MALNAD COLLEGE OF ENGINEERING, HASSAN

Department of Electronics and Communication Engineering

An Autonomous Institution Affiliated to VTU, Belagavi

Scheme of Teaching and Examinations

Autonomous Programmes

Master of Technology (M.Tech.)

(Specialization in Digital Electronics and Communication Systems)

Academic Year 2024-25

SCHEME OF EVALUATION

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50 % of the maximum marks. Minimum passing marks in SEE is 50 % of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CONTINUOUS INTERNAL EVALUATION

1. Two CIE each of 25 Marks will be conducted.
2. Two skill development activities each of 25 Marks will be conducted.
3. The weighted sum of two tests, two Skill Development Activities, will be evaluated to 50 marks. CIE methods/ question paper is designed to attain the different levels of as per the outcome defined for the course.

SEMESTER END EXAMINATION

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have **six** full questions.
3. Each full question is for 20 marks. There will be one full question (with a maximum of four subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions.

Examination	Maximum marks	Minimum marks to qualify
CIE	**50**	**25**
SEE	**50**	**25**

Department of Electronics and Communication Engineering
Malnad College of Engineering, Hassan
M.Tech (Digital Electronics and Communication Systems)
Scheme for 2024-2026 batch

VISION OF THE DEPARTMENT

To produce industry ready, research oriented and socially responsible Electronics & Communication Engineers.

MISSION OF THE DEPARTMENT

- To create an ambience for learning.
- To conduct research, beneficial to the society.
- To promote industry-academic interaction at all-levels.
- To be continuously agile to the needs of the stake holders.

I SEMESTER

Sl. No.	Course Type	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial/SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	PCC	24ECS11	Advanced Machine Learning and Deep Learning	3	0	0	03	50	50	100	3
2	IPCC	24ECS12	Advanced Embedded Systems	3	2	0	03	50	50	100	4
3	PCC	24ECS13	Digital Circuits & Logic Design	3	0	0	03	50	50	100	3
4	PEC	24ECS11X	Professional Elective I	3	0	0	03	50	50	100	3
5	PEC	24ECS12X	Professional Elective II	3	0	0	03	50	50	100	3
6	PECL	24ECS14X	Lab Elective	0	4	0	03	50	50	100	2
7	NCMC	24RM	Research Methodology and IPR (Online)	Online Courses (online.vtu.ac.in)							PP
								300	300	600	18

Professional Elective I		Professional Elective II	
24ECS111	ASIC Design	24ECS121	System Verilog
24ECS112	Advanced Computer Networking	24ECS122	Advanced Wireless Communication
24ECS113	Advanced Signal Processing	24ECS123	Multimedia & Applications
24ECS114	Power Converters	24ECS124	Process Control

Lab Elective			
24ECS14A	Advanced Machine Learning and Deep Learning Lab	24ECS14B	Electronics and Communication Lab

Note: **BSC**-Basic Science Courses, **PCC**: Professional Core Courses. **IPCC**-Integrated Professional Core Courses, **PCC(PB):** Professional Core Courses (Project Based), **PCCL**-Professional Core Course lab ,**NCMC**- Non Credit Mandatory Course, **L**-Lecture, **P**-Practical, **T/SDA**-Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students), **MRMI107**-Research Methodology and IPR (Online) for the students who have not studied this course in the Undergraduate level. This course is not counted for vertical progression, Students have to qualify for the award of the master's degree.

M- Master program **xx** – **CV** for Civil Engineering Stream, **EE** – Electrical & Electronics Engineering Stream, **EC** - Electronics and Communication Engineering Stream, **CS**- Computer Science and Engineering

BSC: **Basic Science Courses**: Courses like Mathematics/ Science are the prerequisite courses that the concerned engineering stream board of Studies will decide. **PCC**: **Professional Core Course**: Courses related to the stream of engineering, which will have both CIE and SEE components, students have to qualify in the course for the award of the degree. **IPCC**: **Integrated Professional Core Course**: Refers to a Professional Theory Core Course Integrated with practicals of the same course. The IPCC's theory part shall be evaluated by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. **PCC (PB): Project Based Learning Course**: Project Based Learning course is a professional core course. Students have to complete a project out of learning from the course and SEE will be viva voce on project work. **PCCL: Professional Core Course Laboratory:** Practical courses whose CIE will be evaluated by the class teacher and SEE will be evaluated by the two examiners.

SDA:Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry. 5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in the modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.Students and the course instructor/s are to be involved either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities that will enhance their skills. The prepared report shall be evaluated for CIE marks.

24RM -Research Methodology and IPR- Non Credit Mandatory Course (NCMC).If students have not studied this course in their undergraduate program then he /she has to take this course at http://online.vtu.ac.in and to qualify for this course is compulsory before completion of the minimum duration of the program (Two years), however, this course will not be considered for vertical progression.

II SEMESTER											
Sl. No	Course Type	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/ Seminar	Tutorial/ SDA	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	IPCC	24ECS21	Antenna Theory and Design	3	2	0	05	50	50	100	4
2	PCC	24ECS22	Advanced Communication system	3	0	0	03	50	50	100	3
3	PCC	24ECS23	Error Control Coding	3	0	0	03	50	50	100	3
4	PCC	24ECS24	Multimedia Over Communication Links	3	0	0	03	50	50	100	3
5	PEC	24ECS21X	Professional Elective III	3	0	0	03	50	50	100	3
6	PEC	24ECS22X	Professional Elective IV	3	0	0	03	50	50	100	3
7	PCCL	24ECS25	Advanced Communication Laboratory	0	3	0	03	50	50	100	2
8	AEC/ SEC	24ECS26X	Ability/Skill Enhancement Course (Offline/Online)	00 01	02 00		02 01	50	50	100	1
								400	400	800	22

Professional Elective III		Professional Elective IV	
24ECS211	Wireless Sensor Networks	24ECS221	Statistical Signal Processing
24ECS212	Cryptography and Network Security	24ECS222	Array Signal Processing
24ECS213	Biomedical Signal Processing	24ECS223	Digital Compression
24ECS214	Advances in Image Processing	24ECS224	Wavelet Transforms and Applications

Skill Enhancement Course			
24ECS261	Modeling and Simulation of Antenna Using Simulation Tool	24ECS262	Python Programming
24ECS263	MATLAB and Simulink		

Third & Fourth Semester (For the students who are willing to take up two-semester duration Industry/Research Internship Leading to Project work /start-up)

IIISEMESTER (A)											
Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical	Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1.	PEC	24ECS311	Professional Elective (Online Courses)	03	00	00	03	100	-	100	3
2.	PEC	24ECS312	Professional Elective (Online Courses)	03	00	00	03	100		100	3
3.	INT	24INT383	Research Internship /Industry-Internship leading to project work/ Startup	Two-semester duration, SEE in the IV semester which leads to project work /start-up			03	100	---	100	4
4.	PROJ	24PRJ384	Project Phase I	06	00	00	12	100	-	100	2
TOTAL								400	-	400	12

IV SEMESTER (A)										
Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/Field	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	INT	24INT481	Research Internship / Industry Internship Leading to Project Work/Start-up	Two Semester Duration		03	100	100	200	12
2	PROJ	24PRJ482	Project Phase II			03	100	100	200	16
TOTAL						06	200	200	400	28

INT: Industry/ Research Internship leading to the project work /startup
PRJ: Project work outcome of Internship (Project Phase-II is Viva voce SEE)
Taking up a two-semester Industry/Research Internship that leads to project work or a start-up can be a highly rewarding experience for students. It allows them to apply theoretical knowledge in practical settings, gain valuable industry or research experience, and potentially develop innovative solutions or business ideas.

Here are some key steps and considerations for students pursuing such an internship:

Industry Internship: The main objective of the industry internship is to ensure that the intern is exposed to a real-world environment and gain practical experience. Often, it may be a practical exposure to the theory that has been learned during the academic period. The industry internship helps students understand of analytical concepts and tools, hone their skills in real-life situations, and build confidence in applying the skills learned.

Research Internship: A research internship is an opportunity for students or early career professionals to gain hands-on experience in conducting research under the guidance of a mentor or within a research team. These internships can take place in academic institutions, research organizations, government agencies, or private companies

Research /Industry Internship: In the third-semester Students have to be in touch with a guide/mentor/coordinator and regularly submit the report referred to the progress internship. Based on the progress report the Guide/Mentor/coordinator has to enter the CIE marks at the end of the 3rd semester. At the beginning of the 4th semester, students have to define the project topic out of the learning due to the Internship, upon completion of the project work he/she has to attend the SEE at the parent Institute.

Internship Leading to Start-up: An internship that leads to a startup is an exciting pathway, blending real-world experience with entrepreneurial ambition. Here's a comprehensive guide to transitioning an internship experience into launching your startup: 1) Maximize your internship experience, 2) Identifying Viable Business Ideas, 3) Research and Validation 4) Building a Business Plan 5) Networking and Mentorship 6) Securing Funding 7) Establishing Startup 8) Launching and Marketing. By following these steps, you can effectively transition from an internship to launching a successful startup. This journey requires dedication, resilience, and a willingness to learn and adapt.

24Mxx301 to 303: MOOC courses of 12 weeks duration are the courses suggested by the Board of Studies. The online courses selected should not be the same as those studied in the

first and second semesters of the program. The student will not be eligible to get their degree if they unintentionally select online courses that match previously finished courses. These courses are not considered for the vertical progression; however, qualifying for these courses and earning the credits is a must for the award of the degree. It is permitted to complete these online MOOC courses either in 1st, 2nd, 3rdor 4thsemester.

For the students who are willing to take an Industry Internship for one-semester duration and independent project work next semester

III Semester (B)

Course Type	Course Code	Course Title	Credits			Total Credits	Total Contact Hours
			L	P	SDA		
PEC/MDC	24ECS311	Professional Elective (Online Course)	03	00	00	**3**	03
	24ECS312	Professional Elective (Online Course)	03	00	00	**3**	03
	24ECS313	Professional Elective (Online Courses)	03	00	00	**3**	03
INT	24INT384	Industry Internship	One-semester duration			**11**	03
Total						**20**	12

IV Semester (B)

Course Type	Course Code	Course Title	Credits		Total Credits	Total Contact Hours
			L	P		
PROJ	24PRJ481	Project Work	--	08	**20**	03
Total					**20**	03

Industry Internship: The main objective of the industry internship is to ensure that the intern is exposed to a real-world environment and gains practical experience. Often, it may be a practical exposure to the theory that has been learned during the academic period. The industry internship helps students understand of analytical concepts and tools, hone their skills in real-life situations, and build confidence in applying the skills learned. The students who take up a one-semester Internship in the Industry have to appear SEE at the institute at the end of the semester as per the examination calendar.

Project Work: Students in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare a synopsis, and narrate the methodology to carry out the project work. Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through Power Point slides.
- Answer the queries and be involved in debate/discussion.
- Submit two copies of the typed report with a list of references.
- The participants shall take part in discussions to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident

CIE marks for the project report (20 marks), seminar (20 marks) and question and answer (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Principal. The committee shall consist of internal guide and a faculty from the department with the senior most acting as the Chairperson.

Semester End Examination SEE marks for the project report (30 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of the report and presentation skill, participation in the question and answer session) by the examiners appointed by the

University.

Mxx301 to 303:MOOC courses of 12 weeks duration are the courses suggested by the Board of Studies The online courses selected should not be the same as those studied in the first and second semesters of the program. The student will not be eligible to get their degree if they unintentionally select online courses that match previously finished courses. These courses are not considered for the vertical progression; however, qualifying for these courses and earning the credits is a must for the award of the degree. It is permitted to complete these online MOOC courses either in 3rd semester or in 4th semester.

