M.TECH IN DIGITAL ELECTRONICS & COMMUNICATION SYSTEMS
(LEC)
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the academic year 2022-23)

Advanced Engineering Mathematics

Course Code	**22LEC11**	CIE Marks	50
Teaching Hours/Week(L:T:P)	**3:0:0**	SEE Marks	50
Total Number of Lecture Hours	**50**	Exam Hours	**03**
Credits – 03			

Advanced Digital Signal Processing

Course Code	**22LEC13**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**3:2:0**	SEE Marks	50
Total Number of Lecture Hours	**40 hours Theory+10 Lab slots**	Exam Hours	**03**
Credits - 04			

Course learning objectives: This course will enable students:

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

Module-1

Multirate Digital Signal Processing: Introduction, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion, Applications of multirate signal processing, Digital filter banks, two channel quadrature mirror filter banks, M-channel QMF bank (Text 1).

Module-2

Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and backward linear prediction. Solution of the Normal Equations. The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters (Text 1).

Module-3

Adaptive filters: Applications of Adaptive Filters-Adaptive Channel Equalization, Adaptive noise cancellation, Linear Predictive coding of Speech Signals, Adaptive direct form FIR filters-The LMS algorithm, Properties of LMS algorithm. Adaptive direct form filters- RLS algorithm (Text 1).

Module-4

Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods. **Parametric Methods for Power Spectrum Estimation**: Relationship between the auto correlation and the model parameters, Yule and Walker methods for the AR Model Parameters, Burg Method for the AR Model parameters, Unconstrained least-squares method for the AR Model parameters, Sequential estimation methods for the AR Model parameters, ARMA Model for Power Spectrum Estimation (Text 1).

Module-5

Wavelet Transforms: The Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future.
Continuous Wavelet and Short Time Fourier Transform: Wavelet Transform, Mathematical preliminaries, Properties of wavelets. Discrete Wavelet Transform: Haar scaling functions, Haar wavelet function, Daubechies Wavelets (Chapters 1, 3 & 4 of Text 2).

Teaching Learning Process: Chalk and Talk/ Power Point Presentations

Practical Component of IPCC: Conduct the experiments using MATLAB/Scilab/TMS 320 C5X DSP Processors

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.
9.	Cascade Digital IIR Filter Realization.
10.	Parallel Realization of IIR filter.
11.	Estimation of power spectrum using parametric methods (Yule-Walker &Burg).
12.	Design of LPC filter using Levinson-Durbin algorithm.
13.	Time-Frequency Analysis with the Continuous Wavelet Transform.
14.	Signal Reconstruction from Continuous Wavelet Transform Coefficients.

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 **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 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 experiments shall 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**.

SEE for IPCC

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

The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of sub-questions), **should have a mix of topics** under that module.
3. 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)

Textbooks:

1. Digital Signal Processing Principles, Algorithms, and Applications by John G. Proakis, Prentice-Hall International Inc., 4th Edition, 2012.
2. Insight into Wavelets- from Theory to Practice', K P Soman, Ramachandran, Resmi, PHI, Third Edition, 2010

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.

Course outcomes:

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

COs	**Description**	Blooms Level
CO1	Able to analyze and implement the frequency analysis & correlation of discrete-time linear time invariant systems.	Analyse
CO2	Able to implement sampling rate conversion by decimation & Interpolation process and design digital filter banks	Analyse
CO3	Able to analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm	Analyse
CO4	Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm.	Analyse
CO5	Able to understand parametric & non-parametric methods for power spectrum estimation.	Understand

Advanced Communication Systems 1

Course Code	**22LEC13**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**3:0:2**	SEE Marks	50
Total Number of Lecture Hours	**40 hours Theory+10 SDA**	Exam Hours	**03**
Credits - 04			

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

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.

CIE for the theory component of IPCC

1. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain COs and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.

4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Textbook:

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: 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, analyze and authenticate the output to interpret and conclude.

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

Course outcomes:

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

Digital Circuits and Logic Design

Course Code	**22LEC14**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**25 hours Theory+10 SDA**	Exam Hours	**03**
Credits - 03			

Module-1

Threshold Logic: Introductory Concepts, Synthesis of Threshold Networks, Capabilities, Minimization, and Transformation of Sequential Machines: The Finite- State Model, Further Definitions, Capabilities.

Module-2

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

Module-3

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

Module-4

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

Module-5

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

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Textbook:

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

Reference Books:

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

2ndEdition, PHI, 2004.

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=MWDKe4Ayg7c
https://www.youtube.com/watch?v=YhtAC4WCKeU
https://www.youtube.com/watch?v=7SYiI9ssdlA&t=69s
https://www.youtube.com/watch?v=HzTePILLrsA
https://www.youtube.com/watch?v=7SYiI9ssdlA
https://www.youtube.com/watch?v=jiK42XKC9Yo
https://www.youtube.com/watch?v=hk37zJcec9I

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, analyze and authenticate the output to interpret and conclude.

