, "The Theory of Relational Databases", 1993, Computer Science Press, Rokville, Maryland
5. Ullman, J. D., "Principals of database systems", Galgotia publications, 1999
6. Oracle Xi Reference Manual

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.	**PO1**
CO2	Perform Query Optimization.	**PO2, PO4, PO11**
CO3	Have knowledge of parallel and distributed database systems.	**PO5**
CO4	Have knowledge of new database architectures and query operators	**PO5; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 613P	Advanced Data Base Management System	2	3		3	2						2	2	3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 655P	Advanced Database Management System Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Knowledge of Database Management System				
Co-requisites					

Course Objectives

- To understand the basic concepts and terminology related to DBMS and Relational Database Design
- To the design and implement Distributed Databases.
- To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports

Course Outcomes

On completion of this course, the students will be able to

1. Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.
2. Perform Query Optimization.
3. Have knowledge of Parallel and distributed database systems.
4. Have knowledge of new database architectures and query operators.

Catalog Description

The course complements the theory ETCS 613P. The aims is to have hands-on session for the concepts students have learnt in theory classes.

List of Experiment (Indicative)

1	Exercise based on Data Definition Language Commands	**2 lab hours**
2	Exercise based on Data Manipulation Language Commands	**2 lab hours**
3	Exercise based on Data Control Language, Transfer Control Language Commands	**2 lab hours**

4	Exercise based on In Built Functions	**2 lab hours**
5	Exercise based on Nested Queries and Join Queries	**2 lab hours**
6	Exercise based on Set operators.	**2 lab hours**
7	Exercise based on Views	**2 lab hours**
8	Exercise based on Control Structure.	**2 lab hours**
9	Exercise based on Procedure and Function	**2 lab hours**
10	Exercise based on Trigger	**2 lab hours**
11	Exercise based onIndexing and Query Processing	**2 lab hours**
12	Exercise based onQuery Evaluation Plans	**2 lab hours**
13	Exercise based onConcurrency and Transactions	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.	**PO1**
CO2	Perform Query Optimization.	**PO2, PO4, PO11**
CO3	Have knowledge of parallel and distributed database systems.	**PO5**
CO4	Have knowledge of new database architectures and query operators	**PO5; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 655P	Advanced Database Management System Lab	2	3		3	2						2	2	3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 615P	**Soft Computing**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

1. The primary objective of this course is to provide an introduction to the basic principles, techniques, and applications of soft computing.
2. Upon successful completion of the course, students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
3. Provide the mathematical background for carrying out the optimization associated with neural network learning.
4. Aim of this course is to develop some familiarity with current research problems and research methods in Soft Computing by working on a research or design project.

Course Outcomes

On completion of this course, the students will be able to

1. Develop application on different soft computing techniques like Fuzzy, GA and Neural network.
2. Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.
3. Understand different soft computing tools to solve real life problems.
4. Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques.

Catalog Description

The main objective of the course is to expose the students to soft computing, various types of soft computing techniques, and applications of soft computing. Upon completion of course the students will be able to get idea on artificial Intelligence, neural network, fuzzy Logic and genetic algorithms.

Course Content

Unit I: **12 lecture hours**

Introduction: Introduction to Soft Computing Concepts, Importance of tolerance in imprecision and uncertainty, Soft Computing Constituents and Conventional Artificial Intelligence, From Conventional AI to Computational Intelligence, Fuzzy Set Theory, Neural Networks and Evolutionary Computation

Neural Networks: Overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

Unit II: **12 lecture hours**

Introduction to Fuzzy Sets: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation.

Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations.

Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.

Uncertainty based Information: Information & Uncertainty, Non specificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets, Defuzzyfication.

Unit III: **8 lecture hours**

Evolutionary Computation: Genetic Algorithms and Genetic Programming, Evolutionary Programming, Evolutionary Strategies and Differential Evolution Coevolution, Different operators of Genetic Algorithms, Analysis of Selection Operations, Convergence of Genetic Algorithms.

Unit IV: **8 lecture hours**

Rough Sets: Introduction, Imprecise categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.

Hybrid Systems: Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks. Fuzzy Logic bases Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Text Books:

1. Anderson J.A, “An Introduction to Neural Networks”, PHI, 1999.

2. Hertz J. Krogh, R.G. Palmer, “Introduction to the Theory of Neural Computation”, Addison-Wesley, California, 1991.

Reference Books:

1. “Neural Networks-A Comprehensive Foundations”, Prentice-Hall International, New Jersey,1999.

2. Freeman J.A. & D.M. Skapura. “Neural Networks: Algorithms, Applications and Programming Techniques”, Addison Wesley, Reading, Mass, (1992).

3. G.J. Klir& B. Yuan, “Fuzzy Sets & Fuzzy Logic”, PHI, 1995.

4. Melanie Mitchell, “An Introduction to Genetic Algorithm”, PHI, 1998.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop application on different soft computing techniques like Fuzzy, GA and Neural network.	**PO1**
CO2	Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.	**PO2, PO4**
CO3	Understand different soft computing tools to solve real life problems	**PO3, PO5**

CO4	Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques	**PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 615P	Soft Computing	2	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 657P	**Soft Computing Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

1. The primary objective of this course is to provide an introduction to the basic principles, techniques, and applications of soft computing.
2. Upon successful completion of the course, students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
3. Provide the mathematical background for carrying out the optimization associated with neural network learning.
4. Aim of this course is to develop some familiarity with current research problems and research methods in Soft Computing by working on a research or design project.

Course Outcomes

On completion of this course, the students will be able to

1. Develop application on different soft computing techniques like Fuzzy, GA and Neural network.
2. Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.
3. Understand different soft computing tools to solve real life problems.
4. Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques.

Catalog Description

The course complements the theory ETCS 615P. The aims is to have hands-on session for the concepts students have learnt in theory classes.

List of Experiment (Indicative)

1	Create a perceptron with appropriate number of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weight.	**2 lab hours**

2	Write a program to implement artificial neural network without back propagation.	**2 lab hours**
3	Write a program to implement artificial neural network with back propagation	**2 lab hours**
4	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.	**2 lab hours**
5	Implement travelling sales person problem (TSP) using genetic algorithms.	**2 lab hours**
6	Plot the correlation plot on dataset and visualize giving an overview of relationships among data on soya bins data. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.	**2 lab hours**
7	Implement linear regression and multi-regression for a set of data points	**2 lab hours**
8	Implement crisp partitions for real-life iris dataset.	**2 lab hours**
9	Write a program to implement Hebb's rule.	**2 lab hours**
10	Write a program to implement Delta rule.	**2 lab hours**
11	Write a program to implement logic gates.	**2 lab hours**
12	Implement SVM classification by fuzzy concepts.	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop application on different soft computing techniques like Fuzzy, GA and Neural network.	**PO1**
CO2	Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.	**PO2, PO4**

CO3	Understand different soft computing tools to solve real life problems	**PO3, PO5**
CO4	Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques	**PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 657P	Soft Computing Lab	2	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 617P	**Data Preparation and Analysis**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

Provide insight into methods and tools for analysis and processing of the data generated by modern information systems

Course Outcomes

On completion of this course, the students will be able to

1. Prepare data for analysis
2. Perform exploratory data analysis.
3. Develop meaningful data visualizations.
4. Work on a variety of real world datasets.

Catalog Description

Data preparation may be one of the most difficult steps in any machine learning project. The reason is that each dataset is different and highly specific to the project. The aim of this course is to consider data preparation as a step in a broader predictive modeling machine learning project.

Course Content

Unit I: **9 lecture hours**

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.
Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.

Unit II: **10 lecture hours**

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.

Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.

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Unit III: 11 lecture hours

Exploratory Data Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation.

Unit IV: 10 lecture hours

Visualization: Designing visualizations, Time series, Geo-located data, Correlations and connections, Hierarchies and networks, interactivity.

Text Books:

1.Glenn J. Myatt, Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publishers, 2007.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Prepare data for analysis	**PO1, PO2**
CO2	Perform exploratory data analysis.	**PO2**
CO3	Develop meaningful data visualizations.	**PO3, PO4**
CO4	Work on a variety of real world datasets	**PO5, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 617P	Data Preparation and Analysis	3	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 659P	**Data Preparation and Analysis Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

Provide insight into methods and tools for analysis and processing of the data generated by modern information systems

Course Outcomes

On completion of this course, the students will be able to

1. Prepare data for analysis
2. Perform exploratory data analysis.
3. Develop meaningful data visualizations.
4. Work on a variety of real world datasets.

Catalog Description

The course complement ETCS 671P. The aim of this course is to give practical hands-on to undergo various step for data preparation.

List of Experiments (Indicative)

1	Data preprocessing methods on student and labor datasets Implement data cube for data warehouse on 3-dimensional data	**2 lab hours**
2	Implement various missing handling mechanisms, Implement various noisy handling mechanisms.	**2 lab hours**
3	Develop k-means and MST based clustering techniques, Develop the methodology for assessment of clusters for given dataset.	**2 lab hours**
4	Design algorithms for association rule mining algorithms.	**2 lab hours**
5	Derive the hypothesis for association rules to discovery of strong association rules; Use confidence and support thresholds.	**2 lab hours**

6	Construct Haar wavelet transformation for numerical data, Construct principal component analysis (PCA) for 5-dimensional data	**2 lab hours**
7	Implement linear regression and multi-regression for a set of data point Implement binning visualizations for any real time dataset, Implement linear regression techniques.	**2 lab hours**
8	Visualize the clusters for any synthetic dataset, Implement the program for converting the clusters into histograms.	**2 lab hours**
9	Write a program to implement agglomerative clustering technique.	**2 lab hours**
10	Write a program to implement divisive hierarchical clustering technique.	**2 lab hours**
11	Develop scalable clustering algorithms.	**2 lab hours**
12	Develop scalable a priori algorithm..	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Prepare data for analysis	**PO1, PO2**
CO2	Perform exploratory data analysis.	**PO2**
CO3	Develop meaningful data visualizations.	**PO3, PO4**
CO4	Work on a variety of real world datasets	**PO5, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 659P	Data Preparation and Analysis Lab	3	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 624P	**Software Testing Techniques**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Software Engineering				
Co-requisites	--				

Course Objectives

1. To study fundamental concepts in software testing.

2.To discuss various software testing issues and solutions in software unit test, integration and system testing.

3.To expose the advanced software testing topics, such as object-oriented software testing methods.

4. To gain software testing experience by applying software testing knowledge and methods to practice-oriented software testing projects.

5. To understand software test automation problems and solutions.

6. To learn how to write software testing documents, and communicate with engineers in various forms.

7. To gain the techniques and skills on how to use modern software testing tools to support software testing projects.

Course Outcomes

On completion of this course, the students will be able to

CO1. Have an ability to apply software testing knowledge and engineering methods.

CO2. Have an ability to design and conduct a software test process for a software testing project.

CO3. Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.

CO4. Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.

CO5.Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.

CO6. Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problem.

CO7. Have an ability to use software testing methods and modern software testing tools for their testing projects.

Catalog Description

After completing this course, you will have an understanding of the fundamental principles and processes of software testing. You will have actively created test cases and run them using an automated testing tool. You will be being writing and recognizing good test cases, including input data and expected outcomes.

Course Content

Unit I: **12 lecture hours**

Fundamentals of software testing - software verification and validation – V test model: V model for software, testing during proposal stage, testing during requirements stage, testing during test-planning phase, test during design phase, VV model, critical roles and responsibilities.

Unit II: **12 lecture hours**

Levels of testing – Acceptance testing – feature based testing (special tests part – I) –
Application based testing (special tests part – II)
Test planning –test policy, contents, strategy, test plan, Quality plan, test plan template, guidelines, test administration and estimation, standards, building test data, test cases, scenarios, templates for test cases, test scripts, effective test cases, building test data, generation of test data, roles and responsibilities in testing life cycle, test process monitoring.

Unit III: **8 lecture hours**

Testing related data, defect data, efficiency data, categories of test metrics, estimated, budgeted, approved and actual, resources, effectiveness in testing, defect density, defect leakage ratio, residual defect density, test team efficiency, test case efficiency, rework, MTBF/ MTTR, test reports, status reports, integration test reports, system test reports, final test reporting, test status report, Bench marking.

Unit IV: **8 lecture hours**

Test Automation: Scope of Automation, Design and Architecture of automation, Process Model for Automation, challenges in automation. Load Runner, Selenium, QTP, RFT and RQM.

Text Books

1. M. G. Limaye, "Software Testing: Principles and Techniques and Tools," Tata McGraw – Hill Education, 1st Edition, 2012.

Reference Books/Materials

1. Srinivasan Desikan, Gopalaswamy Ramesh, "Software Testing: Principles and Practices", Pearson 2012

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme

Components	Quiz I	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Have an ability to apply software testing knowledge and engineering methods.	**PO1**
CO2	Have an ability to design and conduct a software test process for a software testing project.	**PO3**

CO3	Have an ability to identify the needs of software test automation, and define and develop a test tool to support test automation.	**PO3**
CO4	Have an ability understand and identify various software testing problems, and solve these problems by designing and selecting software test models, criteria, strategies, and methods.	**PO4**
CO5	Have an ability to use various communication methods and skills to communicate with their teammates to conduct their practice-oriented software testing projects.	**PO4**
CO6	Have basic understanding and knowledge of contemporary issues in software testing, such as component-based software testing problem.	**PO5**
CO7	Have an ability to use software testing methods and modern software testing tools for their testing projects.	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 624P	SOFTWARE TESTING TECHNIQUES	3		3	3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS626P	**Software Reliability and Reuse**	L	T	P	C
Version 1.0		4	-	-	4
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. To learn about the engineering techniques for developing and maintaining reliable software systems.
2. To measure the reliability of software systems.
3. To understand about fault prevention, fault removal, fault tolerance and failure forecasting in software systems.
4. To reduce the software development cost by using the previous developed software

Course Outcomes

On completion of this course, the students will be able to

1. Understanding the fundamental concepts of Software Reliability.
2. Understand the fault handling and failure forecasting techniques in software systems.
3. Implement or update software using existing software assets
4. Appreciate the improvement in software development productivity

Catalog Description

This course is a step by step description of software quality and software reliability engineering process. It includes introduction to software quality, prediction and measurement of software size and cost, software reliability engineering process, defining necessary reliability, developing operational profiles, decision making based on the test results, techniques to improve and predict software reliability, application of quality concept to agile and incremental software development processes. The focus is on the reliability of object-oriented software systems.

Course Content

Unit I: **09 lecture hours**

Software Reliability Ideas of Software Reliability, Computation of software reliability, Classes of software reliability Models.

Time Dependent Software Reliability Models: Time between failure reliability Models, Fault

Counting Reliability Models.

Unit II: **11 lecture hours**

Fault injection model of Software Reliability, Input Domain Reliability Model, and Orthogonal defect classification, Software availability Models. Software Reliability Modeling: A general procedure for reliability modeling.

Unit III: **10 lecture hours**

Introduction Software Reuse and Software Engineering, Concepts and Terms, Software Reuse products, Software Reuse processes, Software reuse paradigms. State of the Art and the Practice: Software Reuse Management, Software Reuse Techniques, Aspects of Software Reuse, Organizational Aspects, Technical Aspects and Economic Aspects.
Usability Attributes, Representation and Modelling Paradigms, Abstraction and Composition in development paradigm.

Unit IV: **10 lecture hours**

Object - Oriented Domain Engineering: Abstraction and parameterization techniques, Composition techniques in Object Orientation.
Component Storage and Retrieval, Reusable Asset Integration. Software Reuse technologies: Component Based Software Engineering, COTS based development, Software Reuse Metrics, Tools for Reusability.

Text Books

1. Michael R. Lyu, "Handbook of Software Reliability Engineering," IEEE Computer Society Press, McGraw-Hill Book Company, 2005.

2. Ivar Jacobson, Martin Gress, Patrick Johnson, "Software Reuse," Pearson Education,2004.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understanding the fundamental concepts of Software Reliability	**PO1; PO2**
CO2	Understand the fault handling and failure forecasting techniques in software systems.	**PO3; PO4**
CO3	Implement or update software using existing software assets	**PO5; PO9**
CO4	Appreciate the improvement in software development productivity	**PO11**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 626P	Software Reliability and Reuse	3	2	2	3	1				2		2		2	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 628A	**Softwatre Reverse Engineering**	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Concepts of Security				
Co-requisites	--				

Course Objectives

1. An improved ability to understand, maintain, evolve, and secure software.
2. An understanding of the most popular and relevant uses of software reversing.
3. Facility with several software reverse engineering tools.
4. Facility with assembly language and interpreted languages like Java Byte code.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand the problem in the existing process.

CO2. Collect the large amount of data/ information for the product

CO3. Depth analyze of the products and extraction of real time data

CO4. Understand the principles behind the design of the product, ways to redesign and improve the performance of the system.

CO5. An understanding of the most popular and relevant uses of software reversing.

CO6. Facility with several software reverse engineering tools.

Catalog Description

This course aims to educate students in the main usage scenarios and contexts in which software reverse engineering (SRE), or reversing, is used. In addition, the course will provide students with the opportunity to gain facility with current reverse engineering software tools and techniques through hands-on exercises. Several scenarios have been developed (complete with descriptive scenarios) and each includes a series of exercises, ranging from easy to very difficult.

Course Content

Unit I: **12 lecture hours**

Need for Reverse Engineering, Software Reverse Engineering, Reverse Applications, Low

Level Software, The Reversing Process, The Tools, Is Reversing Legal.

Low Level Software: High Level Perspectives, Low Level Perspectives, Assembly Language, A Primer on Compilers and Compilation, Execution Environments.

Unit II: **10 lecture hours**

Reverse Engineering Tools: Different Reversing Approaches, Dis-assemblers, Debuggers, De-compilers, System-Monitoring Tools, Patching Tools, Miscellaneous Reversing Tools.

Beyond the Documentation: Reversing and Interoperability, Laying the Ground Rules, Locating Undocumented APIs.

Object Flow Graph: Abstract Language, Object Flow Graph, Containers, Flow Propagation

Algorithm, Object Sensitivity, The elib Program.

Unit III: **10 lecture hours**

Class Diagram: Class Diagram Recovery, Declared Vs Actual Types, Containers, The elib Program.

Object Diagram: The Object Diagram, Object Sensitivity, Dynamic Analysis, The elib Program.

Interaction Diagram: Interaction Diagram, Interaction Diagram, Interaction Diagram Recovery, Dynamic Analysis.

State Diagram: State Diagram, Abstract Interpretation, State Diagram Recovery, The elib Program.

Package Diagram: Package Diagram Recovery, Clustering, Concept Analysis, The elib Program, Tool Architecture, The elib Program, Perspectives.

Unit IV: **8 lecture hours**

Reversing Malware: Types of malware, Sticky software, Future malware, Uses of malware, Malware vulnerability, Polymorphism, Metamorphism, establishing a secure environment.

Anti Reversing Techniques: Anti reversing, Basic approaches to anti reversing Eliminating symbolic information, Code encryption, Active anti debugger techniques, Confusing Disassemblers, Code obfuscation, Control flow transformations, Data transformations.