For the students who are willing to take a research-leading paper publication in Q1/Q2/Q3 Journals and to a PhD Registration

III Semester (C)

Course Type	Course Code	Course Title	Credits			Total Credits	Total Contact Hours
			L	P	SDA		
PCC/IPCC /PEC/MD C	24ECS311	Professional Elective (Online Course)	03	00	00	**3**	03
	24ECS312	Professional Elective (Online Course)	03	00	00	**3**	03
	24ECS313	Professional Elective (Online Courses)	03	00	00	**3**	03
	24ECS314	Professional Elective (Online Courses	03	00	00	**3**	03
INT	24PRJ385	Project Phase-I	One-semester duration			**6**	03
Total						**18**	15

IV Semester (C)

Course Type	Course Code	Course Title	Credits		Total Credits	Total Contact Hours
			L	P		
PROJ	24PRJ481	Project Work Phase-II	--	08	**20**	03
Total					**22**	03

Project Work Phase-1: Typically the initial phase in any project, is crucial as it lays the foundation for the entire project. This phase involves defining the project's scope, objectives, and initial planning. Here's a structured approach to effectively carry out Project Phase-I:

- Project Charter: Outlines the project's purpose, objectives, and stakeholders.
- Scope Statement: Defines the project boundaries and deliverables.
- Requirements Document: Captures all project requirements.
- Project Plan: Details the approach, timeline, and resource allocation.
- Risk Management Plan: Identifies and plans for potential risks.
- Feasibility Study Report: Assesses technical, economic, and operational feasibility.

Students in consultation with the guide shall carry out literature survey/visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare a synopsis, and narrate the methodology to carry out the project work. Each student, under the guidance of a faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and be involved in debate/discussion.
- Submit two copies of the typed report with a list of references.
- The participants shall take part in discussions to foster a friendly and stimulating environment

in which the students are motivated to reach the highest and become self-confident.

Continuous Internal Evaluation (100 Marks)
CIE marks for the project report (60 marks), seminar (20 marks) and question and answer (20marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Principal. The committee shall consist of an internal guide and a faculty from the department with the senior most acting as the Chairperson.

Project Work Phase-II: Each student shall be involved in carrying out the project work jointly in constant consultation with internal guide and external guide and prepare the project report as per the norms of the university to avoid plagiarism. Phase II of a project typically involves the detailed execution of the planned activities, continuous monitoring and control of the project's progress, and making necessary adjustments to ensure the project stays on track. Keep detailed records of all project activities, decisions, and changes. Ensure all project documentation is organized and accessible. Conduct a final project review to evaluate overall performance, achievements, and lessons learned. Document best practices and areas for improvement for future projects.

Paper Publication Process: Publishing a research paper based on your project in a Q1/Q2/Q3 journal involves several key steps, from writing the manuscript to navigating the peer review process. Here's a comprehensive guide:
Writing the Manuscript: Choose a clear and concise title that accurately reflects the content. Write an abstract summarizing the research question, methods, results, and conclusions.
Literature Review: Review relevant existing research to establish the foundation of your study. Identify gaps that your research aims to fill.
Methodology: Describe the research design, methods, and procedures in detail. Include information on data collection, analysis, and any tools or software used.
Results: Present the findings of your research clearly and logically. Use tables, figures, and charts to illustrate key results.
Discussion: Interpret the results and explain their implications. Compare your findings with existing research and discuss any discrepancies or new insights.
Conclusion: Summarize the main findings and their significance. Suggest potential future research directions.
References: Cite all sources used in your research following the journal's citation style.
JournalSelection: Choose a journal that aligns with the scope and focus of your research. Consider the journal's impact factor (Q1, Q2, Q3) and audience.
Review Journal Guidelines: Carefully read the journal's submission guidelines and ensure your manuscript adheres to them.
Prepare Your Manuscript: Format your manuscript according to the journal's guidelines. Include all required sections and supplementary materials.
Cover Letter: Write a cover letter to the journal editor highlighting the significance of your research and why it fits the journal.
Submit the Manuscript: Use the journal's online submission system to submit your manuscript. Ensure all required information and documents are included.

Semester End Examination SEE marks for the project report (60 marks), seminar (20marks) and question and answer session (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University

Semester- I

ADVANCED MACHINE LEARNING AND DEEP LEARNING			
Course Code	**24ECS11**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the fundamental concepts of machine learning and its applications
- To master the concepts of classification and clustering techniques.
- To develop a deep understanding of convolutional neural networks (CNNs) and their architecture.
- To apply deep learning techniques to large-scale datasets and real-world problems.

Module-1

Introduction and Regression: Introduction, Types of Learning, Simple Linear Regression: Hypothesis, Cost Function, Learning Rate, Gradient Descent for Linear Regression, Multivariate Linear regression, Polynomial Linear Regression.

RBT Levels: L2, L3

Module-2

Neural Networks: Introduction, Neurons, Perceptrons, Multilayer Neural Networks, Recurrent Networks, Unsupervised Learning Networks, Evolving Neural Networks.

RBT Levels: L3

Module-3

Convolutional Neural Networks: The operation, Pooling, Convolution and Pooling as an infinitely strong prior, Variants of the basic functions, efficient algorithms, Random or Unsupervised Features, Neuroscientific Basis for Convolutional Networks.

RBT Levels: L3

Module-4

Recurrent Neural Networks: RNN, Bidirectional RNN, Encoder-Decoder Sequence to sequence architecture, Deep Recurrent Networks, Recursive Neural Networks, The Long Short Term Memory and other Gated RNNs, Optimization for Long Term Dependencies.

RBT Levels: L3

Module-5

Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications.

RBT Levels: L3, L4

Suggested Learning Resources:

Books

1. Deep Learning - Goodfellow, Bengio and Courville
2. Fundamentals of Deep Learning – Nikhil Budama
3. Neural Networks and Deep Learning – CharuAggarwal

Hands-on Deep Learning Algorithms with Python – SudharsanRavichandran

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/

Skill Development Activities Suggested

- Individual or group projects to apply learned concepts to real-world problems.
- Regular coding assignments to reinforce theoretical concepts.
- Experimentation with different libraries and frameworks (e.g., TensorFlow, PyTorch, Scikit-learn).
- Guest lectures from industry experts to provide insights into current trends.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	**Demonstrate** a comprehensive understanding of machine learning and deep learning fundamentals and their applications.	L2
CO2	**Apply** various machine learning algorithms and deep learning architectures to solve complex problems.	L3
CO3	**Develop** and implement machine learning models using appropriate programming languages and tools.	L4

Semester- I

ADVANCED EMBEDDED SYSTEMS			
Course Code	**24ECS12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory +10 hours Lab	Total Marks	100
Credits	04	Exam Hours	03

Course Learning Objectives:

1. To understand the difference between Embedded Systems and General Computing Systems
2. To understand the Classification of Embedded Systems based on Performance, Complexity along with the Domains and Areas of Applications of Embedded Systems
3. Analysis of a Real Life example on the bonding of Embedded Technology with Human Life
4. To understand the difference between Microcontrollers and ARM Cortex processors.
5. To learn Programming using assembly and C language, CMSIS for variety of End Applications.

Module - 1

Embedded System: Embedded v/s General Computing System, classification, application and purpose ofES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Optocoupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems.

RBT Levels: L2, L3

Module - 2

Hardware Software Co-Design: Embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment(IDE),Files generated during compilation, simulators, emulators and debugging.

RBT Levels: L3

Module - 3

ARM - 32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence.

RBT Levels: L3

Module - 4

Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface, Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex- M3 Programming using assembly and C language, CMSIS.

RBT Levels: L3

Module - 5

Introduction to RISC - V: Operations of the Computer Hardware, Operands of the Computer Hardware, Signed and Unsigned Numbers, Representing Instructions in the Computer, Logical Operations, Instructions for Making Decisions, RISC-V Addressing for Wide Immediate and Addresses, Parallelism and Instructions: Synchronization

RBT Levels: L3, L4

Suggested Learning Resources:

Text Books

1. 'Introduction toembedded systems', K. V.Shibu, TMH education Pvt.Ltd., 2009.
2. 'The Definitive Guide tothe ARM Cortex-M3', Joseph Yiu, Newnes,(Elsevier), 2nd edn, 2010.
3. 'Computer Organization and Design RISC-V Edition', David A. Patterson, John L. Hennessy, Morgan Kaufmann, ISBN: 9780128122761.

Reference Books

'Embedded systems - A contemporary design tool', James K.Peckol, JohnWiley, 2008

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/

Skill Development Activities Suggested

1. Interact with industry (small, medium, and large).
2. Involve in research / testing / projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve incase studies and field visits/ fieldwork.

4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.

Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No	Course Outcomes	Blooms Level
CO 1	Understand the basic hardware components and their selection methods based on the attributes ofEmbedded Systems	L2
CO 2	Describe the code design process and firmware design approaches	L2
CO 3	Acquaint the knowledge ofARM Cortex M3Processor anditssalient features.	L3
CO 4	Understand the basics of RISC – V Architecture.	L3
CO 5	Apply and use Programming Techniques for different End Uses	L3, L4

PRACTICAL COMPONENT OF IPCC

Using suitable simulation software in Linux

Develop and test Assembly Language Program (ALP) using ARM/RISC Processor.

1.	Develop and test programs: a) To create child process and display it's ID. b) Execute child process function using switch structure.
2.	Develop and test the program for a multi-threaded application, where communication is through shared memory for the conversion of lowercase text touppercase text.
3.	Develop program for inter-thread communication using message queue. Data is to be input from the keyboard for the chosen application.
4.	Create 'n' number of child threads. Each thread prints the message "I'm in thread number …" and sleeps for 50 ms and then quits. The main thread waits for complete execution of all the child threads and then quits. Compile and execute in Linux.
5.	Implement the multi-thread application satisfying the following: a) Two child threads are created with normal priority. b) Thread 1 receives and prints its priority and sleeps for 50ms and then quits. c) Thread 2 prints the priority of the thread 1 and rises its priority to above normal and retrieves the new priority of thread 1, prints it and then quits. d) The main thread waits for the child thread to complete its job and quits.
6.	Write ALP to find the square of a number (1 to 10) using look-up table.
7.	Write an ALP to arrange a series of 32 bit numbers in ascending/descending order.
8.	Write an ALP to count the number of ones and zeros in two consecutive memory locations.
9.	Interface a simple Switch and display its status through Relay, Buzzer and LED. (Study Expt.)
10.	Implement a clock capable of displaying (and being set to the correct time). Include an alarm facility which can be set by the user and will 'go off' at the correct time.

Semester- I

DIGITAL CIRCUITS & LOGIC DESIGN			
Course Code	**24ECS13**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the concepts of sequential machines
- Design Sequential Machines/Circuits
- Analyze the faults in the design of circuits
- Apply fault detection experiments to sequential circuits

Module-1

Threshold Logic: Introductory Concepts, Synthesis of Threshold Networks

Capabilities, Minimization, and Transformation of Sequential Machines: The Finite- State Model, Further Definitions, Capabilities.

RBT Levels: L2, L3

Module-2

Fault detection by path sensitizing: Detection of multiple faults, Failure-Tolerant Design, Quadded Logic, Reliable Design and Fault Diagnosis Hazards: Fault Detection in Combinational Circuits.