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

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the concepts of sequential machines.	Understand
CO2	Able to to understand the Sequential Machines/Circuits.	Understand
CO3	Able to analyse the faults in the design of circuits.	**Analyse**
CO4	Able to analyse fault detection experiments to sequential circuits.	**Analyse**
CO5	Able to understand the structure of sequential machines.	Understand

Advanced Computer Networks

Course Code	**22LEC15**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**25 hours Theory+10 SDA**	Exam Hours	**03**
Credits - 03			
Module-1			
Foundation: Building a Network, Applications, Requirements, Network Architecture, Implementing Network Software, Performance (Text 1: Chapter 1.1, 1.2, 1.3, 1.4, 1.5).			
Module-2			
Advanced Internetworking: The Global Internet, Multicast, Multicast addresses, Multicast, Multiprotocol Label Switching (MPLS) End-to-End protocols: Simple Demultiplexer (UDP), Reliable Byte Stream (TCP) (Text 1: Chapter 4.1, 4.2, 4.3, 5.1, 5.2).			
Module-3			
Congestion Control and Resource Allocation: Allocating Resources, Issues in Resource allocation, Queuing Disciplines, TCP Congestion Control, Congestion-Avoidance Mechanisms, Quality of Service. (Text 1: Chapter 6.1, 6.2, 6.3, 6.4 and 6.5).			
Module-4			
Applications: Traditional Applications: Electronic Mail (SMTP, POP, IMAP, MIME), World Wide Web (HTTP), Multimedia Applications, Infrastructure Services (Domain Name System (DNS), Network Management (SNMP), Overlay Networks (Text 1: Chapter 9.1, 9.2, 9.3, 9.4. Text 2: Chapter 23.1 to 23.16, Chapter 24, Chapter 25, Chapter 27.1 to 27.8).			
Module-5			
End-to End data: Presentation formatting, Multimedia Data Network Security: Security attacks, Cryptographic building blocks, Key Predistribution, Authentication protocols, Firewalls (Text 1: Chapter 7.1, 7.2, 8.1, 8.2, 8.3, 8.5).			

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.

CIE for the theory component of IPCC

1. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

1. 'Computer Networks: A System Approach', Larry Peterson and Bruce S Davis, 5thEdition, Elsevier -2014.

2. 'Internetworking with TCP/IP, Principles, Protocols and Architecture', Douglas E Comer, 6thEdition, PHI – 2014

Reference Books:

1. 'Computer Networks, Protocols, Standards and Interfaces',Uyless Black, 2ndEdition, PHI.
2. 'TCP /IP Protocol Suite', Behrouz A Forouzan, 4thEdition, Tata McGraw- Hill

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=aDdArElVJvQ**
- **https://www.youtube.com/watch?v=f1y25BfOH9I**
- **https://www.youtube.com/watch?v=ZYIdYIt7W_g**
- **https://www.youtube.com/watch?v=sRTDMvT3dL8**

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, analyze and authenticate the output to interpret and conclude.

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

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the network services, protocols and architectures, explain why they are layered.	Understand
CO2	Able to to understand the Advanced Internetworking applications and their protocols, and ability to work on their own applications (e.g. Client Server applications, Web Services).	Understand
CO3	Able to analyse various techniques for Congestion avoidance and Resource Allocation.	**Analyse**
CO4	Able to understand the application layered protocols.	Understand
CO5	Able to understand the concept of Network Security through cryptographic blocks, authentication protocols and Firewalls.	Understand

Research Methodology and IPR

Course Code	**22RMI16**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**3:0:0**	SEE Marks	50
Total Number of Lecture Hours	**40 hours Theory**	Exam Hours	**03**
Credits – 03			

Advanced Communication Laboratory 1

Course Code	**22LEC17**	CIE Marks	50
Lecture Hours/Week (L:T:P:S)	**1:2:0:0**	SEE Marks	50
Credits - 02	Exam Hours:3	Total Marks	**100**
Credits - 02			

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

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

1. Understand the modulation and demodulation of modulation techniques
2. Understand the different modulation techniques under Rayleigh fading and AWGN environment and probability of error analysis
3. Understand the behavior of the different filtering techniques
4. Understand the generation of PN sequence and understand its properties.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

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 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each 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 average of 02 tests 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 average marks of two tests 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

BOS recommended ONLINE courses

Course Code	**22AUD18/22AEC18**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)		SEE Marks	50
Total Number of Lecture Hours		Total Marks	**100**
Credits	PP	Exam Hours	**03**
Module-1			

SEMESTER -II

Advanced Communication Systems -2

Course Code	**22LEC21**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Credits - 04			
Module-1			
Synchronization – Signal Parameter estimation, Carrier Phase Estimation, Symbol Timing Recovery, Performance of ML estimators. [Text 1, Chapter 5] **Fading** – Large scale, small scale; Statistical characterization of multipath channels – Delay and Doppler spread, classification of multipath channels, scattering function; Binary signaling over frequency non selective Rayleigh fading channel [Text 1, Chapter 13].			
Module-2			
Fading Contd.: - Diversity techniques for performance improvement with binary signalling over FNS, Slow fading channels – power combining and Maximal ratio combining; Frequency selective channels – Rake receivers, Performance, Tap weight Synchronization, Application to CDMA [Text 1, Chapter 13]. **Multicarrier Signaling**: A brief overview of Frequency Diversity [Text 2, Sec 3.4.1, 3.4.2]. Multicarrier Communications in AWGN channel- Single carrier vs Multicarrier, OFDM, FFT Implementation, Spectral Characteristics, Power and bit allocation, Peak to Average Power Ratio, Channel Coding Considerations [Text 1, 11.2.1 to 11.2.9] and [Text 2, Sec 3.4.4].			
Module-3			
Capacity of wireless channel: AWGN channel capacity [Sec 5.1 All subsections], Resources of AWGN channel [5.2 All sub sections], Linear time invariant Gaussian channel [5.3 All sub sections], Capacity of Fading Channels [Sec5.4 All subsections] [Text 2 Chapter 5].			
Module-4			
MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels, Physical modeling of MIMO channels, Modeling of MIMO fading channels [Text 2, Chapter 7].			
Module-5			

MIMO capacity and multiplexing architectures: The VBLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Receiver architectures –
(Linear decorrelator, Successive cancellation, Linear MMSE receiver), Information theoretic optimality, Connections with CDMA multiuser detection and ISI equalization, Slow fading MIMO channel [Sections 8.1 to 8.4, 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.