Text Books

1. Reversing: Secret of Reverse Engineering, Eldad Eilam, Wiley Publishing, Inc.

2. Reverse Engineering, Wills, Linda M., Newcomb, Philip (Eds.), Springer, 1996, ISBN 978-0-585-27477-5

Reference Books/Materials

1. Practical Reverse Engineering: x86, x64, ARM, Windows® Kernel, Reversing Tools, and Obfuscation, Bruce Dang, Alexandre Gazet, Elias Bachaalany, John Wiley & Sons, Inc, ISBN: 978-1-118-78731-1.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the problem in the existing process.	**PO2**
CO2	Collect the large amount of data/ information for the product	**PO3**
CO3	Depth analyze of the products and extraction of real time data	**PO3**
CO4	Understand the principles behind the design of the product, ways to redesign and improve the performance of the system.	**PO3**

CO5	An understanding of the most popular and relevant uses of software reversing.	**PO4**
CO6	Facility with several software reverse engineering tools.	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 628A	Software Reverse Engineering		3	3	3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS630P	Software Security	L	T	P	C
Version 1.0		4	-	-	4
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

1) Identify typical security vulnerabilities of web applications listed in OWASP top 10, such as SQL injection, XSS, and XSRF, by reviewing the source code and by penetration testing. Students should also be able to fix the identified vulnerabilities.
2) Explain typical cryptography concepts and algorithms that are related to web application, including e.g. block cipher, stream cipher, digital signature, and SSL/TSL handshaking procedure.
3) Apply the threat modeling methods to create threat models of a medium-sized web application by using misuse cases and attack trees.
4) Describe and compare software engineering practices and standards related to software security, such as software touch points, common criteria, BASIMM, and Open SAMM.
5) Create software security test cases and prioritizing the test cases by applying the risk-based testing framework.
6) Explain key authentication and authorization concepts and methods, such as different authentication methods, multilevel and multilateral security control, and role-based access control.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understands security issues relating to system development.

CO2. Knows software development techniques to avoid security problems.

CO3Can explain the most common weaknesses in software security and how such problems can be mitigated in software.

CO4. Can identify common security threats, risks, and attack vectors for software systems.

Catalog Description

The course gives an overview of security issues for software, and provides programming methods for the development of secure applications. The main focuses of the course are programming techniques for the development of safe and secure applications

Course Content

Unit I **12 lecture hours**

Security a Software Issue: Introduction, The problem, Software Assurance and Software Security, Threats to software security, Sources of software insecurity, Benefits of detecting software security defects early, managing secure software development.

Secure Software: Introduction, Properties of Secure Software, Influencing the security properties of software, Asserting and specifying the desired security properties.

Unit II **8 lecture hours**

Requirements Engineering for Secure Software: Introduction, Misuse and abuse cases, the SQUARE process Model, SQUARE sample outputs, Requirements elicitation, Requirements prioritization.

Secure Software Architecture and Design: Introduction, Software Security practices for Architecture and Design - architectural risk analysis, Software security knowledge for Architecture and Design - Security principles, Security guidelines and Attack patterns.

Unit III **10 lecture hours**

Secure Coding and Testing: Introduction, Code analysis, Coding Practices, Software Security testing, Security testing considerations throughput the SDLC.

System Assembly Challenges: Introduction, Security failures, functional and attacker perspectives for security analysis in web services and identity management, system complexity drivers and security, Deep technical problem complexity.

Unit IV **10 lecture hours**

Governance and Managing for more Secure Software: Introduction, Governance and security, adopting an enterprise software security framework, Defining adequate security, Risk Management framework for software security, Security and Project Management, Maturity of Practice.

Text Books

1. Julia H. Allen, Sean Barnum, Robert J. Ellison, Gary McGraw, and Nancy R. Mead, "Security Engineering: A Guide for Project Managers," Pearson Education, 2009.

Reference Books/Materials

1. Dijiang Huang, AnkurChowdhary, Sandeep Pisharody, "Software-Defined Networking and Security (Data-Enabled Engineering)1st Edition", CRC Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz I	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understands security issues relating to system development.	**PO2**
CO2	Knows software development techniques to avoid security problems.	**PO1**

CO3	Can explain the most common weaknesses in software security and how such problems can be mitigated in software.	**PO2**
CO4	Can identify common security threats, risks, and attack vectors for software systems.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 630P	Software Security	3	3		2									3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS614P	**Android Security**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Advanced of Computer communication				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to:-

1. Appreciate the risks to **Android** applications.
2. Understand the structure of **Android** package files.
3. Understand the **Android security** model and the protections provided by the **Android** OS.
4. Apply defensive programming techniques for common **Android** vulnerabilities.

Course Outcomes

On completion of this course, the students will be able to

CO1. Identify the types of security threats for Android Applications.

CO2. Apply the security protocols to Android Applications.

CO3. Will be able to perform Malware Analysis on Android Applications.

Catalog Description

This course will also provide a systematic explanation of android applications as a discrete discipline and will provide an in-depth coverage of android package files. It makes the understanding of security model and protection provided by android OS. It also help to apply defensive programming techniques for common android vulnerabilities.

Course Content

Unit I: **12 lecture hours**

App Development, Android Application development and APK internals, Understanding the internals of Android Mobile OS. Study the architecture, design and security of mobile computing in the context of Android.

Unit II: 8 lecture hours

Refresher Linux OS, Emulator and ADB, APK Internals, Networking, Device Rooting,

Refresher TCP/IP Attacks, TCP/IP Attacks Using Android, DAC and MAC Permissions, Android Internals.

Unit III: 12 lecture hours

Framework, Init, Zygote, Binder, Service Manager, Activity Manager, Reverse Engineering, Malware Analysis.

Unit IV: 8 lecture hours

Bouncer, Code Injection, Privacy Violation, System Call Hardening, ASLR, ROP, Framework Exploits.

Text Books

1. 1. Y. Karim, Embedded Android, Vol. 1, O'Reilly Media, 2013.

2. E. Nikolay, Android Security Internals: An In-Depth Guide to Android's Security Architecture, No Starch Press,

2014

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz I	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the types of security threats for Android Applications.	**PO1, PO2**
CO2	Apply the security protocols to Android Applications.	**PO3,**
CO3	Will be able to perform Malware Analysis on Android Applications.	**PO4, PSO 1, PSO 2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 614P	Android Security	1	1	2	2									3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS656P	Android security Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to:-

1. Appreciate the risks to **Android** applications.
2. Understand the structure of **Android** package files.
3. Understand the **Android security** model and the protections provided by the **Android** OS.
4. Apply defensive programming techniques for common **Android** vulnerabilities.

Course Outcomes

On completion of this course, the students will be able to

CO1. Identify the types of security threats for Android Applications.

CO2. Apply the security protocols to Android Applications.

CO3. Will be able to perform Malware Analysis on Android Applications.

CO4. Apply defensive programming techniques for common **Android** vulnerabilities.

Course Content

List of Experiments

1	Android app components and permissions	**3 lab hours**
2	2. Android security architecture	**3 lab hours**
3	3. App vulnerabilities (e.g., leaking content providers, input validation issues, hardcoding, etc.)	**3 lab hours**
4	4. Tapjacking	**3 lab hours**
5	5. App pen-testing using Drozer	**3 lab hours**
6	6. Client-side Injection	**3 lab hours**

7	7. App monitoring and hooking	**3 lab hours**
8	8. Dex file analysis and app reverse engineering	**3 lab hours**
9	9. Android app analysis and testing e.g. using concolic execution	**2 lab hours**
10	10. Malware analysis and detection (using machine learning)	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the types of security threats for Android Applications.	**PO2**
CO2	Apply the security protocols to Android Applications.	**PO3**
CO3	Will be able to perform Malware Analysis on Android Applications.	**PO5**
CO 4	Apply defensive programming techniques for common **Android** vulnerabilities.	**PSO1, PO9**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 656P	Android security Lab		2	3		3				3				3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 616P	**FORMAL METHODS FOR SECURITY**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basic knowledge about Cyber security				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to :-

1. Understand Temporal Logic and Model Checking for program verifications.

2. Perform verification of concurrent and reactive programs/systems using model-checking and propositional temporal logic.

3. Apply application of static and dynamic program analysis and model-checking for detecting common security vulnerabilities in programs and communication protocols.

Course Outcomes

CO1.To understand the formal methods of Security and its application.

CO2.To have experience with some formal modeling tools.

CO3.To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.

CO4.To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations.

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CO5.To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.

Catalog Description

In this course graduates will be able to get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis. This get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations. During the course, students should enhance their inquisitiveness to ever-evolving domain of information security and apply their knowledge to solve problems.

Course Content

Unit I: **12 lecture hours**

Formal Methods – Propositional and Predicate logic, and theorem-proving, Fixed-points and their role in program analysis and model-checking.

Unit II: **8 lecture hours**

Verification of sequential programs using weakest preconditions and inductive methods, and verification of concurrent and reactive programs/systems using model-checking and propositional temporal logic (CTL and LTL).

Unit III: **8 lecture hours**

Application of static and dynamic program analysis and model-checking for detecting common security vulnerabilities in programs and communication protocols, Information flow and taint analysis for security of web applications

Unit IV: **12lecture hours**

pi-calculus for formal modelling of mobile systems and their security. SPIN, PVS, TAMARIN, Frama-C and Isabelle tools.

Text Books

1. Edmund M. Clarke, OrnaGrumberg and DoronPeled, Model Checking, MIT Press, 1999.
2. Lloyd, J.W., Logic and Learning: Knowledge Representation, Computation and Learning in Higher-order Logic, Springer Berlin Heidelberg, 2003.

Reference Books/Materials

1. M. Ruth and M. Ryan, Logic in Computer Science - Modelling and Reasoning about Systems, Cambridge
University Press, 2004 .
2. G. Bella, Formal Correctness of Security Protocols, Springer, 2009.
3. Datta A, Jha S, Li N, Melski D and Reps T, Analysis Techniques for Information Security, Synthesis

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the formal methods of Security and its application.	**PO1**
CO2	To have experience with some formal modeling tools.	**PO2**
CO3	To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.	**PO4, PO5**
CO4	To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations. .	**PO3**
CO5	To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 616P	FORMAL METHODS FOR SECURITY	3	3	3	3	2								3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS658P	FORMAL METHODS FOR SECURITY LAB	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning of Cyber security				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to :-

1. Understand Temporal Logic and Model Checking for program verifications.

2. Perform verification of concurrent and reactive programs/systems using model-checking and propositional temporal logic.

3. Apply application of static and dynamic program analysis and model-checking for detecting common security vulnerabilities in programs and communication protocols.

Course Outcomes

Upon completion of the course the students will be able to:

CO1.To understand the formal methods of Security and its application.

CO2.To have experience with some formal modeling tools.

CO3.To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.

CO4.To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations.

.

CO5.To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.

Catalog Description

In this course graduates will be able to get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis. This get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations. During the course, students should enhance their inquisitiveness to ever-evolving domain of information security and apply their knowledge to solve problems.

Course Content

1	To study about formal security tools.	**2 lab hours**
2	Programs based on propositional logic.	**2 lab hours**
3	Programs based on predicate logic.	**2 lab hours**
4	Verification of sequential programs using weakest preconditions.	**2 lab hours**
5	Verification of sequential programs using inductive methods.	**2 lab hours**
6	Verification of concurrent and reactive programs.	**4 lab hours**
7	Study of applications of static and dynamic program analysis for detecting security vulnerabilities in programs.	**4 lab hours**
8	Study of information flow and taint analysis for security of web applications.	**4 lab hours**
9	Security analysis of SPIN and PVS	**4 lab hours**
10	Study about TAMARIN, Frama-C and Isabelle tools.	**4 lab hours**
11	To make minor project related to security.	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the formal methods of Security and its application.	**PO1**
CO2	To have experience with some formal modeling tools.	**PO2**
CO3	To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.	**PO4, PO5**
CO4	To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations. .	**PO3**
CO5	To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 658P	FORMAL METHODS FOR SECURITY LAB	3	2	3	3	3								3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS618P	**Blockchain Technology**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Cryptography				
Co-requisites	Basic Mathematics				

Course Objectives

1. Help in understanding Creation of block and working of blockchain technology to innovate and improve business process.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand blockchain technology.

CO2. Develop blockchain based solutions and write smart contract using Hyper ledger Fabric and Ethereum frameworks.

CO3. Build and deploy block chain application for on premise and cloud-based architecture.

CO4. Integrate ideas from various domains and implement them using block chain technology in different perspectives.

Catalog Description

Through this subject, student will be able to understand the coarse grained aspects of Blockchain Technology. Student will understand the applications of Blockchain and its working in networks. The internals of framework and working will be discussed throughout the course duration.

Course Content

Unit I: **8 lecture hours**

Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete.

Cryptography: Hash function, Digital Signature -ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.

Unit II: **12 lecture hours**

Blockchain: Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.

Unit III: **12 lecture hours**

Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.

Cryptocurrency: History, Distributed Ledger, Bitcoin protocols -Mining strategy and rewards, Ethereum -Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin.

Unit IV: **8 lecture hours**

Cryptocurrency Regulation: Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Block chain.

Text Books

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin andCryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).

Reference Books/Materials

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Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand block chain technology.	**PO1**
CO2	Develop blockchain based solutions and write smart contract using Hyperledger Fabricand Ethereum frameworks	**PO2, PO3**
CO3	Build and deploy block chain application for on premise and cloud-based architecture	**PO5**
CO4	Integrate ideas from various domains and implement them using blockchain technologyin different perspectives.	**PO5, PO6, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 618P	Blockchain Technology	3	3	3		2	2						2	3		2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS660P	**Blockchains Technology Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Basics of Cryptography				
Co-requisites	Basics of Mathematics				

Course Objectives

The Lab taps into the transformative potential of block chain and related technologies to achieve the goals set out for Sustainable Development.

Course Outcomes

On completion of this course, the students will be able to

CO1.To understand the practical implementation of Blockchain technology.
CO2. To be able to explain the different components involved within Blockchain implementation.
CO3. To know when and why you may want to use Blockchain within your environment.
CO4. To be able to implement IoT asset tracking app using Block chain.
CO5. To be able to Secure art using block chain digital certificates.

Catalog Description

This course complements ETCS304A. It enables students to utilize potential of blockchain into aoptimal solution(s). The list of experiments helps to understand details of component, implementation and application domain of blockchain.

List of Experiments (Indicative)

1	Study and implementation of hash chain.	**2 lab hours**
2	Study and implementation of index structure.	**2 lab hours**
3	Implementation of asymmetric key algorithms	**2 lab hours**
4	Analysis of soft fork and hard fork structures.	**2 lab hours**

5	Analysis of block chain platforms.	**2 lab hours**
6	Analysis of crypto currencies (Bitcoin, Litecoin, Ripple)	**2 lab hours**
7	Analysis of blockchain concurrency and scalability.	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the practical implementation of Block chain technology.	**PO1**
CO2	To be able to explain the different components involved within Block chain implementation.	**PO3**
CO3	To know when and why you may want to use Block chain within your environment.	**PO2, PO4**
CO4	To be able to implement IoT asset tracking app using Block chain.	**PO3, PO4, PO5**
CO5	To be able to Secure art using block chain digital certificates.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 660P	Blockchain Technology Lab	2	2	3	3	3								3		2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 637P	**Agile Software Engineering**	L	T	P	C
Version 1.0	-	3	1	0	4
Pre-requisites/Exposure	-				
Co-requisites	-				

Course Objectives

This course makes student learn the fundamental principles and practices associated with each of the agile development methods. To apply the principles and practices of agile software development on a project of interest and relevance to the student.

Course Outcomes

On completion of this course, the students will be able to

1. Analyze existing problems with the team, development process and wider organization.
2. Apply a thorough understanding of Agile principles and specific practices
3. Select the most appropriate way to improve results for a specific circumstance or need
4. Judge and craft appropriate adaptations to existing practices or processes depending upon analysis of typical problems

Catalog Description

This course will provide you with a comprehensive overview of the principles, processes, and practices of agile software product management and development. Throughout the class, you'll gain an understanding of the drivers behind agility in software development and learn techniques for initiating, planning and executing on software development projects using agile methodologies. Our goal is to help you effectively apply and adapt agile tools and techniques in the software development lifecycle from product ideation to deployment, including establishing a product strategy and roadmap, creating agile team environment

Course Content

Unit I: 10 lecture hours

Software is new product development – Iterative development – Risk-Driven and Client-Driven iterative planning – Time boxed iterative development – During the iteration, No changes from external stakeholders –Evolutionary and adaptive development - Evolutionary requirements analysis – Early "Top

Ten” high-level requirements and skillful analysis – Evolutionary and adaptive planning – Incremental delivery – Evolutionary delivery – The most common mistake – Specific iterative and Evolutionary methods.

Unit II: 10 lecture hours

Agile development – Classification of methods – Theagile manifesto and principles – Agile project management – Embrace communication and feedback – Simple practices and project tools – Empirical Vs defined and prescriptive process – Principle-based versus Rule-Based – Sustainable discipline: The human touch – Team as a complex adaptive system – Agile hype – Specific agile methods. The facts of change on software projects –Key motivations for iterative development – Meeting the requirements challenge iteratively – Problems with the waterfall. Research evidence – Early historical project evidence – Standards-Body evidence – Expert and thought leader evidence – A Business case for iterative development – The historical accident of waterfall validity.

Unit III: 10 lecture hours

Method overview – Lifecycle – Work products, Roles and Practices values – Common mistakes and misunderstandings – Sample projects – Process mixtures – Adoption strategies – Fact versus fantasy – Strengths versus “Other” history.

Unit IV: 10 lecture hours

Agile – Motivation – Evidence – Scrum – Extreme Programming – Unified Process – Evo – Practice Tips.

Project management – Environment – Requirements – Test – The agile alliances – The manifesto – Supporting the values – Agile testing – Nine principles and six concrete practices for testing on agile teams.

Text Books:

1.Elisabeth Hendrickson, “Agile Testing” Quality Tree Software Inc .

2.CraigLarman “Agile and Iterative Development – A Manager’s Guide” Pearson Education

.**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Analyze existing problems with the team, development process and wider organization.	**PO1, PO2**
CO2	Apply a thorough understanding of Agile principles and specific practices.	**PO3, PO4**
CO3	Select the most appropriate way to improve results for a specific circumstance or need	**PO5, PO6**
CO4	Judge and craft appropriate adaptations to existing practices or processes depending upon analysis of typical problem.	**PO5, PO11**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 637P	Agile Software Engineering	3	3	3	3	3	2					2		2	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 621P	**Cloud Computing And Security**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Cloud Computing				
Co-requisites	Knowledge of Security				

Course Objectives

1. Ground-up coverage on the concepts & guiding principles on cloud landscape and architectural principles with primary focus on security techniques and security design
2. Deep dive on Security architecture, design patterns and best practices

Course Outcomes

On completion of this course, the students will

1. Have the theoretical understanding of information security and practical skills for designing and analyzing secure computing systems.
2. Understand the architectural principles of distributed services and applications. They are able to design, analyze and implement distributed, cloud and mobile computing systems.
3. Have in-depth knowledge of their chosen thesis topic and are able to apply it to solving technical and scientific problems.
4. Have strong software development skills and other technical and professional skills that enable them to take key roles in an industrial research and development environment, and they are qualified to continue to doctoral studies in academia.

Catalog Description

In this coursedeal with common cloud misconfigurations, how to perform a risk assessment and verify compliance for various Cloud Services. The course delve deeper into identifying security risks in these cloud services and to implement best practices to mitigate the common cloud misconfigurations.

Course Content

Unit I: 9 lecture hours

Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, Concepts implementation and relevance in the cloud computing, and their importancein PaaS, IaaS and SaaS. e.g. User authentication in the cloud; Relevant cloud security design principles; least privilege, separation of duties, Defence in Depth, Fail Safe, Economy of Mechanism, Complete Mediation, Open Design, Least Common Mechanism, Weakest Link.

