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 Engineering

for

The Admission Batch of AY 2022-23

First Year - Effective from Academic Year **2022-23**

Second Year - Effective from Academic Year **2023-24**

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 Engineering. 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 Engineering is tabulated in Table 1.

Table 1. Credit Requirement for M.Tech in Electronics Engineering

Semester	**Credits**
I	**17**
II	**17**
III	**15**
IV	**15**
Total Credits	**64**

Program Structure for
Master of Technology in Electronics Engineering
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)			
		Test1	Test 2	Avg					
EC500T	Computer programming Paradigms	40	40	40	60	3	-	-	100
EC501T	Business Communication 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	Artificial Intelligence & Machine Learning
EC503T	Data Science & Applications
EC504T	Advanced Processor Architecture-I

Course Code	Department Level Elective Course-II
EC505T	Basics of VLSI
EC506T	Mobile communication
EC507T	Wireless Networks

Course Code	Department Level Elective Course-III
EC508T	Optical Communication
EC509T	Speech Processing
EC5010T	IOT Basics & Smart sensors

Program Structure for

Master of Technology in Electronics Engineering
Semester II

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC520T	Power Electronics System Design	03	--	03	--	03
EC521T	Advanced Digital Communication	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	Power Electronics System Design	40	40	40	60	3	--	--	100
EC521T	Advanced Digital Communication	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	Advanced Processor Architecture-II

Course Code	Department Level Elective Course-V
EC524T	Robotics & Industrial Applications
EC525T	Blockchain Technology

Course Code	Department Level Elective Course-VI
EC526T	MIMO System for 5G
EC527T	Internet of Everything

Program Structure for

Master of Technology in Electronics Engineering
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC600LC	Internship / Relevant Certification	-	-	-	03	03
EC601LC	Dissertation-III	-	-	-	12	12
TOTAL		-	-	-	15	**15**

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
EC601LC	Dissertation-III	-	-	-	-	-	50	50	100
TOTAL		-	-	-	-	-	150	50	200

Program Structure for

Master of Technology in Electronics Engineering
Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC602LC	Dissertation-IV	-	30	-	15	15
Total		-	30	-	15	**15**

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

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,	8

		signatures, symbols, well known marks, certification marks 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	Artificial Intelligence and Machine Learning	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	Artificial Intelligence and Machine Learning	40	40	40	60	–	--	–	100

Course Objectives:

1. To conceptualize the basic ideas and techniques of AI
2. To distinguish various search techniques and to make student understand knowledge representation and planning
3. To introduce students to the basic concepts and techniques of Machine Learning
4. To become familiar with regression methods, classification methods, clustering methods

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

1. Identify the various characteristics of Artificial Intelligence.
2. Choose an appropriate problem solving method for an agent to find a sequence of actions to reach the goal state.
3. Analyze the strength and weakness of AI approaches to knowledge representation, reasoning and planning.
4. Gain knowledge about basic concepts of Machine Learning.
5. Identify machine learning techniques suitable for a given problem.
6. Solve the problems using various machine learning techniques.

Prerequisite:

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

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hrs
1.	**Introduction to Artificial Intelligence(AI)**	Introduction and Definition of Artificial Intelligence. Intelligent Agents : Agents and Environments ,Rationality, Nature of Environment, Structure of Agent, types of Agent	07
2.	**Problem Solving**	Problem Solving Agent, Formulating Problems, Example Problems Uninformed Search Methods: Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Method: A* Search Optimization Problems: Hill climbing Search, Simulated annealing, Genetic algorithm	07
3.	**Knowledge, Reasoning and Planning**	Knowledge based agents First order logic: syntax and Semantic, Knowledge Engineering in FOL Inference in FOL : Unification, Forward Chaining, Backward Chaining and Resolution Planning Agent, Types of Planning: Partial Order, Hierarchical Order, Conditional Order	07
4.	**Introduction to Machine Learning**	Machine Learning, Types of Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps in developing a Machine Learning Application. Introduction – Fundamental concept – Evolution of Neural Networks	06
5.	**Learning with Regression and trees:**	Learning with Regression : Linear Regression, Logistic Regression. Learning with Trees: Decision Trees, Constructing Decision Trees using Gini Index, Classification and Regression Trees (CART)	06
6.	**Learning with Classification and clustering**	Classification: Rule based classification, classification by Bayesian Belief networks, Hidden Markov Models. Support Vector Machine: Maximum Margin Linear Separators, Quadratic Programming solution to finding maximum margin separators, Kernels for learning non-linear functions. Clustering: Expectation Maximization Algorithm, Supervised learning	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 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.

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2. Samir Roy and Chakraborty, —Introduction to soft computing‖, Pearson Edition.
3. Peter Harrington —Machine Learning In Action‖, DreamTech Press Ethem Alpaydın, —Introduction to Machine Learning‖, MIT Press.
4. Han Kamber, —Data Mining Concepts and Techniques‖, Morgann Kaufmann Publishers
5. Kevin P. Murphy , Machine Learning — A Probabilistic Perspective‖
6. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education

References:

1. Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
2. Satish Kumar "Neural Networks A Classroom Approach" Tata McGrawHill.
3. Han Kamber, —Data Mining Concepts and Techniques‖, Morgann Kaufmann Publishers.
4. Margaret.H.Dunham, —Data Mining Introductory and Advanced Topics‖, Pearson Education

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC503T	Data Science & Applications	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	Data Science & Applications	40	40	40	60	--	--	--	100

Course Objectives:

1. To understand the foundations of the Data Science process, methods and techniques
2. To understand management of data and make prediction 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 ethical responsibilities of data scientist and organization
6. To work on various application 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

Prerequisite: BDA, ML , DBMS, Python, NLP

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Introduction to data science**	Definition, working, defining goal, benefits and uses of Data Science, Data science vs BI, The data science process, Role of a Data Scientist.	06
2.	**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, Common machine learning models, Feature engineering, Model selection, Performance metrics and hyperparameter optimization, Model Deployment	08
3.	**Text Analytics**	Introduction to text Analytics, Need of Text Analytics, Understanding Text, Cleaning Text Data Sets, Text Classification, Text Clustering, Text mining techniques	06
4.	**Data visualisation and communication**	Identifying audience requirements, Data scientist as 'storyteller', Building a narrative, Explaining the technical - how to communicate the role played by ML and/or AI techniques resulting in an informed audience, Introduction to Data Visualization, Visualization Tools(Area Plots,Histograms,Bar Charts, Pie Charts, Box Plots, Scatter Plots,Waffle Charts, Word Clouds), Visualizing Geospatial Data, visualizing time series data, Importance of data visualization Dashboards	08
5.	**Ethics of data science**	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	06
6.	**Applications**	Healthcare, Banking, Finance, Sports, Advertisement, Transport, Tourism	05

Theory Assessments:

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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. 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)
EC504T	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				
		Test1	Test 2	Avg					
EC504T	Advanced Processor architecture-I	40	40	40	60	--	--	--	100

Course Objectives

1. To outline the various factors that contribute to processor performance.
2. To understand the hardware & software enhancements that lead to improved computing experience.
3. To elaborate on the importance of parallelism in processor systems.
4. To analyze issues that present constraints to increasing processor power.