Teaching-Learning Process: Chalk and Talk, Power Point Presentations.

Continuous Internal Evaluation:

- Three Unit Tests each of **20 Marks**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs
- The sum of three 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

Textbooks:
1. 'Digital Communications', John G. Proakis, Masoud Salehi, Pearson Education, ISBN:978-9332535893, 5thedition, 2014
2. 'Fundamentals of Wireless Communication', David Tse, Pramod Viswanath, Cambridge University Press, ISBN:0521845270, 1stedition, 2005

Reference Book:
'Digital Communication Systems', Simon Haykin, Wiley, ISBN:978-0471-64735-5, 2014

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=wgo5qpqnEV4
https://www.youtube.com/watch?v=4ibjrRzvJ5E
https://www.youtube.com/watch?v=hTZ2Mb4BIsw
https://www.youtube.com/watch?v=MFaxyD-p80M
https://www.youtube.com/watch?v=sS-gibJNZRU
https://www.youtube.com/watch?v=70wpxrp3tAQ
https://www.youtube.com/watch?v=85xBuy9YQMs

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, analyze and authenticate the output to interpret and conclude.

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

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the models for fading channels, and concepts of diversity in time, frequency and space.	Understand
CO2	Able to to understand the the concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver.	Understand
CO3	Able to analyse the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.	Analyse
CO4	Able to analyse schemes to improve performance in a multipath fading environment including maximal ratio combining, RAKE receivers, OFDM and MIMO.	Analyse
CO5	Able to analyse the performance of a OFDM MIMO scheme to meet specified rate in a given multipath environment.	Understand

Antenna Theory and Design

Course Code	**22LEC22**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**3:2:0**	SEE Marks	50
Total Number of Lecture Hours	**40 hours Theory+10 Lab slots**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Credits - 04

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

Course outcomes:

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

Question paper pattern:

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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub question covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Laboratory Experiments:

NOTE: Experiments can be done using Hardware tools such as Spectrum analyzers, Signal sources, Power Supplies, Oscilloscopes, High frequency signal sources, Fiber optic kits, Microwave measurement benches, DSP processor kit, FPGA kit, Logic analyzers, PC setups, etc. Software tools based experiments can be done using, FEKO or equivalent open source simulator, MATLAB etc.

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.

Textbook:

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

Reference Books:

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

Professional Electives 1

Wireless Sensor Networks

Course Code	**22LEC231**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Module-1			
Introduction: Sensor Mote Platforms, WSN Architecture and Protocol Stack (Chap. 1Text 1). **WSN Applications**: Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications (Chap. 2 Text 1).			
Module-2			
Factors Influencing WSN Design: Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption (Chap. 3 Text 1). **Physical Layer**: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards (Chap. 4 of Text 1).			
Module-3			
Medium Access Control: Challenges for MAC, CSMA Mechanism, Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access (Chap. 5 of Text 1). **Network Layer**: Challenges for Routing, Data-centric and Flat Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols (Chap. 7 of Text 1).			
Module-4			
Transport Layer: Challenges for Transport Layer, Reliable Multi Segment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol, Event-to-Sink Reliable Transport (ESRT) Protocol, GARUDA (Chap. 8 Text 1). **Application Layer**: Source Coding (Data Compression), Query Processing, Network Management (Chap. 9 Text 1).			
Module-5			

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

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

3. Three Tests to be conducted with each of 20 Marks
4. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks
CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs defined for the course.

Semester End Examination:

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

Textbooks:

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

Web links and Video Lectures (e-Resources):

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

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

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 outcomes:

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

Nano electronics

Course Code	**22LEC232**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module-1

Introduction: Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. Moores' law 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 nanosystems (Text 1).

Module-2

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 dept profiling: electron, mass, Ion beam, Reflectometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties (Text1).

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 (Text1).

Carbon Nanostructures: Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes (Text 2).

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 (Text1).

Module-5

Methods of measuring properties: atomic, crystallography, microscopy, spectroscopy (Text 2).
Applications: Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIPs, NEMS, MEMS (Text1).

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
1. The question paper will have ten full questions carrying equal marks.
2. Each full question is for 20 marks.
3. There will be two full questions (with a maximum of four sub questions) from each module.
4. Each full question will have sub questions covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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:

'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):

https://www.youtube.com/watch?v=wdNFCWLuC10&list=PLbMVogVj5nJT8RG5Q4CpsJXiGqXE6t8N1
https://www.youtube.com/watch?v=2bDf7JSRvf8

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, analyze and authenticate the output to interpret and conclude.

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

The prepared report shall be evaluated for CIE marks.

