Mahatma Education Society's

Pillai College of Engineering

(Autonomous)

Affiliated to University of Mumbai

Dr. K. M. Vasudevan Pillai's Campus , Sector 16, New Panvel – 410 206.

Department of Electronics & Computer Science

Syllabus

of

M.Tech. in Electronics & Computer Science

for

The Admission Batch of AY 2025-26

First Year - Effective from Academic Year **2025-26**

Second Year - Effective from Academic Year **2026-27**

as per

Choice Based Credit and Grading System

Mahatma Education Society's

Pillai College of Engineering

Dr. K. M. Vasudevan Pillai's Campus , Sector - 16, New Panvel – 410 206

Vision

Pillai College of Engineering (PCE) will admit, educate and train a diverse population of students who are academically prepared to benefit from the Institute's infrastructure and faculty experience, to become responsible professionals or entrepreneurs in a technical arena. It will further attract, develop and retain, dedicated, excellent teachers, scholars and professionals from diverse backgrounds whose work gives them knowledge beyond the classroom and who are committed to making a significant difference in the lives of their students and the community.

Mission

To develop professional engineers with respect for the environment and make them responsible citizens in technological development both from an Indian and global perspective. This objective is fulfilled through quality education, practical training and interaction with industries and social organizations.

Department of Electronics & Computer Science

Vision

To produce professionally competent and socially responsible engineers capable of working globally.

Mission

To provide in-depth quality education in Electronics & Computer Science Engineering and prepare the students for lifelong learning.

To develop professional engineers who can critically and creatively apply the knowledge of engineering principles to solve real world problems.

To inculcate entrepreneurship skills and impart ethical and social values.

Engineering Graduates will be able to

1. Gain knowledge and skills to analyse and design Electronics circuits as well as Computer Programs.
2. Develop hardware and software systems in the areas like Artificial Intelligence & Machine learning, Big Data, Information Security, Automation, Embedded Systems, Signal Processing and Communication Systems.
3. Apply modern Electronics and Computer engineering techniques and tools to find solutions for real life interdisciplinary problems.

The Autonomous status of the institute has given an opportunity to design and frame the curriculum in such a way that it incorporates all the needs and requirements of recent developments in all fields within the scope of the Technical education. This curriculum will help graduates to attain excellence in their respective field. The curriculum has a blend of basic and advanced courses along with provision of imparting practical knowledge to students through projects. The syllabus has been approved and passed by the Board of Studies.

Outcome based education is implemented in the academics and every necessary step is undertaken to attain the requirements. Every course has its objectives and outcomes defined in the syllabus which are met through continuous assessment and end semester examinations. Evaluation is done on the basis of Choice Based Credit and Grading System (CBCGS). Optional courses are offered at department and institute level. Selection of electives from the same specialization makes the student eligible to attain a M. Tech. degree.

Every learner/student will be assessed for each course through (i) an Internal/Continuous assessment during the semester in the form of either Practical Performance, Presentation, Demonstration or written examination and (ii) End Semester Examination (ESE), in the form of either theory or viva voce or practical, as prescribed by the respective Board Studies and mentioned in the assessment scheme of the course content/syllabus. This system involves the Continuous Evaluation of students' progress Semester wise. The number of credits assigned with a course is based on the number of contact hours of instruction per week for the course. The credit allocation is available in the syllabus scheme of each semester.

The performance of a learner in a semester is indicated by a number called Semester Grade Performance Index (SGPI). The SGPI is the weighted average of the grade points obtained in all the courses by the learner during the semester. For example, if a learner passes five courses (Theory/labs./Projects/ Seminar etc.) in a semester with credits C1, C2, C3, C4 and C5 and learners grade points in these courses are G1, G2, G3, G4 and G5 respectively, then learners SGPI is equal to:

$$SGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4 + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

The learner's up to date assessment of the overall performance from the time s/he entered for the programme is obtained by calculating a number called the Cumulative Grade Performance Index (CGPI), in a manner similar to the calculation of SGPI. The CGPI therefore considers all the courses mentioned in the scheme of instructions and examinations, towards the minimum requirement of the degree learners have enrolled for. The CGPI at the end of this semester is calculated as,

$$CGPI = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots + C_i * G_i + \ldots + C_nG_n}{C_1 + C_2 + C_3 + \cdots + C_i + \ldots + C_n}$$

The Department of Electronics & Computer Science offers a M. Tech. programme in Electronics & Computer Science. This is a four semester course. The complete course is a 72 credit course which comprises core courses and elective courses.

The credit requirement for the M.Tech. in Electronics & Computer Science is tabulated in Table 1.

Table 1. Credit Requirement for M.Tech in Electronics & Computer Science

Semester	Credits
I	**17**
II	**17**
III	**23**
IV	**23**
Total Credits	**80**

Program Structure for
Master of Technology in Electronics & Computer Science
Semester I

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC500T	Computer programming Paradigms	03	--	03	--	03
EC501T	Business Communication and Intellectual Property Rights	03	--	03	--	03
EC50xT	Department Level Optional Course-I	03	--	03	--	03
EC50xT	Department Level Optional Course-II	03	--	03	--	03
EC50xT	Department Level Optional Course-III	03	--	03	--	03
EC511L	Course Lab-I	--	02	--	01	01
EC512L	Dissertation-I	--	02	--	01	01
TOTAL		**15**	**04**	**15**	**02**	**17**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Oral/Practical	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test 1	Test 2	Avg					
EC500T	Computer programming Paradigms	40	40	40	60	3	-	-	100
EC501T	BusinessCommunication and Intellectual Property Rights	40	40	40	60	3	-	-	100
EC50xT	Department Level Optional Course-I	40	40	40	60	3	-	-	100
EC50xT	Department Level Optional Course-II	40	40	40	60	3	-	-	100
EC50xT	Department Level Optional Course-III	40	40	40	60	3	-	-	100
EC511L	Course Lab-I	--	--	--	--	--	25	25	50
EC512L	Dissertation-I	--	--	--	--	--	25	25	50
TOTAL		**200**	**200**	**200**	**300**	**15**	**50**	**50**	**600**

Course Code	Department Level Elective Course-I
EC502T	Natural Language Processing
EC503T	Generative and Explainable AI
EC504T	Big Data Analytics

Course Code	Department Level Elective Course-II
EC505T	Advanced Mobile Communication
EC506T	Wireless Technology
EC507T	Ethical Hacking and Digital Forensics

Course Code	Department Level Elective Course-III
EC508T	Advanced Processor Architecture-I
EC509T	Embedded System and RTOS
EC510T	Advanced Robotics

Program Structure for
Master of Technology in Electronics & Computer Science
Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC520T	Data Science	03	--	03	--	03
EC521T	Integrated Circuit Technology	03	--	03	--	03
EC5xxT	Department Level Optional Course-IV	03	--	03	--	03
EC5xxT	Department Level Optional Course-V	03	--	03	--	03
EC5xxT	Department Level Optional Course-VI	03	--	03	--	03
EC531L	Course Lab-II	--	02	--	01	01
EC532L	Dissertation-II	--	02	--	01	01
TOTAL		**15**	**04**	**15**	**02**	**17**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
EC520T	Data Science	40	40	40	60	3	--	--	100
EC521T	Integrated Circuit Technology	40	40	40	60	3	--	--	100
EC5xxT	Department Level Optional Course-IV	40	40	40	60	3	--	--	100
EC5xxT	Department Level Optional Course-V	40	40	40	60	3	--	--	100
EC5xxT	Department Level Optional Course-VI	40	40	40	60	3	--	--	100
EC531L	Course Lab-II	--	--	--	--	--	25	25	50
EC532L	Dissertation-II	--	--	--	--	--	25	25	50
TOTAL		**200**	**200**	**200**	**300**	**15**	**50**	**50**	**600**

Course Code	Department Level Elective Course-IV
EC522T	Deep Learning
EC523T	Intelligent Robotics
EC524T	Reinforcement Learning

Course Code	Department Level Elective Course-V
EC525T	Advanced Processor Architecture-II
EC526T	Advanced VLSI Design
EC527T	FPGA-based System Design

Course Code	Department Level Elective Course-VI
EC528T	Blockchain Technology
EC529T	Internet of Everything
EC530T	Edge and Fog Computing

Program Structure for
Master of Technology in Electronics & Computer Science
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
ENGG 401	Research Methodology	3	-	3	-	03
EC600LC	Internship / Relevant Certification	-	10	-	05	05
EC601LC	Dissertation-III	-	30	-	15	15
TOTAL		3	40	3	20	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
ENGG 401	Research Methodology	40	40	40	60	2	-	-	100
EC600LC	Internship / Relevant Certification	-	-	-	-	-	50	50	100
EC601LC	Dissertation-III	-	-	-	-	-	50	50	100
TOTAL		-	-	-	-	-			300

Program Structure for
Master of Technology in Electronics & Computer Science
Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC602LC	Dissertation-IV	-	46	-	23	23
Total		-	46	-	23	23

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
EC602LC	Dissertation-IV	-	-	-	-	-	100	100	200
TOTAL		-	-	-	-	-	100	100	200

Master of Technology
In
Electronics & Computer Science

(Semester I)

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC500T	Computer programming Paradigms	03	--	--	03	–	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		1	2	Average					
EC500T	Computer programming Paradigms	40	40	40	60	–	--	–	100

1. Course Objectives:

This course will help the students to learn

1. To Introduce students to functional, logic and concurrent programming paradigms.
2. To Enable students to formulate newer abstractions in the above paradigms.
3. To Familiarize students with writing functional and Object oriented programs.
4. To Prepare students to solve real-world problems using appropriate programming paradigms.