Course Outcomes

1. Ability to know the performance metrics for the processor
2. Ability to explain the protection mechanism employed in advanced processors.
3. Ability to describe various enhancements in advanced processor architectures leading to high performance
4. Ability to analyze the complexities in pipeline design
5. Ability to describe issues dealing with parallelism in computing systems

Prerequisite: Computer Organization

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Performance Metrics**	Processor performance equation, Energy and power within a microprocessor and power-reduction techniques, Designing for increasing performance of a Computer, Trends in Cost, Dependability, Benchmarking	08
2.	**X86 Protection Mechanism**	Protected mode register set, Segmentation in protected mode, Segment Descriptors ,Virtual memory management, Address Translation, Privilege levels, Protection rules, Gate descriptors , Multitasking and task switching mechanisms , Paging	14
3.	**Architectural Enhancements**	CISC and RISC processors ,Pipelined processors , Superscalar Architectures , Out-of-Order Execution , VLIW processors , Super-pipelining, Branch Prediction logic	12
4.	**Case Study on the Pentium processor**	Architecture , Register Organization , Instruction pairing, Split-line access mechanism , Branch Prediction logic , On-chip cache organizations, Write-Once policy, Cache coherence	11
5.	**Pipelining concepts**	Pipeline performance , Arithmetic pipelines , Hazards, Detection logic and minimization techniques , Dynamic Instruction scheduling , Pipeline scheduling theory	3
6.	**Parallelism**	Amdahl's law , Instruction-level parallelism (ILP), Thread-level parallelism (TLP), Symmetric multi-processors(SMP),Multi-threading , Multi-processor Organizations, Multi-core processors (CMP) , Clusters, Non-Uniform memory access (NUMA) , Vector Computation, Graphic processing units(GPU)	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 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 the number of hours assigned to each module.

Reference Books :-

1. J.L. Hennessy, and D.A. Patterson, Computer Architecture: A quantitative approach, Fifth Edition, Morgan Kaufman Publication, 2012.
2. Walter A. Triebel, The 80386DX Microprocessor, Prentice-Hall International Editions.
3. William Stallings, Computer Organization and Architecture: Designing for Performance, Eighth Edition, Pearson Publications.
4. Don Anderson, Tom Shanley, Pentium Processor System Architecture, Second Edition, Mindshare Inc. 5. M.R. Bhujade, Parallel Computing, Second Edition, New-Age International.
5. Daniel Tabak, Advanced Microprocessors, Second Edition, McGraw-Hill Publications

Research Publications:-

1. M.D. Hill, Michael Marty, "Amdahl's Law in the Multi-core era", Computer, Volume 41, Issue 7, 2008, ISSN :0018-9162 , Pgs. 33-38. 2. J.L. Hennessy, " VLSI Processor Architecture", IEEE Transactions on Computers ,Volume C-33, Issue:12 Pgs. 1221-1246.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC505T	Basics of VLSI	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	Basics of VLSI	40	40	40	60	--	--	--	100

Course Objectives:

1. To teach fundamental principles of VLSI circuit design and layout techniques.
2. To highlight the circuit design issues in the context of VLSI technology
3. To design different scaling effects.
4. To design semiconductor memories and its importance.
5. To teach different clocking techniques and data paths.
6. To highlight different interconnects and delay models.

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

1. Apply the knowledge to demonstrate a clear understanding of choice of technology and technology scaling.
2. Understand the design of MOSFET Inverters.
3. Analyze and design MOS based circuits design styles.
4. Understand the design of Semiconductor Memories.
5. Develop different Data path design
6. Demonstrate a clear understanding of system level design issues such as protection, timing and power dissipation

Prerequisite: Analog Electronics Circuits, Digital Circuits and System Design(DCSD)

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hrs
1.	**Technology Comparison, MOSFET Scaling**	Comparison of BJT, NMOS and CMOS technology Types of scaling, Level 1 and Level 2 MOSFET Models, MOSFET capacitances	07
2.	**MOSFET Inverters**	**Circuit Analysis:** Static and dynamic analysis (Noise, propagation delay and power dissipation) of resistive load and CMOS inverter, comparison of all types of MOS inverters, design of CMOS inverters **Logic Circuit Design**: Analysis and design of 2-I/P NAND and NOR using equivalent CMOS inverter, W/L ratio, Complex circuits	08
3.	**MOS Circuit Design Styles**	**Design Styles:** Static CMOS, pass transistor logic, transmission gate, Pseudo NMOS, Domino, NORA, Zipper, C2MOS, sizing using logical effort **Circuit Realization:** SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX, decoder using above design styles	07
4.	**Semiconductor Memories**	**SRAM:** ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation), Flash (mechanism, NOR flash, NAND flash) **Peripheral Circuits:** Sense amplifier, decoder	06
5.	**Data Path Design**	**Adder:** Bit adder circuits, ripple carry adder, CLA adder **Multipliers and shifter:** Partial-product generation, partial-product accumulation, final addition, barrel shifter	05
6.	**VLSI Clocking and System Design**	**Clocking:** CMOS clocking styles, Clock generation, stabilization and distribution **Low Power CMOS Circuits:** Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling **IO pads and Power Distribution:** ESD protection, input circuits, output circuits, simultaneous switching noise, power distribution scheme **Interconnect:** Interconnect delay model, interconnect scaling and crosstalk	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 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.

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill, 3rd Edition.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education, 2nd Edition.

References:

1. Etienne Sicard and Sonia Delmas Bendhia, "Basics of CMOS Cell Design", Tata McGraw Hill, First Edition. 2. Neil H. E. Weste, David Harris and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education, 3rd Edition.
2. Debaprasad Das, "VLSI Design", Oxford, 1st Edition. 6. Kaushik Roy and Sharat C. Prasad, "Low-Power CMOS VLSI Circuit Design", Wiley, Student Edition.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC506T	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					
EC506T	Mobile Communication	40	40	40	60	--	--	--	100

Prerequisite: Computer Communication and Network

Course Objectives:

1. To get familiar with the basics of wireless systems.
2. To understand various aspects of Mobile radio propagation.
3. To study various emerging technologies like Bluetooth, Zigbee, Wi- fi, WiMax etc.
4. To explore details of UWB.
5. To study advanced technologies used in Wireless communication.
6. To discuss the introduction of 5G technology.

Course Outcomes:

Students will be able to:

1. Get familiar with the basics of wireless systems.
2. Understand various aspects of Mobile radio propagation.
3. Study various emerging technologies like Bluetooth, Zigbee, Wi- fi, WiMax etc..
4. Explore details of UWB.