Course outcomes:

COs	**Description**	Blooms Level
CO1	Able to understand the principles behind Nanoscience engineering and Nanoelectronics.	Understand
CO2	Able to understand the knowledge to prepare and characterize nanomaterials	Understand
CO3	Able to understand the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials	Understand
CO4	Able to understand the analyse the process flow required to fabricate state of the art transistor technology.	Analyse
CO5	Able to analyse the requirements for new materials and device structure in the future technologies.	Understand

Cryptography and Network Security

Course Code	**22LEC233**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module-1

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

Module-2

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

Module-3

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

Module-4

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

Module-5

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

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

5. Three Tests to be conducted with each of 20 Marks
1. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=iTVyKbDCJrA&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2
https://www.youtube.com/watch?v=eIJzIUhks6E&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2&index=3
https://www.youtube.com/watch?v=NrRJInkFsyQ&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2&index=4

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

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 outcomes:

COs	**Description**	Blooms Level

CO1	Able to understand the basics of symmetric key and public key cryptography.	Understand
CO2	Able to understand cryptographic algorithms to encrypt the data.	Understand
CO3	Able to understand the Generation some pseudorandom numbers required for cryptographic applications.	Understand
CO4	Able to understand for providing the authentication and protection for encrypted data.	Understand
CO5	Able to understand techniques and features of Email, IP and Web security.	Understand

Optical Communication and Networking

Course Code	**22LEC234**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module -1

Introduction to optical networks: Optical Networks, optical packet switching, **Propagation of signals in optical fiber:** Different losses, Nonlinear effects, Solutions. **Optical Components (Part-1):** Couplers, Isolators and Circulators (1.3, 1.6, 2.1 up to 2.6, 3.1, 3.2 of Text).

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 (3.3, 3.4, 3.6, 4.1, 4.4.1, 4.4.2, 4.4.5, 4.4.6, 4.4.7 of Text).

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, Signaling and Routing (5.1 up to 5.4, 5.6, 6(introduction), 6.1(introduction), 6.1.1, 6.1.3, 6.1.4, J.1 up to J.5 of Text).

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 (Chapter 7 (full), 10 (introduction), 10.1, 10.2 of Text).

Module -5

Control and Management (Part-1): Network management functions, management framework, Information model, management protocols, Layers within optical layer.
Control and Management (Part-2): Performance and fault management, Impact of transparency, BER

measurement, Optical trace, Alarm management, Configuration management, Optical Safety (8(introduction), 8.1, 8.3, 8.5 (introduction), 8.5.1 up to 8.5.4, 8.6, 8.7 of Text).

Course Outcomes:

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

1. Comprehend the various optical devices and their working strategies
2. Recognize and select various optical networking components according to the prescribed design specifications
3. Learn the aspects of data transmission, loss hindrances and other artifacts affecting the network operation
4. Learn the issues involved in setting up and maintenance of access part of optical network with the latest trends in the data communication.
5. Design a WDM network and study the component and network management aspects

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

- Three Tests to be conducted with each of 20 Marks
- Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs
- The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

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

Semester End Examination:

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

Text Book:

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.

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, 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.

Biomedical Signal Processing

Course Code	**22LEC235**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Module-1			
Introduction-Genesis and significance of bio electric potentials, ECG, EEG, EMG and their monitoring and measurement, Spectral analysis.			
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, Evoked potential estimation.			
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.			

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, 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.

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Textbook:

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

Reference Books:

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

Web links and Video Lectures (e-Resources):

https://www.youtube.com/watch?v=OqNDFF1RsMU
https://www.youtube.com/watch?v=7Kf0kWqqFAk
https://www.youtube.com/watch?v=YTH-CXphdXw
https://www.youtube.com/watch?v=aoLktSYOfwg

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

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 outcomes:

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

Professional Elective 2

Multimedia over Communication Links

Course Code	**22LEC241**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module 1

Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology (Chap. 1 of Text1).
Information Representation: Introduction, Text, Images (Chap. 2- Sections 2.2 and 2.3 of Text 1).

Module 2

Information Representation: Audio and Video (Chap. 2 - Sections 2.4 and 2.5 of Text 1).
Distributed multimedia systems: Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems (Chap. 4 - Sections 4.1 to 4.5 of Text 2).

Module 3

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

Module 4

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

Module 5

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

Course Outcomes:

COs	**Description**	Blooms Level

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

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Books:

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

Reference Book:

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

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

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.

Statistical Signal Processing

Course Code	**22LEC242**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Module-1			
Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes (Text 1).			
Module 2			
Signal Modeling: Least squares method, Padé approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion (Text 1).			
Module 3			
Spectrum Estimation: Nonparametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation (Text 1).			
Module 4			
Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms (Text 1).			
Module 5			
Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beamforming, linearly constrained minimum-variance beam-formers, side-lobe cancellers (Text 2).			

Course Outcomes:

COs	**Description**	Blooms Level
CO1	Able to Analyze statistical DSP algorithms to meet desired needs	Analyze
CO2	Able to Analyze vector space methods to statistical signal processing problems	Analyze
CO3	Able to understand Wiener filter theory and design discrete and continuous Wiener	Understand

	filters	
CO4	Able to Understand Kalman Filter theory and design discrete Kalman filters	Understand
CO5	Able to apply computer tools (such as MATLAB) in developing and testing stochastic DSP algorithms	Analyze

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

- Three Tests to be conducted with each of 20 Marks
- Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs
- The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Books:

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

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

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.