2. Course Outcomes:

On successful completion of course learner/student will be able to:

1. Understand and apply the concepts that form the basis of functional, logic and object oriented programming paradigms.
2. Formulate abstractions with procedures and data in different programming paradigms.
3. Write programs in different programming paradigms especially functional, logic and object oriented paradigms.
4. Formulate, implement and solve a given problem scenario using appropriate programming paradigm

3. Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction**	**Overview of different programming paradigms** – Imperative,logical, functional and object-oriented Programming.	2
2	**Java Programming**	**Introduction:** Principles of OOP, Classes, Objects, Abstraction, Encapsulation, Inheritance, Polymorphism, Message passing Features of Java Language , Data Types, Operators. **Control Statements:** If-Statement, If-else, Nested-if, Switch Statement, break, continue. **Iteration Statements:** for-loop, while-loop, and do-while-loop.	8
3	**Python Programming**	**Introduction:** Features, Identifiers, Keywords, Indention, Variables and Comments, Basic data types: Numeric, Boolean, Compound. **Operators:** Arithmetic, comparison, relational, assignment, logical, bitwise, membership, identity operators, operator precedence. **Control flow statements:** Conditional statements (if, if…else, nested if. Looping in Python: while-loop, for-loop, nested-loops, Loop manipulation using continue, pass, break. **Functions:** Introduction to Functions, Decorators, Iterators and Generators.	8
4	**R Programming**	**Introduction:** Basic functionalities of R , data types and operations: numbers, characters and composites, Numeric variables, strings and factors,R packages. **Data structures:** vectors, matrices, lists and data frames.Grouping, loops and conditional execution, Functions. **Exploratory data analysis:** Range, summary, mean, variance, median, standard deviation, histogram, box plot, scatterplot,Graphics and tables , Visualizations and interpretation of results.	8
5	**Matlab programming**	**Introduction:** Features, Interface, File Types, Array, Matrix Operation. Arithmetic Operator Logical, Relational. **Branch and Loop:** If-statement, If-else statement, Else-if statement Pause, Break, Continue, Switch-case, try-catch, Return Statement, For Loop,While Loop. Types of Function, Return Types. **Interface and Graphics:** Plotting, Multiple Plot, 2-D Plot, Introduction to Graphical User Interface, GUI Function, Property, GUI Component Design.	8
6	**Metaverse Technology**	History, Features, Metaverse value chain, Technologies Involved in the Metaverse. Blockchain Adoption in Metaverse, AR, VR, MR in Metaverse, NFT (non-fungible token) for Metaverse. Financial and Economics of Metaverse, Benefits of Metaverse, Use-cases.	5

4. Theory Assessment:

Internal Assessment: 40 marks

1. Consisting of One Compulsory Class Tests of 40 Marks
2. Continuous evaluation: Class Test/Assignments /Quiz/Case studies/Seminar presentation of 40 Marks

End Semester Examination: 60 Marks

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum

5. Books and References:

A. Books:

1. Scott M L, Programming Language Pragmatics, 4th Edn., Morgan Kaufmann Publishers, 2015
2. E. Balaguruswamy, “Programming with Java A primer”, Fifth edition, Tata McGraw Hill Publication
3. Dr. R. Nageswara Rao, ”Core Python Programming” , Dreamtech Press, Wiley Publication
4. Metaverse: Introduction to The Virtual Reality, Augmented Reality,ISBN-13 : 978-1806030484
5. Beginning R: The Statistical Programming Language by Dr. Mark Gardener, Wiley Publications
6. Peter I. Kattan, MATLAB for Beginners: A Gentle Approach, 2008. ISBN: 9781438203096

B. References:

1. Programming Languages: Concepts and Constructs; 2nd Edition, Ravi Sethi, Pearson Education Asia, 1996.
2. Herbert Schildt, “Java-The Complete Reference”, Tenth Edition, Oracle Press, Tata McGraw Hill Education.
3. Navigating the Metaverse by Cathy Hackl, Dirk Lueth, Tommaso Di Bartolo, John Arkontaky, Yat Siu Released May 2022 Publisher(s): Wiley ISBN: 9781119898993
4. Hands-On Programming with R by Grolemund, O Reilly Publications
5. Stormy Attaway, "MATLAB: A Practical Introduction to Programming and Problem Solving," 2018, Butterworth-Heinemann, ISBN: 978-0128154793

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC501T	Business Communication and Intellectual Property Rights	03	--	--	03	–	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		1	2	Average					
EC501T	Business Communication and Intellectual Property Rights	40	40	40	60	50	--	–	150

Course Objectives: Six

- To provide an outline to effective organisational communication
- To enable learners to formulate professional documents in a structured manner that meets the corporate requirements.
- To foster a comprehensive understanding of marketing strategies for establishing the brand of the business using digital technologies and aim at better customer experience
- To develop creative and impactful presentation skills
- To acquaint learners with the procedure of obtaining Patents, Copyrights, Trademarks and Industrial designs
- To inculcate the ethical code of conduct and corporate etiquettes.

Course Outcomes: Six (Based on Bloom's Taxonomy)

1. Apply business communication strategies and principles to prepare effective communication for developing and presenting business messages
2. Acquire the writing skills necessary for professional documents to meet the corporate requirement.
3. Understand existing and emerging social media tools to execute a comprehensive communication plan
4. Able to illustrate effective presentation, research, organisational and creative skills necessary for lifelong learning.
5. Recognize the crucial role of IP in organisations of different industrial sectors for the purposes of product and technology development

6. Able to determine the importance of ethics and etiquettes in social and professional situations

Prerequisite: Basic language skills

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
I	BUSINESS COMMUNICATION	Role of communication in business organisation, Relevance of communication, Types- Verbal Non-verbal, Channels- Vertical, Horizontal and Lateral	2
II	BUSINESS WRITING	Business Proposals (SWOT analysis), Grant / Research Proposals, Memos, Press Releases, Business Plans	8
III	DIGITAL SOCIAL MEDIA	Communicating via Social Media, Social Media and Public Relations, Social Media strategy and Planning, Content Strategy. Web Content, Organisation and Distribution, Social Networking Sites (LinkedIn, Twitter), Photo sharing Sites (Instagram, Snapchat, Pinterest, News Writing and Community Management, Facebook and business, YouTube and Live Streaming	6
IV	SPEAKING SKILLS	Speaking on Panels, Moderating Panels, Speaking as keynote or Individual Talk, Introducing speakers, Summarising speeches and Meeting conference content, Presentation Skills- Visually present relationship between two or more data sets, , Data Presentation Methods- Line graph, Column chart, Vertical bar, scatter plot, Presentation style- Audience analysis, Care and concern for the audience, effective use of transitions and animations, slide design and content	7
V	INTELLECTUAL PROPERTY FOR BUSINESS	Meaning, Relevance, Business Impact, Protection of Intellectual Property, Types of Intellectual Property **Copyrights –** Introduction, Nature of copyright, Indian copyright law, copyright works, Author and ownership of copyright, Licensing of copyrights, Infringement of copyrights, Remedies and actions, Copyright for digital media, Software/ Internet **Patents**- Concept of patent, Product/Process Patents, Patent Law, Patentable subject matter, Patentability criteria, Duration of patent, Procedure for filing Patent Application, Types of Applications, Procedure of Opposition, Revocation of Patents, Ownership and Maintenance of Patents, Compulsory licensing, Qualification and registration Procedure **Trademarks**- Introduction, Rationale of protection of trademark as (a) an aspect of commercial and (b) of consumer rights, Kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks	8

		and service marks), Indian Trademarks Law, Procedure for Registration of Trademarks, Non Registrable Trademarks, Infringement of Trademarks and Right of Goodwill, Offences and Penalties **Trade secrets** **Designs**- Need for Protection of Industrial designs, Procedure and Infringement **Geographical Indications** – Concept, Procedure of Registration, duration of protection, Infringement, Penalties and Remedies	
VI	ETHICS AND ETHICAL CODE OF CONDUCT	Writing Resume and statement of purpose, Business and corporate activities(special emphasis on business meetings, emails, blogs and webpages), Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions.	4

Theory Assessments:

1. Internal Assessment: Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

2. End Sem Theory Examination:

- Question paper will consist of 5 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

References:

1.Raman Meenakshi & Singh Prakash, ***Business Communication Second edition,*** **Oxford University Press, Paperback, 2012**

2. Jeremy Harris Lipschultz**,** ***Social Media Communication: Concepts, Practices, Data, Law and Ethics Third edition,*** **Paperback, 2020**

3. V. K. Ahuja, ***Intellectual Property Rights In India,*** **Hardcover, 2015**

Sr. No.	Details of Assignments	Details of Activities	Hours
I	Written assignment on summarising a research proposal 4 page grant proposal (to be included as part of term work)	Example of summarising techniques to be demonstrated.	4
II	Written assignment on blog posts, web content	NA	4
III	Presentation skills	Mock Presentation	6
IV	Written Assignment on Resume writing/Statement of Purpose.	NA	2
V	Written Assignment on Intellectual Property	NA	4

Term work will consist of-

1. Assignments-20 marks
2. Grant Proposal- 10 marks
3. Attendance -5 marks
4. Presentation- 15 marks

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC502T	Natural Language Processing	03	--	--	03	–	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		1	2	Average					
EC502T	Natural Language Processing	40	40	40	60	–	--	–	100

Course Objectives:

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To understand the basic text processing techniques and significance of morphology.
3. To get acquainted with the basic concepts and algorithmic description of the main language levels, syntax, semantics.
4. To understand language models generation and applications.
5. To recognize the significance of pragmatics and discourse for natural language understanding.
6. To design and implement applications based on natural language processing

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

1. Have a broad understanding of the field of natural language processing.
2. Apply text processing techniques and analysis of morphology of text
3. Model linguistic phenomena with formal grammars and design semantic structure
4. Create language model and apply it for NLP applications
5. Understand the mathematical and linguistic foundations underlying approaches to analyse pragmatic and resolve coreference
6. Apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction...etc.

Prerequisite: Data structure & Algorithms, Theory of computer science, Probability Theory.

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hrs
1.	**Introduction**	Introduction Introduction to Natural Language Processing, History of NLP, Natural Language Generation, Natural Language Understanding, Generic NLP system, Ambiguity in Natural language, Stages in NLP, Challenges of NLP	07
2.	**Morphology analysis and Language modeling**	Text Processing Challenges, Pre-processing of text (tokenization, text filtration, script validation, stop words), Survey of English and Indian Language Morphology, Inflectional morphology & Derivational morphology, Stemming (Porter stemmer), Lemmatization, Regular expression, Morphological parsing with FST, The role of language models, Simple N-gram models, N-gram for spelling correction.	07
3.	**Syntax analysis**	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank), Rule based POS tagging, Stochastic POS tagging, Introduction to CFG, Parsing with CFG,Sequence labelling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).	07
4.	**Semantic Analysis**	Lexical Semantics, Attachment for fragment of Englishsentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their senses (Homonymy, Polysemy, Synonymy, Hyponymy) WordNet, Vector Space Models of Semantics, Word Sense Disambiguation (WSD), Semantic Role Labelling, Semantic Parsing	06
5.	**Discourse Context and World Knowledge**	Pragmatic analysis and understanding, Discourse: reference resolution, Reference Phenomena, Preferences in Pronoun Interpretation and resolution, Syntactic and Semantic Constraints on Coreference, Coreference Resolution: Coreference, Distinctions in Coreference, Coreference vs. Anaphora, Application,Challenges of Coreference Resolution	06
6.	**Applications of NLP**	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition,Plagiarism Detection	06

Theory Assessments:

1. Internal Assessment: Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

2. End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Books & References:

A. Books:

1. Sharvari Govilkar, Sagar Kulkarni, Dhiraj Amin ― Natural Language Processing, 2018, StartEDU solutions.
2. Daniel Jurafsky, James H. Martin ―Speech and Language Processing‖ Second Edition, Prentice Hall, 2008.
3. Christopher D.Manning and Hinrich Schutze, ― Foundations of Statistical Natural Language Processing ―, MIT Press, 1999.