5. Study advanced technologies used in Wireless communication.
6. Discuss introduction of 5G technology

Detailed Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
1	Introduction to Wireless Networks	Infrastructure of Wireless Networks , Wireless communication systems, Applications of wireless communication systems, Types of wireless communication systems, trends in mobile communication systems.	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	Emerging wireless technologies	Bluetooth, ZigBee, WiMax, Wi-fi, Ad-hoc wireless networks, Wireless sensor networks	08
4	Ultra Wideband System	Introduction, UWB Indoor channel, UWB Capacity Pulsed UWB: Pulse shape, Modulation & Multiple access techniques, Pulsed UWB transceivers Multiband UWB: Modulation of pulsed multiband UWB, MB-OFDM UWB	06
5	Advanced technologies in Wireless Communication	Mobile Machine to Machine communication, Mobile traffic management, cooperative communication	06
6	Introduction to 5G	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

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

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)
EC507T	Wireless Networks	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg.					
EC507T	Wireless Networks	40	40	40	60	--	--	--	100

Course Objectives:

1. To get familiar with basic of wireless system.
2. To understand planning and design of various mobile and wireless networks.
3. To study various WPAN technologies like Bluetooth, Zigbee etc.
4. To explore basics of WAP.
5. To study basic fundamental of WLAN technologies.
6. To discuss introduction of 5G technology.

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

1. Get familiar with basic of wireless system.
2. Understand planning and design of various mobile and wireless networks.
3. Study various WPAN technologies like Bluetooth, Zigbee etc..
4. Explore basics of WAP.
5. Study the basic fundamentals of WLAN technologies.
6. 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	05
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	**WPANs (Low rate and high rate)**	Introduction to wireless PAN, Need of Wireless PAN, Bluetooth Technology: History & Applications, Technical Overview, Bluetooth Specifications, Piconet Synchronization, master-slave switch, Bluetooth security, Enhancements to Bluetooth: Bluetooth Interface issues, Intra & Inter Piconet Scheduling, Scatternet Formation, QoS Assignment, IEEE 802.15 Working group for WPAN, IEEE 802.15.3 & IEEE 802.15.4, Comparison between WPAN System & Comparison between WLAN & WPAN	08
4	**Basics of WAP**	Introduction to WAP, WML basics, Forms and user input, Data base driven WAP	04
5	**Fundamentals of WLANs**	Introduction to wireless LAN, Transmission Techniques, Medium Access Control Protocol Issues: Hidden Terminal Problem, Reliability, Collision Avoidance, Congestion Avoidance, Congestion Control, Energy Efficiency, IEEE 802.11 Standard for Wireless LAN: Network Architecture, Physical Layer, MAC Layer, Security, System design and considerations, Enhancements to IEEE 802.11 MAC: Power Control, Spatial Reusability & QoS Provisioning	09
6	**Introduction to 5G**	Salient features of 5G , 5G technology, 5G Architecture, Advantages and disadvantages, Applications, 5G Advancements, 5G Challenges, 5G future scope	04

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

Text Books:

1. Vijay K. Garg, "Wireless Communication and Networking", Morgan -Kaufmann
2. Series in Networking—Elsevier
3. Theodore S. Rappaport, "wireless communications - principles and practice", PEARSON, Second edition.
4. T L Singal ,"Wireless Communications", Mc Graw Hill Education.
5. 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)
EC508T	Optical 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	Avg.					
EC508T	Optical Communication	40	40	40	60	--	--	--	100

Prerequisite:

Analog and Digital Communication, Physics, Electromagnetic Engineering

Course Objectives:

1. List, write and explain fundamentals and transmission characteristics of optical fiberCommunication.
2. List, write and explain the design of Optical Fiber(OF) Component Material, it's fabrication, connectors, splicers to vary length of OF.
3. List, write and explain fundamentals and transmission characteristics of optical fiber communication.
4. List, write and explain principles and characteristics of various sources, detectors and various fiber optic components.
5. List, write and explain principles and characteristics of various sources, detectors and various fiber optic components.
6. Calculate parameters for optical link budgeting and analyze the link.

Course Outcomes:

1. Analyze the fundamental principle of optical fiber communication.
2. Apply the fundamental principles of optics and light waves to design optical fiber communication.
3. Design optical fiber communication links using appropriate components like optical fiber, light source, detectors, connectors, splicers, etc.
4. Explore concepts of designing and operating principles of optical fiber communication.
5. Apply the knowledge developed in class to contemporary research and industrial areas.
6. Design simple and basic optical fiber communication system with various basic faults, configurations, techniques in mind.

Theory Syllabus

Sr. No.	Module	Detailed Content	Hours	CO Mapping
I	Overview of Optical Fiber Communication	1.1-Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, 1.2-Optical fiber waveguides,	08	CO1
		1.3-Ray theory, cylindrical fiber (no derivations), single mode fiber, cutoff wavelength, and mode field diameter.		
II	Fiber Optic Technology	2.1-Fiber materials, 2.2-Fiber fabrication, 2.3-Fiber optic cables, couplers, splices, connectors	06	CO2
III	Transmission Characteristics	3.1Attenuation, absorption, linear and nonlinear scattering losses, bending losses, 3.2-Modal dispersion, waveguide dispersion, dispersion and 3.3-Pulse broadening, dispersion shifted and dispersion flattened fibers.	07	CO3

IV	Optical Sources	4.1-Working principle and characteristics of sources (LED, LASER), 4.2- Tunable lasers Quantum well lasers , 4.3-Charge capture in Quantum well lasers, Multi Quantum well Laser diodes, 4.4-Surface Emitting Lasers: Vertical cavity Surface Emitting Lasers	06	CO4
V	Optical Detectors	5.1-Working principle and characteristics of detectors (PIN, APD), 5.2-Material requirement for RCEPD, Resonant cavity enhancement (RCE) Photo Detector, 5.3-Noise analysis in detectors, 5.4-Coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance	06	CO5
VI	Optical Fiber Systems	6.1-Introduction, 6.2-Point to point links, 6.3-System considerations, link power budget, and rise time budget. 6.4-RF over fiber, key link parameters, 6.5-Radio over fiber links, microwave photonics	06	CO6

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

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

References:

1. Fiber Optic Communication - Djafar K. Mynbarv, Lowell L. Scheiner.
2. Optical Fiber Communication - Selvarajan, Subartkar, T. Srinivas Tata Mc-Graw Hill Publication.
3. Fundamentals of Fibre Optics in Telecommunication and sensor

System, PalB.P., New Age International

4. Fiber Optic Communication, Agrawal, 3rd edi, Wiley

5. Fibre optics and Optoelectronics by Khare,Oxford University Press

6. Rajappa Papannareddy, Lightwave CommunicationSystems: A PracticalPerspective, Penram International Publishing

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC509T	Speech Processing	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	Speech Processing	40	40	40	60	--	--	--	100

Course Objectives:

1. To understand basic concepts and methodologies for the analysis and modeling of speech signal.
2. To characterize the speech signal as generated by a speech production model.
3. To understand the mechanism of speech and audio perception.
4. To understand the digital representation of the speech waveform.
5. To perform the analysis of speech signals using STFT.
6. To extract the information of the speech or audio signals.
7. To provide a foundation for developing applications in this field.