Micro Electro Mechanical Systems

Course Code	**22LEC243**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
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, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. **Engineering Science for Microsystems Design and Fabrication**: Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular 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, The LIGA Process, Summary on Micromanufacturing. **Microsystem Design**: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.			

Course Outcomes:

COs	Description	Blooms Level
CO1	Able to Understand the technologies related to Micro Electro Mechanical Systems.	Understand
CO2	Able to Understand the scaling laws in miniaturization.	Understand
CO3	Able to Analyse the MEMS devices and develop suitable mathematical models	Analyze
CO4	Able to Understand the various application areas for MEMS devices	Understand
CO5	Able to Understand the design and fabrication processes involved with MEMS devices.	Understand

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Book:

1. 'MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering', Tai-Ran Hsu, John Wiley & Sons, ISBN: 978-0470-08301-7,2nd Edition, 2008

Reference Books:

- 'Micro and Nano Fabrication: Tools and Processes', Hans H. Gatzen, Volker Saile, Jurg Leuthold, Springer, 2015
- 'Micro Electro Mechanical Systems (MEMS)', Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Cengage Learning.

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, 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.

Array Signal Processing

Course Code	**22LEC244**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**
Module 1			
Spatial Signals: Signals in space and time, Spatial Frequency vs Temporal Frequency, Review of Co-ordinate Systems, Maxwell's Equation, Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system –Wave number vector, Slowness vector.			
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, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward -Lawson Frequency-Sampling Design. Non parametric method -Beam forming, Delay and sum Method, Capons Method.			

Course outcomes:

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

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Book:

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

Reference Books:

- 'Array Signal Processing: Concepts and Techniques', Don H. Johnson, Dan E. Dugeon, Prentice Hall Signal Processing Series, 1st Edition, ISBN-13: 978-0130485137.
- 'Spectral Analysis of Signals', PetreStoica and Randolph L. Moses, Prentice Hall, ISBN: 0-13-113956-8, 2005.
- 'Electromagnetic Waves and Antennas', Sophocles J. Orfanidis, ECE Department, Rutgers University, 94 Brett Road Piscataway, NJ 88548058. http://www.ece.rutgers.edu/~orfanidi/ewa/ISBN: 0-07-114243-64, 2003.
- "Real-Time Concepts for Embedded Systems", Qing Li and Carolyn Yao, CMP Books, ISBN:1578201241, 2003.
- "Real Time Systems", Jane W. S. Liu, Prentice Hall, ISBN: 0130996513, 2000.
- "Real-Time Systems Design and Analysis", Phillip A. Laplante, John Wiley & Sons, 2004.

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, 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.

Simulation, Modelling and Analysis

Course Code	**22LEC245**	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Number of Lecture Hours	**30 hours Theory+10 hours SDA**	Total Marks	**100**
Credits	**03**	Exam Hours	**03**

Module 1

Basic Simulation Modeling: 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 behavior 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).

Course Outcomes:

COs	Description	Blooms Level
CO1	Able to Understand the need of simulation and modeling.	Understand
CO2	Able to Understand the simulation of deterministic and probabilistic models, with a focus on statistical data analysis and simulation data.	Understand
CO3	Able to Understand various simulation models.	Understand
CO4	Able to Understand process of selecting of probability distributions.	Understand
CO5	Able to Analyze the output data	Analyze

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Book:

1. 'Simulation modeling 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. 'System modeling and simulation', Frank L. Severance, Wiley, 2009.

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, 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.

Mini Project With Seminar			
Course Code	**22LEC25**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:4:2)	SEE Marks	-
Total Hours of Pedagogy	-	Total Marks	100
Credits	03	Exam Hours	-

Course objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information
- (acknowledging the sources) clearly.
- To develop interactive, communication, organization, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independence and team working.
- To expand intellectual capacity, credibility, judgment, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face the audience confidently, enhance communication skills, involve in group discussion to present andexchange ideas.

Mini-Project with seminar : Each student shall involve in carrying out the project work jointly in constant consultation with Internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes: At the end of the course the student will be able to: • Present the mini-project and be able to defend it. • Make links across different areas of knowledge and generate, develop and evaluate • ideas and information so as to apply these skills to the project task. • Habituated to critical thinking and use problem-solving skills. • Communicate effectively and to present ideas clearly and coherently in both written and oral forms. • Work in a team to achieve a common goal. • Learn on their own, reflect on their learning and take appropriate actions to improve it.
CIE procedure for Mini - Project: The CIE marks awarded for Mini - Project, shall be based on the evaluation of Mini - Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Mini - Project report shall be the same for all the batch mates.

Advanced Communication Lab

Course Code	**22LEC26**	CIE Marks	50
Lecture Hours/Week	**01+02**	SEE Marks	50
Total Number of Lecture Hours	**50**	Exam Hours	**03**
Credits – 02			
Laboratory Experiments: **NOTE:** Experiments can be done using Hardware tools such as Spectrum analyzers, Signal sources, Power Supplies, Oscilloscopes, High frequency signal sources, Fiber optic kits, Microwave measurement benches, DSP processor kit, FPGA kit, Logic analyzers, PC setups, etc. Software tools based experiments can be done using, FEKO or equivalent open source simulator, MATLAB etc.			

Sl. No.	Experiments
2.	MATLAB/C implementation to obtain the radiation pattern of an antenna.
3.	Study of radiation pattern of different antennas.
4.	Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.
5.	Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.
6.	Study of radiation pattern of E& H plane horns.
7.	Significance of Pocklington's integral equation.