Unit II: 10 lecture hours

Cloud Data Security, Cloud Data Life Cycle; Create, Store, Use, Share, Archive, Destroy, Cloud Storage Architectures; Volume Storage, Object based storage, databases, Content Delivery Network(CDN), Cloud Data Security Foundation Strategies; Encryption, Masking,

Unit III: 11 lecture hours

Shared Cloud Platforms Risks and Responsibilities, Cloud Computing Risks by Deployment and service model, Cloud Attack Surface, Threats by deployment model, Cloud Security Policy Implementation issues and Decomposition, NIST 33 Security Principles, Cloud Penetration Testing; Legal and ethical implications, The three pre-test phases, Usage of various tools including Tenable.io(Vulnerability Management, Web Application Scanning & Container Security) and other penetration testing tools.

Unit IV: 10 lecture hours

Cloud Secure Software Development Life Cycle, ISO/IEC 27034-1 Standards for Secure Application, Single Sign On (SSO), Federated Identity Management, Federation Standards, Multifactor Authentication, Cloud Application Architecture; Secure APIs, Tenancy Separation, Cryptography, Sandboxing, Application Virtualization, Runtime Application Self Protection (RASP) .
VM Life Cycle; Overwriting, Degaussing, Destruction, Record Retention, Data Remanence,
Virtualization Security Management, Virtual Threats, Hypervisor Risks, Increased Denial of Service Risks, VM Security Recommendations, Storage Operations, Physical and Logical Isolation, Basic Operational Application Security, Threat Modelling, Application Testing Methods, Change and Configuration Management, Business Continuity and Disaster Recovery, Incident Response.

TEXT BOOKS:

1. Tim Mather, SubraKumaraswamy, ShahedLatif, “Cloud Security and Privacy: An Enterprise
2. Perspective on Risks and Compliance” O'Reilly Media; 1 edition, 2009.
3. Ronald L. Krutz, Russell Dean Vines, “Cloud Security”, 2010.
4. John Rittinghouse, James Ransome, “Cloud Computing” CRC Press; 1 edition, 2009.

5. J.R. ("Vic") Winkler, “Securing the Cloud” Syngress, 2011.
6. Cloud Security Alliance, “Security Guidance for Critical Areas of Focus in Cloud Computing”.
7. Vmware “VMware Security Hardening Guide” White Paper, June 2011
8. Cloud Security Alliance 2010, “Top Threats to Cloud Computing” Microsoft 2013.
9. Evelyn Brown NIST “Guide to Security for Full Virtualization Technologies”, 2011.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Have the theoretical understanding of information security and practical skills for designing and analyzing secure computing systems.	**PO1, PO2**
CO2	Understand the architectural principles of distributed services and applications. They are able to design, analyze and implement distributed, cloud and mobile computing systems.	**PO2**
CO3	Have in-depth knowledge of their chosen thesis topic and are able to apply it to solving technical and scientific problems.	**PO4, PO8**
CO4	Have strong software development skills and other technical and professional skills that enable them to take key roles in an industrial research and development environment, and they are qualified to continue to doctoral studies in academia.	**PO6, PO11, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 621P	Cloud computing and security	3	3		3		2		2			2	2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 661P	**Cloud Computing and Security Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	A basic understanding of TCP/IP, network security, and information security principles				
Co-requisites					

Course Objectives

1. Ground-up coverage on the concepts & guiding principles on cloud landscape and architectural principles with primary focus on security techniques and security design
2. Deep dive on Security architecture, design patterns and best practices

Course Outcomes

On completion of this course, the students will

1. Identify the risks and risk control ownership based on the deployment models and service delivery models of the various products offered by cloud service providers
2. Create accounts and use the services of any one the leading CSPs and be comfortable with the self-service nature of the public cloud, including finding documentation, tutorials, pricing, and security features.
3. Secure access to the consoles used to access the CSP environments.
4. Implement network security controls that are native to both AWS and Azure.

Catalog Description

The course complement ETCS 621P. This course covers Amazon Web Services, Azure, Google Cloud, and other cloud service providers (CSPs). Like foreign languages, cloud environments have similarities and differences, and this course will introduce you to the language of cloud security.

List of Experiments (Indicative)

1	To understand the services of Amazon elastic cloud.	**4 lab hours**
2	To understand the services of Microsoft Azure	**4 lab hours**

3	To understand the services of Hadoop.	**4 lab hours**
4	To understand the services of Aneka elastic cloud.	**4 lab hours**
5	To understand the services of Google apps engine.	**4 lab hours**
6	To understand business solution application of Google apps	**4 lab hours**
7	To understand the application of hypervisors.	**4 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the risks and risk control ownership based on the deployment models and service delivery models of the various products offered by cloud service providers	**PO2**
CO2	Create accounts and use the services of any one the leading CSPs and be comfortable with the self-service nature of the public cloud, including finding documentation, tutorials, pricing, and security features.	**PO5**
CO3	Secure access to the consoles used to access the CSP environments.	**PO5, PO4**
CO4	Implement network security controls that are native to both AWS and Azure	**PO6, PO11, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 661P	Cloud computing and security Lab		3		2	3	2					2	2	3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 623P	**Internet of Things and Security**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Fundamentals of computer network, Network Security, internet technology.				
Co-requisites					

Course Objectives

In this course, student will explore various components of Internet of things such as Sensors, internetworking and cyber space. In the end they will also be able to design and implement IoT circuits and solutions

Course Outcomes

On completion of this course, the students will be able to

1. Understand general concepts of Internet of Things (IoT)
2. Recognize various devices, sensors and applications
3. Apply design concept to IoT solutions
4. Analyze various M2M and IoT architectures
5. Evaluatedesign issues in IoT applications
6. Create IoT solutions using sensors, actuators and Devices

Catalog Description

The Internet of Things (IoT) is everywhere. It provides advanced data collection, connectivity, and analysis of information collected by computers everywhere—taking the concepts of Machine-to-Machine communication farther than ever before. This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions

Course Content

Unit I: **9 lecture hours**

Internet of Things (IoT) Introduction, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications

Unit II: 10 lecture hours

Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.

Unit III: 11 lecture hours

Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi.

Unit IV: 10 lecture hours

Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud. Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT.
CaseStudy: Agriculture, Healthcare, Activity Monitoring

TEXT BOOKS:

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti(Universities Press)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand general concepts of Internet of Things (IoT)	**PO1**
CO2	Recognize various devices, sensors and applications	**PO2**
CO3	Apply design concept to IoT solutions	**PO3**
CO4	Analyze various M2M and IoT architectures	**PO2**
CO5	Evaluatedesign issues in IoT applications	**PO4, PO5**
CO6	Create IoT solutions using sensors, actuators and Devices	**PO11**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 623P	Internet of Things and Security	3	3	2	3	2						2		3	2	1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 663P	**Internet of Things and Security Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Fundamentals of computer network, Network Security, internet technology.				
Co-requisites					

Course Objectives

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-time IoT based projects

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand IoT and its hardware and software components

CO2. Interface I/O, sensors and communication mobiles

CO3. Remotely monitor data and control devices

CO4. Develop real life IoT based projects

Catalog Description

This course supplements ETCS623P. This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions.

List of Experiments (Indicative)

1	Study and Install Python in Eclipse and WAP for data types in python.	**2 lab hours**
2	Write a Program for arithmetic operation in Python.	**2 lab hours**
3	Write a Program for looping statement in Python.	**2 lab hours**
4	Study and Install IDE of Arduino and different types of Arduino.	**2 lab hours**

5	Write program using Arduino IDE for Blink LED.	**2 lab hours**
6	Write Program for RGB LED using Arduino.	**2 lab hours**
7	Study the Temperature sensor and Write Program foe monitor temperature using Arduino. .	**2 lab hours**
8	Study and Implement RFID, NFC using Arduino.	**2 lab hours**
9	Study and implement MQTT protocol using Arduino	**2 lab hours**
10	Study and Configure Raspberry Pi	**2 lab hours**
11	Write a Program for LED blink using Raspberry Pi	**2 lab hours**
12	Study and Implement Zigbee Protocol using Arduino / Raspberry Pi	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand IoT and its hardware and software components	**PO2**
CO2	Interface I/O devices, sensors and communication mobile.	**PO1**
CO3	Remotely monitor data and control devices	**PO4**
CO4	Develop real life IoT based projects	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 663A	Internet of Things and Security Lab	2	3	3	3									3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 625P	Big Data Analytics	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

1. To study the basic technologies that forms the foundations of Big Data.
2. To understand the specialized aspects of big data including big data application, and big data analytics.
3. To study different types Case studies on the current research and applications of the Hadoop and big data in industry

Course Outcomes

On completion of this course, the students will be able to

1. Understand the building blocks of Big Data
2. Understand the specialized aspects of big data with the help of different big data applications
3. Represent the analytical aspects of Big Data
4. Know the recent research trends related to Hadoop File System, MapReduce and Google File System etc

Catalog Description

This course will expose you to the data analytics practices executed in the business world. We will explore such key areas as the analytical process, how data is created, stored, accessed, and how the organization works with data and creates the environment in which analytics can flourish. The course will give you a strong foundation in all the areas that support analytics and will help you to better position yourself for success within your organization.

Course Content

Unit I: **9 lecture hours**

Competitive Advantage Definition: Old and New Notions, the Role of Big Data on Gaining Dynamic, Competitive Advantage, Big Data Driven Business Models, Organizational Challenges. Big Data and Analytics for Government Innovation: Governmental Challenges, Smart City Readiness, Learn to Collaborate, Legal Framework Development.

Unit II: **9 lecture hours**

Big Data and Education: Massive Digital Education Systems: MOOC Educational Model Clusters, Institutional Advantages and Opportunities from MOOCs, Institutional Challenges from MOOCs. Big Data Driven Business Models: Implications of Big Data, for Customer Segmentation, for Value Proposition, for Channels, on Customer Relationships, on Revenue Stream, on Key Resources and Key Partnerships, Organizational Advantages and Opportunities, Organizational Challenges and Threats.

Unit III: **11 lecture hours**

Big Data Governance: Big Data Types, Big Data Maturity Models, TDWI Maturity Model, Analytics Business Maturity Model, Data Flux Data Governance Maturity Model, Gartner Maturity Model, IBM Data Governance Maturity Model, Organizational Challenges Inherent with Governing Big Data, Organizational Benefits of Governing Big Data

Unit IV: **11 lecture hours**

Big Data and Digital Business Evaluation: Digital Business Evaluation Using Big Data, Organizational Advantages and Opportunities, Customer Value Proposition, Customer Segmentation, Channels, Customer Relationship, Organizational Challenges.

New Big Data Tools to Drive Innovation, The Hadoop Platform, 1010 DATA Cloud Analytics, Actian Analytics, Cloudera, Models of Big Data Change , Big Data Business Model, The Maturity Phases of Big Data Business Model, Big Data Change Key Issue, Organizational Challenges, Data Acquisition, Information Extraction, Data Integration, Aggregation, and Representation.

TEXT BOOKS:

1. Big Data Analytics with R and Hadoop by VigneshPrajapati, Packt Publication
2. Big Data Bootcamp by David Feinleib, Apress Publication
3. Big Data and Analytics by Vincenzo Morabito, Springer
4. Data Mining Concepts and Techniques, 3rd Edition, Jiawei Han &Micheline Kamber

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the building blocks of Big Data	**PO1, PO2**
CO2	Understand the specialized aspects of big data with the help of different big data applications	**PO2, PO3**
CO3	Represent the analytical aspects of Big Data	**PO4**
CO4	Know the recent research trends related to Hadoop File System, MapReduce and Google File System etc	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 625P	Big Data Analytics	3	3	2	3	2								3	2	1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 665P	Big Data Analytics Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Knowledge of one Programming Language;				
Co-requisites	Practice of SQL				

Course Objectives

The main goal of this course is to help students learn, understand, and practice big dataanalytics. Mainly the course objectives are: conceptualization and summarization of bigdata and machine learning, trivial data versus big data, big data computing technologies, machine learning techniques, and scaling up machine learning approaches

Course Outcomes

On completion of this course, the students will be able to

CO1. List the components of Hadoop and Hadoop Eco-System

CO2. Access and Process Data on Distributed File System

CO3. Manage Job Execution in Hadoop Environment

CO4. Apply Machine Learning Techniques using R / Python.

Catalog Description

This course supplement ETCS665P. The course will give you a strong foundation in areas that support analytics and will help you to better position yourself for success within your organization.

List of Experiments (Indicative)

1	To draw and explain Hadoop Architecture and Ecosystem with the help of a case study using WorkCount example. To define and install Hadoop.	**4 lab hours**
2	To implement the following file management tasks in Hadoop System (HDFS): Adding files and directories, Retrieving files, Deleting files	**2 lab hours**
3	To run a basic Word Count MapReduce program to understand MapReduce Paradigm: count words in a given file, To view the output file, and To calculate execution time.	**2 lab hours**

4	To perform NoSQL database using mongodb to create, update and insert.	**2 lab hours**
5	To study and implement basic functions and commands in R Programming	**2 lab hours**
6	To build WordCloud, a text mining method using R for easy to understand and visualization than a table data.	**2 lab hours**
7	To implement Bloom Filters for filter on Stream Data in Java	**2 lab hours**
8	To implement Flajolet-Martin Algorithm for counting distinct elements in Stream Data.	**2 lab hours**
9	To implement clustering program using R/Python/Java programming	**2 lab hours**
10	To find Term Frequency and Inverse Document Frequency (tf-idf) Matrix for Recommendation Systems and Plot TF Using R/Python/Java	**2 lab hours**
11	To finding similar documents with Cosine Similarity in R/Python/Java	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	List the components of Hadoop and Hadoop Eco-System	**PO1, PO2, PO5**
CO2	Access and Process Data on Distributed File System	**PO2, PO3, PO5**
CO3	Manage Job Execution in Hadoop Environment	**PO3, PO4**
CO4	Apply Machine Learning Techniques using R / Python.	**PO6, PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 625P	Big Data Analytics	3	3	3	2	2	2							3	2	1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS667P	**Dissertation-I**	L	T	P	C
Version 1.0		-	-	20	10
Pre-requisites/Exposure	Dissertation-I				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
3. To learn the art of technical report writing
4. To learn the art of verbal communication with the help of modern presentation techniques

Course Outcomes

On completion of this course, the students will be able to

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Have practical knowledge on the applications of topic of study on society.

Catalog Description

This is the first part of the major dissertation wherein every student shall be expected to contribute to domain knowledge incrementally. It is expected that the research/project work should be focused in a particular area for concept, design, implementation and/or analysis. Each student will have to undertake a research/project work under a supervisor. Research/project work may be carried out within department or in any other academic / research / industrial / commercial organization under the guidance of the thesis supervisor who must be a faculty member of the department or under a joint supervision including at least one such faculty member. The work will have to be carried out during the 5th semester of study. The student will have to submit a typewritten or printed report on the work done by him / her according to a schedule to be announced by the department. The project-report should be duly approved by the supervisor concerned and should embody results of research / development work carried out by the student.

Student will be continuously evaluated during the semester in form of Dissertation/project Progress Seminars. At the end of the semester, assessment of the research/project work of each student will be made by the board of examiners including supervisors on the basis of a viva-voce examination and the report submitted by the student.

Course Content

The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic.
2. Preparing an Action Plan for conducting the investigation, including team work.
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
4. Final development of product/process, testing, results, conclusions and future directions.
5. Preparing a report in the standard format for being evaluated by the Department.
6. Final Dissertation Presentation before a Departmental Committee.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Carry out the extensive literature survey.	**PO2**
CO2	Learn to write and present technical reports/articles.	**PO5**

CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	**PO2**
CO4	Have practical knowledge on the applications of topic of study on society.	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 667P	Dissertation-I		3			3	3							3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS662P	Dissertation-II	L	T	P	C
Version 1.0		-	-	32	16
Pre-requisites/Exposure	Dissertation-I				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
3. To learn the art of technical report writing
4. To learn the art of verbal communication with the help of modern presentation techniques.

Course Outcomes

On completion of this course, the students will be able to

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.

Catalog Description

This will be culmination of Dissertation I of semester V. Research work may be carried out within department or in any other academic / research / industrial / commercial organization under the guidance of the thesis supervisor who must be a faculty member of the department or under a joint supervision including at least one such faculty member. The student will have to submit typewritten or printed report on the work done by him / her according to a schedule
to be announced by the department. The project-report should be duly approved by the supervisor concerned and should embody results of research / development work carried out
by the student.

Student will be continuously evaluated during the semester in form of Dissertation Progress Seminars. At the end of the semester, assessment of the research work of each student will be made by the board of examiners including supervisors on the basis of a viva-voce examination and the report submitted by the student.

Students are required to publish their research work in form of research publication. The result will be declared only after acceptance or publication of full length paper in peer reviewed Conference or Journal.

Course Content

The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic.
2. Preparing an Action Plan for conducting the investigation, including team work.
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
4. Final development of product/process, testing, results, conclusions and future directions.
5. Preparing a report in the standard format for being evaluated by the Department.
6. Final Dissertation Presentation before a Departmental Committee.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz I	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Carry out the extensive literature survey.	**PO2**
CO2	Learn to write and present technical reports/articles.	**PO5**
CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	**PO2**
CO4	Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 662P	Dissertation-II		3			3	3							3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

6.3 Scheme of studies- M.Tech(CSE) with specialization Cyber Security- Part Time:

Semester I

S.No	Course Code	Course Title	L	T	P	C
1	ETCS 601P	Design and Analysis of Algorithms	3	1	-	4
2	ETCS 603P	Fundamentals of Cyber Security	3	1	-	4
3	ETCS 605P	Mathematical Foundation for Cyber Security	3	1	-	4
4	ETCS 651P	Design and Analysis of Algorithms Lab	-	-	2	1
5	ETCS 653P	Fundamentals of Cyber Security Lab	-	-	2	1
6		Audit Course - I *	2	-	-	-
TOTAL			**11**	**3**	**4**	**14**

SEMESTER II

S.No	Course Code	Course Title	L	T	P	C
1	ETCS 602P	Applied Cryptography	3	1	-	4
2	ETCS 604P	Web Application and Penetration Testing	3	1	-	4
3	ETCS 606P	Wireless Adhoc Networks	3	1	-	4
4	ETCS 652P	Applied Cryptography Lab	-	-	2	1
5	ETCS 654P	Wireless Ad hoc Networks Lab	-	-	2	1
6		Audit Course - I *	2	-	-	-
TOTAL			**11**	**3**	**4**	**14**

SEMESTER III

S.No	Course Code	Course Title	L	T	P	C
1	ETCS 608P	Malware Analaysis and Network Security	4	-	-	4
2	ETCS 610P	Security Analysis of Protocols	4	-	-	4
3	ETCS 612P	Software Security	4	-	-	4
4	**Departmental Electives (with lab)**					
i	ETCS 614P	Android Security	3	1	-	4
	ETCS 656P	Android Security Lab	-	-	2	1
ii	ETCS 616P	Formal Methods for Security	3	1	-	4
	ETCS 658P	Formal Methods for Security Lab	-	-	2	1
iii	ETCS 618P	Blockchain Technology	3	1	-	4
	ETCS 660P	Blockchain Technology Lab	-	-	2	1
TOTAL			**15**	**1**	**2**	**17**

SEMESTER IV

S.No	Course Code	Course Title	L	T	P	C
1	ETCS 608P	Malware Analaysis and Network Security	4	-	-	4
2	ETCS 610P	Security Analysis of Protocols	4	-	-	4
3	ETCS 612P	Software Security	4	-	-	4
4	**Departmental Electives (with lab)**					
i	ETCS 614P	Android Security	3	1	-	4
	ETCS 656P	Android Security Lab	-	-	2	1
ii	ETCS 616P	Formal Methods for Security	3	1	-	4
	ETCS 658P	Formal Methods for Security Lab	-	-	2	1
iii	ETCS 618P	Blockchain Technology	3	1	-	4
	ETCS 660P	Blockchain Technology Lab	-	-	2	1
TOTAL			**15**	**1**	**2**	**17**

SEMESTER V

S.No	Course Code	Course Title	L	T	P	C
1	ETCS 619P	Cyber Forensics, Audit and Investigation	3	1	-	4
2	**Departmental Electives (with lab)**					
i	ETCS 621P	Cloud Computing and Security	3	1	-	4
	ETCS 661P	Cloud Computing and Security Lab	-	-	2	1
ii	ETCS 623P	Internet of Things and Security	3	1	-	4
	ETCS 663P	Internet of Things and Security Lab	-	-	2	1
iii	ETCS 625P	Big Data Analytics	3	1	-	4
	ETCS 665P	Big Data Analytics Lab	-	-	2	1
3	ETCS 667P	Dissertation-I		-	20	10
TOTAL			**6**	**2**	**22**	**19**

SEMESTER VI

1	ETCS 662P	Dissertation-II	-	-	32	16
TOTAL			**0**	**0**	**32**	**16**

ETCS601P	**Design and analysis of algorithms**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Advanced Computer Programming				
Co-requisites	--				

Course Objectives

1. The student should be able to choose appropriate data structures, understand the ADT/libraries, and use it to design algorithms for a specific problem.
2. Students should be able to understand the necessary divide and conquer algorithms.
3. To familiarize students with greedy and dynamic programming concepts
4. Student should be able to come up with analysis of efficiency and proofs of correctness.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand the implementation of symbol table using hashing techniques.
CO 2 Develop and analyze algorithms for red-black trees, B-trees and Splay trees.
CO 3 Understanding the concept and usage of greedy and dynamic programming
CO 4 Understanding the concept of backtracking, branch and bound technique.