RBT Levels: L3

Module-3

Fault-location experiments: Boolean Differences, Limitations of Finite – State Machines, State Equivalence and Machine Minimization, Simplification of Incompletely Specified Machines.

RBT Levels: L3

Module-4

Structure of Sequential Machines: Introductory Example, State Assignments Using Partitions, The Lattice of closed Partitions, Reductions of the Output Dependency, Input Independence and Autonomous Clocks, Covers and Generation of closed Partitions by state splitting, Information Flow in Sequential Machines, decompositions, Synthesis of Multiple Machines.

RBT Levels: L3

Module-5

State Identifications and Fault-Detection Experiments:

Homing Experiments, Distinguishing Experiments, Machine Identification, Fault Detection Experiments, Design of Diagnosable Machines, Second Algorithm for the Design of Fault Detection Experiments, Fault-Detection.

RBT Levels: L3, L4

Suggested Learning Resources:

Textbook:

1. 'Switching and Finite Automata Theory', Zvi Kohavi, TMH, ISBN: 978_0_07_099387_7, 2nd Edition, 2008.

Reference Books:

1. 'Digital Circuits and logic Design', Charles Roth Jr., Cengage Learning, 7thedition, 2014.
2. 'Fault Tolerant and Fault Testable Hardware Design', Parag K Lala, Prentice Hall Inc. 1985.
3. 'Introductory Theory of Computer', E. V. Krishnamurthy, Macmillan Press Ltd, 1983
4. 'Theory of computer science – Automata, Languages and Computation', Mishra & Chandrasekaran, 2ndEdition, PHI, 2004.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No	Course Outcomes	Blooms Level
CO 1	Understand the basic hardware components and their selection methods based onthe attributes ofEmbedded Systems	L2
CO 2	Describe the code design process and firmware design approaches	L2
CO 3	Acquaint the knowledge ofARM Cortex M3Processor anditssalient features.	L3
CO 4	Understand the basics of RISC – V Architecture.	L3
CO 5	Apply and use Programming Techniques for different End Uses	L3, L4

Semester- I

Professional Elective I

ASIC DESIGN			
Course Code	24ECS111	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- To learn ASIC methodologies and programmable logic cells to implement a function on IC.
- To Analyse back-end physical design flow, including partitioning, floor-planning, placement, and routing.
- To Gain sufficient theoretical knowledge for carrying out FPGA and ASIC designs

Module-1

Introduction to ASICs: Full custom, Semi-custom and Programmable ASICs, ASIC Design flow, ASIC cell libraries. **CMOS Logic**: Data path Logic Cells: Data Path Elements, Adders: Carry skip, Carry bypass, Carry save, Carryselect, Conditional sum, Multiplier (Booth encoding), Data path Operators, I/O cells, Cell Compilers.

RBT Levels: L2

Module-2

ASIC Library Design: Logical effort: Predicting Delay, Logical area and logical efficiency, Logical paths, Multi-stage cells, Optimum delay and number of stages, library cell design.

Programmable ASIC Logic Cells: MUX as Boolean function generators, Acted ACT: ACT 1, ACT 2 and ACT 3 Logic Modules, Xilinx LCA:XC3000 CLB, Altera FLEX and MAX, Programmable ASIC I/O Cells: Xilinx and Altera I/O Block

RBT Levels: L2, L3

Module-3

Low-level design entry: Schematic entry: Hierarchical design, The cell library, Names, Schematic Icons & Symbols, Nets, Schematic Entry for ASICs, Connections, vectored instances & buses, Edit in place, attributes, Netlist screener.

ASIC Construction: Physical Design, CAD Tools System partitioning, Estimating ASIC size. **Partitioning:** Goals and objectives, Constructive Partitioning, Iterative Partitioning Improvement, KL, FM and Look Ahead algorithms.

RBT Levels: L2, L3

Module-4

Floor planning and placement: Goals and objectives, Measurement of delay in Floor planning, Floor planning tools, Channel definition, I/O and Power planning and Clock planning.

Placement: Goals and Objectives, Min-cut Placement algorithm, Iterative Placement Improvement, Time driven placement methods, Physical Design Flow.

RBT Levels: L2, L3

Module-5

Routing: Global Routing - Goals and objectives, Global Routing Methods, Global routing between blocks, Back-annotation. Detailed Routing - Goals and objectives, Measurement of Channel Density, Left-Edge Algorithm, Area-Routing Algorithms, Multilevel routing, Timing –Driven detailed routing, Final routing steps, Special Routing, Circuit extraction and DRC.

RBT Levels: L3, L4

Suggested Learning Resources:

Books

1. Michael John Sebastian Smith, "Application - Specific Integrated Circuits", Addison- Wesley Professional, 2005
2. Neil H.E. Weste, David Harris, and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective" , Addison Wesley/ Pearson education 3rdedition, 2011
3. Vikram Arkalgud Chandrasetty, "VLSI Design: A Practical Guide for FPGA and ASIC Implementations" Springer, ISBN: 978-1-4614-1119-2. 2011
4. Rakesh Chadha, Bhasker J, "An ASIC Low Power Primer", Springer, ISBN: 978-14614-4270-7.
5. Peter J. Ashenden Digital Design (Verilog): An Embedded Systems Approach Using Verilog,1st Edition, Kindle Edition.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Skill Development Activities Suggested

- Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
- Real world Problem Solving: Applying the ASIC front end and backend concepts.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Describe the concepts of ASIC design methodology, data path elements, logical effort.	L2
CO2	Analyze the design of ASICs suitable for specific tasks, perform design entry and explain the physical design flow.	L3
CO3	Design data path elements for ASIC cell libraries and compute optimum path delay.	L3
CO4	Create floor plan including partition and routing with the use of CAD algorithms	L3,L4

Semester 1

ADVANCED COMPUTER NETWORKING			
Course Code	24ECS112	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives: This Course will enable students to

- Focus on advanced networking concepts for next generation network architecture and design.
- Acquire knowledge about SDN and virtualization for designing next generation networks.

Module-1

Medium Access Control Sub Layer: Wireless LANs, Broadband Wireless, Bluetooth, RFID.
The Network Layer: Network Layer Design Issues, Congestion Control Algorithms, Quality of Service, The Network Layer in the Internet.

RBT Levels: L2

Module-2

The Application Layer: The Domain Name System, Electronic Mail, The World Wide Web.

RBT Levels: L2, L3

Module-3

Software Defined Network (SDN): Evolution of Switches and Control Planes, Cost, SDN Implications for Research and Innovation
Genesis of SDN: The Evolution of Networking Technology, Forerunners of SDN, Software Defined Networking is Born, Sustaining SDN Interoperability, Open Source Contributions, Network Virtualization
How SDN Works: Fundamental Characteristics of SDN, SDN Operation, SDN Devices, SDN Controller, SDN Applications, Alternate SDN Methods

RBT Levels: L2, L3

Module-4

The Openflow Specification: OpenFlow Overview, OpenFlow 1.0 and OpenFlow Basics, OpenFlow Additions - 1.1, 1.2, 1.3, 1.4, 1.5, Improving OpenFlow Interoperability, Optical Transport Protocol Extensions, OpenFlow Limitations

RBT Levels: L2, L3

Module-5

Network Functions Virtualization: Definition of NFV, Virtualize, Standards, OPNFV, Leading NFV Vendors, SDN Vs NFV, In-Line Network Functions.
SDN Open Source: SDN Open Source Landscape, The OpenFlow Open Source Environment, Profiles of SDN Open Source Users, OpenFlow Source Code, Switch Implementations, Controller Implementations, SDN Applications, Orchestration and Network Virtualization, Simulation, Testing and Tools, Open Source Cloud Software, Example: Applying SDN Open Source.

RBT Levels: L3, L4

Suggested Learning Resources:

Text Books:

1. Andrew S. Tanenbaum, David J. Wetherall, Computer Network, 5th Edition. Pearson Education.
2. Paul Goransson, Chuck Black and Timothy Culver, Software Defined Networks – A Comprehensive Approach, 2nd Edition, 2017, Morgan Kaufmann.

Reference books:

1. Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition, Tata McGraw Hill, 2007.
2. James F Kurose, Keith W Ross, Computer Networking- A Top-down Approach Featuring the Internet, 7th Edition, 2017, Pearson Education.
3. Alberto Leon Garcia, Indra Widjaja, Communication Networks-Fundamental Concepts and Key Architectures, Fifth reprint 2002 , Tata McGraw Hill.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Skill Development Activities Suggested @081120

- The students with the help of the course teacher can take up relevant technical – activities which will enhance

their skill.

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Understand advanced concepts and next generation networks.	L2
CO2	Analyze network Algorithms, Protocols and their functionalities.	L3
CO3	Comprehend features of SDN and its application to next generation systems.	L3
CO4	Analyze the performance of various server implementations.	L3, L4

Semester- 1

ADVANCED SIGNAL PROCESSING			
Course Code	24ECS113	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To know the analysis of discrete time signals.
- To study the modern digital signal processing algorithms and applications.
- To Have an in-depth knowledge of use of digital systems in real time applications
- To apply the algorithms for wide area of recent applications.

Module-1

Analysis of Discrete Time Signals: Basic elements of a DSP System – Review of Sampling and Quantisation – Sampling theorem for low pass and band pass signals, uniform and non-uniform quantization, Application of quantisation in lossy compression of signals – Lloyd Max quantizer; Fourier analysis of Continuous and Discrete time signals –Review of Fourier series and Fourier transform, Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Interpretation of DFT Spectrum, Review of DFT properties – Convolution and correlation, Convolution of long sequences, Leakage effect, Windowing – Introduction to other transforms : Discrete Cosine Transform (DCT), Walsh Hadamard Transform (WHT), Karhunen Loeve Transform (KLT) – Applications.

RBT Levels: L2, L3

Module-2

Digital Filters and Implementation: Review of FIR and IIR filter design – Notch filter– Comb filter– All pass filters – Applications – Structures for digital filter realization: Signal flow graph and block diagram representations, FIR and IIR Filter structures, Lattice structures – Finite word length effects – Fixed-point and floating-point DSP arithmetic, Effects of quantization, Scaling, Limit cycles in fixed point realizations of IIR digital filters, Limit cycles due to overflow. Quantization effect in DFT and FFT computation.

RBT Levels: L3, L4

Module-3

Multirate Signals and Systems: Introduction to multirate signal processing with applications, Multirate System Fundamentals – Decimation and Interpolation, Transform domain analysis of Decimators and Interpolators, Decimation and Interpolation filters, Fractional sampling rate alteration, Practical sampling rate converter design.

RBT Levels: L3, L4

Module-4

Introduction to 2-D Signals and Systems: Polyphase decomposition and efficient structures – Introduction to digital filter banks – The DFT filter bank, Two Channel Quadrature Mirror Filter bank (QMF), Perfect Reconstruction.

RBT Levels: L3, L4

Module-5

Introduction to 2-D Signals and Systems: Elementary 2D signals – Linear shift Invariant systems – Separability – 2D convolution – Introduction to 2D transforms: 2D DFT, 2D DCT, Applications.