B. References:

1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008).
2. Daniel M Bikel and ImedZitouni ― Multilingual natural language processing applications Pearson, 2013.
3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor) ― The Handbook of Computational Linguistics and Natural Language Processing
4. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
5. Brian Neil Levine, An Introduction to R Programming
6. Niel J le Roux, Sugnet Lubbe, A step by step tutorial: An introduction into R application and programming.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC503T	Generative and Explainable AI	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC503T	Generative and Explainable AI	40	40	40	60	--	--	--	100

Course Objectives:

1. To understand the fundamental concepts and mathematical foundations of generative models, including probability theory, generative processes, and basic architectures such as GANs, VAEs, and Autoencoders.
2. To design and train Generative Adversarial Networks (GANs) to generate realistic images and data, and understand their applications in image generation, data augmentation, and anomaly detection.
3. To implement and apply Variational Autoencoders (VAEs) for dimensionality reduction, feature learning, and density estimation using mathematical concepts such as evidence lower bound and reparameterization trick.
4. To develop XAI skills, including feature attribution, saliency maps, and attention mechanisms, to improve model interpretability.
5. To implement and evaluate explainable generative models such as LIME, TreeExplainer, and SHAP, and apply visualization techniques like t-SNE, PCA, and UMAP to understand the behavior of generative models in applications such as medical imaging and recommender systems.
6. To explore advanced topics in generative models like flow-based models, normalizing flows, and diffusion models, as well as advanced explainability techniques for innovative computer engineering solutions.

Course Outcomes: Upon successful completion of the course students will be able to

1. Demonstrate an understanding of the fundamental concepts of generative models, including generative processes, probability theory, and mathematical foundations.

2. Design and implement Generative Adversarial Networks (GANs) and Variational Autoencoders (VAEs) for various applications in computer engineering, including image and audio synthesis, data augmentation, and dimensionality reduction.
3. Analyze and evaluate the performance of generative models, including GANs and VAEs, using metrics such as precision, recall, F1-score, and mean squared error.
4. Apply Explainable AI (XAI) techniques to improve model interpretability and decision-making systems in computer engineering applications.
5. Critically evaluate the strengths and limitations of various generative models, including GANs and VAEs, in different applications.
6. Identify research directions and future trends in generative and explainable AI, including advanced topics such as flow-based models, normalizing flows, diffusion models, causality detection, model-based explanations, and multi-modal fusion.

Prerequisite: Applied Mathematics, Machine Learning Fundamentals, Probability and Statistics, Programming Skills

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Introduction to Generative Models**	Overview of generative models, Basic concepts: generative processes, probability theory, and mathematical foundations, Role of Generative models in computer engineering	06
2.	**Generative Adversarial Networks (GANs)**	History and motivation for GANs, Adversarial Training: Adversarial networks, generator and discriminator, Loss functions: binary cross-entropy, KL-divergence, Optimization algorithms: gradient descent, Adam; GAN Architectures: Convolutional GANs (CGANs), Conditional GANs (CGANs), Variational Autoencoder-GAN (VAE-GAN), StyleGAN; Realistic Image generation, Data augmentation, Adversarial attacks on GANs, Anomaly detection, Challenges and limitations of GANs.	08
3.	**Variational Autoencoders (VAEs) and Variational Inference**	Overview of VAEs and variational inference, Mathematical foundations: evidence lower bound, and reparameterization trick; Role of VAEs in dimensionality reduction, feature learning, and density estimation.	06
4.	**Explainable AI Fundamentals**	Introduction to Explainable AI (XAI); Evolution of XAI, Need for Explainability: Trust and transparency in AI, Legal and regulatory requirements, User acceptance and adoption; Explainability vs Interpretability; Types of Interpretability, Interpretability techniques: feature attribution, saliency maps, attention mechanisms; model interpretability and decision-making systems using XAI.	08

5.	**Explainable Generative Models**	Types of explainable generative models: neural networks, Bayesian networks, Explainable generative models: LIME, TreeExplainer, SHAP, Visualization techniques for generative models: t-SNE, PCA, UMAP; Evaluation of Explainability: Quantitative Metrics, Qualitative Methods; Case Study: applying explainability techniques to various domains (e.g. medical imaging, recommender systems).	06
6.	**Advanced Models in Generative and Explainable AI**	Advanced topics in generative models: flow-based models, normalizing flows, diffusion models, Advanced topics in explainable AI: causality detection, model-based explanations, multi-modal fusion. Research directions and future trends in generative and explainable AI.	05

Theory Assessments:

1. Internal Assessment: Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

2. End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Books and References:

A. Textbooks:

1. "Generative Models" by David M. Blei, Publisher: Cambridge University Press, Edition: 2020.
2. "Generative Adversarial Networks" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Publisher: MIT Press Edition: 1st Edition (2016).
3. "Explainable AI: Interpreting, Explaining and Visualizing Deep Learning" by Christoph Molnar. Publisher: Lulu Press, Edition: 2019
4. "Interpretable Machine Learning" by Christoph Molnar

B. References:

1. "Generative Adversarial Text to Image Synthesis" by T. Han et al. (2017)
2. "What You Don't Know About Deep Learning" by Jason Eisner (2017)
3. "Interpretability Beyond Feature Attribution" by Marco Tulio Ribeiro et al. (2018)
4. "Generative Adversarial Networks" by Ishaan Gulrajani, et al. (2017), Publisher: Cambridge University Press Edition: 1st edition.

Course Code	Course Name	Theory (Hrs)	Practical (Hrs)	Tutorial (Hrs)	Theory (Credits)	Practical/Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC504T	Big Data Analytics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg					
EC504T	Big Data Analytics	40	40	40	60	--	--	--	100

1. Course Objectives:

The course is aimed to:

1. To introduce the fundamental concepts, characteristics, and applications of Big Data.
2. To explain the architecture and components of Hadoop and MapReduce frameworks for large-scale data processing.
3. To describe the structure, types, and business applications of NoSQL databases.
4. To familiarize students with data stream models and stream processing algorithms.
5. To teach various similarity detection techniques and clustering algorithms used in Big Data Analytics.
6. To expose students to real-time Big Data models, recommendation systems, and industrial case studies.

2. Course Outcomes:

On successful completion of course learner/student will be able to:

1. Identify the characteristics, types, challenges, and real-life applications of Big Data.
2. Demonstrate the ability to process large-scale data using Hadoop and MapReduce programming models.
3. Analyze NoSQL database architectures and distinguish between different NoSQL models for solving Big Data problems.
4. Apply stream processing techniques and evaluate algorithms for real-time data analysis.
5. Design clustering models and compare similarity measures for Big Data pattern recognition.
6. Develop real-time Big Data applications using graph-based models and illustrate recommendation systems.

Prerequisite: Database Management Systems (DBMS), Data Structures and Algorithms, Python Programming / Programming for Data Science

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Overview Of big data analytics**	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach Big Data Challenges, Examples of Big Data in Real Life, Big Data Applications	03
2.	**Data analytics using MapReduce/ Hadoop**	Introduction to Big Data Frameworks: Hadoop, Core Hadoop Components; Hadoop Ecosystem-Overview, Hadoop Limitations. MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures. Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations, Computing Selections by MapReduce, Computing Projections by MapReduce, Union, Intersection, and Difference by MapReduce	10
3.	**No SQL**	Introduction to NoSQL, NoSQL Business Drivers, NoSQL Data Architecture Patterns: Key-value stores, Graph stores, Column family (Bigtable)stores, Document stores, Variations of NoSQL architectural patterns, NoSQL Case Study, NoSQL solution for big data. Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; NoSQL systems to handle big data problems.	6
4.	**Mining Data Streams**	The Stream Data Model: A Data- Stream-Management System, Examples of Stream Sources, Stream Queries, Issues in Stream Processing. Sampling Data in a Stream : Sampling Techniques. Filtering Streams: The Bloom Filter Counting Distinct Elements in a Stream : The Count-Distinct Problem, The Flajolet-Martin Algorithm, Combining Estimates, Space Requirements . Counting Ones in a Window: The Cost of Exact Counts, The Datar-Gionis-Indyk-Motwani Algorithm, Query Answering in the DGIM Algorithm.	12

5.	**Finding Similar Items and Clustering**	Distance Measures: Definition of a Distance Measure, Euclidean Distances, Jaccard Distance, Cosine Distance, Edit Distance, Hamming Distance. CURE Algorithm, Stream-Computing , A stream-Clustering Algorithm, Initializing & Merging Buckets, Answering Queries.	10
6.	**Real-Time Big Data Models**	PageRank Overview, Efficient computation of PageRank: PageRank Iteration Using MapReduce, Use of Combiners to Consolidate the Result Vector. Introduction to Recommendation System: content based Recommendation System, collaborative Recommendation System, hybrid Recommendation System. Issues and challenges Recommendation System Big Data Case Studies – How big companies use Big Data : Walmart, Netflix, eBay etc…. Demonstration of Graph Database : NEO4J Example: Social Network Circle ,	4

Assessments:

1. **Internal Assessment:** Two Internal assessments will be conducted for 40 marks each. Two tests should cover at least 80% syllabus. The average marks of two tests should be considered as final IA marks.

2. End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to the number of hours assigned to each module.

3. Suggested Experiments:

Software Requirements if any: Windows / Linux Desktop OS / Kali Linux, Hadoop, R studio, Mongodb

1. HDFS Basics, Hadoop Ecosystem Tools Overview. Installing Hadoop.
2. Copying File to Hadoop.
3. Copy from Hadoop File system and delete file.
4. Moving and displaying files in HDFS.
5. Programming exercises on Hadoop.
6. To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands.
7. Experiment on Hadoop Map-Reduce / PySpark:
8. Write a program to implement a word count program using MapReduce.
9. Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc.
10. Implementing DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language

11. Implementing any one Clustering algorithm (K-Means/CURE) using Map-Reduce
12. Mini Project: One real life large data application to be implemented (Use standard Datasets available on the web)

4. Theory Assessment:

A. Internal Assessment (IA): Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.

B. End Semester Theory Examination: In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

1. Question paper will consist of 3 questions, each carrying 20 marks.
2. Question number 1 will be compulsory and based on maximum contents of the syllabus
3. Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
4. Total three questions need to be solved.