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

Course outcomes:
At the end of the course the student will be able to:
1. Plot the radiation pattern of specified antennas using MATLAB and wave guide setup.
2. Determine gain and directivity of a given antenna.
3. Obtain the S-parameters of Magic tee and directional couplers.
4. Test the IC CD4051 for modulation techniques.
5. Comprehend the multiplexing techniques using OFC kit.

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and Marks allotted to the procedure part to be made zero.

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 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 downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each 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 average of 02 tests 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 average marks of two tests 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

SEMESTER –II

Suggested ONLINE courses			
Course Code	22AUD27	CIE Marks	50
Lecture Hours/Week (L:P:SDA)		SEE Marks	50
Total Number of Lecture Hours	2	Exam Hours	**03**
Credits – PP			
Module-1			

SEMESTER –III

Error Control Coding

Course Code	22LEC31	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Number of Lecture Hours	25 hours Theory+10 SDA	Exam Hours	**03**
Credits – 04			
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, Multiplestep majority logic (8.1,8.4 of Text 2).
Module-5
Convolution codes: Encoding of convolutional codes: Systematic and Nonsystematic Convolutional Codes, Feedforward encoder inverse, A catastrophic encoder, Structural properties of convolutional codes: state diagram, state table, state transition table, tree diagram, trellis diagram. Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding (11.1, 11.2, 12.1,13.1 of Text 2).

Course outcomes:

COs	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

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

- Three Tests to be conducted with each of 20 Marks
- Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs
- The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

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

Semester End Examination:

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

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Textbooks:

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

Reference Books:

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

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

1. Interact with industry (small, medium, and large).
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.

Professional elective 3

Advances in Image Processing

Course Code	22LEC321	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module-1			
The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.			
Module-2			
Image Pre-processing: Pixel brightness transformations, geometric transformations, local pre-processing.			
Module-3			
Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing.			
Module-4			
Shape representation and description: Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull.			
Module-5			
Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds.			

Course outcomes:

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

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

- Three Tests to be conducted with each of 20 Marks
- Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs
- The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

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

Semester End Examination:

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

Text Book:

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

Reference Books:

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

Internet of Things

Course Code	22LEC322	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module-1			
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.
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.

Course outcomes:

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

1. Understand the basic concepts IoT Architecture and devices employed.
2. Analyze the sensor data generated and map it to IoT protocol stack for transport.
3. Apply communications knowledge to facilitate transport of IoT data over various available communications media.
4. 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.
5. Apply knowledge of Information technology to design of IoT applications (Operational Technology).

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Book:

'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

Reference Book:

'Internet of Things – A Hands on Approach', ArshdeepBahga and Vijay Madisetti, Orient Blackswan Private Limited - New Delhi, First edition, 2015

Real Time Systems

Course Code	22LEC323	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module 1			
Introduction to Real-Time Embedded Systems: Brief history of Real Time Systems, A brief history of Embedded Systems. **System Resources:** Resource Analysis, Real-Time Service Utility, Scheduling Classes, The Cyclic Executive, Scheduler Concepts, Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Re-entrant Functions.			
Module 2			
Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Monotonic least upper bound, Necessary and Sufficient feasibility, Deadline – Monotonic Policy, Dynamic priority policies. **I/O Resources:** Worst-case Execution time, Intermediate I/O, Execution efficiency, I/O Architecture. **Memory:** Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems.			
Module 3			
Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion. **Soft Real-Time Services:** Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services.			

Module 4
Embedded System Components: Firmware components, RTOS system software mechanisms, Software application components. **Debugging Components:** Exceptions assert, Checking return codes, Single step debugging, kernel scheduler traces, Test access ports, Trace ports, Power- On self-test and diagnostics.
Module 5
Performance Tuning: Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length. **High availability and Reliability Design:** Reliability and Availability, Similarities and differences, Reliability, Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design.

Course outcomes:
At the end of the course the students will be able to:
1. Analyze Real time operating systems.
2. Distinguish a real-time system with other systems.
3. Describe the functions of Real time operating systems.
4. Demonstrate embedded system applications.
5. Design a Real Time operating system.

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks
CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

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Text Book:
"Real-Time Embedded Systems and Components", Sam Siewert, Cengage Learning India Edition, 2007.
Reference Books:
1. "Real time systems", Krishna CM and Kang Singh G, Tata McGraw Hill ISBN: 0-07-114243-64, 2003.
2. "Real-Time Concepts for Embedded Systems", Qing Li and Carolyn Yao, CMP Books, ISBN:1578201241, 2003.
3. "Real Time Systems", Jane W. S. Liu, Prentice Hall, ISBN: 0130996513, 2000.
4. "Real-Time Systems Design and Analysis", Phillip A. Laplante, John Wiley & Sons, 2004.

