Semester - II

Antenna Theory and Design			
Course Code	MECE201	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- Students are able to analyze Maxwell's equations for wave propagation and to attain knowledge on the basic antenna parameters.
- Able to understand antenna arrays and synthesis.
- Select the antennas for specific application.

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]

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]

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.

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]

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 modelling weighted residual formulations and computational consideration, Calculation of antenna and scatter characteristics. [Chapter 14 Text 1]

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

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	Study of digital modulation techniques using CD4051 IC.
8	Conduct an experiment for Voice and data multiplexing using optical fiber.
9	Determination of the modes transit time, electronic timing range and sensitivity of Klystron source.
10	Determination of VI characteristics of GUNN diode, and measurement of guide wave length, frequency and VSWR.
11	Determination of coupling coefficient and insertion loss of directional couplers and Magic tee.
12	Build a hardware pseudo-random signal source and determine statistics of the generated signal source.

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. Minimum passing marks in SEE is 40% 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

CIE for the theory component of IPCC

1. Two Tests each of **25 Marks**
2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for **10 marks**. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test at the end /after completion of all the experimentsshall be conducted for **50 marks** and scaled down to **05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by the University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources:

Books

Textbook:

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

Reference Books:

1. 'Antenna Theory Analysis and Design', C. A. Balanis, John Wiley,
2. 2 nd Edition, 2007 2. 'Antennas and Wave Propagation', J. D. Krauss, McGraw Hill TMH, 4 th Edition, 2010
3. 3. '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

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. The subject is practical based.
2. 10 to 12 experiments are to be conducted for this subject.
3. Students should carry out all the experiments and maintain the observation and lab record.
4. At the end of the semester students can apply all theory and lab concepts and carry out a project.

Course outcome (Course Skill Set)

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

Sl. No.	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

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**1**	**1**	**1**
CO2	**3**	**3**	**1**	**2**	**1**	**1**
CO3	**3**	**3**	**2**	**1**	**1**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**1**

Semester- II

Embedded System Design			
Course Code	**MECE202**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hours of teaching and 10-12 sessions for Skill Development Activities	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

To provide an overview of Design Principles of Embedded System.

To provide clear understanding about the role of firmware, operating systems in correlation with hardware systems.

Module-1

Introduction to embedded systems: Embedded systems, Processor embedded into a system, Embedded hardware units and device in a system, Embedded software in a system, Examples of embedded systems, Design process in embedded system, Formalization of system design, Design process and design examples, Classification of embedded systems, skills required for an embedded system designer.

Module-2

Devices and communication buses for devices network: IO types and example, Serial communication devices, Parallel device ports, Sophisticated interfacing features in device ports, Wireless devices, Timer and counting devices, Watchdog timer, Real time clock, Networked embedded systems, Serial bus communication protocols, Parallel bus device protocols-parallel communication internet using ISA, PCI, PCI-X and advanced buses, Internet enabled systems network protocols, Wireless and mobile system protocols

Module-3

Device drivers and interrupts and service mechanism: Programming-I/O busy-wait approach without interrupt service mechanism, ISR concept, Interrupt sources, Interrupt servicing (Handling) Mechanism, Multiple interrupts, Context and the periods for context switching, interrupt latency and deadline, Classification of processors interrupt service mechanism from Context-saving angle, Direct memory access, Device driver programming.

Module-4

Inter process communication and synchronization of processes, Threads and tasks: Multiple process in an application, Multiple threads in an application, Tasks, Task states, Task and Data, Clear-cut distinction between functions. ISRS and tasks by their characteristics, concept and semaphores, Shared data, Inter-process communication, Signal function, Semaphore functions, Message Queue functions, Mailbox functions, Pipe functions, Socket functions, RPC functions.

Module-5

Real-time operating systems: OS Services, Process management, Timer functions, Event functions, Memory management, Device, file and IO subsystems management, Interrupt routines in RTOS environment and handling of interrupt source calls, Real-time operating systems, Basic design using an RTOS, RTOS task scheduling models, interrupt latency and response of the tasks as performance metrics, OS security issues. Introduction to embedded software development process and tools, Host and target machines, Linking and location software

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Books

Embedded Systems: Architecture, Programming, and Design Raj Kamal Tata McGraw hill, 2nd edition 2013 **Reference Book(s):**

1 Computer as Components, Principles of Embedded Computing System Design Marilyn Wolf Elsevier, 3rd edition 2014

Web links and Video Lectures (e-Resources):

- https://youtu.be/GaZBpY9Ys1Y 2. https://youtu.be/SUusup7FfJo 3.https://youtu.be/dHsHP9RrXBw?list=PLJ5C_6qdAvBH-JNRIlupFb44miyx9M8JD 4.https://youtu.be/vn7aT9-cYzQ 5. https://youtu.be/-rWGzFDLnAYhttps://youtu.be/dHsHP9RrXBw?list=PLJ5C_6qdAvBH-JNRIlupFb44miyx9M8JD.

Skill Development Activities Suggested

- 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 evaluated for CIE marks.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Expected to understand the selection procedure of Processors in the Embedded domain. Design Procedure for Embedded Firmware	L3
CO2	Expected to visualize the role of Real-time Operating Systems in Embedded Systems ·	L3
CO3	Expected to evaluate the Correlation between task synchronization and latency issues	L3, L4

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**-**	**2**	**2**	**-**	**1**
CO2	**2**	**-**	**2**	**2**	**-**	**1**
CO3	**2**	**-**	**2**	**2**	**-**	**1**

Semester- II

Advanced Communication System			
Course Code	**MECE203**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	02:00:02	SEE Marks	50
Total Hours of Pedagogy	30 hours Theory+10 SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

- To understand the different ways of presenting the signals and different modulation schemes for efficient communication.
- To understand and analyse different demodulation techniques without loss of data.
- To analyze and demonstrate the model of discrete time channel.
- To understand the working principles of different Equalizers.
- To understand and analyze Spread Spectrum digital communication system.