5. Term Work Assessment: The final certification and acceptance of TW ensures the satisfactory performance of laboratory work and minimum passing in the TW.

A. Term Work: Term Work shall consist of practical's based on the above list. Also Term work Journal must include at least 2 assignments based on the topics mentioned in the syllabus.
B. Term Work Marks: 25 Marks (Total marks) = 15 Marks (Experiment) + 5 Marks (Assignments) + 5 Marks (Attendance).

6. Books and References:

A. Books:

1. CreAnand Rajaraman and Jeff Ullman Mining of Massive Datasets, Cambridge University Press,
2. Alex Holmes Hadoop in Practice, Manning Press, Dreamtech Press.
3 Dan Mcary and Ann Kelly Making Sense of NoSQL – A guide for managers and the rest of us Manning Press.

B. References:

1. Anand Rajaraman and Jeff Ullman "Mining of Massive Datasets", Cambridge University Press
2. Alex Holmes "Hadoop in Practice", Manning Press, DreamTech Press. [3] Dan McCreary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.
3. Bill Franks , "Taming The Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics", Wiley
4. Chuck Lam, "Hadoop in Action", Dreamtech Press
5. Judith Hurwitz, Alan Nugent, Dr. Fern Halper, Marcia Kaufman, "Big Data for Dummies",
6. MongoDB: The Definitive Guide Paperback, Kristina Chodorow (Author), Michael Dirolf, O'Reilly Publication

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC505T	Advanced Mobile Communication	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Average					
EC505T	Advanced Mobile Communication	40	40	40	60	--	--	--	100

Course Objectives:

1. To get familiar with the basics of mobile networks.
2. To understand various aspects of Mobile radio propagation.
3. To study 2G system technologies i.e. GSM and CDMA.
4. To explore details of 3G system technologies i.e. GSM and CDMA.
5. To study 4G LTE advanced technologies used in mobile services.
6. To discuss the advanced technologies and introduction of 5G technology.

Course Outcomes:

Students will be able to:

1. Get familiar with the basics of mobile networks.
2. Understand various aspects of Mobile radio propagation.
3. Study 2G system technologies i.e. GSM and CDMA.
4. Explore 3G system technologies i.e. GSM and CDMA.
5. Study 4G LTE advanced technologies used in mobile services.
6. Discuss the advanced technologies and introduction of 5G technology.

Prerequisite: Computer Communication and Network

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction to Mobile Networks**	Introduction to Mobile Computing, Telecommunication enerations, Electromagnetic Spectrum, Antenna, Signal ropagation, Signal Characteristics, , Multiplexing, Spread pectrum: DSSS & FHSS	06
2	**Mobile Radio Propagation**	Large scale fading: Free space propagation model, the three basic propagation mechanisms, reflection, ground reflection (two-ray) model, diffraction, scattering, practical Link budget design using path loss models Small scale fading: Small scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Ricean distributions.	08
3	**2G GSM and CDMA Mobile** Services	GSM: GSM Network Architecture, air interface specifications, GSM signalling protocol architecture, GSM channels, GSM services and features, GSM multifare structure, GSM speech coding, GSM Call procedures, Authentication and security in GSM, and handoff procedures in GSM. GSM evolution: GPRS, HSCSD and EDGE architecture, radio specifications. IS-95: CDMA air interface, CDMA channels, power control in CDMA system, handoff, and RAKE receiver.	08
4	**3G GSM and CDMA Mobile** **Services**	UMTS: Objectives, standardization and releases, network architecture, air interface specifications, channels, security procedure, W-CDMA air interface, attributes of W-CDMA system, W-CDMA channels. Cdma2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control.	06
5	**4G LTE Mobile services**	Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure. Physical layer: Frames, slots, and symbols, modulation, coding, multiple-antenna techniques. Logical and Physical Channels: Mapping of data onto (logical) sub-channels, Establishing a connection, Physical layer retransmissions and reliability, Power control, and handover.	06

6	**Advanced techniques for 4G deployment and beyond, Introduction to 5G Technology**	Multi-antenna Techniques: Smart antennas, Multiple input Multiple output systems. Cognitive radio: Architecture, spectrum sensing. Software Defined Radio (SDR): Components and Applications. Salient features of 5G , 5G technology, 5G Architecture, Advantages and disadvantages, Applications, 5G Advancements, 5G Challenges, 5G future scope.	06

Theory Assessment:

Internal Assessment for 40 marks:

Consisting of Two Compulsory Internal assessment of **40 Marks each** on 40% syllabus for each test. The final marks will be the average of the score of both the tests.

End Semester Examination: 60 Marks

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to the number of hours assigned to each module.

Textbooks:

1. Vijay K. Garg, “Wireless Communication and Networking”, Morgan –Kaufmann Series in Networking—Elsevier
2. KE- LIN DU & M. N. S. Swamy, ―Wireless Communication Systems, Cambridge University Press India Pvt. Ltd
3. Dr. Sunilkumar S. Manvi, Mahabaleshwar S. Kakkasageri, ―Wireless & Mobile Networks: Concepts and Protocols Wiley India
4. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON Second edition.

References:

1. T L Singal “wireless communications”, Mc Graw Hill Education
2. Fundamentals of 5G Mobile Networks: Jonathan Rodriguez (Ist Edition), Wiley Publication.
3. Carlos de Morais Cordeiro, Dharma Prakash Agrawal, ―AD HOC & Sensor Networks – Theory & Applications , Cambridge University Press India Pvt. Ltd

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC506T	Wireless Technology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg.					
EC506T	Wireless Technology	40	40	40	60	--	--	--	100

Course Objectives:

1. To get familiar with the basics of wireless systems.
2. To understand the planning and design of various mobile and wireless networks.
3. To study various emerging WPAN technologies like Bluetooth, Zigbee etc.
4. To explore advanced technologies in Wireless Communication.
5. To discuss the introduction of 5G technology.

Course Outcomes: Upon successful completion of the course students will be able to

1. Get familiar with the basics of wireless systems.
2. Understand planning and design of various mobile and wireless networks.
3. Study various emerging WPAN technologies like Bluetooth, Zigbee etc..
4. Explore advanced technologies in Wireless Communication.
5. Discuss introduction of 5G technology.

Prerequisite: Wireless and mobile communication.

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
1	**Overview of Wireless System**	Advantages, limitations and application wireless media, Infrared Modulation Techniques, DSSS and FHSS, Frequency Spectrum: Radio and Infrared, Wireless generations: 1G: Cellular,2G: Mobile Radio, 3G: UMTS- Security related Encryption Algorithm	09
2	**Planning and design of WWANs**	Basics of fundamental of WWANs, Planning and design of wireless networks, Receiver sensitivity and link budget, Pole capacity of CDMA cell, Uplink and downlink radio link budget for CDMA system	09
3	**Emerging Wireless Technologies**	Bluetooth, ZigBee, WiMax, Wi-fi, Ad-hoc wireless networks, Wireless sensor networks	09
4	**Advanced technologies in Wireless Communication**	Mobile Machine to Machine communication, Mobile traffic management, cooperative communication	06
5	**Introduction to 5G**	Salient features of 5G , 5G technology, 5G Architecture, Advantages and disadvantages, Applications, 5G Advancements, 5G Challenges, 5G future scope	06

Theory Assessments:

1. Internal Assessment: Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

2. End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.

Weightage of marks should be proportional to number of hours assigned to each module

Text Books:

1. Vijay K. Garg, “Wireless Communication and Networking”, Morgan -Kaufmann Series in Networking—Elsevier
2. Theodore S. Rappaport, “wireless communications - principles and practice”, PEARSON, Second edition.
3. T L Singal ,“Wireless Communications”, Mc Graw Hill Education.
4. Fundamentals of 5G Mobile Networks: Jonathan Rodriguez (Ist Edition), Wiley Publication

References:

1. WAP Development with WML and WML Script: Ben Forta and Keith
2. Dr SunilkumarS. Manvi, Mahabaleshwar S. Kakkasageri, “Wireless and Mobile
3. Networks Concepts and Protocol”, Wiley India Pvt Ltd.
4. Raj Kamal, “Internet of Things Architecture & Design Principles” Mcgraw Hill
5. Kazem Sohraby, Daniel Minoli, and Taieb Znati, “Wireless Sensor Networks:
6. Technology, Protocols, and Applications”, Wiley Student Edition.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC507T	Ethical Hacking and Digital Forensics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC507T	Ethical Hacking and Digital Forensics	40	40	40	60	--	--	--	100

Course Objectives:

1. To understand underlying principles of Ethical hacking and digital forensic practices.
2. To learn gathering information from various cyber spaces.
3. To perform security scan to test the applications and systems for vulnerability.
4. To understand and deal with the hacking environment and strategies for covering attack tracks.
5. To learn the importance of incident response and evidence handling in digital forensics.
6. To apply digital forensic knowledge to use various digital forensic tools for live data collection.

Course Outcomes:

1. Describe principles of Ethical hacking and digital forensic.

2. Gather the information required for Digital forensics and Ethical hacking from various cyber spaces.

3. Evaluate testing plan for applications and systems for vulnerability.

4. Understand hacking environments and learn hacker hiding techniques.

5. Explain the methodology of incident response and various security issues.
6. Install and examine various Digital forensics tools for data collection.