Course Outcomes:

1. Demonstrate advanced Knowledge in Digital model representation of speech signals.
2. Design and implement algorithms for processing speech and audio signals considering the properties of acoustic signals and human hearing.
3. Analyze speech signals to extract the characteristics of vocal tract (formants) and vocal cords (pitch).
4. Formulate and design a system for speech recognition and speaker recognition.
5. Acquired knowledge about audio and speech signal estimation and detection.

Prerequisite: Signal System

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Introduction**	Review of digital signal and systems, Transforms representations of signal and systems, Sampling Theorem, Goertzel algorithm, Chirp algorithm.	04
2.	**Digital Models for Speech signals**	Speech production and acoustic tube modeling, acoustic phonetics, anatomy, and physiology of the vocal tract and ear, hearing and perception.	05
3.	**Digital Representations of the Speech Waveform**	Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, Direct digital code conversion.	06
4.	**Time Domain Models for Speech Processing**	Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech V/S silence discrimination using energy & Zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.	10
5.	**Short time Fourier Transform**	Introduction- Definition and Properties, Fourier Transform Interpretation ,Linear Filtering Interpretation ,Sampling rates of Xn (ejw)in Time and Frequency ,Filter Bank Summation Method of Short -Time Synthesis ,Overlap Addition Method for Short -Time Synthesis.	08
6.	**Speech and Audio Processing**	Vocoder- Voice excited channel vocoder, Voice excited and error signal excited LPC vocoders. Adaptive predictive coding of speech, Auditory Modeling. Audio signal processing for Music applications. Speech recognition pattern comparison techniques, Artificial Neural Network.	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 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.

Text Books:

1. L.R. Rabiner and S.W. Schafer-Digital processing of speech signals ‖,Pearson Education, 2009.
2. L R Rabiner, B H Juang, B Yegnanarayana, ―Fundamentals of speech Recognition‖, Pearson Education,1993.

References:

1. Thomas F Quateri, ―Discrete Time Speech Signal Processing―Pearson Edition,2006.
2. Ben Gold and Nelson Morgan, ―Speech &Audio Signal Processing‖, wiley, 2007.
3. Douglas O Shaughnessy, ―Speech Communications‖, 2ndEdition, Oxford university press,2000.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC5010T	IOT Basic & Smart Sensors	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					
EC5010T	IOT Basic & Smart Sensors	40	40	40	60	--	--	--	100

Prerequisite:

Microprocessor & Microcontroller

Course Objectives: Introduce evolution of internet technology and need for IoT.

1. Discuss on IoT reference layers and various protocols and software.
2. To provide in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.
3. To introduce the students to sources and detectors of various Optical sensing mechanisms and provide in-depth understanding of the principle of the basic laws and phenomena on which operation of sensor transformation of energy is based, measurement and theory of instruments and sensors.
4. Train the students to build IoT systems using sensors, single board computers and open source IoT platforms.
5. Make the students apply IoT data for business solutions in various domains in a secure manner.

Course Outcomes:

1. Identify the IoT networking components with respect to the OSI layer.
2. Build schematic for IoT solutions .
3. Design and develop IoT based sensor systems.

4. Select IoT protocols and software.
5. Evaluate the wireless technologies for IoT.
6. Appreciate the need for IoT Trust and variants of IoT and compete in the design, construction, and execution of systems for measuring physical quantities

Theory Syllabus:

Sr. No.	Module	Detailed Content	Hours
I	Introduction to Internet of Things	Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Trends in the Adoption of IoT, Societal Benefits of IoT, Risks, Privacy, and Security. Exemplary Device Boards, Arduino, Linux on Raspberry, Interface and Programming & IOT Device. Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases	5
II	Sensing and Actuation	Sensor fundamentals and characteristics, Optical Sources and Detectors, Intensity Polarization and Interferometric Sensors, Strain, Force, Torque and Pressure sensors, Position, Direction, Displacement and Level sensors, Velocity and Acceleration sensors, Flow, Temperature and Acoustic sensors, Actuators and its types: Hydraulic, Pneumatic, Electrical, Thermal, Magnetic	7
III	Networking and the Internet of Things	IoT and Machine to Machine Communications, IoT protocols, Network configurations, Network Operator Requirements, SNMP, NETCONF, YANG, Interoperability in IoT. SDN	6
IV	Sensor Networks and IoT	Characteristic and challenges, WSN vs Adhoc Networks, Sensor node architecture, Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations. Sensor Network Architecture: Data Dissemination, Flooding and Gossiping-Data gathering Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSNs- Gateway Concepts, Need for gateway, WSN and Internet Communication, WSN Tunneling, Amplifiers and Sensor Noise, Importance and Adoption of Smart Sensors, Architecture of Smart Sensors	9

V	Cloud Computing	Interfacing and data logging with cloud, Evolution of Cloud Computation, Commercial clouds and their features, open source IoT platforms, cloud dashboards, Fog Computing, Introduction to big data analytics and Hadoop.	7
VI	Developing Internet of Things Data Analytics and Tools for IoT	IoT security, Need for encryption, standard encryption protocol, lightweight cryptography, Quadruple Trust Model for IoT-A – Threat Analysis and model for IoT-A, Cloud security	5

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

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

Text Books:

1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.
3. Jacob Fraden, "HandBook of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.
4. Jon. S. Wilson, "Sensor Technology Hand Book", 2011, 1st edition, Elsevier, Netherland.

References:

1. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014
2. LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet

of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.
3. RonaldL. Krutz, Russell Dean Vines,Cloud Security: A Comprehensive Guide to Secure Cloud Computing,Wiley-India, 2010.
4. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition, CRC Press, Florida.
5. Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition, John Wiley, New York.

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

Student has 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.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC520T	Power Electronics System Design	03		--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		1	2	Average					
EC520T	Power Electronics System Design	40	40	40	60	--	--	--	100

Course Objectives:

1. To make students understand & appreciate analytical approach for design of power electronic Systems.
2. To make students ready for research & development oriented jobs in academia & industry by introducing recent research advancements in power electronic converters & their applications in distributed generation & smart grids.

Course Outcomes:

1. Ability to apply mathematical modeling concepts to power electronic systems.
2. Ability to understand the unique nature of computer simulations of power electronic systems.
3. Ability to understand new topologies of DC-AC inverters like multi-level & 4-leg inverters.
4. Perform trajectory planning of robo Ability to gain in-depth knowledge of AC voltage controllers
5. Ability to understand various issues involved in parallel operation of inverters as part of the distributed generation system
6. Be aware of vital role played by power electronic converters in distributed generation & smart grids.