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].

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].

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].

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 [Text1, Chapter 10: 10.1, 10.1- 1, 10.1-2, 10.1-3, 10.1-6, 10.1-7, 10.2, and 10.3].

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].

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Textbook:

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

Reference Books:

1. 'Digital Communications: Fundamentals and Applications: Fundamentals & Applications', Bernard Sklar, Pearson Education, ISBN:9788131720929, 2nd edition, 2009
2. '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**
- **https://www.youtube.com/watch?v=lHSzoWmyynQ**.

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 evaluated for CIE marks.

Course outcome (Course Skill Set)

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

Sl. No.	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	L2
CO2	Able to analyze the Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-bandlimited and bandlimited channels.	L3
CO3	Able to analyze and demonstrate the model of discrete time channel with ISI & the model of discrete time channel by equalizer.	L2,L3
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.	L2, L3
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.	L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain.	PO6

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**1**	**1**	**1**
CO2	**3**	**3**	**1**	**2**	**1**	**1**
CO3	**3**	**3**	**2**	**1**	**1**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**1**

Semester- II

Internet of Things			
Course Code	**MECE204**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course Learning objectives:

- Describe the fundamental concepts of IoT, including its architecture, components, and ecosystem.
- Recognize the various layers of IoT architecture and their roles in IoT solutions.
- Identify and evaluate the major IoT communication protocols and standards (e.g., MQTT, CoAP, HTTP).
- Develop IoT applications by integrating sensors, actuators, and controllers.
- Explain the role of data analytics and data management in IoT applications.
- Explore various case studies of IoT applications in fields like healthcare, smart cities, agriculture, and industrial automation.

Module-1

What is IoT : Genesis, Digitization, Impact, Connected Roadways, Buildings, Challenges
IoT Network Architecture and Design: Drivers behind new network Architectures, Comparing IoT Architectures, M2M architecture, IoT world forum standard, IoT Reference Model, Simplified IoT Architecture.

Module-2

IoT Network Architecture and Design:Core IoT Functional Stack, Layer1 (Sensors and Actuators), Layer 2 (Communications Sublayer), Access network sublayer, Gateways and backhaul sublayer, Network transport sublayer, IoT Network management. Layer 3 (Applications and Analytics) – Analytics vs Control, Data vs Network Analytics, IoT Data Management and Compute Stack

Module-3

Engineering IoT Networks: Things in IoT – Sensors, Actuators, MEMS and smart objects. Sensor networks, WSN, Communication protocols for WSN Communications Criteria, Range, Frequency bands, power consumption, Topology, Constrained Devices, Constrained Node Networks IoT Access Technologies, IEEE 802.15.4 Competitive Technologies – Overview only of IEEE 802.15.4g, 4e, IEEE 1901.2a Standard Alliances – LTE Cat 0, LTE-M, NB-IoT

Module-4

Engineering IoT Networks: IP as IoT network layer, Key Advantages, Adoption, Optimization, Constrained Nodes, Constrained Networks, IP versions, Optimizing IP for IoT. Application Protocols for IoT – Transport Layer, Application Transport layer, Background only of SCADA, Generic web based protocols, IoT Application Layer Data and Analytics for IoT – Introduction, Structured and Unstructured data, IoT Data Analytics overview and Challenges.

Module-5

IoT in Industry (Three Use cases): IoT Strategy for Connected manufacturing, Architecture for Connected Factory Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary substation grid block and automation. Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart street lighting.

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Books

1. 'CISCO, IoT Fundamentals – Networking Technologies, Protocols, Use Cases for IoT', David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Pearson Education, ISBN: 978-9386873743, First edition, 2017
2. 'Internet of Things – A Hands on Approach', ArshdeepBahga and Vijay Madisetti, Orient Blackswan Private Limited - New Delhi, First edition, 2015

Web links and Video Lectures (e-Resources):

- .IEEE IoT Resources: IEEE provides access to IoT research papers, protocol standards, and professional articles on emerging IoT technologies.
- ThingSpeak IoT Platform: A platform for IoT data collection and analytics with guides for using MATLAB, visualization, and IoT system integration.
- IoT Security Foundation: Offers best practices, whitepapers, and insights into ensuring privacy and security in IoT applications.
- Cisco IoT Solutions: Provides insights into IoT architectures and protocols, focusing on networking requirements and solutions.

Skill Development Activities Suggested

- Build Basic IoT Applications with Microcontrollers
- Set Up and Configure IoT Protocols
- Design a Smart Home Prototype
- Cloud Integration and Data Storage
- Create a Real-Time Data Dashboard

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 basic concepts IoT Architecture and devices employed.	L1
CO2	Analyze the sensor data generated and map it to IoT protocol stack for transport.	L4
CO3	Apply communications knowledge to facilitate transport of IoT data over various available communications media	L3
CO4	Design a use case for a typical application in real life ranging from sensing devices to analyzing the data available on a server to perform tasks on the device	L5
CO5	Apply knowledge of Information technology to design of IoT applications (Operational Technology).	L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**1**	**1**	**2**	**1**
CO2	**1**	**2**	**1**	**2**	**1**	**1**
CO3	**1**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**1**	**1**	**1**	**1**
CO5	**1**	**1**	**1**	**1**	**1**	**1**

Semester- II

Nano Electronics			
Course Code	**MECE215A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 Hours Theory + 10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives: This course will enable students to:

- Know the principles behind Nanoscience engineering and Nanoelectronics.
- Apply the knowledge to prepare and characterize nanomaterials.
- Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials.
- Design the process flow required to fabricate state of the art transistor technology.
- Analyze the requirements for new materials and device structure in the future technologies

Module-1

Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moore'slaw and continued miniaturization, Classification of Nanostructures, Electronic properties of atoms and solids: Isolated atom, Bonding between atoms, Giant molecular solids, Free electron models and energy bands, crystalline solids, Periodicity of crystal lattices, electronic conduction, effects of nanometer length scale, Fabrication methods: Top-down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nano systems.

Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques, spectroscopy techniques: photon, radiofrequency, electron, surface analysis and depth profiling: electron, mass, Ion beam, Reflectometry Techniques for property measurement: mechanical, electron, magnetic, thermal properties.

Module-3

Inorganic semiconductor nanostructures: Overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states.

Carbon Nanostructures: Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes

Module-4

Fabrication techniques: Requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques.

Physical processes: Modulation doping, quantum hall effect, resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural.

Module-5

Methods of measuring properties: Atomic, crystallography, microscopy, spectroscopy.

Applications: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIPs, NEMS, MEMS.

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Books

1. 'Nanoscale Science and Technology', Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, John Wiley, 2007
2. Introduction to Nanotechnology', Charles P Poole, Jr, Frank J Owens, John Wiley, Copyright 2006, Reprint 2011

Reference Book

1.Hand Book of Nanoscience Engineering and Technology', Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, CRC press, 2003

Web links and Video Lectures (e-Resources):

1. https://www.digimat.in/nptel/courses/video/117108047/L01.html
2. https://archive.nptel.ac.in/courses/117/108/117108047/

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,
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.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Know the principles behind Nanoscience engineering and Nanoelectronics	L2 (Understand)
CO2	Apply the knowledge to prepare and characterize nanomaterials	L3 (Apply)
CO3	Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials	L2(Understand
CO4	Design the process flow required to fabricate state of the art transistor technology	L3 (Apply)
CO5	Analyze the requirements for new materials and device structure in the future technologies	L3(Apply)

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Digital Communication and Networking domain	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		**1**	**2**	**2**	**-**	**-**
CO2	**2**	**1**	**2**	**2**	**-**	**-**
CO3	**2**	**1**	**2**	**2**	**-**	**-**
CO4	**2**	**1**	**2**	**2**	**-**	**-**
CO5		**1**	**2**	**2**	**-**	**-**

Semester- II

Cryptography and Network Security			
Course Code	**MECE215B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(2:0:2)	SEE Marks	50
Total Hours of Pedagogy	30 Hours Theory+10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Study the network security model, security attacks, mechanisms and services and to demonstrate use of various symmetric key ciphers and their principles.
- Understand the concept of Modular Arithmetic and its application in public key cryptography and apply the knowledge to solve security related problems.
- Understand the design principles of Public key cryptosystems for encryption, key exchange and authentication.
- Comprehend the concept of secured electronic transaction with web security considerations.
- Study the security threats to networks and their counter measures.

Module-1

Information and Network Security Concepts: Cybersecurity, Information security, Network Security, OSI Survey Architecture, Security Attacks & Security Services, Cryptography, Trust and Trustworthiness, Standards.

Module-2

Number Theory: Divisibility and Division Algorithms, The Euclidean Algorithms, Modular Arithmetic, Prime Numbers, Fermat's and Euler's theorems, Testing for Primality, The Chinese Remainder theorem, Discrete Logarithms.

Module-3

Symmetric Ciphers: Classical Encryption Techniques, Block Ciphers and Data Encryption Standard, Finite Fields, Advanced Encryption Standards, Block Cipher Operation, Random Bit Generation and stream Ciphers.

ASymmetric Ciphers: Public-Key Cryptography and RSA – Cryptosystems, RSA Algorithm, Other Public-Key Cryptosystems – Diffe-Hellman Exchange, Elgamal Cryptographic System, Elliptic Curve Arithmetic, Elliptic Curve Cryptography.

Module-4

Cryptographic Data Integrity Algorithms: Cryptographic Hash Function, Message Authentication Codes, Digital Signatures, Lightweight Cryptography and Post-Quantum Cryptography.

Mutual Trust: Cryptography Key Management and Distribution, User Authentication.

Module-5

Network and Internet Security: Transport-Level Security, Wireless Network Security, Electronic Mail Security, IP Security, Network Endpoint Security, Cloud Security, Internet of Things (IoT) Security.

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Books

3. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education Inc., eBook ISBN 13: 978-1-292-43749-1, 8th Edition, 2023 and onwards.
4. Behrouz A. Fourouzan, "Introduction to Cryptography and Network Security" Tata McGraw-Hill, ISBN 978–0–07–287022–0, 1st Edition, 2008 and onwards.
5. Atul Kahate," Cryptography and Network security", Tata McGraw-Hill, ISBN-13: 978-0-07-064823-4, 2nd Edition, 2008 and onwards.
6. H. Yang et al., Security in Mobile Ad Hoc Networks: Challenges and Solution, IEEE Wireless Communications, 2004, https://escholarship.org/uc/item/5p89k583.

Web links and Video Lectures (e-Resources):

1. http://www.facweb.iitkgp.ac.in/~sourav/crypto.html
2. https://nptel.ac.in/courses/106105162

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, analyse 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.	Description	Blooms Level
CO1	Identify and describe different techniques in modern cryptography	L2
CO2	Employ the modular arithmetic fundamentals to cryptography	L4
CO3	Describe, recognize and use the principles of Public key cryptosystems for various applications.	L4
CO4	Recognize the use of cryptography in Data Networks	L4
CO5	Analyse the security issues related to internet and networks	L5

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate master's program.	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and lifelong learning in Electronics domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**2**	**1**	**1**	**1**
CO2	**1**	**1**	**2**	**1**	**1**	**1**
CO3	**1**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**2**	**1**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

Semester- II

Optical Communication and Networking			
Course Code	**MECE215C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 hours Theory+10 hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:: This course will enable students to:

- **Understand the various optical devices and how they operate.**
- **Recognize and choose various components for optical networking in accordance with the established design requirements**
- **Acquire knowledge of the elements of data transmission, loss obstacles, and other network operating artifacts.**
- **Acquire knowledge of the problems associated with setting up and maintaining the optical network's access component while keeping up with current data transmission trends.**
- **Build a WDM network and explore the management of components and networks.**

Module-1

Introduction to optical networks: Optical Networks, optical packet switching, **Propagation of signalsin optical fiber**: Different losses, Nonlinear effects, Solitons. **Optical Components (**Part-1): Couplers, Isolators, and Circulators.