Catalog Description

This course imparts the basic concepts of advance data structures and algorithms. It enables them to write algorithms for solving problems with the help of fundamental data structures. The course of data structures help organizing the data in variety of ways to solve the problem efficiently. The objective of this course is to study paradigms and approaches used to design and analyze algorithms and to appreciate the impact of algorithm design in practice.

Course Content

Unit I: **8 lecture hours**

Introduction to Algorithms: Algorithms and their Performance Analysis, Space Complexity, Time Complexity, Asymptotic Notations

Divide and Conquer Algorithms: General Method, Analyzing Divide and Conquer Algorithms, Applications - Binary Search, Merge Sort, Heap Sort, Priority Queues, Quick Sort, Strassen's Matrix Multiplication.

Unit II: **12 lecture hours**

Advanced Analysis Techniques: Probabilistic Analysis, Amortized Analysis.

Review of Data Structures: Stacks, Queues, Trees, Binary Trees, Binary Search Trees, Graphs – Representation and Traversal, B-Trees, Data Structures for Disjoint Sets.

Advanced Data Structures: Splay Trees, Binomial Heaps, Fibonacci Heaps

Unit III: **12 lecture hours**

Greedy Programming: Fractional Knapsack Problem, Minimum Spanning Tree, Task Scheduling, Activity Selection Problem, Single Source Shortest Path.

Dynamic Programming: Longest Common Subsequence, 0-1 Knapsack Problem, Shortest Path Problems (Single-Source and All-Pair), Travelling Salesperson problem.

Unit IV: **8 lecture hours**

Backtracking: General Method, N-queens Problem, Sum of Subset Problem, Graph Colouring, Longest Common Subsequence

Branch and Bound Technique: General Method, 0/1 Knapsack problem, Travelling Salesperson problem.

Max-flow: Flow Networks, Ford-Fulkerson Method, Bipartite Matching

Polynomials and FFT: Representation of Polynomials, DFT and FFT, Efficient FFT

Implementations

Text Books

1. 1 T H Cormen, C E Leiserson, and R L Rivest, Introduction to Algorithms, Pearsons.
2. M T Goodrich, Roberto Tamassia, Algorithm Design, John Wiley, 2002.

Reference Books/Materials

1. Schaum's outline series, "Data Structure", McGraw Hills.
2. Y. Langsamet. al., "Data Structures using C and C++", PHI.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the implementation of symbol table using hashing techniques.	**PO1**
CO2	Develop and analyze algorithms for red-black trees, B-trees and Splay trees.	**PO4**
CO3	Understanding the concept and usage of greedy and dynamic programming	**PO5**
CO4	Understanding the concept of backtracking, branch and bound technique.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 601P	Design and analysis of algorithms	2	2		3	3								3	2	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 603P	Fundamentals Of Cyber Security	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	None				
Co-requisites	--				

Course Objectives

1. Make students aware of fundamentals of cyber security, and
2. Teach security principles and mechanisms for systems that store, process, and transmit information.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Recognize security issues concerning cyber infrastructure

CO2. Understand various security models and cryptographic solutions

CO3. Assess threats and design necessary solutions

CO4. Implement security protocols at various levels

Catalog Description

This course provides an introduction to the foundational aspects of computer security, such as algorithms and protocols. It also covers ways in which these systems can be attacked and techniques for thwarting these attacks.

Course Content

Unit I: 8 lecture hours

Security principles, threats and attack techniques; Introduction to security; Information Security; Security triad: Confidential, Integrity, Availability; Focus of control; Security threats and attacks; Security management.Authentication and access control; Identification; Authentication; Authentication by passwords; Protecting passwords; Access control structures.

Unit II: 10 lecture hours

Lattice and reference monitors; Security Levels and Categories; Lattice Diagram; Reference Monitors; Security Kernel; Hardware Security Features; Protecting Memory. UNIX security, Windows security; Subjects, objects and access control; General security principles; Access components; Access decisions; Administration and management issue.

Unit III: 10 lecture hours

Cryptography; Cryptographic mechanisms; Digital signatures; Encryption Certificates. Authentication in distributed systems; Key establishments and authentication; Kerberos; Public key infrastructures; Single sign-on.

Unit IV: 12 lecture hours

Software security and database security; Memory management; Data and code; Relational databases; Access control in databases; Statistical database security.Network security; Protocol design principles; ISO architecture; IP security; SSL/TLS; Firewalls; Intrusion detection.

Text Books

1. Dieter Gollmann , Computer Security 3rd Edition, Wiley, 2010
2. AtualKahate, " Cryptography and Network Security", TMH.
3. William Stalling, " Cryptography and Network security", Pearson.

Reference Books/Materials

1. Cyber Security by Godbole, Wiley India
2.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recognize security issues concerning cyber infrastructure	**PO1**

CO2	Understand various security models and cryptographic solutions	**PO2, PO5**
CO3	Assess threats and design necessary solutions	**PO3**
CO4	Implement security protocols at various levels	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 603P	Fundamentals Of Cyber Security	3	2	3	2	2								3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 605P	Mathematical Foundation For Cyber Security	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basic knowledge about Cyber security				
Co-requisites	--				

Course Objectives

Course Outcomes

After completion of this course, student will be able to¬Effectively express the concepts and results of Number Theory.

CO1. Understand basic concepts of various algebraic structures and theorems like Euler's theorem for designing security algorithm.

CO2. Understand coding theory which will be useful for data compression, information hiding

CO3. Illustrate various pseudorandom number generation used for designing security protocols and for its analysis.

CO4. Demonstrate the concept of Probability.

Catalog Description

The goal of this course is for students to be introduced to the basic mathematical and programming tools used in modern security research and practices. The course covers introductory material from a number of disparate fields including functional programming, probability theory, analysis of algorithms, complexity theory, number theory, and group theory.

Course Content

Unit I: **12 lecture hours**

Number Theory: Introduction - Divisibility - Greatest common divisor - Prime numbers - Fundamental theorem of arithmetic - Mersenne primes - Fermat numbers - Euclidean algorithm.

Fermat's theorem - Euler totient function - Euler's theoerem. Congruences: Definition – Basicproperties of congruences - Residue classes - Chinese remainder theorem.

Unit II: **8 lecture hours**

Algebraic Structures: Groups – Cyclic groups, Cosets, Modulo groups - Primitive roots – Discrete logarithms. Rings – Sub rings, ideals and quotient rings, Integral domains. Fields – Finite fields – GF(pn), GF(2n) - Classification - Structure of finite fields. Lattice, Lattice as Algebraic system, sublattices, some special lattices.

Unit III: **8 lecture hours**

Probability Theory: Introduction – Concepts of Probability - Conditional Probability - Baye's
Theorem - Random Variables – discrete and continuous- central Limit Theorem-Stochastic
Process Markov Chain. Coding Theory: Introduction - Basic concepts: codes, minimum distance, equivalence of codes, Linear codes - Linear codes - Generator matrices and parity-check matrices - Syndrome decoding –Hamming codes - Hadamard Code - Goppa codes.

Unit IV: **12 lecture hours**

Pseudorandom Number Generation: Introduction and examples – In distinguish ability of Probability Distributions - Next Bit Predictors - The Blum-Blum-Shub Generator – Security of the BBS Generator.

Text Books

1. D. S. Malik, J. Mordeson, M. K. Sen, Fundamentals of abstract algebra, Tata McGraw Hill

Reference Books/Materials

1. P. K. Saikia, Linear algebra, Pearson Education, 2009.
2. I. Niven, H.S. Zuckerman and H. L. Montgomery, An introduction to the theory of numbers, John Wiley and Sons, 2004.
3. D P Bersekas and J N Tsitsiklis, Introduction to probability, Athena Scientific, 2008
4. Douglas Stinson, 'Cryptography – Theory and Practice', CRC Press, 2006.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	Mapped Program Outcomes
CO1	Understand basic concepts of various algebraic structures and theorems like Euler's theorem for designing security algorithm.	PO1
CO2	Understand coding theory which will be useful for data compression, information hiding	PO2
CO3	Illustrate various pseudorandom number generation used for designing security protocols and for its analysis.	PO4, PO5
CO4	Demonstrate the concept of Probability.	PO3

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
PSO3	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 605P	MATHEMATICAL FOUNDATION FOR CYBER SECURITY	3	3	3	3	2								3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS651P	**Design and analysis of algorithms Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning				
Co-requisites	--				

Course Objectives

1. To understand concept of different sorting algorithms.
2. To understand the concept of dynamic programming.
3. To understand concept of divide and conquer.
4. To understand Dictionary (ADT)
5. To understand concept of greedy algorithms.
6. To understand concept & features like max heap, min heap

Course Outcomes

On completion of this course, the students will be able to

CO 1 Student will be able to implement optimal solution for various dynamic problems.

CO 2 To understand various sorting techniques.

CO 3 Analyze working of various operations on graphs.

CO 4 To understand concept of string matching in data structure

Course Content

List of Experiments

1	To analyze time complexity of insertion sort	**2 lab hours**
2	To analyze time complexity of Quick sort	**2 lab hours**
3	To analyze time complexity of merge sort	**2 lab hours**
4	Implement Largest Common Subsequence.	**2 lab hours**
5	To Implement Optimal Binary Search Tree.	**2 lab hours**
6	To Implement Matrix Chain Multiplication.	**2 lab hours**

7	To Implement Strassen's matrix multiplication Algorithm.	**2 lab hours**
8	To implement Knapsack Problem.	**2 lab hours**
9	To implement Activity Selection Problem.	**2 lab hours**
10	To implement Dijkstra's Algorithm.	**2 lab hours**
11	To implement Warshall's Algorithm.	**2 Labs**
12	To implement Bellman Ford's Algorithm.	**2 Labs**
13	To implement Depth First Search Algorithm.	**1 Lab**
14	To implement BreadthFirst Search Algorithm.	**1 Lab**
15	To implement NaïveString MatchingAlgorithm.	**1 Lab**
16	To implement Rabin Karp String MatchingAlgorithm	**1 Lab**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the implementation of symbol table using hashing techniques.	**PO1**
CO2	Develop and analyze algorithms for red-black trees, B-trees and Splay trees.	**PO4**
CO3	Understanding the concept and usage of greedy and dynamic programming	**PO5**
CO4	Understanding the concept of backtracking, branch and bound technique.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 651P	Design and analysis of algorithms Lab	2	2		3	3								3	2		2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 653P	Fundamentals Of Cyber Security Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	None				
Co-requisites	--				

Course Objectives

1. Make students aware of fundamentals of cyber security, and
2. Teach security principles and mechanisms for systems that store, process, and transmit information.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Recognize security issues concerning cyber infrastructure

CO2. Understand various security models and cryptographic solutions

CO3. Assess threats and design necessary solutions

CO4. Implement security protocols at various levels

Catalog Description

Based on theory subject **ETCS 603P**, the following Practical's are to be performed. It enables students to understand the Fundamental of Cyber Security.

List of Experiments (Indicative)

1	To configure virtual networks using network simulator	**2 lab hours**
2	To install and exploit security tools for protecting a network	**2 lab hours**
3	To implement cryptographic algorithm for building a secure communication network	**4 lab hours**
4	To exploit the vulnerabilities in a LAN environment to launch attacks	**4 lab hours**
5	To identify and secure network systems from malicious software	**4 lab hours**
6	To identify and exploit vulnerable virtual machine image	**2 lab hours**
7	To perform vulnerability assessment of wireless devices and audit the same with penetration testing	**4 lab hours**

8	To analyse the source code and carry out a reverse engineering of binaries and executables	**4 lab hours**
9	To apply machine learning algorithms in intrusion detection dataset	**4 lab hours**
10	To create, install, update, and disassemble Android applications.	**4 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Recognize security issues concerning cyber infrastructure	**PO1**
CO2	Understand various security models and cryptographic solutions	**PO2, PO5**
CO3	Assess threats and design necessary solutions	**PO3**
CO4	Implement security protocols at various levels	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 653P	Fundamentals Of Cyber Security Lab	3	2	3	2	2								3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 602P	**APPLIED CRYPTOGRAPHY**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	**Fundamentals of cyber security**				
Co-requisites	--				

Course Objectives

1. A strong grasp of the basic concepts underlying classical and modern cryptography, and the fundamentals.
2. Understand how security is defined and proven at the cryptographic level.
3. Understand common attacks and how to prevent them.
4. Gain the ability to apply appropriate cryptographic techniques to a security engineering (and management) problem at hand.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Examine and analyze crypto protocols in existing systems.
CO2.Analyze Protocols for identification and login
CO3. Evaluation of Authenticated Key Exchange protocols
CO4. Understanding the Conference Key Protocols and its applications
CO5.Analyze of Key Broadcasting Protocols

Catalog Description

This course covers the usage of cryptographic protocols for computer and network applications. Assuring the quality, validity and privacy of information is one of the key applications of Cryptography. Applications of cryptography ranges from signatures, certificates to trust less multiparty computations.

Course Content

Unit I: 8 lecture hours

Protocols for identification and login: Interactive protocols, ID protocols, Password protocols, Challenge-response protocols, Schnorr's identification protocol, Proving properties in zero-knowledge.

Unit II: **10 lecture hours**

Authenticated Key Exchange: encryption-based protocol and its attacks, Perfect forward secrecy, Protocol based on ephemeral encryption, Attackson Insecure variations, Identity protection, One-sided authenticated key exchange, Deniability

Unit III: **10 lecture hours**

Channel bindings, Formal definitions, Security of protocol AKE1, Password authenticated key exchange - Phishing attacks, ProtocolPAKE0, Protocol PAKE1, Protocol PAKE2, Explicit key confirmation.

Unit IV: **12 lecture hours**

Key exchange protocol with an online TTP, Insecure variations of protocol Online TTP, Conference Key Protocols, Key Broadcasting Protocols.

Text Books

1. A. J. Menezes, P. C. V. Oorschot and S. A. Vanstone, Handbook of Applied Cryptography, CRC Press,1996.
2. J. Pieprzyk, T. Hardjono and J. Seberry, Fundamentals of computer security, Springer, 2003.
3. Abhijit Das and VeniMadhavan C. E., Public-key Cryptography, Theory and Practice, Pearson Education,2009.
4. C. Boyd and A. Mathuria, Protocols for Authentication and Key Establishment, Springer, 2010.
5. L. Dong and K. Chen, Cryptographic Protocol: Security Analysis Based on Trusted Freshness, Springer,2012.

Reference Books/Materials

1. Cyber Security by Godbole, Wiley India

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Examine and analyze crypto protocols in existing systems.	**PO1**
CO2	Analyze Protocols for identification and login	**PO2**
CO3	Evaluation of Authenticated Key Exchange protocols	**PO4**
CO4	Understanding the Conference Key Protocols and its applications	**PO4, PO5**
CO5	Analyze of Key Broadcasting Protocols	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 602P	APPLIED CRYPTOGRAPHY	2	2	3	3	3								3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS604P	**Web Application and Penetration Testing**	L	T	P	C
Version 1.0		3	1	-	4
Pre-requisites/Exposure	Basics of Web Development				
Co-requisites	--				

Course Objectives

1. Understand basic security threats and attacks.
2. Identify security weaknesses.
3. Identify security issues in web applications and SQL injections.

Course Outcomes

On completion of this course, the students will be able to

CO1. Analyze the results from automated web testing tools to validate findings, determine their business impact, and eliminate false positives.

CO2. Manually discover key web application flaws.

CO3. Use Python to create testing and exploitation scripts during a penetration test.

CO4. Discover and exploit SQL Injection flaws to determine true risk to the victim organization.

CO5. Create configurations and test payloads within other web attacks

Catalog Description

This course provides the knowledge and skills Testers need to detect security vulnerabilities in web applications using a combination of manual and automated methods. Testing Web Application security is not intuitive and to be effective you need an understanding of web application design, HTTP, Javascript, browser behavior, and potentially other technologies such as AJAX, JSON, and XML.

Course Content

UnitI **12 lecture hours**

Web Fundamentals – HTML, HTTP 1.0 and 1.1, Client-side scripting, Server-side scripting; Web server architecture - Windows & Linux, IIS and LAMP servers, Network topologies and DMZ.

Web applications: Introduction to web applications, Web application hacking, Overview of browsers, extensions, and platforms Tools: BeFF, Maltego Usage and documentation.

UnitII **8 lecture hours**

OWASP top 10 most critical web application security risks 2017, Attacks, detection evasion techniques, and countermeasures for the most popular web platforms, including IIS, Apache and countermeasures for common web authentication mechanisms, including password-based, multifactor. Tools: Tenable.io Web App Scanning, Lumin, Container Security, Burp Suite Usage and documentation.

Unit III **10 lecture hours**

Advanced session analysis, hijacking, and fixation techniques, cross-site scripting, SQL injection, classic categories of malicious input, Overlong input (like buffer overflows), canonicalization attacks(like the infamous dot-dot-slash), and meta characters, various SQL injection tools and techniques, stealth-encoding techniques and input validation/ output-encoding countermeasures.
Tools: Metasploit, Wireshark usage and documentation.