RBT Levels: L3, L4

Suggested Learning Resources:

Books

1. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4th Edition, Pearson India, 2007.
2. P.P. Vaidyanathan, Multirate systems and filter banks, 2nd Edition, Pearson Education India, 1992.
3. Lim J. S., Two-dimensional signal and image processing, Prentice Hall, 1990.
4. K Deergha Rao, M N S Swamy, Digital Signal Processing: Theory and Practice, Springer, 2018.
5. Steven W. Smith, The Scientist and Engineer's Guide to Digital Signal Processing, California, 1999.
6. Mitra S. K., Digital Signal Processing: A Computer Based Approach, McGraw-Hill Publishing Company, 2013

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Skill Development Activities Suggested

- Mini Project in the area Advanced signal processing using modern tools like MATLAB, Python etc.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Analyze the effect of sampling and quantisation of signals and appraise its relevance with reference to applications.	L2, L3
CO2	Formulate various transform domain representations of 1D and 2D signals and demonstrate their applications with reference to practical signals.	L3, L4
CO3	Examine finite word length effects and design practical filters for real life.	L3, L4
CO4	Demonstrate the effect of sampling rate converters and design distortion free digital filter banks illustrating their applications to process real life signals.	L3, L4
CO5	Analyze and choose architectures to efficiently implement the DSP systems for various applications taking into consideration the practical aspects.	L3, L4

Semester- 1

POWER CONVERTERS			
Course Code	24ECS114	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To analyse switched circuits.
- To analyse single phase and three phase AC to DC converters.
- To analyse and design DC to DC converters.
- To analyse DC to AC converters.
- To analyse AC to AC converters.

Module-1

Analysis of switched circuits: thyristor controlled half wave rectifier – R, L, RL, RC load circuits, classification and analysis of commutation.

RBT Levels: L3

Module-2

Single-Phase and Three-Phase AC to DC converters: half controlled configurations- operating domains of three phase full converters and semi-converters – Reactive power considerations.

RBT Levels: L3

Module-3

Analysis and design of DC to DC converters: Control of DC-DC converters, Buck converters, Boost converters, Buck-Boost converters, Cuk converters.

RBT Levels: L3, L4

Module-4

Single phase and Three phase inverters: Voltage source and Current source inverters, Voltage control and harmonic minimization in inverters.

RBT Levels: L3

Module-5

AC to AC power conversion using voltage regulators: choppers and cyclo-converters, consideration of harmonics.

RBT Levels: L3

Suggested Learning Resources:

Books

1. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons.Inc, Newyork, 1995.
2. Rashid M.H., 'Power Electronics Circuits, Devices and Applications ', Prentice Hall India, New Delhi, 1995.
3. P.C Sen.,' Modern Power Electronics ', Wheeler publishing Co, First Edition, New Delhi, 1998.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Analyse switched circuits.	L3
CO2	Analyse single phase and three phase AC to DC converters.	L3
CO3	Analyse and design DC to DC converters.	L3, L4
CO4	Analyse DC to AC converters.	L3
CO5	Analyse ACto AC converters.	L3

Semester- 1

Professional Elective II

SYSTEM VERILOG			
Course Code	24ECS121	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students to:

- Understand Digital System Verification Using Object Oriented Methods
- Learn the System Verilog Language for Digital System Verification.
- Create/Build Test Benches for the Design/Methodology.
- Use Constrained Random Tests for Verification
- Understand Concepts of Functional Coverage

Module-1

Verification Guidelines: The Verification Process, Basic Test Bench Functionality, Directed Testing, Methodology Basics, Constrained Random Stimulus, Randomization, Functional Coverage, Test Bench Components, Layered Test Bench.

Data Types:Built-In Data Types, Fixed and Dynamic Arrays, Queues, Associative Arrays, Linked Lists, Array Methods, Choosing A Storage Type, Creating New Types With typedef, Creating User Defined Structures, Type Conversion, EnumeratedTypes, Constants and Strings, Expression Width.

RBT Levels: L2, L3

Module-2

Procedural Statements and Routines:Procedural Statements, Tasks, Functions and Void Functions, Task and Function Overview, Routine Arguments, Returning from a Routine, Local Data Storage, Time Values.

Connectingthe Test Bench and Design:Separating the Test Bench and Design, The Interface Construct, Stimulus Timing, Interface Driving and Sampling, System Verilog Assertions.

RBT Levels: L2, L3

Module-3

Randomization:Introduction, Randomization in System Verilog, Constraint Details, Solution Probabilities, Valid Constraints, InLine Constraints, Random Number Functions, Common Randomization Problems, Random Control, Random Number Generators.

RBT Levels: L3

Module-4

Threads and Inter process Communication:Working with Threads, Disabling Threads, Inter Process Communication, Events, Semaphores, Mailboxes, BuildingA Test Bench with Threads and InterProcess Communication.

RBT Levels: L3

Module-5

Functional Coverage: Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, Anatomy of Cover Group, Triggeringa CoverGroup, Data Sampling, Cross Coverage, Generic Cover Groups, Coverage Options, Analyzing Coverage Data, MeasuringCoverage Statistics During Simulation.

RBT Levels: L3, L4

Suggested Learning Resources:

Books

1. Chris Spear, "System Verilog for Verification – A guide to learning the Test bench language features", Springer Publications Second Edition, 2010.
2. Stuart Sutherland, Simon Davidmann, Peter Flake, "System Verilog for Design- A guide to using system Verilog for Hardware design and modelling", Springer Publications Second Edition, 2006.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Skill Development Activities Suggested:

1) Interact with industry (small, medium, and large).
2) Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3) Involve in case studies and field visits/ fieldwork.

4) Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5) Handle advanced instruments to enhance technical talent.
6) Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7) Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Apply the SystemVerilog concepts to verify the design.	L3
CO2	Apply constrained random tests benches using SystemVerilog.	L3
CO3	Appreciate Functional Coverage.	L3, L4

Semester-I

ADVANCED WIRELESS COMMUNICATION			
Course Code	24ECS122	CIE Marks	50
Teaching Hours/Week(L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

1. To enable students understand the various aspects of wireless communication
2. To understand the concept behind the capacity of channels.
3. Gain the information on Linear time-invariant Gaussian channels, Capacity of fading channels
4. Study uplink and downlink model of AWGN channel, fading channels
5. Describe different types of diversity, Understanding concept behind modeling of MIMO.

Module-1

Physical modeling for wireless channels, Input/output model of the wireless channel: Free space, fixed transmit and receive antennas, Free space, moving antenna, Reflecting wall, fixed antenna, Reflecting wall, moving antenna, Reflection from a ground plane, Power decay with distance and shadowing, Moving antenna, multiple reflectors, The wireless channel as a linear time-varying system, Baseband equivalent model, discrete-time baseband model, Additive white noise.

RBT Levels: L2

Module-2

Time and frequency coherence, AWGN channel capacity: Time and frequency coherence: Doppler spread and coherence time, delay spread and coherence bandwidth, Repetition coding, Packing spheres, Capacity-achieving AWGN channel codes, Reliable rate of communication and capacity, Resources of the AWGN channel-Continuous- time AWGN channel, Power and bandwidth, Bandwidth reuse in cellular systems.

RBT Levels: L2, L3

Module-3

Linear time-invariant Gaussian channels, Capacity of fading channels: Single input multiple output (SIMO) channel, Multiple input single output (MISO) channel, Frequency-selective channel, Slow fading channel, receive diversity, Transmit diversity, Transmit and receive diversity, Time and frequencydiversity,Outage forparallelchannels,Fastfadingchannel,Transmittersideinformation,Frequency-selectivefadingchannels.

RBT Levels: L2, L3

Module-4

Uplink and Downlink AWGN channel, Uplink and Downlink fading channel: Capacity via successive interference cancellation, Comparison with conventional CDMA, Comparison with orthogonal multiple access, General K-use ruplink capacity, Symmetric case: two capacity achieving schemes, General case: superposition coding achieves capacity, Slow fading channel, Fast fading channel, Full channel side information, Channel side information at receiver only, Full channel side information, Frequency selective fading channels.

RBT Levels: L2, L3

Module-5

Multiuser diversity, Physical Modeling of MIMO channels: Multiuser diversity gain, Multiuser versus classical diversity, Fair scheduling and multiuser diversity, Channel prediction and feedback, Opportunistic beam forming using dumb antennas, Multiuser diversity in multicell systems, Line-of- sight SIMO channel, Line-of-sight MISO channel, Antenna arrays with only a line-of-sight path, Geographically separated antennas, Line-of-sight plus one reflected path, MIMO multipath channel, Angular domain representation of signals, Angular domain representation of MIMO channels, Statistical modeling in the angular domain, Degrees of freedom and diversity, Dependency on antenna spacing.

RBT Levels: L3, L4

Suggested Learning Resources:

Books

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005.
2. David T, Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge.

Weblinks and Video Lectures (e-Resources):

- https://nptel.ac.in/

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
CO1	Implement physical models of wireless channels. Gain knowledge on communication links and physical model.	L3, L4
CO2	Gain knowledge of key concepts of wireless communication	L3
CO3	Measure capacity of AWGN channel, LTI Gaussian channels and various fading channels.	L3
C04	Study uplink and downlink model of AWGN channel, fading channels and multiuser diversity.	L2, L3

Semester- I

MULTIMEDIA AND APPLICATIONS			
Course Code	24ECS123	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 Hours

Course objectives:

This course will enable students to:

- Understanding basics of multimedia including text, image, audio, video and multimedia networking terminology.
- Explore how multimedia is used in different applications like image compression and text compression.
- Understand various audio and video compression techniques.
- Comprehend the various video compression standards and Multimedia Networks with applications.
-

Module-1

Introduction: Multimedia information representation, Multimedia networks, Multimedia applications, Application and networking terminology, Network QoS and application QoS, Digitization principles, Text, images, audio and video.

RBT Levels: L2

Module-2

Text and image compression: Compression principles, Text compression- Run length, Huffman, LZW, Document Image compression using T2 and T3 coding, image compression- GIF, TIFF and JPEG.

RBT Levels: L3

Module-3

Audio and Video Compression: Audio compression – principles, DPCM, ADPCM, Adaptive and Linear Predictive coding, Code-Excited LPC, Perceptual coding, MPEG and Dolby coders video compression, Video compression principles.

RBT Levels: L3

Module-4

Video Compression Standards: H.261, H.263, MPEG, MPEG 1, MPEG 2, MPEG-4 and Reversible VLCs, MPEG-7 standardization process of multimedia content description, MPEG 21 multimedia framework.

RBT Levels: L3

Module-5

Multimedia Networks: Basics of Multimedia Networks, Communications and Applications: Quality of Multimedia Data Transmission, Multimedia over IP, Multimedia over ATM Networks, Transport of MPEG-4, Media on Demand (MoD).

RBT Levels: L3, L4

Suggested Learning Resources:

Text Books:

1. Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards" Pearson Education Publishers, 2001, ISBN: 97802013981871.
2. Raif Steinmetz, Klara Nahrstedt, “Multimedia: Computing, Communications and Applications”, Pearson education, 2002.

Reference Books:

1. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “Multimedia Communication Systems”, Pearson education, 2004.
2. Hans. W. Barz, Gregory A. Bassett, "Multimedia Networks: Protocols, Design and Applications", John Wiley & Sons publications, 2016. ISBN: 9781119090137.
3. John Billamil, Louis Molina, “Multimedia: An Introduction”, PHI, 2002.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Semester Course outcome (Course Skill Set)

At the end of the course the student will be able to:

Sl. No.	Description	Blooms Level
	@081120	1
CO1	Deploy the right multimedia communication models.	L3, L4
CO2	Apply QoS to multimedia network applications with efficient routing techniques.	L3

CO3	Discuss the various standards and quality aspects of digital video formats used for multimedia application.	L2
C04	Solve the security threats in the multimedia networks.	L3
C05	Develop the real-time multimedia network applications.	L4

Semester- I

PROCESS CONTROL			
Course Code	24ECS124	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the need of process control, basic principles of various manufacturing processes and apply engineering knowledge to do problem analysis in process control.
- To define common dynamics of processes found in many industries and model them mathematically.
- To select the proper controller and apply the tuning rules to achieve optimum performance.
- To understand, interpret and implement tuning of the controllers using various methods and study about digital controllers.
- To select advanced control strategy to enhance the performance.