Module-2

Optical Components (Part-2): Multiplexers and Filters, Optical Amplifiers, detectors. **Modulation - Demodulation:** Formats, Ideal receivers, Practical direct detection receivers, Optical preamplifiers, Bit error rates, Coherent detection.

Module-3

Transmission System Engineering: System model, Power penalty, Transmitter, Receiver, Crosstalk. **Client Layers of optical layer**: SONET/SDH: Multiplexing, layers, Frame structure.

Asynchronous Transfer Mode: ATM functions, Adaptation layers, Quality of Service (QoS) and flow control, Signalling and Routing.

Module-4

WDM network elements: Optical line terminals, Optical line amplifiers, Optical Add/ Drop Multiplexers, Optical cross-connects.

WDM Network Design: Cost trade-offs, LTD and RWA problems, Routing and wavelength assignment, Wavelength conversion**.**

Module-5

Control and Management (Part-1): Network management functions, management framework, Information model, management protocols, Layers within the optical layer.

Control and Management (Part-2): Performance and fault management, Impact of transparency, BER measurement, Optical trace, Alarm management, Configuration management, Optical Safety.

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Text Book

7. .1. ''Optical Networks', Rajiv Ramaswami, Kumar N. Sivarajan and Galan H Sasaki, Morgan Kaufman Publishers, 3rd edition, 2010.

Reference Books

1.Optical fiber communication', John M. Senior, Pearson edition, 2000.
2. 'Optical fiber Communication', Gerd Keiser, John Wiley, New York, 5th Edition, 2017
3. 'Fiber Optic Networks', P. E. Green, Prentice Hall, 1994.

Web links and Video Lectures (e-Resources):

- .https://onlinecourses.nptel.ac.in/noc20_ph07/preview

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
[7] Work on different software/s (tools) to simulate, analyse 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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Comprehend the various optical devices and their working strategies	L2 Understand
CO2	Recognize and select various optical networking components according to the prescribed design specifications	L2 Understand
CO3	Learn the aspects of data transmission, loss hindrances, and other artifacts affecting the network operation	L2 Understand
CO4	Learn the issues involved in setting up and maintaining access part of the optical network with the latest trends in the data communication	L2 Understand
CO5	Design a WDM network and study the component and network management aspects	L3 Analyze

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	To demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program	PO3
4	An ability to create, select, and apply appropriate techniques, resources, and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability engineering. to apply Professional ethics, responsibilities, and norms of engineering	PO5
6	An ability to recognize the need to engage in independent and lifelong learning in Electronics and Communication Domain	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	-	1	-	2
CO2	1	1	-	1	-	2
CO3	2	1	1	1	-	2
CO4	2	1	1	1	-	2
CO5	2	2	2	1	-	2

Semester- II

RF and Microwave Circuit Design			
Course Code	**MECE215D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

- To know the basic components in RF/Microwave circuit and know the features associated with wave propagating through a RF/Microwave Circuit.
- To understand the concept of creation of standing wave and losses in a RF/Microwave circuit and analysing the same in a graphical presentation.
- To analyse the Gain and Noise present in an RF/Microwave circuit.
- Analyse the applications of RF/Microwave circuit based on their construction and characteristics.

Module-1

Wave propagation in networks: Introduction, Reasons for using RF/Microwaves, Applications, RF Waves, RF and Microwave circuit design, Introduction to Components Basics, Analysis of Simple Circuit in Phasor Domain, RF Impedance Matching, Transmission Media, High Frequency Parameters, Formulation of S parameters, Properties of S-Parameters, Transmission Matrix, Generalized S-parameters.

Module-2

Smith chart and its Applications: Introduction, Smith Chart, Derivation of Smith Chart, Smith Chart Circular and Radial Scales, Application of Smith chart.

Module-3

Basic consideration in active networks: Stability Considerations – Stability Circles, Graphical and analytical solution of stability criteria, **Gain Considerations**– power gain concepts, mismatch factor, input and output, VSWR, Maximum gain design, unilateral figure of merit; and **Noise Considerations** - sources of noise, noise model of a noisy resistor, equivalent noise temperature, noise figure, noise figure of cascaded networks, constant noise figure circles.

Module-4

RF/Microwave Amplifiers: Small Signal Design: Introduction, Types of amplifier, Design of different types of amplifiers **RF/Microwave Frequency Conversion:** Mixers: Introduction, Mixer Types, Conversion Losses for SSB Mixers, SSB versus DSB mixers, One diode mixers, Two diode Mixers.

Module-5

RF/Microwave Control Circuit Design: Introduction, PN Junction Devices, Phase shifters, Digital phase shifters, Semiconductor phase shifters, PIN diode attenuators. **RF and Microwave IC design:** MICs, MIC materials, Types of MICs, Hybrid verses Monolithic ICs, Chip mathematics

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Textbook:

'Radio Frequency and Microwave Electronics (Illustrated)', Matthew M. Radmanesh, Pearson India, 2015.