Unit IV **10 lecture hours**

Vuln hub Virtual Machine Exploitations using various learning done during class lecture. VAPT Steps: Target Recon, Scanning and Service Enumeration, Vulnerabilities and Exploitation, PostExploitation - Owning, Pivoting, Privilege, Issues.

Text Books

1. Himanshu Kumar, “Learning Nessus for Penetration Testing,” Packt Publishing Limited.

Reference Books/Materials

1. DafyddStuttard, Marcus Pinto, “The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws, 2ed”, Wiley.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Analyze the results from automated web testing tools to validate findings, determine their business impact, and eliminate false positives.	**PO2**
CO2	Manually discover key web application flaws.	**PO4**
CO3	Use Python to create testing and exploitation scripts during a penetration test.	**PO5**
CO4	Discover and exploit SQL Injection flaws to determine true risk to the victim organization.	**PO3**
CO5	Create configurations and test payloads within other web attacks	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 604P	Web Application and Penetration Testing		3	3	3	2								3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS606P	**Wireless Adhoc Networks**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Advanced of Computer communication				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to:-

1. Architect adhoc networks for various application setups.
2. Devise appropriate data dissemination protocols and model links cost.
3. Understand the fundamental concepts of wireless adhoc networks and have a basic knowledge of the various protocols at various layers.
4. Evaluate the performance of adhoc networks and identify bottlenecks.

Course Outcomes

On completion of this course, the students will be able to

CO 1 Understand need for ad hoc networks.

CO 2 Explain the constraints of physical layer that affect the design and performance of ad hoc network.

CO3 Understand why protocols required for wired network may not work for wired network at MAC, Network and Transport Layer.

CO4 Explain the operations and performance of various MAC layer protocols, unicast routing protocols and transport layer protocols proposed for ad hoc networks.

CO5 Understand security issues and QoS requirements

Catalog Description

This course will also provide a systematic explanation of adhoc network as a discrete discipline and will provide an in-depth coverage of mobile systems and devices, mobile operating systems used for application development, mobile databases, client-server computing agents, application servers, security protocols, and mobile Internet, and ad-hoc and sensor networks.

Course Content

Unit I: **12 lecture hours**

Introduction to adhoc networks – definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models: Indoor and out door models.

Unit II: **8 lecture hours**

MAC Protocols: design issues, goals and classification. Contention based protocols- with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN.

Unit III: **12 lecture hours**

Network protocols, Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing.

Unit IV: **8 lecture hours**

Transport layer: Issues in designing- Transport layer classification, adhoc transport protocols. Security issues in adhoc networks: issues and challenges, network security attacks, secure routing protocols. Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques. Integration of adhoc with Mobile IP networks.

Text Books

1. C.Siva Ram Murthy and B.S.Manoj, Ad hoc Wireless Networks Architectures and protocols, 2nd edition, Pearson Education. 2007

2. Charles E. Perkins, Ad hoc Networking, Addison – Wesley, 2000

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz I	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand need for ad hoc networks.	**PO1, PO2**
CO2	Explain the constraints of physical layer that affect the design and performance of ad hoc network.	**PO3,**
CO3	Understand why protocols required for wired network may not work for wired network at MAC, Network and Transport Layer.	**PO4**
CO4	Explain the operations and performance of various MAC layer protocols, unicast routing protocols and transport layer protocols proposed for ad hoc networks.	**PSO1, PSO2**
CO5	Understand security issues and QoS requirements	**PO10**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 606P	Wireless Adhoc Networks	1	1	2	2						2			3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 652P	**Applied Cryptography Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	**Fundamentals Of Cyber Security**				
Co-requisites	--				

Course Objectives

1. A strong grasp of the basic concepts underlying classical and modern cryptography, and the fundamentals.
2. Understand how security is defined and proven at the cryptographic level.
3. Understand common attacks and how to prevent them.
4. Gain the ability to apply appropriate cryptographic techniques to a security engineering (and management) problem at hand.

Course Outcomes

On completion of this course, the students will be able to:

CO1. Examine and analyze crypto protocols in existing systems.

CO2. Analyze Protocols for identification and login

CO3. Evaluation of Authenticated Key Exchange protocols

CO4. Understanding the Conference Key Protocols and its applications

CO5. Analyze of Key Broadcasting Protocols

Catalog Description

Based on theory subject **ETCS 602P**, the following Practical's are to be performed.

List of Experiments (Indicative)

1	Implement the following SUBSTITUTION & TRANSPOSITION TECHNIQUES concepts: a)Caesar Cipher b)Playfair Cipher	**4 lab hours**

	c)Hill Cipher d)Vigenere Cipher e)Rail fence – row & Column Transformation	
2	Implement the following algorithms: a)DES b)RSA Algorithm c)Diffiee-Hellman d)MD5 e)SHA-1	**4 lab hours**
3	Implement the Signature Scheme - Digital Signature Standard	**4 lab hours**
4	Demonstrate how to provide secure data storage, secure data transmission and for creating digital signatures (GnuPG)	**4 lab hours**
5	Setup a honey pot and monitor the honeypot on network (KF Sensor)	**4 lab hours**
6	Installation of rootkits and study about the variety of options	**4 lab hours**
7	Perform wireless audit on an access point or a router and decrypt WEP and WPA. (Net Stumbler)	**4 lab hours**
8	Demonstrate intrusion detection system (ids) using any tool (snort or any other s/w).	**4 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Examine and analyze crypto protocols in existing systems.	**PO1**
CO2	Analyze Protocols for identification and login	**PO2**
CO3	Evaluation of Authenticated Key Exchange protocols	**PO4**
CO4	Understanding the Conference Key Protocols and its applications	**PO4, PO5**
CO5	Analyze of Key Broadcasting Protocols	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 652P	Applied Cryptography Lab	2	2	3	3	3								3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS654P	**Wireless Adhoc Networks Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning				
Co-requisites	--				

Course Objectives

1. To understand concept Network Simulator 3.
2. To understand the important files of NS3.
3. To understand concept wifi to bus connectivity using NS3.
4. To understand concept of Wifi to LTE(4G) connection.
5. To understand concept & features of GSM architecture

Course Outcomes

On completion of this course, the students will be able to

CO 1 Student will be able to work on virtual networking platform.

CO 2 To understand various usage of virtual platform for networking.

CO 3 Analyze working of wifi to BUS (CSMA).

CO 4 To understand concept of connectivity on a virtual networks.

Course Content

List of Experiments

1	Program in NS 3 to connect WIFI TO BUS(CSMA)	**4 lab hours**
2	Program in NS 3 to create WIFI SIMPLE INFRASTUCTURE MODE	**4 lab hours**
3	Program in NS 3 to create WIFI SIMPLE ADHOC MODE	**4 lab hours**
4	Program in NS 3 to connect WIFI TO WIRED BRIDGING	**4 lab hours**
5	Program in NS 3 to create WIFI TO LTE(4G) CONNECTION	**4 lab hours**

6	Program in NS3 for CREATING A SIMPLE WIFI ADHOC GRID	**4 lab hours**
7	Introduction to GSM Architecture	**4 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Student will be able to work on virtual networking platform.	**PO2**
CO2	To understand various usage of virtual platform for networking.	**PO3**
CO3	Analyze working of wifi to BUS (CSMA).	**PO5**
CO 4	To understand concept of connectivity on a virtual networks.	**PSO1, PO9**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 654P	Wireless Adhoc Networks Lab		2	3		3				3				3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 607P	Security And Privacy Issues In Wireless Networks	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Introduction to Computers Networks				
Co-requisites					

Course Objectives

Wireless Networks possess more security risk as compared to wired networks. The objective of this course is to study and examine security and privacy issues in new and emerging types of wireless networks.

Course Outcomes

On completion of this course, the students will be able to

1. Acquire the working knowledge of security building blocks so that it can be applied to solve the problems of designing security solutions in wireless network systems
2. Acquire the fundamental understanding of two main-stream approaches (i.e., data-oriented and voice-oriented) taken by wireless security systems
3. Understand wireless network security MAC and routing protocols.
4. Understand wireless network security systems in depth, and enhance the skills of enabling and configuring a wireless network system

Catalog Description

This course will focus on the security and privacy issues associated with wireless networks. Various attacks against wireless networks and their defense strategies will be analyzed. Upon the completion of this course, students are expected to be able to embark in competitive research in the areas of wireless network security.

Course Content

Unit I: 10 lecture hours

Wireless Networking Trends, Key Wireless Physical Layer Concepts: Frequency, Wavelength, Phase, Coding and modulation, Shannon Theorem, Hamming Distance, Multiple Access Methods, Doppler Shift; Signal Propagation: Reflection, Diffraction, Scattering, Fading, Shadowing, Multipath, MultiAntenna Systems, Beam forming, MIMO, OFDM; Wireless Local Area Networks: IEEE 802.11,Amendments; Wireless Personal Area Networks.

Unit II: 8 lecture hours

GSM: Overview, Architecture, GSM Security Principles; General Packet Radio Services (GPRS):Overview, Architecture; Universal Mobile Telecommunication System (UMTS): Overview, Architecture and Subsystems; LTE: Overview, Architecture and Subsystems.

Unit III: 10 lecture hours

Radio Frequency Identification (RFID); WiMAX (Physical layer, Media access control, Mobility and Networking); Multi hop wireless networks: Position & topology base ad-hoc routing protocols, Proactive and Reactive routing protocols. Route disruption, diversion, routing state based attacks, SRP, Ariadne, SAODV, ARAN, SMT secure routing protocols, Wireless Sensor Networks.

Unit IV: 12 lecture hours

Security of wireless networks: GSM, UMTS, WEP, IEEE 802.11i, Public WiFi hotspots, Bluetooth; Vehicular Ad-hoc Networks: vulnerabilities, challenges, Security architecture
Naming & addressing principles, attacks and protection techniques, Misbehaviour at MAC layer of CSMA/CA, its impact and preventive measures, Mobile IPv4, Mobile IPv6, TCP over Wireless Networks.

TEXT BOOKS:

1. Jochen Schiller, “Mobile Communications”, PHI.
2. K Makki, P Reiher,et. all. “Mobile and Wireless Network Security and Privacy”,Springer, 2007
3. Levente Buttyan, J P Hubaux. “Security and Cooperation in Wireless Networks”, Cambridge University Press, 2008.
4. Uwe Hansmann, LotharMerk, Martin S. Nicklons and Thomas Stober, Principles of Mobile Computing, Springer, New York, 2003
5. Frank Adelstein, Sandeep KS Gupta, Golden Richard, Fundamentals of Mobile and Pervasive Computing, McGraw-Hill.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Acquire the working knowledge of security building blocks so that it can be applied to solve the problems of designing security solutions in wireless network systems	**PO1**
CO2	Acquire the fundamental understanding of two main-stream approaches (i.e., data-oriented and voice-oriented) taken by wireless security systems	**PO2**
CO3	Understand wireless network security MAC and routing protocols.	**PO4**
CO4	Understand wireless network security systems in depth, and enhance the skills of enabling and configuring a wireless network system	**PO5; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 607P	Security And Privacy Issues In Wireless Networks	3	3		3	3							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 609P	**Information Security And Privacy**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Fundamentals of Cyber Security				
Co-requisites					

Course Objectives

This course focuses on the models, tools, and techniques for enforcement of security with some emphasis on the use of cryptography. Students will learn security from multiple perspectives.

Course Outcomes

On completion of this course, the students will be able to

1. Identify, analyze and articulate the importance of managing IS-related risk and security issues in organizations, and the relationship between these and the achievement of business value from IS/IT investments.
2. Demonstrate responsible computer use as it deals with social, political, legal and ethical issues in today's electronic society.
3. Develop and document IS/IT risk and security management plans that detail contingency planning strategies and practices.
4. Identify, analyze, synthesize and articulate the major theories and concepts associated with IS failure and the management of IS risk.

Catalog Description

This course provides an overview of information security and privacy topics. It introduces students to the knowledge and tools they will need to deal with the security/privacy challenges they are likely to encounter in today's cyber world.

Course Content

Unit I: **10 lecture hours**

Passwords, security questions, challenge-response, Cryptographic hash functions, Biometrics, Phishing.

Unit II: **8 lecture hours**

Web security model, Web authentication and session management, Cross-site request forgery, SQLinjection, cross-site scripting, Logic flaws in Web applications, Click jacking..

Unit III: **10 lecture hours**

Online tracking, Symmetric encryption, Kerberos, Memory corruption attacks and defenses, Viruses and rootkits, Spam, Attacks on TCP/IP, DNS, BGP.

Unit IV: **12 lecture hours**

Denial of service, Worms and botnets, Advance Persistent Threats. Firewall and intrusion detection, Public Key Cryptography, SSL and certificates, Anonymity networks, Side channel attacks: acoustics and reflections.

TEXT BOOKS:

1. Network Security (2nd edition) by Kaufman, Perlman, and Speciner
2. Security Engineering by Anderson
3. The Art of Intrusion by Mitnick and Simon
4. The Shellcoder's Handbook by Koziol et al.
5. Secure Programming for Unix and Linux HOWTO by Wheeler
6. Network Security Essentials by Stallings

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**

CO1	Identify, analyze and articulate the importance of managing IS-related risk and security issues in organizations, and the relationshipbetween these and the achievement of business value from IS/IT investments.	**PO2**
CO2	Demonstrate responsible computer use as it deals with social, political, legal and ethical issues in today's electronic society.	**PO8**
CO3	Develop and document IS/IT risk and security management plans that detail contingency planning strategies and practices.	**PO5; PO6**
CO4	Identify, analyze, synthesize and articulate the major theories and concepts associated with IS failure and the management of IS risk.	**PO4; PO3; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 609P	Information Security And Privacy		3	2	3	2	2		2				2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 611P	Cyber Crime and IT Law	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

The course deals with Cyber law as per Indian/IT act 2008.It also covers overview of Intellectual l Property Right and Trademark Related laws with respect to Cyber Space.

Course Outcomes

On completion of this course, the students will be able to

1.Make Learner Conversant With The Social And Intellectual Property Issues Emerging From 'Cyberspace.

2.Explore the Legal and Policy Developments in Various Countries to Regulate Cyberspace.

3.Develop the Understanding of Relationship between Commerce and Cyberspace.

4. Acquaintance with Information Technology Act and Legal Framework of Right to Privacy, Data Security and Data Protection.

Catalog Description

The objectives of this course is to enable learner to understand, explore, and acquire a critical understanding cyber law. Develop competencies for dealing with frauds and deceptions (confidence tricks, scams) and other cybercrimes for example, child pornography etc. That are taking place via the internet.

Course Content

Unit I: **8 lecture hours**

Introduction to cybercrime and cyber law, cyber space and information technology, Nature and scope of cybercrime, Jurisdiction of cybercrime.

Unit II: **8 lecture hours**

Important definitions under IT Act 2000, Cybercrime issues: unauthorized access, White collar crimes, viruses, malwares, worms, Trojans, logic bomb, Cyber stalking, voyeurism, obscenity in internet, Software piracy,

Unit III: **10 lecture hours**

IT Act 2000, offences under IT Act and IT (amendment) Act, 2008. CRPC overview, Case studies,Role of intermediaries, Electronic evidence, Cyber terrorism, espionage, warfare and protected system.
Overview of amended laws by the IT Act, 2000: The Indian Penal Code, 1860, The Indian EvidenceAct, 1872, The Banker's Book Evidence Act, 1891, The Reserve Bank of India Act, 1934, CyberTheft and the Indian Telegraph Act, 1885. Relevant Case laws. Digital Signatures and certificate -legal issues, amendments: IT Act 2008, IT Act 2020

Unit IV: **12 lecture hours**

Intellectual Property rights: Introduction to IP, Copyright, Related Rights, Trademarks, Geographical Indications, Industrial Design, Patents, Licensing and transfer of technology, WIPO Treaties, Copyrights Act, Patents Act, Trademarks Act.

TEXT BOOKS:

1. Cyber Security, Cyber Crime and Cyber Forensics: Applications and Perspectives, Raghu Santanam, M. Sethumadhavan, Information Science Reference
2. Pfleeger, Charles P. and Shari L. Pfleeger. Security in Computing, 4th Edition. Upper Saddle River, NJ: Prentice Hall, 2008
3. Cybercrime: Security and Surveillance in the Information Age, Douglas Thomas; Brian Loader
4. Computer Crime: A Crime-Fighters Handbook by David Icove

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Make Learner Conversant With The Social And Intellectual Property Issues Emerging From ‘Cyberspace.	**PO6**
CO2	Explore the Legal and Policy Developments in Various Countries to Regulate Cyberspace.	**PO7, PO8**
CO3	Develop the Understanding of Relationship between Commerce and Cyberspace.	**PO5; PO11**
CO4	Acquaintance with Information Technology Act and Legal Framework of Right to Privacy, Data Security and Data Protection.	**PO8; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 611P	Cyber Crime and IT Law					1	3	2	3			2	3	2	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 613P	**Advanced Database Management System**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Knowledge of Database Management System				
Co-requisites					

Course Objectives

- To understand the basic concepts and terminology related to DBMS and Relational Database Design
- To the design and implement Distributed Databases.
- To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports

Course Outcomes

On completion of this course, the students will be able to

1. Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.
2. Perform Query Optimization.
3. Have knowledge of Parallel and distributed database systems.
4. Have knowledge of new database architectures and query operators.

Catalog Description

The course presupposes a basic knowledge of conceptual modelling for data base systems and implementation using relational DBMS and SQL. The course aims to a more profound understanding of database theories, models, and methods and an ability to use these in different situations.

Course Content

Unit I: **10 lecture hours**

Relational Databases: Integrity Constraints revisited, Extended ER diagram, Relational Algebra & Calculus, Functional, Muilti-valued and Join Dependency, Normal Forms, Rules about functional dependencies.

Query Processing and Optimization: Valuation of Relational Operations, Transformation of Relational Expressions, Indexing and Query Optimization, Limitations of Relational Data Model, Null Values and Partial Information.

Unit II: 10 lecture hours

Deductive Databases: Datalog and Recursion, Evaluation of Datalog program, Recursive queries with negation.

Objected Oriented and Object Relational Databases: Modeling Complex Data Semantics, Specialization, Generalization, Aggregation and Association, Objects, Object Identity, Equality and Object Reference, Architecture of Object Oriented and Object Relational Databases

Parallel and Distributed Databases: Distributed Data Storage – Fragmentation & Replication, Location and Fragment Transparency Distributed Query Processing and Optimization, Distributed Transaction Modeling and concurrency Control, Distributed Deadlock, Commit Protocols, Design of Parallel Databases, Parallel Query Evaluation.

Unit III: 10 lecture hours

Advanced Transaction Processing: Nested and Multilevel Transactions, Compensating Transactions and Saga, Long Duration Transactions, Weak Levels of Consistency, Transaction Work Flows, Transaction Processing Monitors.

Active Database and Real Time Databases: Triggers in SQL, Event Constraint and Action: ECA Rules, Query Processing and Concurrency Control, Compensation and Databases Recovery

Image and Multimedia Databases: Modeling and Storage of Image and Multimedia Data, Data Structures – R-tree, k-d tree, Quad trees, Content Based Retrieval: Color Histograms, Textures, etc., Image Features, Spatial and Topological Relationships, Multimedia Data Formats, Video Data Model, Audio & Handwritten Data, Geographic Information Systems (GIS)

Unit IV: 12 lecture hours

WEB Database: Accessing Databases through WEB, WEB Servers, XML Databases, and Commercial Systems.