Module-1

Introduction: Introduction to Process Control. Control objectives, servo regulatory control, and classification of process variables.

Modeling of some Chemical Process Systems: Modeling basics, Degree of Freedom, Mass Balance, Energy Balance equations, linearization of nonlinear systems, Modeling of Level Tank System, Continuous Stirred Tank Heater, Continuous Stirred Tank Reactor, Transfer function.

RBT Levels: L2

Module-2

Elements of Process Control: Dead time, Interacting and non-interacting systems, self-regulation, inverse response, capacity of process, integrating systems, multi-capacity process.

Process Identification: Dynamic behavior of first and second order processes, Obtaining First Order Plus Time Delay (FOPTD) model with Process Reaction curve. Obtaining second order model of processes.

RBT Levels: L2, L3

Module-3

Common Controller Modes: Controller Modes, ON OFF, Multi position, time proportional controller, Theory Proportional, Integral and Derivative modes, PI, PD, PID Controller, Electronics Controller implementation, Dynamic Behavior of closed loop systems with P, I, D, PI , PID modes.

RBT Levels: L2, L3

Module-4

Discretisation and Implementation Issues: Discrete time control mode realization. Velocity and Position algorithm of PID control. Integral windup, anti-windup systems, controller bias, bumps less transfer.

Tuning of Controllers: Application and tuning, ZN Tuning (Open loop and Closed loop), Performance criteria, Integral criteria.

RBT Levels: L3, L4

Module-5

Some Advance Control Techniques: Cascade Control, Feed forward Control, ratio Control, Air Fuel Ratio Control for Drum Boilers. Level Control in Drum Boiler, Shrinking and Swelling, Inverse response of Drum Boiler.

RBT Levels:L3, L4

Suggested Learning Resources:

Books

1. G. Stephanopolous, “Chemical Process Control An Introduction to Theory and Practice”, Prentice Hall India, August 2000.
2. Surekha Bhanot, “Process Control Principles and Applications”, Oxford, 2008
3. C.D. Johnson, “Process Control Instrumentation Technology”, Prentice Hall India.
4. Thomas Marlin, “Process Control Designing Processes and Control for Dynamic Performance”, Tata MC Graw Hill, 2012.
5. F.G. Shinskey, “Process Control Systems Application Design and Adjustment” 3rd editionn, McGraw Hill International, 6. D. E. Seborg, T.F. Edgar, D. A. Mellichamp, “Process Dynamics and Control”, Wiley, 2004.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Skill Development Activities Suggested

- To develop a simple control loop for a system using microcontroller or hardware circuit e.g. on off control of heaters/temperature control systems, displaying of the variables on computer screens or LCD screens etc.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

Sl. No.	Description	Blooms Level
CO1	Understand the need of process control, basic principles of various manufacturing processes and apply engineering knowledge to do problem analysis in process control.	L2, L3
CO2	Define common dynamics of processes found in many industries and model them mathematically.	L2
CO3	Select the proper controller and apply the tuning rules to achieve optimum performance.	L3
CO4	Understand, interpret and implement tuning of the controllers using various methods and study about digital controllers.	L2, L3, L4
CO5	Select advanced control strategy to enhance the performance.	L3

ADVANCED MACHINE LEARNING AND DEEP LEARNING LAB			
Course Code	**24ECS14A**	CIE Marks	50
Teaching Hours/Week (L:P:T/SDA)	0:4:0	SEE Marks	50
Credits	02	Exam Hours	03

Course Objectives:

- To apply theoretical knowledge to practical scenarios.
- To gain proficiency in implementing machine learning algorithms.
- To analyse real-world problems and develop appropriate solutions.

Sl.No.	Experiments
1	Implement multivariate linear regression.
2	Implementing Decision tree Classification.
3	Implement K-means clustering algorithm.
4	Write a program for Gradient Descent Learning.
5	Implement Bidirectional Recurrent neural network.
6	Implementation of Natural Language Processing.
7	Implementation of Speech Recognition.
8	Case study- Convolutional Neural Networks.
	Demonstration Experiments (For CIE)
9	Visualizing linear regression: Use a physical model or software to demonstrate how a line fits to data points.
10	Overfitting and underfitting: Demonstrate the effects of overfitting and underfitting using simple datasets.
11	Convolution operation: Visualize the convolution process using image patches.
12	Language modelling: Generate text using a simple RNN model.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Implement and apply machine learning techniques in prediction problems.
2. Implement suitable learning algorithms to solve a given problem.
3. Implement a model based on machine learning for an application.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours

Suggested Learning Resources:

- Deep Learning - Goodfellow, Bengio and Courville
- Fundamentals of Deep Learning – Nikhil Budama
- Neural Networks and Deep Learning – CharuAggarwal
- Hands-on Deep Learning Algorithms with Python – SudharsanRavichandran

ELECTRONICS AND COMMUNICATIONLABORATORY			
Course Code	**24ECS14B**	CIE Marks	50
Teaching Hours/Week (L:P:T/SDA)	0:4:0	SEE Marks	50
Credits	02	Exam Hours	03

Course Objectives:

- To apply theoretical knowledge to practical scenarios.
- To design and analyseanalog and mixed-signal circuits.
- To implement and evaluate timing and oscillation circuits.
- To analyse and implement communication systems.

Sl. No.	Experiments
	Part - A
1	Design a Two-Stage direct coupled Differential Amplifier with series voltage Negative Feedback of β=50.
2	Design a Voltage regulator using operational amplifier to produce output of 12V with maximum load current of 50mA.
3	Design a Two-stage CS Amplifier with overall gain of 100. Plot the frequency response and estimate the Bandwidth and Q factor.
4	Design a Darlington Emitter follower using MOSFET/BJT with and without bootstrap; plot the frequency response. Also calculate gain and bandwidth.
5	Design and realize:i) Four-bit weighted R – 2R ladder DAC. ii) Two-bit Flash ADC using Op-amp.
6	Design and verify an IC 555 timer-based pulse generator for the specified pulse of 2ms.
7	Using IC NE 566 Voltage Controlled Oscillator, design a circuit to generate square and triangular waveform with a time period of 0.2ms.
	Part - B
8	Design a radio receiver for a given frequency (88 to 108 MHz) and measure the sensitivity, selectivity, and fidelity of the same.
9	Generate PAM and PDM signals for a pulse duration of 10 msec using IC 555 Timer.
10	Implement an AM and FM systems and measure its noise figure.
11	Consider the bit sequence of length 10,000. Modulate it with BPSK, BASK, BFSK. Transmit the signal through AWGN channel. Vary the SNR. Compare the theoretical and simulated probability of error.
12	Design and implement the Adaptive delta modulation and demodulation.

Course outcomes(Course Skill Set):

At the end of the course the student will be able to:

1. Analyze frequency response of BJT/ MOSFET circuits.
2. Design Analog circuits using OPAMPs and IC555 for different applications.
3. Design and test circuits for Analog and digital modulation/demodulation schemes.
4. Design and test circuits for Analog to digital signal conversion techniques.
5. Design and analysis of feedback circuits.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours

Suggested Learning Resources:

- "Analog Integrated Circuit Design" by David A. Johns and Ken Martin.
- "Design of Analog CMOS Integrated Circuits" by Behzad Razavi.
- "Op-Amps and Linear Integrated Circuits" by Ramakant A. Gayakwad.
- "555 Timer IC: Operation and Application" by Michael T. R. R. Haskell.
- "Communication Systems" by Simon Haykin.
- "Digital Communications" by John G. Proakis and Masoud Salehi.

Semester- II

Antenna Theory and Design

Course Code	24ECS21	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**3:2:0**	SEE Marks	50
Total Number of Lecture Hours	**40 hours Theory+10 Lab slots**	Total Marks	**100**
Credits	**04**	Exam Hours	**03**

Module-1

Antenna Fundamentals and Definitions: Radiation Mechanisms, Overview, EM Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation patterns, Directivity and Gain, Antenna impedance, Radiation efficiency, Antenna polarization. [Chapter 2 Text 1]

RBT levels: L2, L3

Module-2

Arrays: Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Non uniformly excited equally spaced linear arrays, Mutual coupling. **Antenna Synthesis**: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method, Comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods, Dolph Chebyshev linear array, Taylor line source method. [Chapter 8 Text 1]

RBT levels: L2, L3

Module-3

Resonant Antennas: Wires and Patches, Dipole antenna, Yagi-Uda antennas, Micro-strip antenna. **Broadband antennas**: Traveling wave antennas Helical antennas, Biconical antennas, Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.

RBT levels: L2, L3

Module-4

Aperture antennas: Techniques for evaluating gain, Reflector antennas-Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice. [Chapter 9 Text 1]

RBT levels: L2, L3

Module-5

CEM for antennas: The method of moments: Introduction of the methods moments, Pocklington's integral equation, Integral equation and Kirchhoff's networking equations, Source modeling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics. [Chapter 14 Text 1]

RBT levels: L2, L3

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to Classify the different types of antennas	Understand
CO2	Able to Define and illustrate various types of array antennas	Understand
CO3	Able to Design antennas like Yagi-Uda, Helical antennas and other broad band antennas	Analyse
CO4	Able to understand the different antenna synthesis methods	Analyse
CO5	Able to Apply methods like Method of Moments, Pocklington's integral equation, Source modelling.	Understand

Laboratory Experiments:
PRACTICAL COMPONENT OF IPCC: Conduct the experiments using MATLAB / Scilab / any antenna simulation tool.

Sl. No.	Experiments
1.	MATLAB/C implementation to obtain the radiation pattern of an antenna.
2.	Study of radiation pattern of different antennas.
3.	Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.
4.	Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.
5.	Study of radiation pattern of E& H plane horns.
6.	Significance of Pocklington's integral equation.
7.	Measurement of radiation pattern of reflector antennas
8.	Design and simulation of Microstrip antenna
9.	Performance analysis of Log periodic antenna
10.	Performance analysis of Helix antenna.

Textbook:

1. 'Antenna Theory and Design', Stutzman and Thiele, John Wiley, 2nd Edition, 2010

Reference Books:

- 'Antenna Theory Analysis and Design', C. A. Balanis, John Wiley, 2nd Edition, 2007
- 'Antennas and Wave Propagation', J. D. Krauss, McGraw Hill TMH, 4th Edition, 2010
- 'Antennas and propagation', A.R.Harish, M.Sachidanada, Pearson Education, 2015

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=GWKNKxERoyk https://www.youtube.com/watch?v=66cOzMYWmWc

Advanced Communication Systems

Course Code	24ECS22	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**3:0:0**	SEE Marks	50
Total Number of Lecture Hours	**40 hours Theory**	Exam Hours	**03**
Credits - 03			

Module-1

Signal Representation: Low pass representation of bandpass signals, Low pass representation of bandpass random process [Text 1, Chapter 2:2.1, and 2.9 only]. **Modulation**: Representation of digitally modulated Signals, Modulation Schemes without memory (Band Limited Schemes - PAM, BPSK, QPSK, MPSK, MQAM, Power Limited Schemes – FSK, MFSK, DPSK, DQPSK), modulation schemes with memory (Basics of CPFSK and CPM – Full Treatment of MSK), Transmit PSD for Modulation Schemes. (Section 3.4) [Text 1, Chapter 3:3.1, 3.2 and 3.3].