RF and Microwave Circuit Design

Course Code	22LECS324	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module 1			
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

Course outcomes:
At the end of the course the students will be able to:
1. Discuss and analyze waves propagation in Networks
2. Apply the Smith Chart for finding various parameters in transmission lines
3. Analyze the basic considerations in active networks
4. Describe and design active networks
5. Design RF/MW Frequency Mixers and phase shifters

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks
CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

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

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

LTE 4G Broadband

Course Code	22LEC325	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module -1			
Evolution Beyond Release 8, LTE-Advanced for IMT-Advanced, LTE Specifications and 3GPP Structure. **System Architecture Based on 3GPP SAE:** Basic System Architecture Configuration with only E-UTRAN Access Network, System Architecture with E-UTRAN and Legacy 3GPP Access Networks, System Architecture with E-UTRAN and Non-3GPP Access Networks, IMS Architecture, PCC and QoS			
Module -2			
Introduction to OFDMA, SC-FDMA and MIMO in LTE: LTE Multiple Access Background, OFDMA Basics, SC-FDMA Basics MIMO Basics. **Physical Layer:** Transport Channels and their Mapping to the Physical Channels, Modulation, Uplink User Data Transmission, Downlink User Data Transmission, Uplink Physical Layer Signaling Transmission, PRACH Structure, Downlink Physical Layer Signaling Transmission.			
Module -3			
Physical Layer Procedures, UE Capability Classes and Supported Features, Physical Layer Measurements and Parameter Configuration. **LTE Radio Protocols:** Protocol Architecture, The Medium Access Control, The Radio Link Control Layer, Packet Data Convergence Protocol			
Module -4			
Radio Resource Control (RRC): X2 Interface Protocols Understanding the RRC ASN.1 Protocol Definition,			

Early UE Handling in LTE. **Mobility:** Mobility Management in Idle State, Intra-LTE Handovers 190, Intersystem Handovers Differences in E-UTRAN and UTRAN Mobility.

Module -5

Radio Resource Management:
Overview of RRM Algorithms, Admission Control and QoS Parameters, Downlink Dynamic Scheduling and Link Adaptation, Uplink Dynamic Scheduling and Link Adaptation, Interference Management and Power Settings, Discontinuous Transmission and Reception (DTX/DRX), RRC Connection Maintenance. **Performance:** Layer 1 Peak Bit Rates, Terminal Categories Link Level Performance, Link Budgets Spectral Efficiency Latency, LTE Reframing to GSM Spectrum Dimensioning.

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Course Outcomes:
At the end of the course the student will be able to:
1. Describe the system architecture and the function standard specified components of the system of LTE 4G.
2. Comprehend the Multiple Access process incorporated in the radio physical layer.
3. Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from a number of users.
4. Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
5. Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks
CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Book:
1. 'LTE for UMTS Evolution to LTE-Advanced', HarriHolma and Antti Toskala, John Wiley & Sons, Ltd., Second Edition - 2011, Print ISBN: 9780470660003.

Reference Books:
1. 'Fundamentals of LTE', Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews, Rias Muhamed, Prentice Hall Communications Engineering and Emerging Technologies Series from Ted Rappaport, 1st Edition, Sept 2010.
2. 'LTE – The UMTS Long Term Evolution; From Theory to Practice' by Stefania Sesia, IssamToufik, and

Matthew Baker, John Wiley & Sons Ltd, 2009.

Professional elective 4

Pattern Recognition & Machine Learning

Course Code	22LEC331	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			

Module 1

Introduction: Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory **Distributions**: Binary and Multinomial Variables, The Gaussian Distribution, The Exponential Family, Nonparametric Methods (Ch. 1, 2).

Module-2

Supervised Learning
Linear Regression Models: Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison **Classification & Linear Discriminant Analysis:** Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Mode (Ch. 3, 4).

Module-3

Supervised Learning
Kernels: Dual Representations, Constructing Kernels, Radial Basis Function Network, Gaussian Processes
Support Vector Machines: Maximum Margin Classifiers, Relevance Vector Machines
Neural Networks: Feed-forward Network, Network Training, Error Backpropagation (Ch. 5, 6, 7).

Module-4

Unsupervised Learning
Mixture Models: K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures, Alternative View of EM.
Dimensionality Reduction: Principal Component Analysis, Factor/Component Analysis, Probabilistic PCA, Kernel PCA, Nonlinear Latent Variable Models (Ch. 9, 12).

Module-5

Probabilistic Graphical Models: Bayesian Networks, Conditional Independence, Markov Random Fields, Inference in Graphical Models, Markov Model, Hidden Markov Models (Ch.8, 13).

Course outcomes:

1. At the end of the course the students will be able to:
2. Identify areas where Pattern Recognition and Machine Learning can offer a solution.
3. Describe the strength and limitations of some techniques used in computational Machine Learning for classification, regression and density estimation problems.
4. Describe and model data.
5. Solve problems in Regression and Classification.
6. Discuss main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems.

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Book:

1. 'Pattern Recognition and Machine Learning', Christopher Bishop, Springer, 2006.

VLSI Design for Signal Processing

Course Code	22LEC332	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module 1			
Introduction to DSP Systems: Typical DSP Algorithms, DSP Application Demands and Scaled CMOS Technologies, Representations of DSP Algorithms. **Iteration Bounds**: Data flow graph Representations, loop bound and Iteration bound. Algorithms for Computing Iteration Bound, Iteration Bound of multi rate data flow graphs.			
Module 2			
Pipelining and Parallel Processing: pipelining of FIR Digital Filters, parallel processing, Pipelining and parallel processing for low power. **Retiming**: Definition and Properties, Solving Systems of Inequalities, Retiming Techniques.			
Module 3			
Unfolding: An Algorithm for Unfolding, Properties of Unfolding, Critical path, Unfolding and Retiming, Application of Unfolding. **Folding**: Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding of Multirate Systems			
Module 4			
Systolic Architecture Design: systolic array design Methodology, FIR systolic array, Selection of Scheduling Vector, Matrix-Matrix Multiplication and 2D systolic Array Design, Systolic Design forspace representation			

containing Delays.
Fast convolution: Cook-Toom Algorithm, Winograd Algorithm, Iterated convolution, cyclic convolution Design of fast convolution Algorithm by Inspection.