Data Warehousing: Data Warehousing Architecture, Multidimensional Data Model, Update Propagation OLAP Queries. Data Mining: Knowledge Representation Using Rules, Association and Classification Rules, Sequential Patterns, Algorithms for Rule Discovery

Case Study: Oracle Xi

TEXT BOOKS:

1. Elmarsi, Navathe, Somayajulu, Gupta, "Fundamentals of Database Systems", 4th Edition, Pearson Education, 2007

2. Garcia, Ullman, Widom, "Database Systems, The complete book", Pearson Education, 2007

3. R. Ramakrishnan, "Database Management Systems", McGraw Hill International Editions, 1998

Reference Books:

1. Date, Kannan, Swaminathan, "An Introduction to Database Systems", 8th Edition Pearson Education, 2007

2. Singh S.K., "Database System Concepts, design and application", Pearson Education, 2006.

3. Silberscatz, Korth, Sudarshan, "Database System Concepts", Mcgraw Hill, 6th Edition, 2006

4. D. Maier, "The Theory of Relational Databases", 1993, Computer Science Press, Rokville, Maryland

5. Ullman, J. D., "Principals of database systems", Galgotia publications, 1999

6. Oracle Xi Reference Manual

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.	**PO1**
CO2	Perform Query Optimization.	**PO2, PO4, PO11**
CO3	Have knowledge of parallel and distributed database systems.	**PO5**
CO4	Have knowledge of new database architectures and query operators	**PO5; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 613P	Advanced Data Base Management System	2	3		3	2						2	2	3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 655P	Advanced Database Management System Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Knowledge of Database Management System				
Co-requisites					

Course Objectives

- To understand the basic concepts and terminology related to DBMS and Relational Database Design
- To the design and implement Distributed Databases.
- To understand advanced DBMS techniques to construct tables and write effective queries, forms, and reports

Course Outcomes

On completion of this course, the students will be able to

1. Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.
2. Perform Query Optimization.
3. Have knowledge of Parallel and distributed database systems.
4. Have knowledge of new database architectures and query operators.

Catalog Description

The course complements the theory ETCS 613P. The aims is to have hands-on session for the concepts students have learnt in theory classes.

List of Experiment (Indicative)

1	Exercise based on Data Definition Language Commands	**2 lab hours**
2	Exercise based on Data Manipulation Language Commands	**2 lab hours**
3	Exercise based on Data Control Language, Transfer Control Language Commands	**2 lab hours**
4	Exercise based on In Built Functions	**2 lab hours**
5	Exercise based on Nested Queries and Join Queries	**2 lab hours**
6	Exercise based on Set operators.	**2 lab hours**

7	Exercise based on Views	**2 lab hours**
8	Exercise based on Control Structure.	**2 lab hours**
9	Exercise based on Procedure and Function	**2 lab hours**
10	Exercise based onTrigger	**2 lab hours**
11	Exercise based onIndexing and Query Processing	**2 lab hours**
12	Exercise based onQuery Evaluation Plans	**2 lab hours**
13	Exercise based onConcurrency and Transactions	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.	**PO1**
CO2	Perform Query Optimization.	**PO2, PO4, PO11**
CO3	Have knowledge of parallel and distributed database systems.	**PO5**
CO4	Have knowledge of new database architectures and query operators	**PO5; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 655P	Advanced Database Management System Lab	2	3		3	2						2	2	3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 615P	**Soft Computing**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

- The primary objective of this course is to provide an introduction to the basic principles, techniques, and applications of soft computing.
- Upon successful completion of the course, students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
- Provide the mathematical background for carrying out the optimization associated with neural network learning.
- Aim of this course is to develop some familiarity with current research problems and research methods in Soft Computing by working on a research or design project.

Course Outcomes

On completion of this course, the students will be able to

1. Develop application on different soft computing techniques like Fuzzy, GA and Neural network.
2. Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.
3. Understand different soft computing tools to solve real life problems.
4. Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques.

Catalog Description

The main objective of the course is to expose the students to soft computing, various types of soft computing techniques, and applications of soft computing. Upon completion of course the students will be able to get idea on artificial Intelligence, neural network, fuzzy Logic and genetic algorithms.

Course Content

Unit I: **12 lecture hours**

Introduction: Introduction to Soft Computing Concepts, Importance of tolerance in imprecision and uncertainty, Soft Computing Constituents and Conventional Artificial Intelligence, From Conventional AI to Computational Intelligence, Fuzzy Set Theory, Neural Networks and Evolutionary Computation

Neural Networks: Overview of biological Neuro-system, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Hopfield Networks, Associative Memories, Applications of Artificial Neural Networks.

Unit II: **12 lecture hours**

Introduction to Fuzzy Sets: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation.

Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations,
Aggregation Operations.

Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations.

Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Propositions, Fuzzy Qualifiers, Linguistic Hedges.

Uncertainty based Information: Information & Uncertainty, Nonspecificity of Fuzzy & Crisp Sets, Fuzziness of Fuzzy Sets, Defuzzyfication.

Unit III: **10 lecture hours**

Evolutionary Computation: Genetic Algorithms and Genetic Programming, Evolutionary Programming, Evolutionary Strategies and Differential Evolution Coevolution, Different operators of Genetic Algorithms, Analysis of Selection Operations, Convergence of Genetic Algorithms.

Unit IV: **10 lecture hours**

Rough Sets: Introduction, Imprecise categories Approximations and Rough Sets, Reduction of Knowledge, Decision Tables, and Applications.

Hybrid Systems: Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks. Fuzzy Logic bases Neural Networks, Genetic Algorithm for Neural Network Design and Learning, Fuzzy Logic and Genetic Algorithm for Optimization, Applications.

Text Books:

1. Anderson J.A, “An Introduction to Neural Networks”,PHI, 1999.
2. Hertz J. Krogh, R.G. Palmer, “Introduction to the Theory of Neural Computation”, Addison-Wesley, California, 1991.

Reference Books:

1. “Neural Networks-A Comprehensive Foundations”, Prentice-Hall International, New Jersey,1999.
2. Freeman J.A. & D.M. Skapura. “Neural Networks: Algorithms, Applications and Programming Techniques”, Addison Wesley, Reading, Mass, (1992).
3. G.J. Klir& B. Yuan, “Fuzzy Sets & Fuzzy Logic”, PHI, 1995.
4. Melanie Mitchell, “An Introduction to Genetic Algorithm”, PHI, 1998.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop application on different soft computing techniques like Fuzzy, GA and Neural network.	**PO1**
CO2	Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.	**PO2, PO4**
CO3	Understand different soft computing tools to solve real life problems	**PO3, PO5**
CO4	Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques	**PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 615P	Soft Computing	2	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 657P	**Soft Computing Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

- The primary objective of this course is to provide an introduction to the basic principles, techniques, and applications of soft computing.
- Upon successful completion of the course, students will have an understanding of the basic areas of Soft Computing including Artificial Neural Networks, Fuzzy Logic and Genetic Algorithms.
- Provide the mathematical background for carrying out the optimization associated with neural network learning.
- Aim of this course is to develop some familiarity with current research problems and research methods in Soft Computing by working on a research or design project.

Course Outcomes

On completion of this course, the students will be able to

1. Develop application on different soft computing techniques like Fuzzy, GA and Neural network.
2. Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.
3. Understand different soft computing tools to solve real life problems.
4. Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques.

Catalog Description

The course complements the theory ETCS 615P. The aims is to have hands-on session for the concepts students have learnt in theory classes.

List of Experiment (Indicative)

1	Create a perceptron with appropriate number of inputs and outputs. Train it using fixed increment learning algorithm until no change in weights is required. Output the final weight.	**2 lab hours**

2	Write a program to implement artificial neural network without back propagation.	**2 lab hours**
3	Write a program to implement artificial neural network with back propagation	**2 lab hours**
4	Implement Union, Intersection, Complement and Difference operations on fuzzy sets. Also create fuzzy relation by Cartesian product of any two fuzzy sets and perform max-min composition on any two fuzzy relations.	**2 lab hours**
5	Implement travelling sales person problem (TSP) using genetic algorithms.	**2 lab hours**
6	Plot the correlation plot on dataset and visualize giving an overview of relationships among data on soya bins data. Analysis of covariance: variance (ANOVA), if data have categorical variables on iris data.	**2 lab hours**
7	Implement linear regression and multi-regression for a set of data points	**2 lab hours**
8	Implement crisp partitions for real-life iris dataset.	**2 lab hours**
9	Write a program to implement Hebb's rule.	**2 lab hours**
10	Write a program to implement Delta rule.	**2 lab hours**
11	Write a program to implement logic gates.	**2 lab hours**
12	Implement SVM classification by fuzzy concepts.	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Develop application on different soft computing techniques like Fuzzy, GA and Neural network.	**PO1**
CO2	Implement Neuro-Fuzzy and Neuro-Fuzz-GA expert system.	**PO2, PO4**
CO3	Understand different soft computing tools to solve real life problems	**PO3, PO5**
CO4	Develop familiarity with application areas of current research problems and research methods in Soft Computing Techniques	**PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 657P	Soft Computing Lab	2	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 617P	**Data Preparation and Analysis**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

Provide insight into methods and tools for analysis and processing of the data generated by modern information systems

Course Outcomes

On completion of this course, the students will be able to

1. Prepare data for analysis
2. Perform exploratory data analysis.
3. Develop meaningful data visualizations.
4. Work on a variety of real world datasets.

Catalog Description

Data preparation may be one of the most difficult steps in any machine learning project. The reason is that each dataset is different and highly specific to the project. The aim of this course is to consider data preparation as a step in a broader predictive modeling machine learning project.

Course Content

Unit I: **9 lecture hours**

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.
Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.

Unit II: **10 lecture hours**

Data Gathering and Preparation: Data formats, parsing and transformation, Scalability and real-time issues.

Data Cleaning: Consistency checking, Heterogeneous and missing data, Data Transformation and segmentation.

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Unit III: **11 lecture hours**

Exploratory Data Analysis: Descriptive and comparative statistics, Clustering and association, Hypothesis generation.

Unit IV: **10 lecture hours**

Visualization: Designing visualizations, Time series, Geo-located data, Correlations and connections, Hierarchies and networks, interactivity.

Text Books:

1.Glenn J. Myatt, Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publishers, 2007.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Prepare data for analysis	**PO1, PO2**
CO2	Perform exploratory data analysis.	**PO2**
CO3	Develop meaningful data visualizations.	**PO3, PO4**
CO4	Work on a variety of real world datasets	**PO5, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 617P	Data Preparation and Analysis	3	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 659P	Data Preparation and Analysis Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

Provide insight into methods and tools for analysis and processing of the data generated by modern information systems

Course Outcomes

On completion of this course, the students will be able to

1. Prepare data for analysis
2. Perform exploratory data analysis.
3. Develop meaningful data visualizations.
4. Work on a variety of real world datasets.

Catalog Description

The course complement ETCS 671P. The aim of this course is to give practical hands-on to undergo various step for data preparation.

List of Experiments (Indicative)

1	Data preprocessing methods on student and labor datasets Implement data cube for data warehouse on 3-dimensional data	**2 lab hours**
2	Implement various missing handling mechanisms, Implement various noisy handling mechanisms.	**2 lab hours**
3	Develop k-means and MST based clustering techniques, Develop the methodology for assessment of clusters for given dataset.	**2 lab hours**
4	Design algorithms for association rule mining algorithms.	**2 lab hours**
5	Derive the hypothesis for association rules to discovery of strong association rules; Use confidence and support thresholds.	**2 lab hours**
6	Construct Haar wavelet transformation for numerical data, Construct principal component analysis (PCA) for 5-dimensional data	**2 lab hours**

7	Implement linear regression and multi-regression for a set of data point Implement binning visualizations for any real time dataset, Implement linear regression techniques.	**2 lab hours**
8	Visualize the clusters for any synthetic dataset, Implement the program for converting the clusters into histograms.	**2 lab hours**
9	Write a program to implement agglomerative clustering technique.	**2 lab hours**
10	Write a program to implement divisive hierarchical clustering technique.	**2 lab hours**
11	Develop scalable clustering algorithms.	**2 lab hours**
12	Develop scalable a priori algorithm..	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Prepare data for analysis	**PO1, PO2**
CO2	Perform exploratory data analysis.	**PO2**
CO3	Develop meaningful data visualizations.	**PO3, PO4**
CO4	Work on a variety of real world datasets	**PO5, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Cours e Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 659P	Data Preparati on and Analysis Lab	3	3	3	3	2							2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS608P	**Malware Analysis and Network Security**	L	T	P	C
Version 1.0		3	1	-	4
Pre-requisites/Exposure	Sound Knowledge of Debuggers, Disassembler & Assembly Language				
Co-requisites	--				

Course Objectives

- Understand History of malicious code
- Understand Types of Malware
- Understand How to collect malware samples
- Understand Identifying malware through behavioral analysis
- Understand Reverse engineering of malware code (Static Analysis)
- Understand Malware defenses
- Understand Malware Forensics
- Understand Automated Malware Analysis

Course Outcomes

On completion of this course, the students will be able to

1.To carry out independent analysis of modern malware samples using both static and dynamic analysis techniques.

2.Have an intimate understanding of executable formats, Windows internals and API, and analysis techniques.

3.Extract investigative leads from host and network based indicators associated with a malicious program.

4.Apply techniques and concepts to unpack, extract, decrypt, or bypass new antianalysis techniques in future malware samples.

5.Achieve proficiency with industry standard tools including IDA Pro, OllyDbg,WinDBG, PE Explorer, ProcMon etc.

Catalog Description

This course introduces students to malware research and analysis. The course will provide students an overview of malware research, intelligence gathering related to malware, and provide students basic skills required to analyze and dis-assemble malicious programs. Students will explore the tools required for analysis and reverse engineering of malicious code, learn malware defense techniques, how malware functions, and will perform live analysis and reverse engineering exercises.

Course Content

Unit I: **13 lecture hours**

Goals of Malware Analysis, AV Scanning, Hashing, Finding Strings, Packing and Obfuscation, PE file format, Static, Linked Libraries and Functions, Static Analysis tools, Virtual Machines and their usage in malware analysis, Sandboxing, Basic dynamic analysis, Malware execution, Process Monitoring, Viewing processes, Registry snapshots, Creating fake networks.

Unit II: **7 lecture hours**

X86 Architecture- Main Memory, Instructions, Opcodes and Endianness, Operands, Registers, Simple Instructions, The Stack, Conditionals, Branching, Rep Instructions, Disassembly, Global and local variables, Arithmetic operations, Loops, Function Call Conventions, C Main Method and Offsets. Portable Executable File Format, The PE File Headers and Sections, IDA Pro, Function analysis, Graphing, The Structure of a Virtual Machine, Analyzing Windows programs, Anti-static analysis techniques, obfuscation, packing, metamorphism, polymorphism.

Unit III: **10 lecture hours**

Live malware analysis, dead malware analysis, analyzing traces of malware, system calls, api calls, registries, network activities. Anti-dynamic analysis techniques, VM detection techniques, Evasion techniques, , Malware Sandbox, Monitoring with Process Monitor, Packet Sniffing with Wireshark, Kernel vs. User-Mode Debugging, Olly Dbg, Breakpoints, Tracing, Exception Handling, Patching.

Unit IV: **10 lecture hours**

Downloaders and Launchers, Backdoors, Credential Stealers, Persistence Mechanisms, Handles, Mutexes, Privilege Escalation, Covert malware launching- Launchers, Process Injection, Process Replacement, Hook Injection, Detours, APC injection, YARA rule based detection. Android Malware Analysis: Android architecture, App development cycle, APK Tool, APKInspector,Dex2Jar, JD-GUI, Static and Dynamic Analysis.

Text Books

1. Programming Massively Parallel Processors: A Hands-on Approach; David Kirk, Wen-meiHwu; Morgan Kaufman; 2010 (ISBN: 978-0123814722)
2. CUDA Programming: A Developer's Guide to Parallel Computing with GPUs; Shane Cook; Morgan Kaufman; 2012 (ISBN: 978-0124159334)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To carry out independent analysis of modern malware samples using both static and dynamic analysis techniques.	**PO2; PO4**
CO2	Have an intimate understanding of executable formats, Windows internals and API, and analysis techniques.	**PO1**
CO3	Extract investigative leads from host and network based indicators associated with a malicious program.	**PO4; PO5**
CO4	Apply techniques and concepts to unpack, extract, decrypt, or bypass new antianalysis techniques in future malware samples.	**PO3; PO5; PO8**

CO5	Achieve proficiency with industry standard tools including IDA Pro, Olly Dbg, Win DBG, PE Explorer, Proc Monetc	**PO5; PO11; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 608P	Malware Analysis and Network Security	3	3	3	2	2			2			2	3	3	1	1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 610P	**Security Analysis of Protocols**	L	T	P	C
Version 1.0		4	0	0	4
Pre-requisites/Exposure	Concepts of Security				
Co-requisites	--				

Course Objectives

1. Ability to understand concepts of security analysis.
2. Ability to design and analyse the security of security protocols.
3. Ability to take up doctoral level research work in security
4. Understand the conceptual foundation of information security awareness.
5. Study the physical and logical perimeters of information assets and its security.

Course Outcomes

On completion of this course, the students will be able to

CO1. Get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.
CO2. Get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations.
CO3. Enhance their inquisitiveness to ever-evolving domain of information security and apply their knowledge to solve problems.
CO4. Understand the "art" and "science" of research and should be capable enough to apply this training to newer/other fields and problems.
CO5. Solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.

Catalog Description

This is a project-oriented course intended to give students hands-on experience in using a variety of analysis techniques to evaluate cryptographic protocols and other security mechanisms. A network protocol such as SSL (Secure Sockets Layer) may fail in three ways: the protocol design may be flawed, the cryptography may be inadequate, or the implementation may be buggy. This course is primarily concerned with techniques for identifying design flaws, but we will also talk about cryptography and secure implementation to the extent that they affect protocol design.

Course Content

Unit I: **12 lecture hours**

Introduction: Security protocols, Security properties, Public-key certificates and infrastructures, Cryptographic hash functions, Digital signatures, Security protocol vulnerabilities.

Unit II: **10 lecture hours**

Security Protocols: Needham- Schroeder public-key protocol and its security analysis, Protocols for anonymity, Anonymity and MIX networks, Fairness and contract signing, Fair exchange and contract signing protocols, Game-based verification of contract signing protocols. Yahalom protocol: Secrecy, Authentication, Non-repudiation, Anonymity; Dolev-Yao threat model.

Unit III: **10 lecture hours**

Finite-state checking (Murphi), Infinite-state symbolic analysis (SRI constraint solver), Probabilistic model checking (PRISM), CSP: Basic building blocks, Parallel operators, Process behaviour, Modelling security protocols in CSP - Trustworthy processes, Modelling an intruder, protocol goals.

Unit IV: **8 lecture hours**

Transformations: Transformations on protocols, Safe simplifying transformations, Structural transformations. Formal analysis: Formal definitions of security for symmetric ciphers, Formal model for secure key exchange. Theorem proving - Rank functions, Secrecy of shared key, Authentication.

Text Books

1. Julia H. Allen, Sean Barnum, Robert J. Ellison, Gary McGraw, and Nancy R. Mead,“Security Engineering: A Guide for Project Managers,” Pearson Education, 2009.