Reference Books:

'RF circuit design theory and applications', Reinhold Ludwig, and Pavel Bretchko, Pearson Education edition, 2004.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=VdYsAAX0Unc
https://www.youtube.com/watch?app=desktop&v=bVdwu1IoX4k&t=0s
https://www.youtube.com/watch?v=cCRysRD4sxk
https://www.youtube.com/watch?v=k-5CuN7iANQ

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss and analyze waves propagation in Networks	L2, L3
CO2	Apply the Smith Chart for finding various parameters in transmission lines	L3
CO3	Analyze the basic considerations in active networks	L2,L3
CO4	Describe and design active networks	L3, L4
CO5	Design RF/MW Frequency Mixers and phase shifters	L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain.	PO6

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**1**	**1**	**1**
CO2	**3**	**3**	**1**	**2**	**1**	**1**
CO3	**3**	**3**	**2**	**1**	**1**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**1**

Semester- II

Error Control Coding			
Course Code	**MECE216A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	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 the concept of the Entropy, information rate and capacity for the discrete memoryless channel.
- Apply modern algebra and probability theory for the coding.
- Compare Block codes such as Linear Block Codes, Cyclic codes etc., and Convolutional codes.
- Detect and correct errors for different data communication and storage systems.
- Implement different Block code encoders and decoders.
- Analyze and implement convolutional encoders and decoders.
- Analyze and apply soft and hard Viterbi algorithm for decoding of convolutional codes.

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).

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).

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).

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, Multiple step majority logic (8.1,8.4 of Text 2).

Module-5

Convolution codes: Encoding of convolutional codes: Systematic and Non-systematic Convolutional Codes, Feed forward 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).

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Books

8. 'Digital Communication systems', Simon Haykin, Wiley India Private. Ltd, ISBN 978-81-265-4231-4, First edition, 2014
9. 'Error control coding', Shu Lin and Daniel J. Costello. Jr, Pearson, Prentice Hall, 2nd edition, 2004
10. 'Theory and practice of error control codes', Blahut. R. E, Addison Wesley, 1984
11. 'Introduction to Error control coding', Salvatore Gravano, OxfordUniversity Press, 2007
12. 'Digital Communications - Fundamentals and Applications', Bernard Sklar, Pearson Education (Asia) Pvt. Ltd., 2nd Edition, 2001

Web links and Video Lectures (e-Resources):

- www.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	Able to understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel.	Understand
CO2	Able to Apply modern algebra and probability theory for the coding.	Apply
CO3	Able to understand and Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes.	Understand
CO4	Able to Understand error detection and correction for different data communication and storage systems.	Understand
CO5	Able to Analyze and implement different Block code encoders and decoders, and also Convolutional encoders and decoders including soft and hard Viterbi algorithm.	Analyze

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
4	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**----**	**----**	**1**	**1**
CO2	**3**	**3**	**----**	**----**	**1**	**1**
CO3	**3**	**3**	**----**	**----**	**1**	**1**
CO4	**3**	**3**	**----**	**----**	**1**	**1**
CO5	**3**	**3**	**----**	**----**	**1**	**1**

Semester- II

Micro Electro Mechanical Systems (MEMS)			
Course Code	**MECE216B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(2:0:2)	SEE Marks	50
Total Hours of Pedagogy	30 Hours Theory+10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	3

Course Learning objectives:

- Understand the technologies related to Micro Electro Mechanical Systems.
- Understand the working principles of micro systems.
- Analyse the MEMS devices and develop suitable mathematical models.
- Analyse the scaling laws in miniaturization.
- Describe the design and fabrication processes involved with MEMS devices.

Module-1

Overview of MEMS and Microsystems: MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.

Module-2

Working Principles of Microsystems: Introduction, Micro sensors, Micro actuation, MEMS with Micro actuators, Micro accelerometers, Microfluidics.

Engineering Science for Microsystems Design and Fabrication:
Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry.

Module-3

Engineering Mechanics for Microsystems Design: Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.

Module-4

Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.

Module-5

Overview of Micro-manufacturing: Introduction, Bulk Micro-manufacturing, Surface Micromachining, LIGA Process, Summary on Micro manufacturing.

Microsystem Design: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method, Computer Aided Design (CAD).

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Books

1. Tai-Ran Hsu, "MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering", John Wiley & Sons, ISBN: 978-0470-08301-7,2nd Edition, 2008.
2. Hans H. Gatzen, Volker Saile, Jurg Leuthold, "Micro and Nano Fabrication: Tools and Processes", Springer, 2015.
3. James J. Allen, "Micro Electro Mechanical System Design", CRC Press, Taylor & Francis, ISBN-13: 978-0-8247-5824-0, 2005.

Web links and Video Lectures (e-Resources):

1. https://www.inup.cense.iisc.ac.in/mems
2. https://nptel.ac.in/courses/117105082

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.

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 technologies related to Micro Electro Mechanical Systems.	L1, L2
CO2	Understand the working principles of micro systems.	L1, L2, L3
CO3	Analyse the MEMS devices and develop suitable mathematical models	L4
CO4	Analyse the scaling laws in miniaturization.	L4
CO5	Describe the design and fabrication processes involved with MEMS devices.	L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate master's program.	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and lifelong learning in Electronics domain.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**1**	**1**	**1**	**2**	**1**
CO2	**2**	**2**	**1**	**2**	**1**	**1**
CO3	**1**	**1**	**2**	**1**	**1**	**1**
CO4	**1**	**1**	**1**	**2**	**1**	**1**
CO5	**1**	**1**	**2**	**1**	**1**	**1**

Semester- II

Automotive Electronics			
Course Code:	**MECE216C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 Hours Theory + 10 Hours SDA	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

This course will enable students:

1. Implement various control requirements in the automotive system.
2. Comprehend dashboard electronics and engine system electronics.
3. Identify various physical parameters that are to be sensed and monitored for maintaining the stability of the vehicle under dynamic conditions.
4. Understand and implement the controls and actuator system pertaining to the comfort and safety of commuters.
5. Design sensor network for mechanical fault diagnostics in an automotive vehicle

Module-1

Automotive Fundamentals and The Systems Approach to Control and Instrumentation: Use of Electronics in the Automobile, Antilock Brake Systems (ABS), Electronic steering control, Power steering, Traction control, electronically controlled suspension.