Prerequisite: Basic Mathematics, Algorithms, Data Structures, Basic Probability and Statistics, Algorithms

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
	Introduction to Ethical Hacking and Digital Forensics	Introduction to Ethical hacking: definition, difference between hacking and ethical hacking. Vulnerability, Attack Vector. Five stages of hacking: Reconnaissance, Probing, Actual attack, maintaining presence, Covering attack tracks, Digital Forensic, Rules for Digital Forensic, The Need for Digital Forensics, Types of Digital Forensics, Ethics in Digital Forensics, Digital Evidences: Types and characteristics and challenges for Evidence Handling.	04
	Information Gathering	**Information gathering:** from social media accounts, extraction of photographs, exit data, phone number, vehicle registration number, dumpster dumping, Google street view and Google history. Social Engineering techniques, Google Dork query, Browser extension to collect information. Principles of Ethical hacking (Legality & Ethics). Introduction to OWAPS, types of OWAPS	05
	Enumeration and System Hacking	**Scanning & Enumeration**: Port Scanning, Network Scanning, Vulnerability Scanning, NMAP Scanning tool, OS Fingerprinting, Enumeration. **System Hacking**: Password cracking techniques, Key loggers, Escalating privileges, URL Hiding Files, Sniffers & SQL Injection: Active and passive sniffing, ARP Poisoning, Session Hijacking, DNS Spoofing, Conduct SQL Injection attack, Countermeasures. Study of open-source scanning tools.	06
	Hacking Environment by Hiding hacker details	Installation and configuration of DVWA environment. Virtual box installation, Installation of Kali Linux within virtual box. Kali	10

		Linux penetration testing and ethical hacking tools. What is TOR? How can you use it to protect your anonymity online? Proxy chain for using proxy servers, hiding your IP and obtaining access. What is VPN and how you can stay anonymous with VPN. Mac-changer,use of mac-changer to change your MAC address. Incident Response and Forensic Analysis.	
	Incident Response Methodology	Incident Goals of Incident response, Incident Response Methodology, Formulating Response Strategy, IR Process – Initial Response, Investigation, Remediation, Tracking of Significant, Investigative Information, Reporting Pre-Incident Preparation, Incident Detection.	08
	Digital Forensic Tools	Live Data Collection: Live Data Collection on Microsoft Windows Systems: Live Data Collection on Unix-Based Systems Forensic Duplication Forensic Image Formats, Traditional Duplication, Live System Duplication, Forensic Duplication tools Disk and File System Analysis: Media Analysis Concepts, File System Abstraction Model The Sleuth Kit: Installing the Sleuth Kit, Sleuth Kit Tools Partitioning and Disk Layouts : Partition Identification and Recovery, Redundant Array of Inexpensive Disks Special Containers : Virtual Machine Disk Images, Forensic Containers Hashing, Carving : Foremost , Forensic Imaging : Deleted Data , File Slack , dd , dcfldd , dc3dd Data Analysis Analysis Methodology Investigating Windows systems, Investigating UNIX systems, Investigating Applications, Web Browsers, Email, Malware Handling: Static and Dynamic Analysis, Writing a Report, sample for writing a forensic report.	06

Theory Assessments:

1. **Internal Assessment:** Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.
2. **End Sem Theory Examination:**
   - Question paper will consist of 4 questions, each carrying 20 marks.
   - Total 3 questions need to be solved.
   - Q.1 will be compulsory, based on the entire syllabus.
   - Remaining questions will be randomly selected from all the modules.
   - Weightage of marks should be proportional to number of hours assigned to each module.

Text Books:

1. Mark Rhodes-Ousley,"Information Security: The Complete Reference", Second Edition, McGraw-Hill, 2013.
2. Dafy dd Stutarf, Marcus Pinto,"Web Application Hackre's Handbook",Wiley.
3. Skoudis E. Perlman R. "Counter hack: A step by step Guide to Computer Attacks andeffective Defense", Prentice Hall Professional technical Reference, 2001.
4. Jason Luttgens, Matthew Pepe, Kevin Mandia, "Incident Response and computer forensics",3rd Edition Tata McGraw Hill, 2014.
5. Nilakshi Jain, Dhananjay Kalbande,"Digital Forensic: The fascinating world of Digital Evidences" Wiley India Pvt Ltd 2017.
6. Cory Altheide, Harlan Carvey"Digital forensics with open-source tools"Syngress Publishing, Inc. 2011

References:

1. The Internet of Things (MIT Press) by Samuel Greengard.
2. The Internet of Things (Connecting objects to the web) by Hakima Chaouchi (Wiley Publications)..
3. RFID and the Internet of Things, by Hervechabanne, Wiley.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC508T	Advanced Processor Architecture-I	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Average					
EC508T	Advanced Processor Architecture-I	40	40	40	60	--	--	--	100

Course Objectives:

1. To review fundamental computer architecture concepts
2. To classify and analyze parallel processing systems.
3. To differentiate between multiprocessor and multi-core architectures .
4. To understand pipelining hazards and instruction-level parallelism (ILP)
5. To explore memory hierarchy designs and optimizations.
6. To study advanced and emerging processor design techniques..

Course Outcomes: Upon successful completion of the course students will be able to

1. Explain the fundamental concepts of computer architecture including ISA, pipelining, and memory organization.
2. Classify and evaluate parallel processing systems using Flynn's taxonomy and differentiate array processors, clusters, and NUMA systems.
3. Analyze the design and performance of multiprocessor and multi-core architectures, including interconnection networks and memory models.
4. Identify and resolve pipelining hazards using techniques such as forwarding and branch prediction; explain instruction-level parallelism using superscalar and VLIW approaches.
5. Evaluate cache and virtual memory designs, replacement policies, and understand memory consistency models for parallel programs.
6. Describe and analyze advanced processor design techniques including speculative execution, simultaneous multi-threading, vector processing, and emerging architectures like quantum and neuromorphic computing..

Prerequisite: Basic Computer Architecture, Digital Logic Design, Microprocessors and Microcontrollers

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hrs
1.	**Introduction to Advanced Processor Architectures**	**Fundamentals:** Review of basic computer architecture concepts, including instruction set architecture (ISA), pipelining, and memory organization. **Parallel Processing:** Classification of parallel systems (Flynn's Taxonomy), array processors, clusters, and NUMA (Non-Uniform Memory Access) computers. **Multiprocessor Systems:** Interconnection networks, shared memory vs. distributed memory architectures. **Multi-Core Architectures:** Introduction to multi-core processors, their organization and performance evaluation.	06
2.	**Pipelining and Instruction-Level Parallelism**	Epitaxy: Introduction to Epitaxy concept. Silicon Oxidation: Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality. Device Isolation: LOCOS, Shallow Trench Isolation (STI) Deposition: Physical Vapor Deposition-Evaporation and Sputtering systems, Chemical Vapor Deposition: APCVD, LPCVD, PECVD systems	08
3.	**Memory Hierarchy and Optimization**	**Cache Memory:** Cache organization, mapping functions, replacement policies, and write policies. **Virtual Memory:** Segmentation, paging, and page replacement algorithms. **Memory Consistency Models:** Sequential consistency, weak consistency, and their implications for parallel programming	10

4.	**Advanced Processor Design Techniques**	**Branch Prediction:** Static and dynamic branch prediction techniques. **Speculative Execution:** Techniques for speculative execution and its impact on performance. **Multi-Threading:** Simultaneous multi-threading (SMT) and its benefits. **Vector Processing:** Introduction to vector instructions and their use in high-performance computing	08
5.	**Parallel Programming and Architectures**	**Parallel Programming Models:** Shared memory, message passing, and data parallelism. **Synchronization and Communication:** Techniques for synchronization and communication in parallel systems. **Case Studies:** Examining specific advanced processor architectures (e.g., Intel Core series, AMD Ryzen, GPUs)	04
6.	**Emerging Trends in Processor Architecture**	**Neuromorphic Computing:** Introduction to brain-inspired computing and its potential. **Quantum Computing:** An overview of quantum computing concepts and architectures. **Specialized Accelerators:** Introduction to hardware accelerators for specific tasks (e.g., machine learning)	03

Theory Assessments:

1. Internal Assessment: Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

2. End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Text Books:

1. **John L. Hennessy and David A. Patterson ,** *"Computer Architecture: A Quantitative Approach",* Morgan Kaufmann, 6th Edition, 2019

2. **David A. Patterson and John L. Hennessy,** *"Computer Organization and Design: The Hardware/Software Interface",* Morgan Kaufmann, 5th or 6th Edition

References:

1. **Kai Hwang,** *"Advanced Computer Architecture: Parallelism, Scalability, Programmability",* McGraw-Hill Education, 2003
2. **Andrew S. Tanenbaum and Todd Austin,** *"Structured Computer Organization",* Pearson Education, 6th Edition
3. **Richard Y. Kain,** *"Advanced Computer Architecture: A Systems Design Approach",* Pearson Education

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC509T	Embedded Systems and RTOS	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC509T	Embedded Systems and RTOS	40	40	40	60	--	--	--	100

Course Objectives:

1. Understand the fundamental concepts and architecture of embedded systems and real-time operating systems.
2. Analyze and design embedded system hardware and software components for real-time applications.
3. Develop proficiency in programming microcontrollers and interfacing sensors and actuators using Embedded C/C++.
4. Apply real-time scheduling algorithms and task synchronization techniques in RTOS environments.
5. Integrate embedded systems with communication protocols and IoT platforms for real-world applications.
6. Explore advanced topics such as hardware-software co-design, system-on-chip (SoC) architectures, and embedded system security.

Course Outcomes: After successfully completing this course, students will be able to:

1. Demonstrate comprehensive knowledge of embedded system architectures and real-time operating system concepts.
2. Design and develop embedded system applications using microcontrollers and RTOS with effective task management and scheduling.
3. Implement synchronization, communication, and resource-sharing mechanisms in real-time embedded systems.

4. Analyze and apply various real-time scheduling algorithms to ensure system predictability and reliability.
5. Develop IoT-enabled embedded applications by integrating communication protocols and cloud platforms.
6. Employ hardware-software co-design principles for efficient embedded system development.

Prerequisite: Microprocessor and Peripherals, Microcontroller & Applications

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Advanced Embedded System Architecture**	Overview of embedded system concepts, ARM Cortex-A, Cortex-R and Cortex-M processor families, System on Chip (SoC) design principles, Memory hierarchy and management: cache, virtual memory, Low power design and power management techniques, Hardware accelerators and FPGA in embedded systems.	04
2.	**Embedded Software Design**	Embedded C and C++ for real-time systems, Cross-compilation, build systems, toolchains, Software development lifecycle for embedded software, Device drivers, middleware, and bootloader design, Software testing and debugging methods in embedded environments	05
3.	**RTOS Fundamentals and Advanced Concepts**	RTOS concepts and architecture, Real-time task scheduling: fixed priority, dynamic priority scheduling, Synchronization and communication mechanisms: semaphores, mutexes, events, message queues, Real-time clocks and timers, interrupt handling, Resource sharing and priority inversion problem and solutions (PIP, PCP, HLP), RTOS APIs and programming with FreeRTOS, VxWorks, QNX, ThreadX	06
4	**Embedded Networking and IoT Protocols**	Embedded network stacks: TCP/IP, UDP, Wireless protocols: Bluetooth Low Energy (BLE), ZigBee, LoRaWAN, NB-IoT, IoT architecture and platforms, Protocols for IoT: MQTT, CoAP, AMQP, Security issues in embedded and IoT systems	10
5	**Hardware-Software Co-Design**	Co-design methodologies, Hardware description languages (HDL): VHDL, Verilog basics, FPGA and CPLD architecture for	08

		embedded systems, System-level design and verification, Embedded system prototyping	
6	**Real-Time System Modeling and Verification**	Modeling techniques: State machines, Petri nets, UML,Worst-case execution time (WCET) analysis, Real-time system simulation and verification, Formal verification methods for real-time systems, Reliability, fault tolerance, and safety in embedded systems	06

Theory Assessments:

1. Internal Assessment: Two Internal assessments will be conducted for 40 marks each with average marks of both assessments as final score.