RBT levels: L2, L3

Module-2

Demodulation: Vector Channel, Vector Channel +AWGN, Performance parameters, Optimum Coherent Detection for power limited and Bandlimited schemes, Optimal Coherent detection for schemes with memory, Optimal Non– Coherent detection for schemes without and with memory (FSK, DPSK, DQPSK), Comparison of detection schemes [Text 1, Chapter 4: 4.1, 4.2.- 4.2.2, 4.3, 4.4, 4.5.1, 4.5.2, 4.5.5 and 4.6].

RBT levels: L2, L3

Module-3

Bandlimited Channels: Bandlimited channel characterization, signaling through band limited linear filter channels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes, Optimum receiver for channel with ISI and AWGN. **Linear Equalizers**: Zero forcing Equalizer, MSE and MMSE, Baseband and Passband Linear Equalizers. Performance of ZFE and MSE (Excluding 9.4-3, 9.4-4) [Text 1, Chapter 9: 9.1, 9.2 - 9.2.1,
9.2.2, 9.2.3, 9.3-9.3.1, 9.3.2 and 9.4].

RBT levels: L2, L3

Module-4

Non-Linear Equalizers: Decision - feedback equalization, Predictive DFE, Performance of DFE [Text 1, Chapter 9: 9.5: 9.5-1 only] .

Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive Fractionally spaced Equalizer (Tap Leakage Algorithm), Adaptive equalization of Trellis - coded signals [Text 1, Chapter 10: 10.1, 10.1- 1, 10.1-2, 10.1-3, 10.1-6,10.1-7, 10.2, 10.3].

RBT levels: L2, L3

Module-5

Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS spread spectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS, Synchronization of SS systems[Text 1, Chapter 12: 12.1, 12.2 (except 12.2.1), 12.2.2, 12.2.5, 12.3, 12.4, 12.5].

RBT levels: L2, L3

Textbook:
Digital Communications , John G. Proakis, Masoud Salehi, Pearson Education, ISBN:978-9332535893, 5th edition, 2014

Reference Books:

- 'Digital Communications: Fundamentals and Applications: Fundamentals & Applications', Bernard Sklar, Pearson Education, ISBN:9788131720929, 2nd edition, 2009
- 'Digital Communications Systems', Simon Haykin, Wiley, ISBN:9788126542314, 1st edition, 2014

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=atUKokLXt3k**
- **https://www.youtube.com/watch?v=4oQBM94-jGs**
- **https://www.youtube.com/watch?v=gP09GMjZ6q4**
- **https://www.youtube.com/watch?v=lHSzoWmyynQ**

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Skill development activities: Under Skill development activities in a concerning course, the students should

- Interact with industry (small, medium, and large).
- Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
- Involve in case studies and field visits/ fieldwork.
- Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
- Handle advanced instruments to enhance technical talent.
- Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
- Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical – activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the concepts of low pass and Bandpass signals representations at the Transmitter, the process of Detection and Estimation at the receiver in the presence of AWGN	Understand
CO2	Able to analyze the Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-bandlimited and bandlimited channels.	Analyse
CO3	Able to analyze and demonstrate the model of discrete time channel with ISI & the model of discrete time channel by equalizer.	Analyse
CO4	Able to understand single carrier equalizers for various symbol modulation schemes and detection methods for defined channel models, and compute parameters to meet desired rate and performance requirements.	Analyse
CO5	Able to analyze the Non band limited and Non power limited spread spectrum systems for communications in a Jamming environment, multiuser situation and low power intercept environment.	Analyse

Error Control Coding

Course Code	**24ECS23**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			

Module-1

Information theory: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem (Chap. 5 of Text 1).
Introduction to algebra: Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2m) and its properties, (Only statements of theorems without proof) Computation using Galois field GF (2m) arithmetic, Vector spaces and Matrices (Chap. 2 of Text 2).

RBT levels: L2, L3

Module-2

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes(Chap. 3 of Text 2).

RBT levels: L2, L3

Module-3

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes (Chap. 4 of Text2).

RBT levels: L2, L3

Module-4

BCH codes: Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. (6.1,6.2,6.7 of Text 2) Primitive BCH codes over GF (q), **Reed -Solomon codes** (7.2,7.3 of Text 2).
Majority Logic decodable codes: One -step majority logic decoding, Multiplestep majority logic (8.1,8.4 of Text 2).

RBT levels: L2, L3

Module-5

Convolution codes: Encoding of convolutional codes: Systematic and Nonsystematic Convolutional Codes, Feedforward encoder inverse, A catastrophic encoder, Structural properties of convolutional codes: state diagram, state table, state transition table, tree diagram, trellis diagram. Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding (11.1, 11.2, 12.1,13.1 of Text 2).

RBT levels: L2, L3

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the concept of modern algebra, probability theory, the Entropy, information rate and capacity for the Discrete memoryless channel.	Understand
CO2	Able to understand and Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes.	Understand
CO3	Able to Understand error detection and correction for different data communication and storage systems.	Understand
CO4	Able to Analyze and implement different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm.	Analyze

Textbooks:

1. 'Digital Communication systems', Simon Haykin, Wiley India Private. Ltd, ISBN 978-81-265-4231-4, First edition, 2014
2. 'Error control coding', Shu Lin and Daniel J. Costello. Jr, Pearson, Prentice Hall, 2nd edition, 2004

Reference Books:

1. 'Theory and practice of error control codes', Blahut. R. E, Addison Wesley, 1984
2. 'Introduction to Error control coding', Salvatore Gravano, Oxford University Press, 2007
3. 'Digital Communications - Fundamentals and Applications', Bernard Sklar, Pearson Education (Asia) Pvt. Ltd., 2nd Edition, 2001

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
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3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Multimedia over Communication Links

Course Code	24ECS24	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**3:0:0**	SEE Marks	50
Total Number of Lecture Hours	**40 hours Theory**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module 1

Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology (Chap. 1 of Text1).

Information Representation: Introduction, Text, Images (Chap. 2- Sections 2.2 and 2.3 of Text 1).

RBT levels: L2, L3

Module 2

Information Representation: Audio and Video (Chap. 2 - Sections 2.4 and 2.5 of Text 1).

Distributed multimedia systems: Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems (Chap. 4 - Sections 4.1 to 4.5 of Text 2).

RBT levels: L2, L3

Module 3

Multimedia Processing in Communication: Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders(Chap. 3 - Sections 3.1, 3.2, 3.6, 3.7 of Text 2).

RBT levels: L2, L3

Module 4

Multimedia Communication Standards: Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4 (Chap. 5 - Sections 5.1 to 5.4 and 5.5.1 of Text 2).

RBT levels: L2, L3

Module 5

Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks (Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2).

RBT levels: L2, L3

Course Outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand basics of different multimedia networks and applications	Understand
CO2	Able to Analyze media types like audio and video to represent in digital form.	Analyze
CO3	Able to understand different compression techniques to compress audio.	Understand
CO4	Able to Understand different compression techniques to compress audio video.	Understand
CO5	Able to understand the basics of Multimedia Communication Across Networks	Understand

Text Books:

- 'Multimedia Communications', Fred Halsall, Pearson education, 2001, ISBN - 9788131709948.
- 'Multimedia Communication Systems', K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, Pearson education, 2004. ISBN- 9788120321458.

Reference Book:

- Ralf Steinmetz, Klara Nahrstedt, 'Multimedia: Computing, Communications and Applications', Pearson education, 2002, ISBN - 9788177584417.

Skill development activities: Under Skill development activities in a concerning course, the students should

- Interact with industry (small, medium, and large).
- Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
- Involve in case studies and field visits/ fieldwork.
- Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
- Handle advanced instruments to enhance technical talent.
- Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
- Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.
- All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Professional Elective III

Wireless Sensor Networks

Course Code	24ECS211	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module-1

Introduction: Sensor Mote Platforms, WSN Architecture and Protocol Stack (Chap. 1Text 1).
WSN Applications: Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications (Chap. 2 Text 1).

RBT levels: L2, L3

Module-2

Factors Influencing WSN Design: Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption (Chap. 3 Text 1). **Physical Layer**: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards (Chap. 4 of Text 1).

RBT levels: L2, L3

Module-3

Medium Access Control: Challenges for MAC, CSMA Mechanism, Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access (Chap. 5 of Text 1).
Network Layer: Challenges for Routing, Data-centric and Flat Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols (Chap. 7 of Text 1).

RBT levels: L2, L3

Module-4

Transport Layer: Challenges for Transport Layer, Reliable Multi Segment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol, Event-to-Sink Reliable Transport (ESRT) Protocol, GARUDA (Chap. 8 Text 1).
Application Layer: Source Coding (Data Compression), Query Processing, Network Management (Chap. 9 Text 1).

RBT levels: L2, L3

Module-5

Time Synchronization: Challenges for Time Synchronization, Network Time Protocol, Timing-Sync Protocol for Sensor Networks (TPSN), Reference- Broadcast Synchronization (RBS), Adaptive Clock Synchronization (ACS) (Chap. 11 of Text1).
Localization; Challenges in Localization, Ranging Techniques, Range-Based Localization Protocols, Range-Free Localization Protocols. (Chap. 12 Text 1).

RBT levels: L2, L3

Textbooks:

- 'Wireless Sensor Networks', Ian F. Akyildiz and Mehmet Can Vuran, John Wiley & Sons Ltd. ISBN 978-0- 470-03601-3 (H/B), 2010
- Wireless Sensor Networks:Signal Processing and Communications Perspectives', Ananthram Swami, et. al., John Wiley & Sons Ltd., ISBN 978-0470-03557-3, 2007

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=IR4jIFiHwgc
https://www.youtube.com/watch?v=TNXS05Efumo
https://www.youtube.com/watch?v=7h5Wwk_mheg
https://www.youtube.com/watch?v=sx0UPzztC5o
https://www.youtube.com/watch?v=SHO9eeWxPxY
https://www.youtube.com/watch?v=ZYIdYIt7W_g&t=24s

Skill development activities: Under Skill development activities in a concerning course, the students should

- Interact with industry (small, medium, and large).
- Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
- Involve in case studies and field visits/ fieldwork.
- Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
- Handle advanced instruments to enhance technical talent.
- Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
- Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill.
The prepared report shall be evaluated for CIE marks.

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the basic concepts of Wireless sensor networks architecture and protocols. .	Understand
CO2	Able to understand the challenges in designing a Wireless sensor networks.	Understand
CO3	Able to the function of Data link and Network layer Protocols.	Understand
CO4	Able to understand the function of Transport layer Protocols.	Analyse
CO5	Able to analyse the wireless sensor network system for different applications under consideration	Understand

Cryptography and Network Security

Course Code	24ECS212	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module-1

Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads, Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6).
SYMMETRIC CIPHERS: Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2: Section2.1, 2.2, Chapter 4).

RBT levels: L2, L3

Module-2

Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5). Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie – Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1:Chapter 8, Chapter 9: Section 9.1, 9.3, 9.4).

RBT levels: L2, L3

Module-3

Pseudo-Random-Sequence Generators and Stream Ciphers: Linear Congruential Generators, Linear Feedback Shift Registers, Design and analysis of stream ciphers, Stream ciphers using LFSRs, A5, Hughes XPD/KPD, Nanoteq, Rambutan, Additive generators, Gifford, Algorithm M, PKZIP (Text 2: Chapter 16).

RBT levels: L2, L3

Module-4

One-Way Hash Functions: Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA], One way hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes. Digital Signature Algorithm, Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4).