Module-2

Automotive instrumentation Control: Operational amplifiers, Digital circuits, Logic circuits, Microcomputer fundamentals, Microcomputer operations, Microprocessor architecture, digital to analog converter, analog to digital converter, Microcomputer applications in automotive systems, Instrumentation applications of microcomputers, Microcomputer in control systems

Module-3

The Basics of Electronic Engine control: Integrated body: Climate controls, Motivation for Electronic Engine Control, Concept of An Electronic Engine Control System, Definition of General Terms, Definition of Engine Performance Terms, Electronic fuel control system, Engine control sequence, Electronic Ignition, Sensors and Actuators, Applications of sensors and actuators, air flow rate sensor,Indirect measurement of mass air flow, Engine crankshaft angular position sensor, Automotive engine control actuators, Digital engine control, Engine speed sensor, Timing sensor for ignition and fuel delivery, Electronic ignition control systems, Safety systems, Interior safety, Lighting, Entertainment systems.

Module-4

Vehicle Motion Control and Automotive diagnostics: Cruise control system, Digital cruise control, Timing light, Engine analyzer, On-board and off-board diagnostics, Expert systems. Stepper motor-based actuator, Cruise control electronics, Vacuum - antilock braking system, Electronic suspension system Electronic steering control, Computer-based instrumentation system, Sampling and Input\output signal conversion, Fuel quantity measurement, Coolant temperature measurement, Oil pressure measurement, Vehicle speed measurement, Display devices, Trip-Information-Computer, Occupant protection systems.

Module-5

Future automotive electronic systems: Alternative Fuel Engines, Collision Wide Range Air/Fuel Sensor, Alternative Engine, Low Tire Pressure Warning System, Collision avoidance Radar Warning Systems, Low Tire Pressure Warning System, Radio Navigation, Advance Driver information System. Alternative-Fuel Engines, Transmission Control, Collision Avoidance Radar Warning System, Low Tire Pressure Warning System, Speech Synthesis Multiplexing in Automobiles, Control Signal Multiplexing, Navigation Sensors, Radio Navigation, Signpost Navigation, Dead Reckoning Navigation Future Technology, Voice Recognition Cell Phone Dialling Advanced Driver Information System, Automatic Driving Control.

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy 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 ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) 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, selecting one full question from each module

Suggested Learning Resources:

Text Book

1. Understanding Automotive Electronics', William B. Ribbens, SAMS/Elsevier publishing, 6thEdition, 2002.

Reference Book:

1. Automotive Electrics and Automotive Electronics-Systems and Components, Networking and Hybrid Drive', Robert Bosch Gmbh, Springer Verlag, 5th Edition, 2007.

Web links and Video Lectures (e-Resources):

- https://www.google.co.in/books/edition/Understanding_Automotive_Electronics/lu9BhR2T20YC?hl=en&gbpv=1&dq=inauthor:%22William+Ribbens%22&printsec=frontcover
- https://video.search.yahoo.com/search/video?fr=mcafee&p=video+lectures+of+automotive+electronics+by+william+R+ribbins&type=E210US1641G0#id=1&vid=0979dfee1e4a7bba82a158a7df45f039&action=click

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

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

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Implement various control requirements in the automotive system.	Understand
CO2	Comprehend dashboard electronics and engine system electronics	Analyze
CO3	Identify various physical parameters that are to be sensed and monitored for maintaining the stability of the vehicle under dynamic conditions	Analyze
CO4	Understand and implement the controls and actuator system pertaining to the comfort and safety of commuters	Understand
CO5	Design sensor network for mechanical fault diagnostics in an automotive vehicle	Understand

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain.	PO6

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	2	1
CO2	1	2	1	2	1	1
CO3	1	1	2	1	1	1
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1

Semester- II

Simulation, Modelling and Analysis			
Course Code	**MECE216D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	30 hours Theory+10 SDA	Total Marks	100
Credits	3	Exam Hours	03

Course Learning objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To expand intellectual capacity, credibility.
- To train students to work without any fear, confidently the exchange ideas.

Module-1

Basic Simulation Modelling: Nature of simulation, Systems, Models and Simulation, Discrete- Event Simulation, Simulation of Single Server Queuing System, Simulation of inventory system, Parallel and distributed simulation and the high level architecture, Steps in sound simulation study, and Other types of simulation, Advantages and disadvantages.(1.1, 1.2, 1.3, 1.4, 1.4.1, 1.4.2, 1.4.3, 1.5, 1.5.1, 1.5.2, 1.6, 1.7,
1.8, 1.9 of Text).

Module-2

Review of Basic Probability and Statistics: Random Variables and their properties, Simulation Output Data and Stochastic Processes, Estimation of Means, Variances and Correlations, Confidence Intervals and Hypothesis tests for the Mean

Building valid, credible and appropriately detailed simulation models:
Introduction and definitions, Guidelines for determining the level of models detail, Management's Role in the Simulation Process, Techniques for increasing model validity and credibility, Statistical procedure for comparing the real world observations and simulation output data. (4.2, 4.3, 4.4, 4.5, 5.1, 5.2, 5.4, 5.5, 5.6, 5.6.1, 5.6.2 of Text).

Module-3

Selecting Input Probability Distributions: Useful probability distributions, activity I, II and III. Shifted and truncated distributions; Specifying multivariate distribution, correlations, and stochastic processes; Selecting the distribution in the absence of data, Models of arrival process. (6.2, 6.4, 6.5, 6.6, 6.8, 6.10, 6.11, 6.12 of Text).