2. End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Text Books:

1. ***Jane W.S. Liu*, " Comprehensive coverage of real-time system fundamentals, scheduling algorithms, and design techniques.",** *Real-Time Systems, Pearson Education, 2000.*
2. **Tammy Noergaard, "***Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmer"s*, 2nd Edition, Newnes, 2012.
3. **Jonathan W. Valvano, "***Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers"*, 2017.
4. **Qing Li, Caroline Yao, "***Real-Time Concepts for Embedded Systems"*, CMP Books, 2003.

References:

1. **Tim Wilmshurst,** "*Designing Embedded Systems with PIC Microcontrollers"*, Newnes, 2007.
2. **Joseph Yiu,** "*The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors"*, 3rd Edition, Newnes, 2013.

3. **Jonathan W. Valvano,** "*Embedded Systems: Real-Time Interfacing to Arm® Cortex™-M Microcontrollers"*, 2011.
4. **Albert M. K. Cheng,** "*Real-Time Systems: Scheduling, Analysis, and Verification"*, Wiley, 2002.
5. **David E. Simon,** " *Embedded Software Primer"*, Pearson Education, 1999.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC510T	Advanced Robotics	03	02	--	03	01	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC510T	Advanced Robotics	40	40	40	60	25	–	25	150

Prerequisite:

Course Objectives:

1. Understand the fundamental concepts and specifications of robotic systems.
2. Develop mathematical models of robotic manipulators using transformation techniques.
3. Analyze robot kinematics and dynamics including direct and inverse approaches.
4. Formulate velocity and dynamic equations using Jacobian and Lagrangian methods.
5. Plan trajectories in joint and Cartesian spaces using appropriate algorithms.
6. Design and evaluate control strategies (PID, LQR) for robotic motion control.

Course Outcomes:Upon successful completion of the course students will be able to

1. Describe various robot specifications, classifications, and coordinate systems.
2. Construct mathematical models using homogeneous transformation matrices and D-H parameters.
3. Solve forward and inverse kinematics problems for simple robotic systems.
4. Analyze robot velocity kinematics and derive dynamic equations using Jacobian, Lagrangian, and Newton-Euler methods.
5. Implement trajectory planning techniques in both joint and Cartesian spaces for robotic arms.

6. Design and analyze control systems including PID and LQR for one-axis robot models.

Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
1	**Basics of Robotic Technology**	Robot Specifications: Axes, Capacity & Speed, Reach & Stroke, Tool Orientation, Resolution, accuracy and precision of Robot. Robot Degrees of Freedom, Robot Links, Joints and Symbols, Robot Coordinates, Robot Reference Frames Robot Classification	06
II	**Mathematical Modeling of a Robot**	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations - position and orientation Denavit-Hartenberg representation of forward kinematics,	06
III	**Kinematics & Dynamics of Robot**	Direct (Forward) Kinematics: Homogeneous coordinates, Link coordinates, Coordinate frame, coordinate transform, Arm equations, An example – Four Axis SCARA. Inverse Kinematics: Inverse kinematics problem, Tool Configuration, An example – Four Axis SCARA.	06
IV	**Velocity Kinematics & Dynamics**	Differential motions and velocities: Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities. Dynamic Analysis of Forces: Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two-axis robot	07
V	**Trajectory planning**	Path vs. Trajectory Joint-Space vs. Cartesian-Space Descriptions Basics of Trajectory Planning Joint-Space Trajectory Planning: Third-Order Polynomial Trajectory Planning, Fifth-Order Polynomial Trajectory Planning, Linear Segments with Parabolic Blends, Linear Segments with Parabolic Blends and Via Points, Higher-Order Trajectories, Other Trajectories Cartesian-Space Trajectories Continuous Trajectory Recording	07

VI	**Robotic Control**	Basics of control systems for one-axis robots. State-Space Control Methodology(one-axis robot). Introduction to Controllers. Design of Controllers (P, PI, PD, PID). Study of LQR Controller for One Axis Robot.	07

Hardware Requirements: STM microcontroller
Software Requirements: Scilab, Matlab

Sr. No.	Detailed Lab Description
1	Forward Kinematics of Cylindrical Robot Coordinates.
2	Forward Kinematics of 3 DOF Robots using D-H algorithm.
3	Inverse Kinematics of 2 DOF Robots
4	Inverse Kinematics of 3 DOF Robots
5	Inverse Kinematics of 3 DOF Robot Arm.
6	Trajectory using Third Order Polynomial.
7	PID Controller Tuning for Motor Control
8	Inverted Pendulum Control
9	Modeling of Mobile Robot and Manipulator
10	Mini Project

Theory Assessments:

Internal Assessment: Two Internal assessments will be conducted for 40 marks each with the average marks of both assessments as final score.

End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Lab Assessments:

1.Term work Assessment:

At least 07 Experiments and 3 Assignments based on the entire syllabus and **one course mini project/seminar** must be submitted by a maximum batch of 2 to 3 students. Term work

assessment must be based on the overall performance of the student with every experiment and Course-project is graded from time to time.

2. Practical/Oral/Viva Assessment: Based on the above contents and entire syllabus.

Text Books:

1 Saeed B. Niku, "Introduction to Robotics: Analysis, Systems,Applications",Pearson Education Inc., New DELHI, 2006

2. Schilling, Robert J. Fundamentals of robotics: analysis and control. Simon & Schuster Trade, 1996.

3. Corke, Peter I., Witold Jachimczyk, and Remo Pillat. Robotics, vision and control: fundamental algorithms in MATLAB. Vol. 73. Berlin: Springer, 2011.

References:

1. R Mittle, I Nagrath, "Robotics and Control", Tata Mc Graw Hill, 2017

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC5011L	Course Lab I	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC5011L	Course Lab I	--	--	--	--	25	25	--	50

Course Name: Course Lab

Students have to perform course lab I based on DLOC I ,II and III.

Student has to complete lab experiments/lab work/case studies specified respect to the course

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC5012L	Dissertation I	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC5012L	Dissertation I	--	--	--	--	25	25	--	50

Course Name: Dissertation-I

- Students have to select project topics from the repository created by the faculty of the department. The same faculty will be continued as mentors/guide for dissertation I, II, III and IV
- Students should do a literature survey in the identified topic and finalize it with consultation of the Guide/Supervisor.
- Students should use multiple literatures (at least 20 papers from Refereed Journals/conferences) and understand the topic and research gap.
- Compile the report in standard format and present Seminar in front of the Panel of Examiners.
- Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of I semester.

Master of Technology
In
Electronics & Computer Science

(Semester II)

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC520T	Data Science	3	-	-	-	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC520T	Data Science	40	40	40	60	-	-	-	100

Prerequisite: BDA, ML, DBMS, Python, NLP

Course Objectives: The course is aimed to:

1. To understand the foundations of the Data Science process, methods and techniques.
2. To understand management of data and make predictions over the data.
3. To understand the principles of text analytics.
4. To understand why visualization is an important part of data analysis.
5. To understand the ethical responsibilities of data scientists and organizations.
6. To work on various applications of data science.

Course Outcomes:Upon successful completion of the course students will be able to

1. Learn the fundamentals of data science to enable, reproduce and scalable data from a variety of sources.
2. Generate and process dataset and develop models for prediction
3. Analyze text for common theme and trends
4. Design visualizations and narrate stores based on data
5. Develop data science project ethically
6. Analyze importance and impact of data science in varied applications

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
I	Introduction to data science	Definition, working, defining goal, benefits and uses of Data Science, Data science, Big data & BI, The data science process, Role of a Data Scientist. Definition and meaning of feature in various kinds of data(e.g., structured data, unstructured data(text data, imagedata))• Types of features(continuous, categorical)	5
II	Data management and Predictive modeling	Data management - Understanding how to create the data set, Data collection methods, Data preparation - importance of data 'cleaning', validity and quality. Data analysis - how format and volume of data limits methods of analysis available Predictive Modeling - Probability and Statistics Basics, Concept of Loss function, Common machine learning models, Feature engineering, Model selection, Performance metrics and hyperparameter optimization, K-fold cross validation, Model Deployment	5
III	Text Analytics	Introduction to text Analytics, Need of Text Analytics, Understanding Text, Cleaning Text Data Sets, Text Classification, Text Clustering, Text mining techniques	5
IV	Data visualization and Ethics of data science	Introduction to Data Visualization, Visualization Tools(Area plots,Histograms,Bar Charts, Pie Charts, BoxPlots, Scatter Plots,Waffle Charts, Word Clouds),Visualizing Geospatial Data, visualizing time series data, Importance of data visualization Dashboards. DataVisualization using R, Python and Tableau. Responsibilities of actuaries around data science and AI, Data Science Ethics, Doing good data science, Owners of the data, Valuing different aspects of privacy, Getting informed consent, The Five Cs, Developing ethical and professional safeguards	6
V	GenerativeAI	Introduction to generative AI and discriminative AI.Distinguish generative AI from discriminative AI.Capabilities of generative AI and its use cases in the real world. Applications of generative AI in different sectors and industries. Generative AI models and tools for text,code, image, audio, and video generation. Leverage generative AI tools, like GPT 3.5, ChatCSV, andtomat.ai, available to Data Scientists for querying and preparing data. Examine real-world scenarios where generative AI can enhance data science workflows.	7
VI	Applications	Healthcare, Banking, Finance, Sports, Advertisement, Transport, Tourism	5

Theory Assessments:

Internal Assessment: Two Internal assessments will be conducted for 40 marks each with the average marks of both assessments as final score.

End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Question 1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to the number of hours assigned to each module.

Text Books and References:

1. Davy Cielen, Meysman, Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2. Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O’ Reilly, 1st edition, 2018
4. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley
5. Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
6. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
7. EMC Education Services,”Data Science and Big Data Analytics”,Wiley

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC521T	Integrated Circuit Technology	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC521T	Integrated Circuit Technology	40	40	40	60	-	--	--	100

Prerequisite:

1. Basics of VLSI circuits

Course Objectives: The course is aimed to:
1.To provide knowledge of semiconductor devices fabrication processes.
2. To provide knowledge of fundamental building blocks of IC fabrication.
3. To provide knowledge of CMOS design process flow.
4. To provide basic CMOS circuit layout knowledge using Lambda design rules.
5. To be familiar with various VLSI technologies and novel devices
6. To provide knowledge of various multigate device configurations.