RBT levels: L2, L3

Module-5

E-mail Security: Pretty Good Privacy-S/MIME (Text 1: Chapter 17: Section 17.1, 17.2).
IP Security: IP Security Overview, IP Security Policy, Encapsulation Security Payload (ESP), Combining security Associations. (Text 1: Chapter 18: Section18.1 to 18.4).
Web Security: Web Security Considerations, SSL (Text 1: Chapter 15: Section 15.1, 15.2).

RBT levels: L2, L3

Textbooks:

- 'Cryptography and Network Security Principles and Practice', William Stallings, Pearson Education Inc., ISBN: 978-93325-1877-3, 6th Edition, 2014
- 'Applied Cryptography Protocols, Algorithms, and Source code in C', Bruce Schneier, Wiley Publications ISBN: 9971-51348-X, 2nd Edition

Reference Books:

- 'Cryptography and Network Security', Behrouz A. Forouzan, TMH, 2007
- 'Cryptography and Network Security', Atul Kahate, TMH, 2003

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=iTVyKbDCJrA&**list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2**
https://www.youtube.com/watch?v=eIJzIUhks6E&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2&index=3

- **https://www.youtube.com/watch?v=NrRJInkFsyQ&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2&index=4**

Skill development activities: Under Skill development activities in a concerning course, the students should

- Interact with industry (small, medium, and large).
- Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
- Involve in case studies and field visits/ fieldwork.
- Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
- Handle advanced instruments to enhance technical talent.
- Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
- Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The
students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand and design the basics of cryptographic algorithms, symmetric key and public key cryptography.	L2,L3
CO2	Able to understand the Generation some pseudorandom numbers required for cryptographic applications.	L2
CO3	Able to understand for providing the authentication and protection for encrypted data.	L1,L2
CO4	Able to understand techniques and features of Email, IP and Web security.	L2

Biomedical Signal Processing

Course Code	24ECS213	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module-1

Introduction-Genesis and significance of bio electric potentials, ECG, EEG, EMG and their monitoring and measurement, Spectral analysis.

RBT levels: L2, L3

Module-2

Filtering- Digital and Analog filtering, Correlation and Estimation techniques, AR / ARMA models.

RBT levels: L2, L3

Module-3

ECG-Pre-processing, Measurements of amplitude and time intervals, Classification, QRS detection, ST segment analysis, Base line wander removal, waveform recognition, morphological studies and rhythm analysis, automated diagnosis based on decision theory ECT compression, Evoked potential estimation.

RBT levels: L2, L3

Module-4

EEG: Evoked responses, Epilepsy detection, Spike detection, Hjorth parameters, averaging techniques, removal of Artifacts by averaging and adaptive algorithms, pattern recognition of alpha, beta, theta and delta waves in EEG waves, sleep stages.

RBT levels: L2, L3

Module-5

EMG-Wave pattern studies, bio feedback, Zero crossings, Integrated EMG. Time frequency methods and Wavelets in Biomedical Signal Processing.

RBT levels: L2, L3

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- Involve in case studies and field visits/ fieldwork.
- Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
- Handle advanced instruments to enhance technical talent.
- Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
- Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant
technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Textbook:

- 'Biomedical Digital Signal Processing', Willis J Tompkins, Prentice Hall of India, 1996.

Reference Books:

- 'Biomedical Signal Processing (in IV parts)', R E Challis and RI Kitney, Medical and Biological Engg. and current computing, 1990-91.
- Special issue on 'Biological Signal Processing', Proc. IEEE 1972.
- 'Biomedical Signal Processing', Arnon Cohen, Volumes I & II, CRC Press.
- 'Time frequency and Wavelets in Biomedical Signal Processing', Metin Akay, IEEE Press, 1999. Current Published literature.

Web links and Video Lectures (e-Resources):
https://www.youtube.com/watch?v=OqNDFF1RsMU
https://www.youtube.com/watch?v=7Kf0kWqqFAk
https://www.youtube.com/watch?v=YTH-CXphdXw
https://www.youtube.com/watch?v=aoLktSYOfwg

Skill development activities: Under Skill development activities in a concerning course, the students should

- Interact with industry (small, medium, and large).
- Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
- Involve in case studies and field visits/ fieldwork.
- Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
- Handle advanced instruments to enhance technical talent.
- Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
- Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.
- All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand a biomedical system.	Understand
CO2	Able to understand various methods of acquiring bio signals.	Understand
CO3	Able to understand various sources of bio signal distortions and its remedial techniques.	Understand
CO4	Able to Analyze ECG and EEG signal with characteristic feature points.	Analyze
CO5	Able to understand the use of bio signals in diagnosis, patient monitoring and physiological investigation.	Understand

Advances in Image Processing

Course Code	24ECS214	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Exam Hours	**03**
Credits – 03			

Module-1
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images. **RBT levels: L2, L3**
Module-2
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing. **RBT levels: L2, L3**
Module-3
Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing. **RBT levels: L2, L3**
Module-4
Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull. **RBT levels: L2, L3**
Module-5
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds. **RBT levels: L2, L3**

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the representation of the digital image and its properties.	Understand
CO2	Able to Apply pre-processing techniques required to enhance the image for its further analysis.	Apply
CO3	Able to understand segmentation techniques to select the region of interest in the image for analysis.	Understand
CO4	Able to Understand the representation of the image based on its shape and edge information	Understand
CO5	Able to Understand the morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.	Analyze

Text Book:

- 'Image Processing, Analysis, and Machine Vision', Milan Sonka, Vaclav Hlavac, Roger Boyle, Cengage Learning, ISBN: 978-81-315-1883-0, 2013

Reference Books:

- 'Digital Image Processing for Medical Applications', Geoff Doughertry, Cambridge university Press, 2010.
- 'Digital Image Processing', S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2011.

Professional Elective IV

Statistical Signal Processing

Course Code	24ECS221	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module-1
Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes (Text 1). **RBT levels: L2, L3**
Module 2
Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion (Text 1). **RBT levels: L2, L3**
Module 3
Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation (Text 1). **RBT levels: L2, L3**
Module 4
Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms (Text 1). **RBT levels: L2, L3**
Module 5
Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beamforming, linearly constrained minimum-variance beam-formers, side-lobe cancellers (Text 2). **RBT levels: L2, L3**

Course Outcomes:

COs	**Description**	Blooms Level
CO1	Able to Analyze statistical DSP algorithms to meet desired needs	Analyze
CO2	Able to Analyze vector space methods to statistical signal processing problems	Analyze
CO3	Able to understand Wiener filter theory and design discrete and continuous Wiener filters	Understand
CO4	Able to Understand Kalman Filter theory and design discrete Kalman filters	Understand
CO5	Able to apply computer tools (such as MATLAB) in developing and testing stochastic DSP algorithms	Analyze

Text Books:

- 'Statistical Digital Signal Processing and Modeling', Monson H Hayes, John Wiley & Sons (Asia) Pvt. Ltd., 2002.
- 'Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing', Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, McGraw Hill International Edition, 2000.

Skill development activities: Under Skill development activities in a concerning course, the students should

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Array Signal Processing

Course Code	24ECS222	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module 1
Spatial Signals: Signals in space and time, Spatial Frequency vs Temporal Frequency, Review of Co- ordinate Systems, Maxwell's Equation, Wave Equation. Solution to Wave equation in Cartesian Co- ordinate system –Wave number vector, Slowness vector. **RBT levels: L2, L3**
Module 2
Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals. **RBT levels: L2, L3**
Module 3
Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former. **RBT levels: L2, L3**
Module 4
Uniform Linear Arrays: Beam pattern in θ, u and ψ -space, Uniformly Weighted Linear Arrays. **Beam Pattern Parameters:** Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering. **RBT levels: L2, L3**
Module 5
Array Design Methods: Visible region, Duality between Time -Domain and Space -Domain Signal Processing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward - Lawson Frequency-Sampling Design. Non parametric method -Beam forming, Delay and sum Method, Capons Method. **RBT levels: L2, L3**

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to Understand the basics of signals in space and time.	Understand
CO2	Able to Understand the important concepts of array signal processing.	Understand
CO3	Able to Understand the basic principle of direction of arrival estimation techniques.	Understand
CO4	Able to Understand the basic principle of direction of arrival estimation techniques.	Understand
CO5	Able to Understand the Concepts of Spatial Frequency along with the Spatial Samplings.	Understand

Text Book:

- 'Optimum Array Processing Part IV of Detection, Estimation, and Modulation Theory', Harry L. Van Trees, John Wiley & Sons, ISBN: 9780471093909, 2002.

Reference Books:

- 'Array Signal Processing: Concepts and Techniques', Don H. Johnson, Dan E. Dugeon, Prentice Hall Signal Processing Series, 1st Edition, ISBN-13: 978-0130485137.
- 'Spectral Analysis of Signals', PetreStoica and Randolph L. Moses, Prentice Hall, ISBN: 0-13-113956-8, 2005.

- 'Electromagnetic Waves and Antennas', Sophocles J. Orfanidis, ECE Department, Rutgers University, 94 Brett Road Piscataway, NJ 88548058. http://www.ece.rutgers.edu/~orfanidi/ewa/ISBN: 0-07-114243- 64, 2003.
- "Real-Time Concepts for Embedded Systems", Qing Li and Carolyn Yao, CMP Books, ISBN:1578201241, 2003.
- "Real Time Systems", Jane W. S. Liu, Prentice Hall, ISBN: 0130996513, 2000.
- "Real-Time Systems Design and Analysis", Phillip A. Laplante, John Wiley & Sons, 2004.

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Digital Compression

Course Code	24ECS223	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Exam Hours	**03**
Credits – 03			

Module-1

Introduction: Compression techniques, Modelling & coding, Distortion criteria, Differential Entropy, Rate Distortion Theory, Vector Spaces, Information theory, Models for sources, Coding uniquely decodable codes, Prefix codes, Kraft McMillan Inequality.

Quantization: Quantization problem, Uniform Quantizer, Adaptive Quantization, Non-uniform Quantization; Entropy coded Quantization, Vector Quantization, LBG algorithm, Tree structured VQ, Structured VQ.

RBT levels: L2, L3

Module-2

Differential Encoding: Basic algorithm, Prediction in DPCM, Adaptive DPCM, Delta Modulation, Speech coding–G.726, Image coding.

Transform Coding: Transforms – KLT, DCT, DST, DWHT; Quantization and coding of transform coefficients, Application to Image compression – JPEG, Application to audio compression.

RBT levels: L2, L3

Module-3

Sub-band Coding: Filters, Sub-band coding algorithm, Design of filter banks, Perfect reconstruction using two channel filter banks, M-band QMF filter banks, Poly-phase decomposition, Bit allocation, Speech coding– G.722, Audio coding–MPEG audio, Image compression.

RBT levels: L2, L3

Module-4

Wavelet Based Compression: Wavelets, Multi resolution analysis & scaling function, Implementation using filters, Image compression–EZW, SPIHT, JPEG 2000.

Analysis/Synthesis Schemes: Speech compression–LPC10, CELP, MELP. **Video Compression:** Motion compensation, Video signal representation, Algorithms for video conferencing & video phones–H.261, H.263, Asymmetric applications–MPEG 4, MPEG 7, Packet video.

RBT levels: L2, L3

Module-5

Loss less Coding: Huffman coding, Adaptive Huffman coding, Golomb codes, Rice codes, Tunstall codes, Applications of Huffman coding, Arithmetic coding, Algorithm implementation, Applications of Arithmetic coding, Dictionary techniques–LZ77, LZ78, Applications of LZ78–JBIG, JBIG2, Predictive coding– Prediction with partial match, Burrows Wheeler Transform, Applications– CALIC, JPEG-LS.