Module-4

Random Number Generators: Linear congruential Generators, Other kinds, Testing number generators.

Generating the Random Variates: General approaches, Generating continuous random variates, Generating discrete random variates, Generating random vectors, and correlated random variates; Generating arrival processes. (7.2, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6 of Text).

Module-5

Output data analysis for a single system: Transient and steady state behaviour of a stochastic process; Types of simulations with regard to analysis; Statistical analysis for terminating simulation; Statistical analysis for steady state parameters; Statistical analysis for steady state cycle parameters; Multiple measures of performance, Time plots of important variables. (9.2, 9.3, 9.4, 9.4.1, 9.4.3, 9.5, 9.5.1, 9.5.2, 9.5.3, 9.6, 9.7, 9.8 of Text).

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. Minimum passing marks in SEE is 40% 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 Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbook:

1. 'Simulation modelling and analysis', Averill Law, McGraw Hill, 4th edition, 2007.

Reference Books:

1. 'Simulation modeling and analysis with ARENA', TayfurAltiok and Benjamin Melamed, Elsevier, Academic press, 2007.
2. 'Discrete event system Simulation', Jerry Banks, Pearson, 2009
3. 'Applied simulation modeling', Seila Ceric and Tadikamalla, Cengage 2009.
4. 'Discrete event simulation', George. S. Fishman, Springer, 2001.
5. 5. 'System modeling and simulation', Frank L. Severance, Wiley, 2009.

Web links and Video Lectures (e-Resources):

- nptel.ac.in

Skill Development Activities Suggested

8. Interact with industry (small, medium, and large).
9. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
10. Involve in case studies and field visits/ fieldwork.
11. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
12. Handle advanced instruments to enhance technical talent.
13. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
14. 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 outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Able to Understand the need of simulation and modelling.	L2
CO2	Able to Understand the simulation of deterministic and probabilistic models, with a focus on statistical data analysis and simulation data.	L2
CO3	Able to Understand various simulation models.	L2
CO4	Able to Understand process of selecting of probability distributions.	L2
CO5	Able to Analyze the output data	L3

Program Outcome of this course

Sl. No.	Description	POs
1	An ability to independently carry out research /investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in Electronics and Communication domain.	PO6

Mapping of COs and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**2**	**1**	**1**	**1**
CO2	**3**	**3**	**1**	**2**	**1**	**1**
CO3	**3**	**3**	**2**	**1**	**1**	**1**
CO4	**3**	**3**	**3**	**2**	**1**	**1**
CO5	**3**	**3**	**3**	**2**	**1**	**1**

Advanced Communication Laboratory

Course Code	**MECEL207**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0 : 0 : 4 : 0	SEE Marks	50
Credits	2	Exam Hours	03

EDA Using Cadence OrCAD or OrCAD Lite or any EDA Tool, design and verify the following:

Course objectives:

- Simulation of communication signals with modulation and demodulation techniques.
- Simulate the digital transmission and reception in AWGN channels.
- Simulate the communication link and display the interference signals.
- Implement the equalisation algorithms using a suitable software platform.
- Simulate the widespread pseudo-random sequences and verify their properties.

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 DPSK modulation and demodulation
6	Simulation of signal constellation QPSK with Rayleigh fading and AWGN
7	Simulation of signal constellation M-array QAM with AWGN fading
8	To simulate the communication link
	Demonstration Experiments (For CIE) if any
9	To simulate Zero Forcing algorithm
10	To simulate LMS algorithm
11	Generation of m-Sequence and verify its properties
12	Generation Gold Sequence and verify its properties

Course outcomes (Course Skill Set):

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

- Simulate the basic digital modulation and demodulation circuits for different engineering applications.
- Simulate the optimum transmission and reception for AWGN channels.
- Implement the equalisation algorithms procedures using suitable software.
- Implement the widespread pseudo-random sequences using suitable software.

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 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.

The duration of SEE is 03 hours

Suggested Learning Resources:

Books

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

2. 'Digital Communications: Fundamentals and Applications:', Bernard Sklar, Pearson Education, ISBN-13: 978-0-13-458856-8, 3rd edition, 2021.

3. ', Simon Haykin, Wiley, ISBN:9788126542314, 1st edition, 2014.

Advanced Digital Signal Processing Laboratory		Semester	II
Course Code	**MECE258A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Total SEE+CIE	100
		Exam Hours	2 Hours
Examination type (SEE)	**Practical**		

Course 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.

Sl. No.	Experiments
1	Generate various fundamental discrete time signals.
2	Basic operations on signals (Multiplication, Folding, Scaling).
3	Find out the DFT & IDFT of a given sequence without using inbuilt instructions.
4	Interpolation & decimation of a given sequence.
5	Generation of DTMF (Dual Tone Multiple Frequency) signals.
6	Estimate the PSD of a noisy signal using periodogram and modified periodogram.
7	Estimation of PSD using different methods (Bartlett, Welch, Blackman-Tukey).
8	Design of Chebyshev Type I, II Filters.
	Demonstration Experiments (For CIE)
9	Cascade Digital IIR Filter Realization.
10	Parallel Realization of IIR filter.
11	Estimation of power spectrum using parametric methods (YuleWalker &Burg).
12	Time-Frequency Analysis with the Continuous Wavelet Transform.

Course outcomes (Course Skill Set):

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

- Analyze and implement the frequency analysis & correlation of discrete-time linear time invariant systems.
- Implement sampling rate conversion by decimation & Interpolation process and design digital filter banks.
- Analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm.
- Understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm.
- Understand parametric & non-parametric methods for power spectrum estimation.