Course Outcomes:Upon successful completion of the course students will be able to

1. Explain crystal growth techniques
2. Demonstrate a clear understanding of various MOS fabrication processes
3. Discuss CMOS fabrication process flow
4. Design basic CMOS circuits with layout
5. Study various VLSI technologies and novel devices
6. Demonstrate a clear understanding of various multigate device configurations.

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
I	Semiconductor manufacturing requirements and Crystal growth techniques	Semiconductor Manufacturing: Semiconductor technology trend, Clean rooms, Wafer cleaning and Gettering. Crystal growth techniques: Czochralski growth, Float Zone growth, Bridgman growth of GaAs, Wafer Preparation and specifications.	6
II	Semiconductor Device Fabrication Processes-1 (Epitaxy, Oxidation and Deposition)	Epitaxy: Introduction to Epitaxy concept. Silicon Oxidation: Thermal oxidation process, Kinetics of growth,Properties of Silicon Dioxide, Oxide Quality.Device Isolation: LOCOS, Shallow Trench Isolation (STI) Deposition: Physical Vapor Deposition-Evaporation and Sputtering systems, Chemical Vapor Deposition: APCVD, LPCVD, PECVD systems	8
III	Semiconductor Device Fabrication Processes-2 (Impurity incorporation, Pattern Transfer and Contacts)	Diffusion: Nature of diffusion, Diffusion in a concentration gradient, diffusion Equation, diffusion systems. Ion Implantation: Penetration range-Nuclear & Electronic stopping and Range, Implantation damage, Annealing-Rapid thermal annealing, Ion implantation systems.Etching: Basic concepts and Classification. Lithography: Introduction to Lithography process, Types of Photoresist, Types of Lithography: Electron beam, Ion beam and X-ray lithography. Metallization and Contacts: Introduction to Metallization, Schottky contacts and Ohmic contacts	10
IV	CMOS Process Flow and Design rules	CMOS Process Flow:N well, P-well and Twin tub, CMOS Latch Up.Design rules: Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	8
V	VLSI Technologies	SOI Technology: SOI structures, fabrication methods and Features. Advanced Technologies: low κ and high κ, BiCMOS, Introduction to MESFET Technology	4

VI	Novel Devices	Multigate Devices: Various multigate device configurations double gate, triple gate (FinFET) and Gate All Around (Nanowire). Nanowire: Concept, VLSI method of fabrication, Nanowire FETs CNT FET: Introduction to Graphene and CNTFET structure	4

Theory Assessments:

Internal Assessment: Two Internal assessments will be conducted for 40 marks each with the average marks of both assessments as final score.

End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Question 1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to the number of hours assigned to each module.

Text Books:

1.James D. Plummer, Michael D. Deal and Peter B. Griffin, “Silicon VLSI Technology”, Pearson, Indian Edition
2. Sorab K. Gandhi, “VLSI Fabrication Principles”, Wiley, StudentEdition

References:

1.Stephen A. Campbell, “The Science and Engineering of Microelectronic Fabrication”, Oxford University Press, 2nd Edition
2. G. S. May and S. M. Sze, “Fundamentals of Semiconductor Fabrication”, Wiley, First Edition.
3. Kerry Bernstein and N. J. Rohrer, “SOI Circuit Design Concepts”, Kluwer Academic Publishers, 1st edition.
4. Jean-Pierre Colinge, “FinFETs and Other Multigate Transistors”, Springer, 1st edition.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC522T	Deep Learning	3	-	-	3	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC522T	Deep Learning	40	40	40	60	-	-	-	100

Prerequisite: Linear Algebra and Calculus**,** Probability and Statistics, Basic Biological Concepts and Machine Learning Basics

Course Objectives: The course is aimed to:

1. To learn the fundamentals of Neural Network.
2. To gain an insight into optimization and regularization of Deep Neural Networks
3. To acquire knowledge of advanced concepts of Convolution Neural Networks, Recurrent Neural Networks and Transformer models.
4. To investigate unsupervised deep learning models including Autoencoders, GANs, and Variational Autoencoders.
5. To Apply transfer learning principles using pre-trained models

Course Outcomes:Upon successful completion of the course students will be able to

1. Gain a foundational understanding of neural networks and deep learning
2. Perform regularization, optimization and select hyperparameters for deep learning models.
3. Implement Convolutional Neural Networks (CNNs) to develop and evaluate supervised deep learning models.
4. Analyze the working of RNNs, LSTMs, and Transformers in modeling sequential and time-series data.

5. Apply the concepts of autoencoders and GANs to develop and analyze unsupervised learning models.
6. Employ transfer learning techniques using pre-trained models to develop efficient and adaptable deep learning solutions.

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
I	**Introduction to Neural Networks and Deep Learning**	**1.1: Introduction to NN** Biological Neuron. McCulloch Pitts NN, Linear Separability, Learning Rule: Perceptron, Delta. **1.2: Introduction to Deep Learning** ML vs DL approach, Types of DL Algorithms, Hyperparameters, Loss functions, Data augmentation, Activation functions: Sigmoid, Tanh, ReLU, Softmax.	5
II	**Training Deep Neural Networks: Optimization and Regularization**	**2.1: Optimization** Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp **2.2: Regularization** Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output	8
III	**Convolutional Neural Networks**	**3.1: Introduction** Edge Detection Filters, Filter Size, Convolutions, Padding, Stride, Compare CNN and ANN, Limitations of CNN. **3.2: Architecture** CNN architecture, Layers: Pooling, Convolutions. DL architecture: LeNET and AlexNET.	8

IV	**Recurrent Neural Networks (RNNs) and Sequence Modeling**	**4.1: Introduction** Recurrent neuron, RNN model, RNN types, Gradients in RNN, Back propagation, Compare CNN and RNN. **4.2: Long Short Term Memory** Selective Read, Selective write, Selective Forget, Gated Recurrent Unit **4.3:** Transformers and Attention Mechanisms: Limitations of RNNs, Introduction to Self-Attention, Transformers, Positional Encoding, BERT/GPT Overview.	8
V	**Autoencoders & Generative Models**	**5.1:** Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders. **5.2:** Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders. **5.3: Generative Adversarial Network:** Discriminative vs. Generative Modeling, Architecture of GAN, Types of GANs, Variational Autoencoders (VAEs) and Introduction to Restricted Boltzmann Machines (RBMs)	5
VI	**Transfer Learning**	6.1 Transfer Learning Concepts: Benefits, Scenarios, What is a Pretrained Model? Popular Model Repositories. 6.2 Customization Techniques: Feature Extraction, Fine-tuning, Layer Freezing. 6.3 Transfer Learning Implementation using VGG16 Model/ MobileNetV2/YOLO/GloVe/ ResNet50	4

Theory Assessments:

Internal Assessment: Two Internal assessments will be conducted for 40 marks each with the average marks of both assessments as final score.

End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Text Books:

1. Satish Kumar, "Neural Networks: A Classroom Approach", McGraw Hill Education; 2ed, 2017.
1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press Ltd, 2016
2. Li Deng and Dong Yu, "Deep Learning Methods and Applications", Now Publishers Inc., 2014.
3. Transfer Learning, Qiang Yang, Yu Zhang, Wenyuan Dai, SinnoJialin Pan, Cambridge University Press.
4. Neural Networks and Deep Learning: A Textbook, Charu C. Aggarwal, Springer

References:

1. Simon Haykin, "Neural Network - A Comprehensive Foundation", 2ed, Pearson Education, 2005.
2. S.N. Sivanandam and S.N. Deepa, "Principles of soft computing", Wiley India
3. François Chollet, "Deep learning with Python," New York: Manning, Vol. 361. 2018.
4. Douwe Osinga, "Deep Learning Cookbook", O′Reilly; 1st edition, 2018, SPD Publishers.
5. Mykel J. Kochenderfer and Tim A. Wheeler, "Algorithms for Optimization", The MIT Press, Cambridge, Massachusetts London.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC525T	Advanced Processor Architecture-II	3	-	-	-	-	-	3
		3	-	-	-	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC525T	Advanced Processor Architecture-II	40	40	40	60	-	-	-	100

Prerequisite: Advanced Processor Architecture-I

Course Objectives: The course is aimed to:

1. Understand the evolution of computer architecture and analyze performance using appropriate metrics and speedup laws.
2. Examine different instruction set architectures and advanced processor designs including superscalar, pipelined, vector, and VLIW architectures.
3. Analyze memory hierarchy design, cache organization, and cache coherence mechanisms in multiprocessor systems.
4. Understand multiprocessor system architectures, interconnection networks, and communication mechanisms.
5. Explore dataflow computing models, systolic architectures, and reconfigurable processor arrays.
6. Analyze VLSI-based parallel architectures for matrix computations and high-performance applications.

Course Outcomes:Upon successful completion of the course students will be able to

1. Evaluate the performance of parallel systems using Amdahl's Law, Gustafson's Law, and other analytical models.
2. Compare and critically analyze CISC, RISC, superscalar, VLIW, and vector processor architectures.
3. Design and analyze pipelined processors and identify solutions for pipeline hazards.
4. Evaluate cache performance using AMAT and analyze cache coherence issues in shared memory systems.
5. Analyze multiprocessor architectures and select appropriate interconnection networks for scalable systems.
6. Design basic systolic array structures and explain VLSI matrix processor architectures for parallel computation.

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
I	**Computer Architecture Foundations**	Evolution of computer architecture, Performance metrics and benchmarking, Parallel computing concepts, Flynn's classification (SISD, SIMD, MISD, MIMD),Shared vs Distributed memory systems, PRAM computational model, Conditions for parallelism,Program partitioning and scheduling,Speedup laws:Amdahl's Law,Gustafson's Law Memory-bounded speedup model	9
II	**Instruction Set and Processor Design**	Instruction Set Architectures (ISA) RISC vs CISC, Scalar processors, Superscalar processors, VLIW architecture, SIMD and Vector processors, Vector processing principles, Case study: Cray Y-MP system .	9

III	**Pipelining and Advanced Execution Techniques Memory Systems and Cache Coherence**	Instruction pipeline design Pipeline hazards and their resolution, Linear and non-linear pipelines, Arithmetic pipeline design,Performance evaluation of pipelines, Introduction to out-of-order execution (overview)	9
IV	**Memory Systems and Cache Coherence**	Memory hierarchy design, Cache memory organization-Mapping techniques, Replacement policies Cache performance parameters, Cache coherence problem (basics), Shared memory organization Interleaved memory-Low-order interleaving, High-order interleaving. Bus addressing and arbitration	9
V	**Multiprocessor and Interconnection Networks**	Multiprocessor system architecture Interconnection networks-Bus-based systems, Crossbar switch, Multistage networks Multiport memory, Hot-spot problem, Message passing mechanisms, Inter-processor communication	9
VI	**Dataflow and VLSI-Based Architectures**	Dataflow computing models-Static dataflow, Dynamic dataflow Systolic array architectures, Mapping algorithms to systolic arrays, Reconfigurable processor arrays, VLSI computational structures, Matrix arithmetic processors, Partitioned matrix algorithms, Arithmetic pipelines in VLSI	

Theory Assessments:

- **Internal Assessment (IA):** Two class tests of 40 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and the second class test when an additional 35% syllabus is completed. Duration of each test shall be one and a half hours.
- **End Semester Theory Examination:** In question, paper weightage of each module will be proportional to the number of respective lecture hours as mentioned in the syllabus.