RBT levels: L2, L3

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the concept of digital compression, including entropy, redundancy, and quantization techniques.	Understand L2
CO2	Able to and evaluate the performance of different lossless coding, sub-band coding and compression algorithms based on metrics like compression ratio, bit rate.	Understand L2
CO3	Able to describe the principles of various compression algorithms, including DCT, sub-band coding, transform coding and wavelet based compression.	Understand L2
CO4	Able to apply different analysis/synthesis scheme for speech and video compression.	Apply L3

Textbook:

- Introduction to Data Compression', K Sayood, Harcourt India Pvt. Ltd. & Morgan Kaufmann Publishers, 1996.

Reference Books:

- 'Digital Coding of Waveforms: Principles and Applications to Speech and Video', N Jayant and P Noll, Prentice Hall, USA, 1984.
- 'Data Compression: The Complete Reference', D Salomon, Springer, 2000.
- 'Fundamentals of Multimedia', Z Li and M S Drew, Pearson Education (Asia) Pvt. Ltd., 2004.

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Wavelet Transforms and Applications

Course Code	24ECS224	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	**40 hours**	Exam Hours	**03**
Credits – 03			

Module-1

Continuous Wavelet Transform: Continuous time frequency representation of signals, The Windowed Fourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, specifications, admissibility conditions, Continuous wavelet transform, CWT as a correlation, CWT as an operator, Inverse CWT.

RBT levels: L2, L3

Module-2

Discrete wavelet Transform: Approximations of vectors in nested linear vector spaces, Example of an MRA, Formal definition of MRA, Construction of genera orthonormal MRA, a Wavelet basis for MRA, Digital filtering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm Filter bank implementation of DWT.

RBT levels: L2, L3

Module-3

Alternative wavelet representations- Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets, biorthogonal analysis and synthesis, Filter bank implementation, Two dimensional Wavelets, filter bank implementation of two-dimensional wavelet transform.

RBT levels: L2, L3

Module-4

Lifting scheme: Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme, lifting scheme in the z- domain, mathematical preliminaries for polyphase factorization, Dealing with Signal Boundary.

RBT levels: L2, L3

Module-5

Applications: Image Compression: EZW Coding, SPIHT, Wavelet Difference Reduction Compression Algorithm, Denoising, speckle removal, edge detection and object isolation, audio compression, communication applications – scaling functions as signalling pulses, Discrete Wavelet Multitone Modulation. **Beyond Wavelet:** Ridge lets and curve lets: Ridge let transform and Digital Curve let transform, Curve let construction, Properties and applications.

RBT levels: L2, L3

Textbooks:

- Wavelet Transforms –Introduction and applications - Raghuveer M. Rao and Ajit S. Bopardikar- - Pearson Education, 2008
- Insight into Wavelets from Theory to practice - K.P Soman, K. I. Ramachandran, PHI, 2006
- Fundamentals of Wavelets: Thory, Algorithms and Applications- J C Goswamy and A K Chan, Wiley- Inderscience Publications, John Wiley and Sons, 1999.

Advanced Communication Laboratory			
Course Code	24ECS25	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	**0:4:0:0**	SEE Marks	50
Credits -02	Exam Hours:3	Total Hours	100

Sl.NO	Experiments
1	Simulation of ASK modulation and demodulation
2	Simulation of FSK modulation and demodulation
3	Simulation of BPSK modulation and demodulation
4	Simulation of QPSK modulation and demodulation
5	Simulation of signal constellation QPSK with Rayleigh fading and AWGN
6	Simulation of signal constellation M-ary QAM with AWGN fading
7	To simulate the communication link
8	To simulate Zero Forcing algorithm
9	To simulate LMS algorithm
10	Generation of m-Sequence and verify its properties
	Generation Gold Sequence and verify its properties
	Note: Conduct the experiments using MATLAB/PYTHON/OCTAVE

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination (SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marks is scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

ABILITY/SKILL ENHANCEMENT COURSE (OFFLINE/ONLINE)

Modelling and Simulation of Antenna Using Simulation Tool			
Course Code	24ECS261	CIE Marks	50
Teaching Hours/Week (L:T:P)	**0:0:2**	SEE Marks	50
Credits -01	Exam Hours:3	Total Marks	100

Course objectives:

- Understand the basic concepts of antenna theory.
- Identify antenna types for specific applications.
- To design antennas like dipole, Yagi-Uda, Microstrip patch antenna, MIMO antenna, Helical antennas and other broad band antennas
- To describe different antenna synthesis methods.

Sl.NO	Experiments
1.	Design and simulate 1 GHz dipole antenna using suitable high frequency simulation tool, for return loss and gain characteristics
2.	Create and simulate a 5 element Yagi-Uda antenna using a copper wire with given data • Resonance frequency of 3 GHz • wire diameter of 1 mm. Study return Loss (RL) and gain characteristics
3.	Design, model and simulate microstrip patch antenna at 2.45 GHZ for blue-tooth applications. Study its radiation pattern in terms of E and H plane.
4.	Design, model and simulate 2 element MIMO antennas for 5G applications in Frequency Range-1. Perform isolation analysis and return loss characterization
5.	Design, model and simulate 4 element array antennas for a suitable frequency and study • Return loss characteristics • gain • radiation pattern.
6.	Design, model and simulate normal mode helical antenna (NMHA) at 1.8 GHz. Study its return loss characteristics and effect of wire radius (between $\lambda/180$ to $\lambda/120$) on Bandwidth.
7.	Design and simulate horn antenna at 2 GHz with a suitable simulator. Study its return loss Characteristics. Observe E-field, H-field and surface current distribution
8.	Design and simulate a parabolic reflector antenna for a suitable frequency with efficiency at 50%. Find reflection coefficient and gain in DB by plotting radiation pattern..
9.	Design, Model and Simulate a log periodic (or planar) antenna at 5 GHz. Study its radiation characteristics and gain.
10.	Design and Analyze VHF/UHF Biconical Antenna. Study its reflection coefficient, bandwidth and Radiation pattern at 300MHz, 600 MHz and 1000 MHz."

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Analyze various antenna parameters and their significance in building the RF system.
- Identify various antenna configurations for suitable applications.
- Design antennas like Yagi-Uda, Helical antennas and other broad band antennas
- Describe different antenna synthesis methods

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be

evaluated for 10 marks.

- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marksis scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 03 hours

Suggested Learning Resources:

- https://pe.gatech.edu/courses/modeling-and-simulation-antennas
- https://www.eledia.org/eledia-unitn/news/antenna-modeling-and-simulation-made-easy-fundamentals-and-hands-on- exercises-2/
- https://www.tonex.com/training-courses/modeling-and-simulation-of-modern-antennas/
- https://innovationspace.ansys.com/product/electromagnetic-simulation-of-an-antenna-using-ansys-discovery/

MATLAB and Simulink			
Course Code	24ECS262	CIE Marks	50
Teaching Hours/Week (L:T:P)	**0:0:2**	SEE Marks	50
Credits -01	Exam Hours:3	Total Marks	100

Course objectives:

- To provide skills for modelling and simulation of communication systems & networks on MatLab platform.
- To provide skills for writing MatLab programs and use communication and signal processing toolboxes.
- To enable the students to implement and validate the algorithms studied in Communication.

Sl. NO	Experiments
1.	Familiarity with MatLab communication and signal processing toolbox
2.	Programs to generate uniformly distributed random variables between [0, 1] using Linear Congruential Generator.
3.	Programs to generate discrete random variables based on inverse transform technique.
4.	Programs to generate discrete random variables based on acceptance rejection technique
5.	Programs to validate random variable generators based on KS test.
6.	Programs to validate random variable generators based on Chi square test.
7.	Programs to validate independence of random variable generators based on Runs test.
8.	Programs to validate independence of random variable generators based on Autocorrelation test.
9.	Programs to use Monte Carlo techniques to estimate parameters of quantities used in communication system.
10.	Designing the digital communication system to evaluate BER vs. SNR performance

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Identify and abstract the simulation model design of communication systems.
- Design and develop modular programming skills on MatLab platform.
- Trace, debug and validate simulation models.
- Able to implement the algorithms required for discrete event simulation.
- Able to implement the validation tests for discrete event simulation models.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation (CIE):

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- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
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- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
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The duration of SEE is 03 hours

Suggested Learning Resources:

- https://www.udemy.com/course/simulink/
- https://in.mathworks.com/learn/training.html
- https://www.nielit.gov.in/calicut/content/online-course-matlab-simulink

https://www.coursera.org/courses?query=matlab%20simulink

Python Programming			
Course Code	24ECS263	CIE Marks	50
Teaching Hours/Week (L:T:P)	**0:0:2**	SEE Marks	50
Credits -01	Exam Hours:3	Total Marks	100

Course objectives:

- To provide skills for modelling and simulation of communication systems & networks on MatLab platform. To provide skills for writing MatLab programs and use communication and signal processing toolboxes.
- To enable the students to implement and validate the algorithms studied in Communication.
- To enable the students to implement and validate the algorithms studied in Communication.

Sl. NO	Experiments
1.	Write a Python program that calculates the sum of the first n terms of the following mathematical series: $1 \frac{x2}{2!} \frac{x4}{4!} \frac{x6}{6!} \frac{xn}{n!} ....$
2.	Write a Python program that reads a file and calculates the number of characters, words, and lines in it.
3.	Write a Python program to compute various matrix and vector operations such as dot product, inner product, outer product, and matrix exponentiation.
4.	• Write a Python program that uses Pandas' built-in visualization tools to create the following plots: • Bar plots • Histograms • Line plots • Scatter plots • Write a program to demonstrate the use of the groupby() method in Pandas. • Write a program that shows how to merge, join, and concatenate dataframes in Pandas. • Write a Python program to create dataframes from CSV and Excel files.
5.	Write a python program to check the validity of a password given by the user. The password should satisfy the following criteria: • Contain at least 1 letter between a and z • Contain at least 1 number between 0 and 9 • Contain at least 1 letter between A and Z • Contain at least 1 character from $, #, @ • Minimum length of password: 6 • Maximum length of password: 12
6.	Write a Python program that performs basic database operations (create, insert, delete, update) using MySQL and its corresponding Python adapter
7.	Write a Python program that accepts a space-separated sequence of words as input and outputs the words in a hyphen- separated sequence after sorting them alphabetically.
8.	Write a Python program that demonstrates data indexing, selection, and filtering using Pandas.
9.	Write a Python GUI application that simulates traffic lights with appropriate colors and text for "Stop", "Wait", and "Go" signals. Write a python program for simple GUI calculator using Tk.
10.	Create a Python class named Person with attributes for name, age, weight (in kg), and height (in feet). The class should have a method get_bmi_result() that calculates the BMI and returns whether the person is "underweight", "healthy", or "obese"
11.	Write a Python program to demonstrate various types of inheritance.

12.	Write a Python program that creates abstract classes and implements abstract methods.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Students will be able to design and implement Python programs that solve complex problems, including mathematical series, file handling, matrix operations, and more.
- Students will be capable of effectively managing and analyzing datasets using Python libraries like Pandas and NumPy, and visualizing the data through bar plots, histograms, line plots, and scatter plots.
- Students will demonstrate the ability to connect Python programs to MySQL databases, perform CRUD (Create, Read, Update, Delete) operations, and manage database interactions proficiently.

Students will be able to apply object-oriented programming concepts like inheritance and abstraction, and develop interactive GUI applications using Tkinter, enhancing the user experience in software solutions

Assessment Details (both CIE and SEE)

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