Reference Books/Materials

1. John Vacca, Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.	**PO2**
CO2	Get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations.	**PO2**
CO3	Enhance their inquisitiveness to ever-evolving domain of information security and apply their knowledge to solve problems.	**PO3**
CO4	Understand the "art" and "science" of research and should be capable enough to apply this training to newer/other fields and problems.	**PO12**
CO5	Solve security issues with understanding of system security and cryptographic attributes with a relevance to standards	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 610P	Security Analysis of Protocols		3	3	3								3	3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS612P	**Software Security**	L	T	P	C
Version 1.0		4	-	-	4
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

1. Identify typical security vulnerabilities of web applications listed in OWASP top 10, such as SQL injection, XSS, and XSRF, by reviewing the source code and by penetration testing. Students should also be able to fix the identified vulnerabilities.
2. Explain typical cryptography concepts and algorithms that are related to web application, including e.g. block cipher, stream cipher, digital signature, and SSL/TSL handshaking procedure.
3. Apply the threat modeling methods to create threat models of a medium-sized web application by using misuse cases and attack trees.
4. Describe and compare software engineering practices and standards related to software security, such as software touch points, common criteria, BASIMM, and Open SAMM.
5. Create software security test cases and prioritizing the test cases by applying the risk-based testing framework.
6. Explain key authentication and authorization concepts and methods, such as different authentication methods, multilevel and multilateral security control, and role-based access control.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understands security issues relating to system development.

C02. Knows software development techniques to avoid security problems.

CO3Can explain the most common weaknesses in software security and how such problems can be mitigated in software.

CO4. Can identify common security threats, risks, and attack vectors for software systems.

Catalog Description

The course gives an overview of security issues for software, and provides programming methods for the development of secure applications. The main focuses of the course are programming techniques for the development of safe and secure applications

Course Content

Unit I **8 lecture hours**

Security a Software Issue: Introduction, The problem, Software Assurance and Software Security, Threats to software security, Sources of software insecurity, Benefits of detecting software security defects early, managing secure software development.

Secure Software: Introduction, Properties of Secure Software, Influencing the security properties of software, Asserting and specifying the desired security properties.

Unit II **10 lecture hours**

Requirements Engineering for Secure Software: Introduction, Misuse and abuse cases, the SQUARE process Model, SQUARE sample outputs, Requirements elicitation, Requirements prioritization.

Secure Software Architecture and Design: Introduction, Software Security practices for Architecture and Design - architectural risk analysis, Software security knowledge for Architecture and Design - Security principles, Security guidelines and Attack patterns.

Unit III **12 lecture hours**

Secure Coding and Testing: Introduction, Code analysis, Coding Practices, Software Security testing, Security testing considerations throughput the SDLC.

System Assembly Challenges: Introduction, Security failures, functional and attacker perspectives for security analysis in web services and identity management, system complexity drivers and security, Deep technical problem complexity.

Unit IV **10 lecture hours**

Governance and Managing for more Secure Software: Introduction, Governance and security, adopting an enterprise software security framework, Defining adequate security, Risk Management framework for software security, Security and Project Management, Maturity of Practice.

Text Books

1. Julia H. Allen, Sean Barnum, Robert J. Ellison, Gary McGraw, and Nancy R. Mead, "Security Engineering: A Guide for Project Managers," Pearson Education, 2009.

Reference Books/Materials

1. Dijiang Huang, Ankur Chowdhary, Sandeep Pisharody, "Software-Defined Networking and Security (Data-Enabled Engineering)1st Edition", CRC Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understands security issues relating to system development.	**PO2**
CO2	Knows software development techniques to avoid security problems.	**PO1**

CO3	Can explain the most common weaknesses in software security and how such problems can be mitigated in software.	**PO2**
CO4	Can identify common security threats, risks, and attack vectors for software systems.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 612P	Software Security	3	3		2									3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS614P	**Android Security**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Advanced of Computer communication				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to:-

1. Appreciate the risks to **Android** applications.
2. Understand the structure of **Android** package files.
3. Understand the **Android security** model and the protections provided by the **Android** OS.
4. Apply defensive programming techniques for common **Android** vulnerabilities.

Course Outcomes

On completion of this course, the students will be able to

CO1. Identify the types of security threats for Android Applications.

CO2. Apply the security protocols to Android Applications.

CO3. Will be able to perform Malware Analysis on Android Applications.

Catalog Description

This course will also provide a systematic explanation of android applications as a discrete discipline and will provide an in-depth coverage of android package files.It makes the understanding of security model and protection provided by android OS. It also help to apply defensive programming techniques for common android vulnerabilities.

Course Content

Unit I: 12 lecture hours

App Development, Android Application development and APK internals, Understanding the internals of Android Mobile OS. Study the architecture, design and security of mobile computing in the context of Android.

Unit II: 8 lecture hours

Refresher Linux OS, Emulator and ADB, APK Internals, Networking, Device Rooting,

Refresher TCP/IP Attacks, TCP/IP Attacks Using Android, DAC and MAC Permissions, Android Internals.

Unit III: 12 lecture hours

Framework, Init, Zygote, Binder, Service Manager, Activity Manager, Reverse Engineering, Malware Analysis.

Unit IV: 8 lecture hours

Bouncer, Code Injection, Privacy Violation, System Call Hardening, ASLR, ROP, Framework Exploits.

Text Books

1. 1. Y. Karim, Embedded Android, Vol. 1, O'Reilly Media, 2013.

2. E. Nikolay, Android Security Internals: An In-Depth Guide to Android's Security Architecture, No Starch Press, 2014

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the types of security threats for Android Applications.	**PO1, PO2**

CO2	Apply the security protocols to Android Applications.	**PO3,**
CO3	Will be able to perform Malware Analysis on Android Applications.	**PO4, PSO 1, PSO 2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 614P	Android Security	1	1	2	2									3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS656P	**Android security Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to:-

1. Appreciate the risks to **Android** applications.
2. Understand the structure of **Android** package files.
3. Understand the **Android security** model and the protections provided by the **Android** OS.
4. Apply defensive programming techniques for common **Android** vulnerabilities.

Course Outcomes

On completion of this course, the students will be able to

CO1. Identify the types of security threats for Android Applications.

CO2. Apply the security protocols to Android Applications.

CO3. Will be able to perform Malware Analysis on Android Applications.

CO4. Apply defensive programming techniques for common **Android** vulnerabilities.

Course Content

List of Experiments

1	Android app components and permissions	**3 lab hours**
2	2. Android security architecture	**3 lab hours**
3	3. App vulnerabilities (e.g., leaking content providers, input validation issues, hardcoding, etc.)	**3 lab hours**
4	4. Tapjacking	**3 lab hours**
5	5. App pen-testing using Drozer	**3 lab hours**
6	6. Client-side Injection	**3 lab hours**

7	7. App monitoring and hooking	**3 lab hours**
8	8. Dex file analysis and app reverse engineering	**3 lab hours**
9	9. Android app analysis and testing e.g. using concolic execution	**2 lab hours**
10	10. Malware analysis and detection (using machine learning)	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the types of security threats for Android Applications.	**PO2**
CO2	Apply the security protocols to Android Applications.	**PO3**
CO3	Will be able to perform Malware Analysis on Android Applications.	**PO5**
CO 4	Apply defensive programming techniques for common **Android** vulnerabilities.	**PSO1, PO9**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 656P	Android security Lab		2	3		3				3				3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 616P	**FORMAL METHODS FOR SECURITY**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basic knowledge about Cyber security				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to :-

1. Understand Temporal Logic and Model Checking for program verifications.

2. Perform verification of concurrent and reactive programs/systems using model-checking and propositional temporal logic.

3. Apply application of static and dynamic program analysis and model-checking for detecting common security vulnerabilities in programs and communication protocols.

Course Outcomes

CO1.To understand the formal methods of Security and its application.

CO2.To have experience with some formal modeling tools.

CO3.To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.

CO4.To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations.

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CO5.To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.

Catalog Description

In this course graduates will be able to get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis. This get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations. During the course, students should enhance their inquisitiveness to ever-evolving domain of information security and apply their knowledge to solve problems.

Course Content

Unit I: **9 lecture hours**

Formal Methods – Propositional and Predicate logic, and theorem-proving, Fixed-points and their role in program analysis and model-checking.

Unit II: **8 lecture hours**

Verification of sequential programs using weakest preconditions and inductive methods, and verification of concurrent and reactive programs/systems using model-checking and propositional temporal logic (CTL and LTL).

Unit III: **11 lecture hours**

Application of static and dynamic program analysis and model-checking for detecting common security vulnerabilities in programs and communication protocols, Information flow and taint analysis for security of web applications

Unit IV: **12 lecture hours**

pi-calculus for formal modelling of mobile systems and their security. SPIN, PVS, TAMARIN, Frama-C and Isabelle tools.

Text Books

1. Edmund M. Clarke, OrnaGrumberg and DoronPeled, Model Checking, MIT Press, 1999.

2. Lloyd, J.W., Logic and Learning: Knowledge Representation, Computation and Learning in Higher-order Logic, Springer Berlin Heidelberg, 2003.

Reference Books/Materials

1. M. Ruth and M. Ryan, Logic in Computer Science - Modelling and Reasoning about Systems, Cambridge
University Press, 2004 .

2. G. Bella, Formal Correctness of Security Protocols, Springer, 2009.

3. Datta A, Jha S, Li N, Melski D and Reps T, Analysis Techniques for Information Security, Synthesis

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the formal methods of Security and its application.	**PO1**
CO2	To have experience with some formal modeling tools.	**PO2**
CO3	To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.	**PO4, PO5**
CO4	To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations. .	**PO3**
CO5	To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 616P	FORMAL METHODS FOR SECURITY	3	3	3	3	2								3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS658P	**FORMAL METHODS FOR SECURITY LAB**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Practical learning of Cyber security				
Co-requisites	--				

Course Objectives

Upon completion of the course the students will be able to :-

1. Understand Temporal Logic and Model Checking for program verifications.
2. Perform verification of concurrent and reactive programs/systems using model-checking and propositional temporal logic.
3. Apply application of static and dynamic program analysis and model-checking for detecting common security vulnerabilities in programs and communication protocols.

Course Outcomes

Upon completion of the course the students will be able to:

CO1.To understand the formal methods of Security and its application.

CO2.To have experience with some formal modeling tools.

CO3.To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.

CO4.To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations.

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CO5.To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.

Catalog Description

In this course graduates will be able to get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis. This get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations.

During the course, students should enhance their inquisitiveness to ever-evolving domain of information security and apply their knowledge to solve problems.

Course Content

1	To study about formal security tools.	**2 lab hours**
2	Programs based on propositional logic.	**2 lab hours**
3	Programs based on predicate logic.	**2 lab hours**
4	Verification of sequential programs using weakest preconditions.	**2 lab hours**
5	Verification of sequential programs using inductive methods.	**2 lab hours**
6	Verification of concurrent and reactive programs.	**4 lab hours**
7	Study of applications of static and dynamic program analysis for detecting security vulnerabilities in programs.	**4 lab hours**
8	Study of information flow and taint analysis for security of web applications.	**4 lab hours**
9	Security analysis of SPIN and PVS	**4 lab hours**
10	Study about TAMARIN, Frama-C and Isabelle tools.	**4 lab hours**
11	To make minor project related to security.	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the formal methods of Security and its application.	**PO1**
CO2	To have experience with some formal modeling tools.	**PO2**
CO3	To get insights into various fields of information security with a deep understanding of theoretical aspects of security and related analysis.	**PO4, PO5**
CO4	To get a broader understanding of various security systems, protocols, complexities, standards, practical applicability, and their limitations. .	**PO3**
CO5	To be able to solve security issues with understanding of system security and cryptographic attributes with a relevance to standards.	**PO2**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 658P	FORMAL METHODS FOR SECURITY LAB	3	2	3	3	3											

1= weakly mapped
2= moderately mapped
3= strongly mapped

ETCS618P	**Blockchain Technology**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Cryptography				
Co-requisites	Basic Mathematics				

Course Objectives

1. Help in understanding Creation of block and working of blockchain technology to innovate and improve business process.

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand blockchain technology.
CO2. Develop blockchain based solutions and write smart contract using Hyperledger Fabric and Ethereum frameworks.
CO3. Build and deploy block chain application for on premise and cloud-based architecture.
CO4. Integrate ideas from various domains and implement them using block chain technologyin different perspectives.

Catalog Description

Through this subject, student will be able to understand the coarse grained aspects of Blockchain Technology. Student will understand the applications of Blockchain and its working in networks. The internals of framework and working will be discussed throughout the course duration.

Course Content

Unit I: **8 lecture hours**

Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete.

Cryptography: Hash function, Digital Signature -ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.

Unit II: **12 lecture hours**

Blockchain: Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain.

Unit III: **10 lecture hours**

Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.

Cryptocurrency: History, Distributed Ledger, Bitcoin protocols -Mining strategy and rewards, Ethereum -Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin.

Unit IV: **10 lecture hours**

Cryptocurrency Regulation: Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Block chain.

Text Books

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).

Reference Books/Materials

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand block chain technology.	**PO1**
CO2	Develop blockchain based solutions and write smart contract using Hyperledger Fabricand Ethereum frameworks	**PO2, PO3**
CO3	Build and deploy block chain application for on premise and cloud-based architecture	**PO5**
CO4	Integrate ideas from various domains and implement them using blockchain technologyin different perspectives.	**PO5, PO6, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 618P	Blockchain Technology	3	3	3		2	2						2	3		2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS660P	Blockchains Technology Lab	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Basics of Cryptography				
Co-requisites	Basics of Mathematics				

Course Objectives

The Lab taps into the transformative potential of block chain and related technologies to achieve the goals set out for Sustainable Development.

Course Outcomes

On completion of this course, the students will be able to

CO1.To understand the practical implementation of Blockchain technology.
CO2. To be able to explain the different components involved within Blockchain implementation.
CO3. To know when and why you may want to use Blockchain within your environment.
CO4. To be able to implement IoT asset tracking app using Block chain.
CO5. To be able to Secure art using block chain digital certificates.

Catalog Description

This course complements ETCS304A. It enables students to utilize potential of blockchain into aoptimal solution(s). The list of experiments helps to understand details of component, implementation and application domain of blockchain.

List of Experiments (Indicative)

1	Study and implementation of hash chain.	**2 lab hours**
2	Study and implementation of index structure.	**2 lab hours**
3	Implementation of asymmetric key algorithms	**2 lab hours**
4	Analysis of soft fork and hard fork structures.	**2 lab hours**

5	Analysis of block chain platforms.	**2 lab hours**
6	Analysis of crypto currencies (Bitcoin, Litecoin, Ripple)	**2 lab hours**
7	Analysis of blockchain concurrency and scalability.	**2 lab hours**

Modes of Evaluation: Quiz/Oral practical oral exam/presentation/projects/Practical Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	To understand the practical implementation of Block chain technology.	**PO1**
CO2	To be able to explain the different components involved within Block chain implementation.	**PO3**
CO3	To know when and why you may want to use Block chain within your environment.	**PO2, PO4**
CO4	To be able to implement IoT asset tracking app using Block chain.	**PO3, PO4, PO5**
CO5	To be able to Secure art using block chain digital certificates.	**PO4**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 660P	Blockchain Technology Lab	2	2	3	3	3				1				3		2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 619P	**Cyber Forensics, Audit and Investigation**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

- To correctly define and cite appropriate instances for the application of computer forensics
- Correctly collect and analyze computer forensic evidence
- Identify the essential and up-to-date concepts, algorithms, protocols, tools, and methodology of Computer Forensics

Course Outcomes

On completion of this course, the students will be able to

1. Identify the need of digital forensic and role of digital evidences.
2. Illustrate forensic duplication and file system analysis.
3. Apply network forensics to collect digital evidence.
4. Practice specialization in Fraud Examination, Forensic Audit

Catalog Description

The objectives of this course is to enable learner to understand, explore, and acquire a critical understanding cyber law. Develop competencies for dealing with frauds and deceptions (confidence tricks, scams) and other cybercrimes for example, child pornography etc. That are taking place via the internet.

Course Content

Unit I: **10 lecture hours**

File system: CHS, LBA, HPA, write blockers, Extracting & recovering partitions, MBR, DOS partition table, Extended partition table, RAID; FAT file system: Architecture, File creation, File deletion; NTFS file system: Architecture, File creation, File deletion, Compression, encryption and indexing.

.

Unit II: **10 lecture hours**

Extended file systems: EXT2, EXT3 and EXT4, Architecture, File creation, File deletion and Journaling; Apple File System (APFS); Other Disk structures; Windows and Linux boot process; File system acquisition and recovery. Windows Forensic Analysis: Window artifacts, Evidence volatility, System time, Logged on user(s),Open files, MRUs, Network information, Process information, Service information, Windows Registry, Start up tasks, Memory dumping; Document Forensics: PDF structure, PDF analysis, MSOffice Document structure and analysis, Macros, Windows thumbnails, Android Thumbnails.

Unit III: **10 lecture hours**

Mobile Forensics: SIM Card, Android architecture, Android File System, Android application, Android SDK, Android Debug Bridge, Memory & SIM acquisition; Virtual Machines, Network Forensics; Cyber crime investigation: Pre investigation, SOP for Investigation; Case scenarios: social media crime, Online defacement crime, Email investigation; CDR Analysis.

Unit IV: **10 lecture hours**

Auditing: Internal Audit and IT Audit Function, IT Governance, Frameworks, Standards, and Regulations, Identifying information assets, Risk assessment, Risk management, Types of Auditing, ISO 27001, PCIDSS

TEXT BOOKS:

1. Computer Evidence - Collection and Preservation.Brown, C.L.T. Course Technology Cengage Learning.
2. Guide to Computer Forensics And Investigations Nelson, Bill ; Phillips, Amelia; Enfinger, Frank; Steuat, Christopher Thomson Course Technology.
3. Computer Forensics – Computer Crime Scene Investigation.Vacca, John R. Charles RiverMedia
4. Bunting, Steve and William Wei. EnCase Computer Forensics: The Official EnCE: EnCaseCertifed Examiner Study Guide. Sybex, 2006
5. Incident Response: Computer Forensics, Prosise, Chris, Kevin Mandia, and Matt Pepe, McGraw-Hill, 2014
6. IT Security Risk Control Management: An Audit Preparation Plan, Raymond Pompon, Apress 2016

7. Carrier, Brian. File System Forensic Analysis. Addison-Wesley Professional

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the need of digital forensic and role of digital evidences.	**PO1, PO2**
CO2	Illustrate forensic duplication and file system analysis.	**PO3**
CO3	Apply network forensics to collect digital evidence.	**PO5; PO9**
CO4	Practice specialization in Fraud Examination, Forensic Audit.	**PO11; PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 619P	Cyber Forensics, Audit and Investigation	2	3	2		2				1		2	2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 621P	**CLOUD COMPUTING AND SECURITY**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Basics of Cloud Computing				
Co-requisites	Knowledge of Security				

Course Objectives

1. Ground-up coverage on the concepts & guiding principles on cloud landscape and architectural principles with primary focus on security techniques and security design
2. Deep dive on Security architecture, design patterns and best practices

Course Outcomes

On completion of this course, the students will

1. Have the theoretical understanding of information security and practical skills for designing and analyzing secure computing systems.
2. Understand the architectural principles of distributed services and applications. They are able to design, analyze and implement distributed, cloud and mobile computing systems.
3. Have in-depth knowledge of their chosen thesis topicand are able to apply it to solving technical and scientific problems.
4. Have strong software development skills and other technical and professional skills that enable them to take key roles in an industrial research and development environment, and they are qualified to continue to doctoral studies in academia.