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  1. Question paper will consist of 3 questions, each carrying 20 marks.
  2. Question number 1 will be compulsory and based on maximum contents of the syllabus Remaining questions will be mixed in nature (for example, if Q.2 has part (a) from module 3 then part (b) will be from other than module 3)
  3. Total three questions need to be solved.

Text Books:

1. Kai Hwang, Advanced Computer architecture Parallelism ,Scalability ,Programmability , Mc Graw Hill,N.Y, 2003
2. Kai Hwang and F.A.Briggs, Computer architecture and parallel processor ' Mc Graw Hill, N.Y, 1999

References:

1. David A. Patterson and John L. Hennessey, ―Computer organization and design Elsevier, Fifth edition, 2014.
2. www.sci.tamucc.edu/~sking/Courses/COSC5351/syllabus.php

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC 528	Block Chain Technology	3	-	-	03	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC 528	Block Chain Technology	40	40	40	60	-	-	-	100

Course Objectives: The course is aimed to:

1. Integrate ideas from blockchain technology into their own projects
2. Integrate ideas from blockchain technology into their own projects
3. Understand the concept of public blockchain
4. Understand the concept of private blockchain
5. Design, build, and deploy smart contracts and distributed applications using cryptocurrency

Course Outcomes: Upon successful completion of the course students will be able to

1. Explain blockchain concepts.
2. Apply cryptographic hash required for blockchain.
3. Apply the concepts of smart contracts for an application
4. Design a public blockchain using Ethereum
5. Design a private blockchain using Hyperledger
6. Design a blockchain application

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
I	Introduction to Blockchain Technology	What is a blockchain, Origin of blockchain (cryptographically secure hash functions), Foundation of blockchain: Merkle trees, Components of blockchain, Block in blockchain, Types: Public, Private, and Consortium, Consensus Protocol, Limitations and Challenges of blockchain	5
II	Cryptocurrency	Cryptocurrency: Bitcoin, Altcoin, and Tokens (Utility and Security), Cryptocurrency wallets: Hot and cold wallets, Cryptocurrency usage, Transactions in Blockchain, UTXO and double spending problem, Bitcoin blockchain: Consensus in Bitcoin, Proof-of-Work (PoW), Proof-of-Burn (PoB), Proof-of-Stake (PoS), and Proof-of-Elapsed Time (PoET), Life of a miner, Mining difficulty, Mining pool and its methods	6
III	Programming for Blockchain	Introduction to Smart Contracts,Types of Smart Contracts, Structure of a Smart Contract, Smart Contract Approaches, Limitations of Smart Contracts Introduction to Programming: Solidity Programming – Basics, functions, Visibility and Activity Qualifiers, Address and Address Payable, Bytes and Enums, Arrays-Fixed and Dynamic Arrays, Special Arrays-Bytes and strings, Struct, Mapping, Inheritance, Error handling Case Study –Voting Contract App, Preparing for smart contract development	6
IV	Public Blockchain	Introduction to Public Blockchain, Ethereum and its Components, Mining in Ethereum, Ethereum Virtual Machine (EVM), Transaction, Accounts, Architecture and Workflow, Comparison between Bitcoin and Ethereum Types of test-networks used in Ethereum, Transferring Ethers using Metamask, Mist Wallet, Ethereum frameworks, Case study of Ganache for Ethereum blockchain. Exploring etherscan.io and ether block structure	7

V	Private Blockchain	Introduction, Key characteristics, Need of Private Blockchain, Smart Contract in a Private Environment, State Machine Replication, Consensus Algorithms for Private Blockchain -PAXOS and RAFT, Byzantine Faults: Byzantine Fault Tolerant (BFT) and Practical BFT Introduction to Hyperledger, Tools and Frameworks, Hyperledger Fabric, Comparison between Hyperledger Fabric & other Technologies Hyperledger Fabric Architecture, Components of Hyperledger Fabric: MSP, Chain Codes, Transaction Flow, Working of Hyperledger Fabric, Creating Hyperledger Network, Case Study of Supply Chain Management using Hyperledger	8
VI	Blockchain in Action: Use Cases	Use case in Financial Services, Insurance, Government, Supply Chain Management, Healthcare, Healthcare payments pre-authorization, The Internet of Things (IoT), Agriculture	6

Theory Assessments:

Internal Assessment: Two Internal assessments will be conducted for 40 marks each with the average marks of both assessments as final score.

End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Text Books References:

1. Davy Cielen, Meysman, Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2. Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3. Ethics and Data Science, D J Patil, Hilary Mason, Mike Loukides, O’ Reilly, 1st edition, 2018
4. Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data, Wiley

References:

1. Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
2. Joel Grus, Data Science from Scratch: First Principles with Python, O'Reilly Media
3. EMC Education Services,”Data Science and Big Data Analytics”,Wiley

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC531L	Course Lab II	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC531L	Course Lab II	--	--	--	--	25	25	--	50

Students have to perform course lab II based on DLOC III ,IV and V.

Student has to complete lab experiments/lab work/case studies specified respect to the course

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC5012L	Dissertation II	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC5012L	Dissertation II	--	--	--	--	25	25	--	50

Course Name: Dissertation-II

- Students have to select project topics from the repository created by the faculty of the department. The same faculty will be continued as mentors/guide for dissertation I, II, III and IV
- Students should do a literature survey in the identified topic and finalize it with consultation of the Guide/Supervisor.
- Students should use multiple literatures (at least 20 papers from Refereed Journals/conferences) and understand the topic and research gap.
- Compile the report in standard format and present Seminar in front of the Panel of Examiners.
- Note: At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of II semester.

Semester III

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
ENGG 401	Research Methodology	3	-	-	03	-	-	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
ENGG 401	Research Methodology	40	40	40	60	-	-	-	100

Prerequisite: Quantitative Techniques, Operations and production management

Course Objectives: The course is aimed to:

1. To understand importance of research and various methods that researcher used to investigate problems
2. To write research proposals.
3. To perform enriched data collection and analysis
4. To write detailed research reports

Course Outcomes:Upon successful completion of the course students will be able to

1. Understand the importance of research and various methods that researchers used to investigate problems.
2. Apply Modern Analytical tools for Business Management Decisions.
3. Derive strategies from the research.
4. Understand the challenges in collecting the data collection and analysis.
5. Interpret the data to make meaningful decisions.

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
I	Introduction to Research	Meaning of research; Types of research- Exploratory research, Conclusive research; The process of research; Research applications in social and business sciences; Features of a Good research study	7
II	Research Problem and Formulation of Research Hypotheses	Defining the Research problem; Management Decision Problem vs Management Research Problem; Problem identification process; Components of the research problem; Formulating the research hypothesis- Types of Research hypothesis; Writing a research proposal-Contents of a research proposal and types of research proposals.	8
III	Research Design	Meaning of Research Designs; Nature and Classification of Research Designs; Exploratory Research Designs: Secondary Resource analysis, Case study Method, Expert opinion survey, Focus group discussions; Descriptive Research Designs: Cross sectional studies and Longitudinal studies; Experimental Designs, Errors affecting Research Design	7
IV	Attitude Measurement and Scaling	Types of Measurement Scales; Attitude; Classification of Scales: Single item vs Multiple Item scale, Comparative vs non-Comparative scales, Measurement Error, Criteria for Good Measurement	7
V	Research Report Writing and Ethics in research	Questionnaire method; Types of Questionnaires; Process of Questionnaire Designing; Advantages and Disadvantages of Questionnaire Method	6
VI	Research Report Writing and Ethics in research	Types of research reports – Brief reports and Detailed reports; Report writing: Structure of the research report Preliminary section, Main report, Interpretations of Results and Suggested Recommendations; Report writing: Formulation rules for writing the report: Guidelines for presenting tabular data, Guidelines for visual Representations. Meaning of Research Ethics; Clients Ethical code; Researchers Ethical code; Ethical Codes related to respondents; Responsibility of ethics in research.	4

Theory Assessments:

Internal Assessment: Two Internal assessments will be conducted for 40 marks each with the average marks of both assessments as final score.

End Sem Theory Examination:

- Question paper will consist of 4 questions, each carrying 20 marks.
- Total 3 questions need to be solved.
- Q.1 will be compulsory, based on the entire syllabus.
- Remaining questions will be randomly selected from all the modules.
- Weightage of marks should be proportional to number of hours assigned to each module.

Text Books References:

1. Business Research Methods – Cooper Schindler
2. Research Methodology Methods & Techniques – C.R.Kothari
3. Statistics for Management – Richard L Levin

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC600LC	Internship / Relevant Certification	-	10	-	05	05

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (Hrs)			
		Test1	Test 2	Avg					
EC600LC	Internship / Relevant Certification	-	-	-	-	-	50	50	100

Course Name: Internship / Relevant Certification

- Students have to give mid-term seminar and at the end of semester submit report and give end-term seminar as requirement of term-work. They will have to submit certificate of internship from the industry.
- Students will have to appear for oral examination.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC601LC	Dissertation III	--	30	--	--	15	--	15

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC601LC	Dissertation III	--	--	--	--	50	--	50	100

Course Name: Dissertation-III

- Students have to create/implement and deploy the project. Critical analysis has to be carried out with conclusion
- The solution to be validated with proper justification and compile the report in standard format and present Seminar in front of Panel of Examiners

Semester IV

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC602LC	Dissertation IV	--	46	--	--	23	--	23

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test 2	Avg. of 2 Tests					
EC602LC	Dissertation IV	--	--	--	--	100	100	--	200

Course Name: Dissertation-IV

- Publish the developed work in terms of Research Paper / Patent / Copyright