Prerequisite:

1. Single phase & three phase AC fundamentals
2. Basic understanding of power electronic devices like SCR, IGBT etc. & commutation techniques
3. Basic working of controlled DC-DC, DC-AC & AC-DC converters, PWM technique for control

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Analysis of Power Devices**	Power transistor, Power MOSFET, SCR, IGBT, design of driver circuits for SCR, BJT, IGBT, MOSFET, selection criteria for switching devices, EMI-EMC issues, protection circuits: Anti saturation protection for BJT and IGBT, overload protection, thermal protection.	06
2.	**Simulation of Power Electronic Converters and Systems**	Brief overview of solving stiff differential equations using ODE solvers like Euler's method, Heun's Method, Trapezoidal rule, introduction to circuit oriented simulators like SPICE, MATLAB, SCILAB, comparison of these simulators, study of transformations from 3-phase to stationary reference frame (Clarke transform) and rotating reference frame, decoupled closed-loop control strategies for converters based on these transformations.	08
3.	**Modeling and Control of Power Electronic Systems**	Concept of zero-order hold (ZOH), first-order hold (FOH) and second-order hold (SOH) elements, energy factor, models of AC-DC, DC-AC, AC-AC and DC-DC converters as simple ZOH, FOH and SOH, PI control for AC-DC converters, PI control for DC-AC converters and AC-AC (AC-DC-AC) converters, PID control for DC-DC converters, closed-loop stability analysis.	08
4.	**Inverters (DC-AC Converters)**	Multilevel inverters topologies and switching, introduction to 4-leg inverters (basic working without SVM techniques), neutral point clamped inverter, study of inverter topologies: online, line-interactive, stand-by, methods of parallel operation of inverters: droop, and master & slave control.	06
5.	**AC Voltage Controllers**	On-Off control, phase control, single-phase full wave analysis with R & R-L load, input power factor, three-phase full wave controller with R-load, static switches.	04
6.	**Grid Interface of Renewable Energy Sources**	Inverter interfacing control strategies for transferring wind and solar energy to grid, instantaneous power theory, reactive power control, synchronization with grid using phase-locked loop, concept of distributed generation system, microgrids, smart grids.	06

Theory 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 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 the number of hours assigned to each module.

Text Books:

1. N. Mohan, T. M. Undeland, W. P. Robbins, Power Electronics: Converters Application and Design, John Wiley & Sons, USA, 2003.
2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2009.
3. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer USA, 2001.
4. F. L. Luo, H. Ye, M. H. Rashid, Digital Power Electronics & Applications, Elsevier Academic Press, USA, 2005.
5. H. Akagi, E. H. Watanabe, M. Aredes, Instantaneous Power Theory and Applications to Power Conditioning, IEEE Press/John Wiley & Sons Ltd., USA, 2007.
6. Q.-C. Zhong, T. Hornik, Control of Power Inverters in Renewable Energy And Smart Grid Integration, IEEE Press/John Wiley & Sons, Ltd., USA, 2013.

References:

1. P. S. Bhimbra, "Power Electronics", Khanna Publishers, 2012
2. M.D. Singh and K. B. Khanchandani, "*Power Electronics*", Tata McGraw Hill
3. P. C. Sen, "*Modern Power Electronics*", Wheeler Publication
4. Ramamurthy, " *Thyristors and Their Applications*"

Course Code	Course Name	Theory (Hrs)	Practical (Hrs)	Tutorial (Hrs)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC521T	Advanced Digital Communication	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					
EC521T	Advanced Digital Communication	40	40	40	60	--	--	--	100

Course Objectives: Students will try:

1. To understand the concepts of random variables and random processes in communication systems.
2. To comprehend the error correcting codes and fundamental limits of their performance.
3. To understand signal diversity and explore MIMO systems.
4. To analyze different equalization techniques for channels with ISI and AWGN
5. To study multichannel and multicarrier systems

Course Outcomes: Students will be able to:

1. Ability to understand the nature of random processes and its statistical characteristics.
2. Ability to appreciate the importance of error correcting codes-Turbo and LDPC.
3. Ability to understand MIMO systems.
4. Ability to analyze various equalizers and their use in communication systems.
5. Ability to understand and analyze multichannel and multicarrier systems.

Prerequisite: Digital Communication

DETAILED SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	Random Variables and Random Process	**Random Variables:** Continuous, discrete, and mixed random variables, probability density function, probability distribution function, and probability mass function, properties of PDF and CDF. Special distributions- Binomial, Poisson, Uniform, Gaussian and Rayleigh Distributions Mean, variance and moments of random variables. **Random Process**: Definitions, statistics of stochastic processes, *n*th order distribution, second-order properties: mean and autocorrelation, Poisson process, normal processes, SSS, WSS. Mean and correlation ergodic processes, transmission of WSS through LTI system, Introduction to Markov process.	09
2.	Error Correction and Control Codes	**Linear block code:** Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder. **Cyclic code:** Code generation, calculation of minimum Hamming distance, error detection capability, error correction capability, implementation of encoder, error detection, syndrome table, error correction and implementation of decoder. **Convolutional code**: Generation, path responses, encoder, state transition table, state diagram, tree diagram, trellis diagram, decoding using Viterbi's algorithm. **LDPC, Turbo Codes**	11
3.	Effects of fading channels on signalling	Classification of multipath channels, channel model for Time variant multipath channels Signal design for fading multipath channels. Performance Improvement through signal diversity, Rake receiver and multipath diversity, recombining techniques. MIMO systems- Basic considerations, Channel Models for Multiple antenna system, signal transmission through slow fading frequency nonselective and frequency selective MIMO Channels.	8
4.	Signalling over Band limited channel	Optimum receiver for channels with ISI and AWGN, Optimum maximum likelihood receiver, discrete time model for a channel with ISI. Linear Equalization: Peak distortion criteria, mean square error criterion , Performance characteristics of MSE equalizer. Decision feedback equalization: Co-efficient optimization, performance characteristics of Decision feedback equalizer, Iterative Equalization and Decoding- Turbo equalization	8
5.	Adaptive Equalizer	Adaptive linear Equalizer:-Zero forcing algorithm, LMS algorithm, convergence properties of LMS algorithm. Self recovering (Blind) equalization based on maximum likelihood criterion.	6

6.	Multichannel and Multicarrier system	Multiple access techniques: TDMA, FDMA, CDMA, Multichannel Digital Communication in AWGN Channels. Multicarrier Communication: Single carrier versus Multicarrier modulation, Capacity of Non-ideal linear filter channel, OFDM modulation and demodulation in an OFDM system, Spectral Characteristics of Multicarrier signals, Bit and Power allocation in Multicarrier modulation, Peak to Average ratio in multicarrier modulation, Channel coding considerations in Multicarrier modulation. An Overview of multi-carrier CDMA .	10

Theory 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.
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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 the number of hours assigned to each module.