Catalog Description

In this coursedeal with common cloud misconfigurations, how to perform a risk assessment and verify compliance for various Cloud Services. The course delve deeper into identifying security risks in these cloud services and to implement best practices to mitigate the common cloud misconfigurations.

Course Content

Unit I: 9 lecture hours

Security Concepts: Confidentiality, privacy, integrity, authentication, non-repudiation, availability, access control, Concepts implementation and relevance in the cloud computing, and their importancein PaaS, IaaS and SaaS. e.g. User authentication in the cloud; Relevant cloud security designprinciples; least privilege, separation of duties, Defence in Depth, Fail Safe, Economy of Mechanism, Complete Mediation, Open Design, Least Common Mechanism, Weakest Link.

Unit II: **10 lecture hours**

Cloud Data Security, Cloud Data Life Cycle; Create, Store, Use, Share, Archive, Destroy, Cloud Storage Architectures; Volume Storage, Object based storage, databases, Content Delivery Network(CDN), Cloud Data Security Foundation Strategies; Encryption, Masking,

Unit III: **11 lecture hours**

Shared Cloud Platforms Risks and Responsibilities, Cloud Computing Risks by Deployment and service model, Cloud Attack Surface, Threats by deployment model, Cloud Security Policy Implementation issues and Decomposition, NIST 33 Security Principles, Cloud Penetration Testing; Legal and ethical implications, The three pre-test phases, Usage of various tools including Tenable.io(Vulnerability Management, Web Application Scanning & Container Security) and other penetration testing tools.

Unit IV: **10 lecture hours**

Cloud Secure Software Development Life Cycle, ISO/IEC 27034-1 Standards for Secure Application, Single Sign On (SSO), Federated Identity Management, Federation Standards, Multifactor Authentication, Cloud Application Architecture; Secure APIs, Tenancy Separation, Cryptography, Sandboxing, Application Virtualization, Runtime Application Self Protection (RASP) .
VM Life Cycle; Overwriting, Degaussing, Destruction, Record Retention, Data Remanence,
Virtualization Security Management, Virtual Threats, Hypervisor Risks, Increased Denial of Service Risks, VM Security Recommendations, Storage Operations, Physical and Logical Isolation, Basic Operational Application Security, Threat Modelling, Application Testing Methods, Change and Configuration Management, Business Continuity and Disaster Recovery, Incident Response.

TEXT BOOKS:

1. Tim Mather, Subra Kumaraswamy, ShahedLatif, “Cloud Security and Privacy: An Enterprise
2. Perspective on Risks and Compliance” O'Reilly Media; 1 edition, 2009.
3. Ronald L. Krutz, Russell Dean Vines, “Cloud Security”, 2010.
4. John Rittinghouse, James Ransome, “Cloud Computing” CRC Press; 1 edition, 2009.

5. J.R. ("Vic") Winkler, “Securing the Cloud” Syngress, 2011.
6. Cloud Security Alliance, “Security Guidance for Critical Areas of Focus in Cloud Computing”.
7. Vmware “VMware Security Hardening Guide” White Paper, June 2011
8. Cloud Security Alliance 2010, “Top Threats to Cloud Computing” Microsoft 2013.
9. Evelyn Brown NIST “Guide to Security for Full Virtualization Technologies”, 2011.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Have the theoretical understanding of information security and practical skills for designing and analyzing secure computing systems.	**PO1, PO2**
CO2	Understand the architectural principles of distributed services and applications. They are able to design, analyze and implement distributed, cloud and mobile computing systems.	**PO2**
CO3	Have in-depth knowledge of their chosen thesis topic and are able to apply it to solving technical and scientific problems.	**PO4, PO8**
CO4	Have strong software development skills and other technical and professional skills that enable them to take key roles in an industrial research and development environment, and they are qualified to continue to doctoral studies in academia.	**PO6, PO11, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 621P	Cloud computing and security	3	3		3		2		2			2	2	3	2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 661P	**Cloud Computing and Security Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	A basic understanding of TCP/IP, network security, and information security principles				
Co-requisites					

Course Objectives

1. Ground-up coverage on the concepts & guiding principles on cloud landscape and architectural principles with primary focus on security techniques and security design
2. Deep dive on Security architecture, design patterns and best practices

Course Outcomes

On completion of this course, the students will

1. Identify the risks and risk control ownership based on the deployment models and service delivery models of the various products offered by cloud service providers
2. Create accounts and use the services of any one the leading CSPs and be comfortable with the self-service nature of the public cloud, including finding documentation, tutorials, pricing, and security features.
3. Secure access to the consoles used to access the CSP environments.
4. Implement network security controls that are native to both AWS and Azure.

Catalog Description

The course complement ETCS 621P. This course covers Amazon Web Services, Azure, Google Cloud, and other cloud service providers (CSPs). Like foreign languages, cloud environments have similarities and differences, and this course will introduce you to the language of cloud security.

List of Experiments (Indicative)

1	To understand the services of Amazon elastic cloud.	**4 lab hours**
2	To understand the services of Microsoft Azure	**4 lab hours**

3	To understand the services of Hadoop.	**4 lab hours**
4	To understand the services of Aneka elastic cloud.	**4 lab hours**
5	To understand the services of Google apps engine.	**4 lab hours**
6	To understand business solution application of Google apps	**4 lab hours**
7	To understand the application of hypervisors.	**4 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Identify the risks and risk control ownership based on the deployment models and service delivery models of the various products offered by cloud service providers	**PO2**
CO2	Create accounts and use the services of any one the leading CSPs and be comfortable with the self-service nature of the public cloud, including finding documentation, tutorials, pricing, and security features.	**PO5**
CO3	Secure access to the consoles used to access the CSP environments.	**PO5, PO4**
CO4	Implement network security controls that are native to both AWS and Azure	**PO6, PO11, PO12**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 661P	Cloud computing and security Lab		3		2	3	2					2	2	3	2	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 623P	**Internet of Things and Security**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Fundamentals of computer network, Network Security, internet technology.				
Co-requisites					

Course Objectives

In this course, student will explore various components of Internet of things such as Sensors, internetworking and cyber space. In the end they will also be able to design and implement IoT circuits and solutions

Course Outcomes

On completion of this course, the students will be able to

1. Understand general concepts of Internet of Things (IoT)
2. Recognize various devices, sensors and applications
3. Apply design concept to IoT solutions
4. Analyze various M2M and IoT architectures
5. Evaluate design issues in IoT applications
6. Create IoT solutions using sensors, actuators and Devices

Catalog Description

The Internet of Things (IoT) is everywhere. It provides advanced data collection, connectivity, and analysis of information collected by computers everywhere—taking the concepts of Machine-to-Machine communication farther than ever before. This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions

Course Content

Unit I: 9 lecture hours

Internet of Things (IoT) Introduction, Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-Machine Communications

Unit II: **10 lecture hours**

Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino.

Unit III: **11 lecture hours**

Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi.

Unit IV: **10 lecture hours**

Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud. Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT.
CaseStudy: Agriculture, Healthcare, Activity Monitoring

TEXT BOOKS:

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press)
2. Internet of Things: A Hands-on Approach", by ArshdeepBahga and Vijay Madisetti(Universities Press)

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand general concepts of Internet of Things (IoT)	**PO1**

CO2	Recognize various devices, sensors and applications	**PO2**
CO3	Apply design concept to IoT solutions	**PO3**
CO4	Analyze various M2M and IoT architectures	**PO2**
CO5	Evaluate design issues in IoT applications	**PO4, PO5**
CO6	Create IoT solutions using sensors, actuators and Devices	**PO11**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 623P	Internet of Things and Security	3	3	2	3	2						2		3	2	1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 663P	**Internet of Things and Security Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Fundamentals of computer network, Network Security, internet technology.				
Co-requisites					

Course Objectives

The objective of this course is to impart necessary and practical knowledge of components of Internet of Things and develop skills required to build real-time IoT based projects

Course Outcomes

On completion of this course, the students will be able to

CO1. Understand IoT and its hardware and software components

CO2. Interface I/O, sensors and communication mobiles

CO3. Remotely monitor data and control devices

CO4. Develop real life IoT based projects

Catalog Description

This course supplements **ETCS623P**. This course gives a foundation in the Internet of Things, including the components, tools, and analysis by teaching the concepts behind the IoT and a look at real-world solutions.

List of Experiments (Indicative)

1	Study and Install Python in Eclipse and WAP for data types in python.	**2 lab hours**
2	Write a Program for arithmetic operation in Python.	**2 lab hours**
3	Write a Program for looping statement in Python.	**2 lab hours**
4	Study and Install IDE of Arduino and different types of Arduino.	**2 lab hours**
5	Write program using Arduino IDE for Blink LED.	**2 lab hours**

6	Write Program for RGB LED using Arduino.	**2 lab hours**
7	Study the Temperature sensor and Write Program foe monitor temperature using Arduino. .	**2 lab hours**
8	Study and Implement RFID, NFC using Arduino.	**2 lab hours**
9	Study and implement MQTT protocol using Arduino	**2 lab hours**
10	Study and Configure Raspberry Pi	**2 lab hours**
11	Write a Program for LED blink using Raspberry Pi	**2 lab hours**
12	Study and Implement Zigbee Protocol using Arduino / Raspberry Pi	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand IoT and its hardware and software components	**PO2**
CO2	Interface I/O devices, sensors and communication mobile.	**PO1**
CO3	Remotely monitor data and control devices	**PO4**
CO4	Develop real life IoT based projects	**PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 663A	Internet of Things and Security Lab	2	3	3	3									3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS 625P	**Big Data Analytics**	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

1. To study the basic technologies that forms the foundations of Big Data.
2. To understand the specialized aspects of big data including big data application, and big data analytics.
3. To study different types Case studies on the current research and applications of the Hadoop and big data in industry

Course Outcomes

On completion of this course, the students will be able to

1. Understand the building blocks of Big Data
2. Understand the specialized aspects of big data with the help of different big data applications
3. Represent the analytical aspects of Big Data
4. Know the recent research trends related to Hadoop File System, Map Reduce and Google File System etc

Catalog Description

This course will expose you to the data analytics practices executed in the business world. We will explore such key areas as the analytical process, how data is created, stored, accessed, and how the organization works with data and creates the environment in which analytics can flourish. The course will give you a strong foundation in all the areas that support analytics and will help you to better position yourself for success within your organization.

Course Content

Unit I: **9 lecture hours**

Competitive Advantage Definition: Old and New Notions, the Role of Big Data on Gaining Dynamic, Competitive Advantage, Big Data Driven Business Models, Organizational Challenges. Big Data and

Analytics for Government Innovation: Governmental Challenges, Smart City Readiness, Learn to Collaborate, Legal Framework Development.

Unit II: 9 lecture hours

Big Data and Education: Massive Digital Education Systems: MOOC Educational Model Clusters, Institutional Advantages and Opportunities from MOOCs, Institutional Challenges from MOOCs. Big Data Driven Business Models: Implications of Big Data, for Customer Segmentation, for Value Proposition, for Channels, on Customer Relationships, on Revenue Stream, on Key Resources and Key Partnerships, Organizational Advantages and Opportunities, Organizational Challenges and Threats.

Unit III: 11 lecture hours

Big Data Governance: Big Data Types, Big Data Maturity Models, TDWI Maturity Model, Analytics Business Maturity Model, Data Flux Data Governance Maturity Model, Gartner Maturity Model, IBM Data Governance Maturity Model, Organizational Challenges Inherent with Governing Big Data, Organizational Benefits of Governing Big Data

Unit IV: 11 lecture hours

Big Data and Digital Business Evaluation: Digital Business Evaluation Using Big Data, Organizational Advantages and Opportunities, Customer Value Proposition, Customer Segmentation, Channels, Customer Relationship, Organizational Challenges.

New Big Data Tools to Drive Innovation, The Hadoop Platform, 1010 DATA Cloud Analytics, Actian Analytics, Cloud era, Models of Big Data Change , Big Data Business Model, The Maturity Phases of Big Data Business Model, Big Data Change Key Issue, Organizational Challenges, Data Acquisition, Information Extraction, Data Integration, Aggregation, and Representation.

TEXT BOOKS:

1. Big Data Analytics with R and Hadoop by Vignesh Prajapati, Packt Publication
2. Big Data Bootcamp by David Feinleib, Apress Publication
3. Big Data and Analytics by Vincenzo Morabito, Springer
4. Data Mining Concepts and Techniques, 3rd Edition, Jiawei Han &MichelineKamber

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the building blocks of Big Data	**PO1, PO2**
CO2	Understand the specialized aspects of big data with the help of different big data applications	**PO2, PO3**
CO3	Represent the analytical aspects of Big Data	**PO4**
CO4	Know the recent research trends related to Hadoop File System, Map Reduce and Google File System etc	**PO5**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 625P	Big Data Analytics	3	3	2	3	2								3	2	1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS 665P	**Big Data Analytics Lab**	L	T	P	C
Version 1.0		0	0	2	1
Pre-requisites/Exposure	Knowledge of one Programming Language;				
Co-requisites	Practice of SQL				

Course Objectives

The main goal of this course is to help students learn, understand, and practice big data analytics. Mainly the course objectives are: conceptualization and summarization of big data and machine learning, trivial data versus big data, big data computing technologies, machine learning techniques, and scaling up machine learning approaches

Course Outcomes

On completion of this course, the students will be able to

CO1. List the components of Hadoop and Hadoop Eco-System
CO2. Access and Process Data on Distributed File System
C03. Manage Job Execution in Hadoop Environment
CO4. Apply Machine Learning Techniques using R / Python.

Catalog Description

This course supplement ETCS665P. The course will give you a strong foundation in areas that support analytics and will help you to better position yourself for success within your organization.

List of Experiments (Indicative)

1	To draw and explain Hadoop Architecture and Ecosystem with the help of a case study using Work Count example. To define and install Hadoop.	**4 lab hours**
2	To implement the following file management tasks in Hadoop System (HDFS): Adding files and directories, Retrieving files, Deleting files	**2 lab hours**
3	To run a basic Word Count Map Reduce program to understand Map Reduce Paradigm: count words in a given file, To view the output file, and To calculate execution time.	**2 lab hours**

4	To perform No SQL database using mongodb to create, update and insert.	**2 lab hours**
5	To study and implement basic functions and commands in R Programming	**2 lab hours**
6	To build Word Cloud, a text mining method using R for easy to understand and visualization than a table data.	**2 lab hours**
7	To implement Bloom Filters for filter on Stream Data in Java	**2 lab hours**
8	To implement Flajolet-Martin Algorithm for counting distinct elements in Stream Data.	**2 lab hours**
9	To implement clustering program using R/Python/Java programming	**2 lab hours**
10	To find Term Frequency and Inverse Document Frequency (tf-idf) Matrix for Recommendation Systems and Plot TF Using R/Python/Java	**2 lab hours**
11	To finding similar documents with Cosine Similarity in R/Python/Java	**2 lab hours**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	List the components of Hadoop and Hadoop Eco-System	**PO1, PO2, PO5**
CO2	Access and Process Data on Distributed File System	**PO2, PO3, PO5**
CO3	Manage Job Execution in Hadoop Environment	**PO3, PO4**
CO4	Apply Machine Learning Techniques using R / Python.	**PO6, PO3**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 665P	Big Data Analytics Lab	3	3	3	2	2	2							3	2	1	

1=weakly mapped
2= moderately mapped
3=strongly mapped

		L	T	P	C
ETCS667P	**Dissertation-I**	L	T	P	C
Version 1.0		-	-	20	10
Pre-requisites/Exposure	Dissertation-I				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
3. To learn the art of technical report writing
4. To learn the art of verbal communication with the help of modern presentation techniques

Course Outcomes

On completion of this course, the students will be able to

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Have practical knowledge on the applications of topic of study on society.

Catalog Description

This is the first part of the major dissertation wherein every student shall be expected to contribute to domain knowledge incrementally. It is expected that the research/project work should be focused in a particular area for concept, design, implementation and/or analysis. Each student will have to undertake a research/project work under a supervisor. Research/project work may be carried out within department or in any other academic / research / industrial / commercial organization under the guidance of the thesis supervisor who must be a faculty member of the department or under a joint supervision including at least one such faculty member. The work will have to be carried out during the 5th semester of study. The student will have to submit a typewritten or printed report on the work done by him / her according to a schedule to be announced by the department. The project-report should be duly approved by the supervisor concerned and should embody results of research / development work carried out by the student.

Student will be continuously evaluated during the semester in form of Dissertation/project Progress Seminars. At the end of the semester, assessment of the research/project work of each student will be made by the board of examiners including supervisors on the basis of a viva-voce examination and the report submitted by the student.

Course Content

The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic.
2. Preparing an Action Plan for conducting the investigation, including team work.
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
4. Final development of product/process, testing, results, conclusions and future directions.
5. Preparing a report in the standard format for being evaluated by the Department.
6. Final Dissertation Presentation before a Departmental Committee.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Carry out the extensive literature survey.	**PO2**
CO2	Learn to write and present technical reports/articles.	**PO5**

CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	**PO2**
CO4	Have practical knowledge on the applications of topic of study on society.	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Orientated	Global Perspective	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 667P	Dissertation-I		3			3	3							3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

ETCS662P	**Dissertation-II**	L	T	P	C
Version 1.0		-	-	32	16
Pre-requisites/Exposure	Dissertation-I				
Co-requisites	--				

Course Objectives

1. To learn how to carry out literature survey
2. To be associated with an area of research/research project and contribute towards domain knowledge.
3. To learn the art of technical report writing
4. To learn the art of verbal communication with the help of modern presentation techniques.

Course Outcomes

On completion of this course, the students will be able to

CO1. Carry out the extensive literature survey.

CO2. Learn to write and present technical reports/articles.

CO3. Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.

CO4. Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.

Catalog Description

This will be culmination of Dissertation I of semester V. Research work may be carried out within department or in any other academic / research / industrial / commercial organization under the guidance of the thesis supervisor who must be a faculty member of the department or under a joint supervision including at least one such faculty member. The student will have to submit typewritten or printed report on the work done by him / her according to a schedule
to be announced by the department. The project-report should be duly approved by the supervisor concerned and should embody results of research / development work carried out
by the student.

Student will be continuously evaluated during the semester in form of Dissertation Progress Seminars. At the end of the semester, assessment of the research work of each student will be made by the board of examiners including supervisors on the basis of a viva-voce examination and the report submitted by the student.

Students are required to publish their research work in form of research publication. The result will be declared only after acceptance or publication of full length paper in peer reviewed Conference or Journal.

Course Content

The assignment to normally include:

1. Review and finalization of the Approach to the Problem relating to the assigned topic.
2. Preparing an Action Plan for conducting the investigation, including team work.
3. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
4. Final development of product/process, testing, results, conclusions and future directions.
5. Preparing a report in the standard format for being evaluated by the Department.
6. Final Dissertation Presentation before a Departmental Committee.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz I	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Carry out the extensive literature survey.	**PO2**
CO2	Learn to write and present technical reports/articles.	**PO5**
CO3	Learn to analyze various methods and techniques applicable to the topic to study and contribute to domain knowledge.	**PO2**
CO4	Learn to analyze/evaluate the result of the experiment carried out and present the results using data visualization methods.	**PO6**

		Engineering Knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual or team work	Communication	Project management and finance	Life-long Learning	Application of Concepts	Research Oriented	Project and Management Skills	Reasoning and Communication Skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
ETCS 662P	Dissertation-II		3			3	3							3	3		

1=weakly mapped
2= moderately mapped
3=strongly mapped