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is 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 are designed by the faculty who is handling the laboratory session and are 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 a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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 marks scored shall be 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 a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

Text Books

1. Digital Signal Processing Principles, Algorithms, and Applications by John G. Proakis, Prentice-Hall International Inc., 4th Edition, 2012.

2. Theory and Application of Digital Signal Processing by Lawrence R. Rabiner and Bernard Gold.

Reference Books

1. Oppenheim, Alan V. Discrete-time signal processing. Pearson Education India, 1999.

2. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer-based approach. Volume 2. New York: McGraw-Hill Higher Education, 2006.

Internet of Things Laboratory		Semester	II
Course Code	**MECE258B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Total SEE+CIE	100
		Exam Hours	2 Hours
Examination type (SEE)	**Practical**		

Course objectives:

- Familiarize with IoT Hardware and Sensors
- Implement IoT Communication Protocols
- Develop and Deploy IoT Applications
- Analyze IoT Data with Basic Analytics and Visualization
- Explore Real-World IoT Applications and Case Studies

Sl.NO	Experiments
1	To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings. ii) To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
2	To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
3	To install MySQL database on Raspberry Pi and perform basic SQL queries.
4	Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.
5	Write a program to create UDP/UDP server on Arduino/Raspberry Pi and respond with humidity data to UDP client when requested.
6	Design a Low Power Wide Area Network (LPWAN) using protocols like LoRa or NB-IoT to support a large number of IoT devices over a wide area. Conduct experiments to evaluate range, power consumption, and data rate trade-offs.
7	Write a program on Arduino/Raspberry Pi to subscribe to MQTT broker for temperature data and print it.
8	Set up an industrial IoT (IIoT) system with sensors monitoring the health of machinery (e.g., temperature, vibration).
	Demonstration Experiments (For CIE)
9	Develop a multi-sensor wearable device that can monitor health metrics (e.g., heart rate, ECG, SpO_2, body temperature) and send data to a cloud platform. Implement real-time analytics and machine learning to detect anomalies and predict potential health issues.
10	Design an IoT gateway that supports multiple communication protocols (e.g., MQTT, CoAP, HTTP, and LoRaWAN).
11	Set up a low-power IoT network using energy harvesting techniques (e.g., solar, piezoelectric, or RF energy harvesting) to power IoT sensors. Measure the energy efficiency, data transmission frequency, and network longevity.
12	Create a simulated model of an IoT-based smart grid that can monitor and manage energy flow, optimize load distribution, and predict faults.

Course outcomes (Course Skill Set):

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

- Demonstrate Proficiency in IoT Hardware and Sensor Interfacing
- Implement and Manage IoT Communication Protocols
- Design and Develop Basic IoT Applications
- Apply IoT Concepts to Real-World Scenarios

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

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

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

- Each experiment is 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 are designed by the faculty who is handling the laboratory session and are 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 a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a 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 marks scored shall be 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 a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- **SEE shall be conducted by the two examiners. One from the same institute as an internal examiner and another from a different institute as an external examiner, appointed by the university.**
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of 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 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 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. Vijay Madisetti, Arshdeep Bahga, Internet of Things. "A Hands on Approach", University Press
2. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
3. Pethuru Raj and Anupama C Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
4. Jeeva Jose, "Internet of Things", Khanna Publishing House, Delhi
5. Adrian McEwen, "Designing the Internet of Things", Wiley

6. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill

Biomedical Signal Processing		Semester	II
Course Code	**MECE258C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	13	Total Marks	100
Credits	01	Exam Hours	01
Examination type (SEE)	MCQ		

Course objectives:

- Possess the basic mathematical, scientific and computational skills necessary to analyse ECG and EEG signals.
- Apply classical and modern filtering and compression techniques for ECG and EEG signals.
- Develop a thorough understanding on basics of ECG and EEG feature extraction.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various techniques.
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding

Module-1

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

Module-2

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

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,

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

Module-5

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

Course outcome (Course Skill Set)

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

1. Describe the origin, properties and suitable models of important biological signals such as ECG and EEG.
2. Know the basic signal processing techniques in analysing biological signals.
3. Acquire mathematical and computational skills relevant to the field of biomedical signal processing.
4. Describe the basics of ECG signal compression algorithms.
5. Know the complexity of various biological phenomena.

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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

- The question paper will have ten questions. Each question is set for 10 marks.
- There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
- The students have to answer 5 full questions, selecting one full question from each module.
- **The duration of the examinations shall be defined by the concerned board of studies**

Suggested Learning Resources:

Books

1. Biomedical Signal Analysis-Rangaraj M Rangayyan, John Wiley & Sons 2002
2. Biomedical Digital Signal Processing- Willis J Tompkins, PHI2001.
3. Biomedical Signal Processing Principles and Techniques-D C Reddy, McGraw-Hill publications, 2005

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

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

1. Involve in case studies and field visits/ fieldwork.
2. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
3. Handle advanced instruments to enhance technical talent.
4. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
5. 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,

	Array Signal Processing	Semester	II
Course Code	**MECE258D**	CIE Marks	50
Teaching Hours/Week (L:P: SDA)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	13 Hours	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives: This course will enable students:

- To Understand the concept of the basics of signals in space and time
- To Understand the important concepts of array signal processing.
- To Understand the basic principle of direction of arrival estimation techniques
- To Understand the basic principle of direction of arrival estimation techniques
- To Understand the Concepts of Spatial Frequency along with the Spatial Samplings

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.

Module-2

Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.

Module-3

Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.

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.

Module-5

Array Design Methods: Visible region, Duality between Time -Domain and Space -Domain Signal Processing, Schoellkopf'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.

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

13. 'Optimum Array Processing Part IV of Detection, Estimation, and Modulation Theory', Harry L. Van Trees, John Wiley & Sons, ISBN: 9780471093909, 2002.
14. 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.