Reference Books:

1. Alberto-Leon Garcia, “Probability and Random Processes for Electrical Engineering”, Pearson Education
2. Dr. Kamilo Feher, “Wireless Digital Communication”, Prentice Hall Publication
3. John G Proakis, Masoud Salehi, “Communication Systems Engineering”, Pearson Education, 2nd edition
4. John Proakis & Masoud Salehi, “Digital Communication”, McGraw-Hill Education, 5th edition
5. John Proakis & Masoud Salehi, “Digital Communication”, McGraw-Hill Education, 5th edition

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC522T	Deep Learning	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					
EC522T	Deep Learning	40	40	40	60	--	--	--	100

Course Objectives:

1. Understand complexity of Deep Learning algorithms and their limitations
2. Be capable of confidently applying common Deep Learning algorithms in practice and implementing their own

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

1. Understand the language and fundamental concepts of artificial neural networks
2. Understand the concepts of TensorFlow, its main functions, operations and the execution pipeline Implement deep learning algorithms,
3. Understand neural networks and traverse the layers of data abstraction which will empower the student to understand data more precisely.
4. Learn topics such as convolutional neural networks, recurrent neural networks, training deep networks and high-level interfaces
5. Build deep learning models in TensorFlow and interpret the results
6. Troubleshoot and improve deep learning models

Prerequisite: Probability and Basic Biological Concepts

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1.	**Introduction to TensorFlow**	Computational Graph, Key highlights, Creating a Graph, Regression example, Gradient Descent, TensorBoard, Modularity, Sharing Variables,KerasPerceptrons: What is a Perceptron, XOR Gate	05
2.	**Artificial Neural Networks**	Activation Functions : Sigmoid,ReLU, Hyperbolic Fns,Softmax Artificial Neural Networks : Introduction, Perceptron Training Rule, Gradient Descent Rule	08
3.	**Optimization and Regularization**	Gradient Descent and Backpropagation: Gradient Descent, Stochastic Gradient Descent, Backpropagation, Some problems in ANN Optimization and Regularization :Overfitting and Capacity, Cross Validation, Feature Selection, Regularization, Hyperparameters.	08
4.	**Introduction to Convolutional Neural Networks**	Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple Filters, CNN applications	08
5.	**Introduction to Recurrent Neural Networks**	Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, LSTM, RNN applications	05
6.	**Deep Learning applications**	Image Processing, Natural Language Processing, Speech Recognition, Video Analytics	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 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.

Text Books:

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

References:

1. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.

Course Code	Course Name	Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
EC523T	Advanced Processor Architecture-II	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					
EC523T	Advanced Processor Architecture-II	40	40	40	60	--	--	--	100

Course Objectives:
1. To outline the various factors those contribute to system design
2. To understand the design flow of application specific processors
3. To elaborate on the importance of VLIWDSP processors & soft-core processors
4. To analyze issues & pitfalls in reconfigurable processor design with FPGA.

Course Outcomes:
1. Ability to explain various types of processors & their design flow in detail
2. Ability to describe various concepts of VLIWDSP processors & soft-core processors
3. Ability to analyze the issues in VLIWDSP processor design
4. Ability to describe pitfalls in designing with reconfigurable processors with FP

Pre-requisites: Computer Organization & Advanced Processor Architecture-I

DETAILED SYLLABUS:

Module No.	Unit No.	Details	Hours
1.	**Computer Architecture Fundamentals.**		**06**
	1.1	A top-Level View of Computer functions and Interconnections	
	1.2	Computer Components, Architecture organization	
	1.3	Concepts and Ways of Parallelism	
	1.4	Domain-Specific Processors and Application Specific Processors	
	1.5	Design Considerations	
2	**Processor Design Flow**		**08**
	2.1	Capturing requirements, Instruction coding	
	2.2	Exploration of Architecture Organizations	
	2.3	Hardware and Software Development	
	2.4	Software tools and libraries	
3	**Memory**		**06**
	3.1	Semiconductor Memories SRAM, DRAM and organization	
	3.2	Principles of Cache memory, Cache Design	

	3.3	Cache Coherency, MESI Protocol	
	3.4	RAID	
4	**I/O, Peripherals and Operating System**		**08**
	4.1	Types of I/Os, I/O Interfacing concepts	
	4.2	PCI, PCI-X, PCI-E	
	4.3	Universal Serial Bus(USB)	
	4.4	Operating System Overview, Scheduling	
	4.5	Memory Management in Operating Systems	
5	**VLIW DSP Processor**		**12**
	5.1	DSP Processor Architecture, DSP-specific requirements	
	5.2	Micro architectural concepts	
	5.3	VLIW and SW programmability	
	5.4	Application specific adaptable core Architecture	
	5.5	Design space Exploration, Complexity of Configurability	
6	**Soft-Core Processors**		**12**
	6.1	Processor Customization	
	6.2	Microprocessor cores in SOC design, Difference between Microprocessor and SOC	
	6.3	Reconfigurable processors with FPGA	
	6.4	Case study of Reconfigurable structure	
	6.5	Pitfalls in VLIW Architectures	

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 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 the number of hours assigned to each module.

Text Books:

1. William Stallings, "Computer Organization and Architecture: Designing for Performance", Eighth Edition, Pearson Publications.
2. Jari Nurmi, "Processor Design: System-on-Chip Computing for ASICs and FPGAs", Springer.
3. Daniel Tabak, Advanced Microprocessors, Second Edition, McGraw-Hill Publications.
4. Hennessy JL, Patterson DA (2003) Computer Architecture: A Quantitative Approach.3rd edition. Elsevier Morgan Kaufmann, San Francisco

Research Publications:

1. Andrea Lodi, Mario Toma, "A VLIW Processor with a Reconfigurable Instruction Set for Embedded Applications", IEEE Journal Of Solid-State Circuits, Vol. 38, No. 11, November 2003,pp-1876-1886.
2. Lodi A, Cappelli A, Bocchi M, Mucci C, "XiSystem: A XiRisc-based SoC with a Reconfigurable I/O Module", IEEE Journal of Solid-State Circuits (JSSC), 2006, Vol.41, No.1, pp-85–96.

Course Code	Course Name	Theory (Hrs)	Practical (Hrs)	Tutorial (Hrs)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC524T	Robotics & Industrial Applications	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					
EC524T	Robotics & Industrial Applications	40	40	40	60	--	--	--	100

Course Objectives:

1. To study different types of Robots and understand the fundamentals of robotics.
2. To study the concepts of Direct Kinematics & Inverse Kinematics.
3. To analyze the Velocity Kinematics and Dynamics.
4. To familiarize students with Trajectory planning of robots.
5. To familiarize students with robot vision.
6. To familiarize students with task planning of robots.

Course Outcomes: Upon successful completion students will be able to

1. Understand the basic concepts of robotics.
2. Perform the kinematic analysis of robots.
3. Ability to analyze the Velocity Kinematics and Dynamics.
4. Perform trajectory planning of robots
5. Describe importance of visionary system in robotic manipulation
6. Perform task planning of robots

Prerequisite: Applied Mathematics, Linear Control Systems.

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Fundamentals of Robotics**	Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	06
2	**Kinematics of Robots**	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation Denavit-Hartenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot	08
3	**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	08
4	**Trajectory planning**	Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	06
5	**Robot Vision**	Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration	06
6	**Task Planning**	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.	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 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.

Text Books:

1. Robert Shilling, "Fundamentals of Robotics - Analysis and control", Prentice Hall of India, 2009

2. Saeed Benjamin Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011

References:

1. John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India, 2009
2. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ", Wiley India Pvt. Ltd., 2006
3. Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill , New York, 2008

Course Code	Course Name	Theory (Hrs)	Practical (Hrs)	Tutorial (Hrs)	Theory (Credits)	Practical/Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC525T	Blockchain Technology	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	Avg. of 2 Tests					
EC525T	Blockchain Technology	40	40	40	60	--	--	--	100

Course Objectives:

1. To understand basics of Blockchain technology
2. To understand concept of cryptocurrency and Bitcoin
3. To understand concepts of Ethereum Blockchain
4. To learn the concepts of Hyperledger
5. To understand solidity programming language and concepts of smart contracts
6. To learn and develop various applications of Blockchain

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

1. Have an understanding and working knowledge of the emerging blockchain technology.
2. Discuss concept of cryptocurrency and Bitcoin
3. Apply the knowledge of Ethereum Blockchain
4. Understand and analyze the working of Hyperledger
5. Explore basics of solidity programming language and smart contracts
6. Develop various applications of Blockchain

Prerequisite: Data Structure and Algorithm, Computer Networks

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction of Cryptography and Blockchain**	What is Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions And Blocks, P2P Systems, Keys As Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain	**07**
2	**Bitcoin and Cryptocurrency**	What is Bitcoin, Bitcoin Network, Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Hot and Cold Storage, Decentralization and Hard Forks, Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency	**08**
3	**Introduction to Ethereum Blockchain**	Introduction to Ethereum, Ethereum Structure,Ethereum Operations, Ethereum Virtual Machine (EVM), Incentive Model, Consensus Mechanisms, How Smart Contracts Work, Metamask Setup, Ethereum Accounts, Initial Coin Offering(ICO)	**07**
4	**Introduction to Hyperledger**	What is Hyperledger? , Distributed Ledger Technology & its Challenges,Hyperledger: Distributed Ledger Frameworks and Domain Specific Blockchains, Hyperledger Fabric, Hyperledger Fabric Architecture, Hyperledger Composer.	**05**
5	**Solidity Programming Language**	Solidity -Language of Smart Contracts, Installing Solidity & Ethereum Wallet, Basics of Solidity, Layout of a Solidity Source File & Structure of Smart Contracts, General Value Types (Int, Real, String, Bytes, Arrays, Mapping, Decision making, Structs ,Ether units, Enum, address, special variables), Solidity Functions , Solidity patterns (pattern withdrawal and restricted access)	**08**
6	**Blockchain Applications**	Blockchain Applications: Internet of Things, Medical Record Management System, Do-main Name Service and future of Blockchain	**04**

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.

Text Book

1.Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
2.Arshdeep Bahga, Vijay Madisetti, Blockchain Applications: A Hands-On Approach Paperback, VPT; 1st edition (31 January 2017)
3.Baset, Salman A., Blockchain Development with Hyperledger,Packt, 2019
4. Parikshit Jain, A Practical Guide To Blockchain And Its Applications, Bloomsbury India,1st Edition,February 2019

Reference Books

1.Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies
2.Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System
3.DR. Gavin Wood, "ETHEREUM: A Secure Decentralized Transaction Ledger,"Yellow paper.2014.
4.Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts
5.Jitendra Chittoda, Mastering Blockchain Programming with Solidity: Write production-ready smart contracts for Ethereum blockchain with Solidity,Packt Publishing; 1st edition (2 August 2019).

Course Code	Course Name	Theory (Hrs)	Practical (Hrs)	Tutorial (Hrs)	Theory (Credits)	Practical/Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC526T	MIMO System for 5G	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	Avg. of 2 Tests					
EC526T	MIMO System for 5G	40	40	40	60	--	--	--	100

Prerequisite: Wireless and mobile communication, Antenna and Digital Communication.

Course Objectives:

1. To get familiar with the basics of the diversity schemes involved in the MIMO system.
2. To understand planning and design of the capacity of deterministic and random MIMO channels and fading channels.
3. To inculcate the design considerations of MIMO antenna system
4. To study various space time coding techniques.
5. To explore various algorithms used to detect the received signal in MIMO systems.
6. To study the advances in MIMO Communication Systems.

Course Outcomes: Learner will be able to…

1. Classify and explain the diversity schemes involved in MIMO with advantages, applications, channel models and power allocation.
2. Calculate the capacity of deterministic and random MIMO channels and fading channels.
3. Classify and compare SISO antenna with MIMO antenna
4. Explain the different space time coding techniques like STBCs, STTCs and Space time turbo codes.
5. Describe various algorithms used to detect the received signal in MIMO systems like Maximum likelihood, MMSE, ZFE.
6. Discuss the advances in MIMO Communication Systems.

Theory Syllabus

Sr. No.	Module	Detailed Content	Hours
I	Introduction to MIMO channel models	Diversity-multiplexing trade-off, transmit diversity schemes, advantages and applications of MIMO systems, Fading Channel Models: Uncorrelated - fully correlated - separately correlated - keyhole MIMO fading models, parallel decomposition of MIMO channel, Power allocation in MIMO: Uniform - adaptive - near optimal power allocation	07
II	MIMO channel capacity	Indoor RF communication and its Propagation models, Capacity for deterministic MIMO Channels: SISO – SIMO – MISO – MIMO, Capacity of random MIMO channels: SISO – SIMO – MISO - MIMO(Unity Channel Matrix, Identity Channel Matrix), Capacity of independent identically distributed channels, Capacity of separately correlated Rayleigh fading MIMO channels, Capacity of keyhole Rayleigh fading MIMO channel,	05
III	MIMO Antenna	Introduction to MIMO antenna, Massive MIMO antenna system and its applications, Performance Parameters of MIMO antenna system (Return loss, Isolation/mutual coupling between antenna elements, Envelope correlation coefficient, Total active reflection coefficient and Channel capacity loss etc.), Mutual coupling reduction techniques in MIMO antenna	04

III	Space-time codes	Advantages, code design criteria, Alamouti space-time codes, SER analysis of Alamouti space-time code over fading channels, Space-time block codes, Space-time trellis codes, Performance analysis of Space time codes over separately correlated MIMO channel, Space-time turbo codes, BLAST Architectures: VBLAST – HBLAST – SCBLAST - DBLAST	08
IV	MIMO detection techniques	Maximum Likelihood, Zero Forcing, Minimum Mean Square Error, Zero Forcing Equalization with Successive Interference Cancellation, Minimum Mean Square Error Successive Interference Cancellation, Lattice Reduction based detection	08
V	Advances in MIMO systems	Spatial modulation, MIMO based cooperative communication and cognitive radio, multiuser MIMO, cognitive-femtocells and large MIMO systems for 5G wireless, MIMO Applications in RADAR, Satellite Communication, Wi-Fi	07

Online Repository Sites:

1. http://nptel.ac.in/courses/117105132

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

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

Text Books:

1. TolgaM.Duman and Ali Ghrayeb, “Coding for MIMO Communication Systems”, John Wiley & Sons Ltd.,2007.
2. R. S. Kshetrimayum, “Fundamentals of MIMO Wireless Communications”, Cambridge University Press, 2017.
3. T. L. Marzetta, E. G. Larsson, H. Yang and H. Q. Ngo, Fundamentals of Massive MIMO, Cambridge University Press, 2016.

4. B. Kumbhani and R. S. Kshetrimayum, "MIMO Wireless Communications over Generalized Fading Channels", CRC Press, 2017.

References:

1. A. Chockalingam and B. S. Rajan, *Large MIMO systems*, Cambridge University Press, 2014.
2. EzioBiglieri, Robert Calderbank and Anthony Constantinides. "MIMO Wireless Communications".
3. Single and Multi Carrier MIMO Transmission for Broadband Wireless Systems by R.Prasad, Rahman and S.S. Das.

4. Mohammad Sharawi "Printed MIMO antenna

Course Code	Course Name	Theory (Hrs)	Practical (Hrs)	Tutorial (Hrs)	Theory (Credits)	Practical /Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC527T	Internet of Everything	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	Avg. of 2 Tests					
EC527T	Internet of Everything	40	40	40	60	--	--	--	100

Course Objectives:

1. Introduce evolution of internet technology and need for IoT.
2. Discuss on IoT reference layers and various protocols and software.
3. To provide in depth knowledge in physical principles applied in sensing, measurement and a comprehensive understanding on how measurement systems are designed, calibrated, characterized, and analyzed.
4. To introduce the students to sources and detectors of various Optical sensing mechanisms and provide in-depth understanding of the principle of the basic laws and phenomena on which operation of sensor transformation of energy is based, measurement and theory of instruments and sensors.
5. Train the students to build IoT systems using sensors, single board computers and open source IoT platforms.
6. Make the students apply IoT data for business solutions in various domains in a secure manner.

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

1. Identify the IoT networking components with respect to the OSI layer.
2. Build schematic for IoT solutions .
3. Design and develop IoT based sensor systems.
4. Select IoT protocols and software.
5. Evaluate the wireless technologies for IoT.
6. Appreciate the need for IoT Trust and variants of IoT and compete in the design, construction, and execution of systems for measuring physical quantities

Prerequisite:

Electronics Devices and Circuits(EDC), Microprocessor and Microcontroller (MPC)

DETAILED THEORY SYLLABUS:

Sr. No.	Module	Detailed Content	Hours
1	**Introduction to Internet of Things**	Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs, Trends in the Adoption of IoT, Societal Benefits of IoT, Risks, Privacy, and Security. Exemplary Device Boards, Arduino, Linux on Raspberry, Interface and Programming & IOT Device. Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, Routing: Transport Protocols, Network Security, Middleware, Databases	06
2	**Sensing and Actuation**	Sensor fundamentals and characteristics, Optical Sources and Detectors, Intensity Polarization and Interferometric Sensors, Strain, Force, Torque and Pressure sensors, Position, Direction, Displacement and Level sensors, Velocity and Acceleration sensors, Flow, Temperature and Acoustic sensors.	07
3	**Networking and the Internet of Things**	IoT and Machine to Machine Communications, IoT protocols, Network configurations, Network Operator Requirements, SNMP, NETCONF, YANG, Interoperability in IoT. SDN	08
4	**Sensor Networks and IoT**	Characteristic and challenges, WSN vs Adhoc Networks, Sensor node architecture, Physical layer and transceiver design considerations in WSNs, Energy usage profile, Choice of modulation scheme, Dynamic modulation scaling, Antenna considerations. Sensor Network Architecture: Data Dissemination, Flooding and Gossiping- Data gathering Sensor Network Scenarios, Optimization Goals and Figures of Merit, Design Principles for WSNs- Gateway Concepts, Need for gateway, WSN and Internet Communication, WSN Tunneling, Amplifiers and Sensor Noise, Importance and Adoption of Smart Sensors, Architecture of Smart Sensors	10

5	**Cloud Computing**	Interfacing and data logging with cloud, Evolution of Cloud Computation, Commercial clouds and their features, open source IoT platforms, cloud dashboards, Fog Computing, Introduction to big data analytics and Hadoop.	08

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.

Text Books:

1. Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2016

2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.

3. Jacob Fraden, "HandBook of Modern Sensors: physics, Designs and Applications", 2015, 3rd edition, Springer, New York.

4. Jon. S. Wilson, "Sensor Technology HandBook", 2011, 1st edition, Elsevier, Netherland.

References:

1. Vijay Madisetti , Arshdeep Bahga, Adrian McEwen (Author), Hakim Cassimally "Internet of Things A Hands-on-Approach" Arshdeep Bahga & Vijay Madisetti, 2014

2. LuYan, Yan Zhang, Laurence T. Yang, Huansheng Ning, The Internet of Things: From RFID to the Next-Generation Pervasive Network, Aurbach publications, March,2008.

3. RonaldL. Krutz, Russell Dean Vines,Cloud Security: A Comprehensive Guide to Secure Cloud Computing,Wiley-India, 2010.

4. John G Webster, "Measurement, Instrumentation and sensor Handbook", 2017, 2nd edition, CRC Press, Florida.

5. Bahaa E. A. Saleh and Malvin Carl Teich, "Fundamentals of photonics", 2012, 1st edition, John Wiley, New York.

Course Code	Course Name	Theory (Hrs.)	Practical (Hrs.)	Tutorial (Hrs.)	Theory (Credits)	Practical/ Oral (Credits)	Tutorial (Credits)	Total (Credits)
EC5031L	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					
EC5031L	Course Lab II	--	--	--	--	25	25	--	50

Course Name: Course Lab

Student has to perform course lab II based on DLOC IV, V and VI

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)
EC5032L	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					
EC5032L	Dissertation II	--	--	--	--	25	25	--	50

Course Name: Dissertation-II

- Students have to perform complete system analysis, Design and develop a theoretical/mathematical background for the system proposed.
- Students should attempt to solve the problem by analytical/simulation/experimental methods. 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 III

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract	Theory	Practical	Total
EC600LC	Internship / Relevant Certification	-	-	-	03	03

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	--	--	--	--	12	--	12

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	--	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					
EC602LC	Dissertation IV	--	--	--	--	100	100	--	200

Course Name: Dissertation-IV

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