Module 5

Pipelined and Parallel Recursive and Adaptive Filter: Pipeline Interleaving in Digital Filter, first order IIR digital Filter, Higher order IIR digital Filter, parallel processing for IIR filter, Combinedpipelining and parallel processing for IIR Filter, Low power IIR Filter Design Using Pipelining and parallel processing, pipelined adaptive digital filter.

Course outcomes:
At the end of the course the student will be able to:
1. Illustrate the use of various DSP algorithms and addresses their representation using block diagrams, signal flow graphs and data-flow graphs
2. Use pipelining and parallel processing in design of high-speed /low-power applications
3. Apply unfolding in the design of parallel architecture
4. Evaluate the use of look-ahead techniques in parallel and pipelined IIR Digital filters.
5. Develop an algorithm or architecture or circuit design for DSP applications

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks
CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Text Book
1. VLSI Digital Signal Processing systems, Design and implementation Keshab K.Parthi Wiley 1999

Reference Book
- Analog VLSI Signal and Information Processing Mohammed Isamail and Terri Fiez Mc Graw-Hill 1994
- VLSI and Modern Signal Processing S.Y. Kung, H.J. White House, T. Kailath Prentice Hall 1985
- Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing Jose E. France, Yannis Tsividis Prentice Hall 1994
- DSP Integrated Circuits Lars Wanhammar Academic Press Series in Engineering 1st Edition

Digital Compression

Course Code	22LEC333	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module-1			
Introduction: Compression techniques, Modelling & coding, Distortion criteria, Differential Entropy, Rate Distortion Theory, Vector Spaces, Information theory, Models for sources, Coding uniquely decodable codes, Prefix codes, Kraft McMillan Inequality. **Quantization:** Quantization problem, Uniform Quantizer, Adaptive Quantization, Non-uniform Quantization; Entropy coded Quantization, Vector Quantization, LBG algorithm, Tree structured VQ, Structured VQ.			
Module-2			
Differential Encoding: Basic algorithm, Prediction in DPCM, Adaptive DPCM, Delta Modulation, Speech coding–G.726, Image coding. **Transform Coding:** Transforms – KLT, DCT, DST, DWHT; Quantization and coding of transform coefficients, Application to Image compression – JPEG, Application to audio compression.			
Module-3			
Sub-band Coding: Filters, Sub-band coding algorithm, Design of filter banks, Perfect reconstruction using two channel filter banks, M-band QMF filter banks, Poly-phase decomposition, Bit allocation, Speech coding–G.722, Audio coding–MPEG audio, Image compression.			

Module-4
Wavelet Based Compression: Wavelets, Multi resolution analysis & scaling function, Implementation using filters, Image compression–EZW, SPIHT, JPEG 2000. **Analysis/Synthesis Schemes:** Speech compression–LPC10, CELP, MELP. **Video Compression:** Motion compensation, Video signal representation, Algorithms for video conferencing & video phones–H.261, H.263, Asymmetric applications–MPEG 4, MPEG 7, Packet video.
Module-5
Loss less Coding: Huffman coding, Adaptive Huffman coding, Golomb codes, Rice codes, Tunstall codes, Applications of Huffman coding, Arithmetic coding, Algorithm implementation, Applications of Arithmetic coding, Dictionary techniques–LZ77, LZ78, Applications of LZ78– JBIG, JBIG2, Predictive coding– Prediction with partial match, Burrows Wheeler Transform, Applications– CALIC, JPEG-LS.

Course outcomes:

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

1. Explain the evolution and fundamental concepts of Data Compression and Coding techniques.
2. Acquire contemporary knowledge in Data Compression and Coding.
3. Analyze the operation of a range of commonly used Coding and Compression techniques
4. Identify the basic software and hardware tools used for data compression.
5. Analyze and evaluate the performance of different Data Compression and Coding methods.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. 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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.
7. The students will have to answer five full questions, selecting one full question from each module.

Textbook:

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

Reference Books:

1. 'Digital Coding of Waveforms: Principles and Applications to Speech and Video', N Jayant and P Noll,

Prentice Hall, USA, 1984.
2. 'Data Compression: The Complete Reference', D Salomon, Springer, 2000.
3. 'Fundamentals of Multimedia', Z Li and M S Drew, Pearson Education (Asia) Pvt. Ltd., 2004.

Wavelet Transforms and Applications

Course Code	22LEC334	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module-1			
Continuous Wavelet Transform: Continuous time frequency representation of signals, The Windowed Fourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, specifications, admissibility conditions, Continuous wavelet transform, CWT as a correlation, CWT as an operator, Inverse CWT			
Module-2			
Discrete wavelet Transform: Approximations of vectors in nested linear vector spaces, Example of an MRA, Formal definition of MRA, Construction of genera orthonormal MRA, a Wavelet basis for MRA, Digital filtering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm Filter bank implementation of DWT			
Module-3			
Alternative wavelet representations- Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets, biorthogonal analysis and synthesis, Filter bank implementation, Two dimensional Wavelets, filter bank implementation of two-dimensional wavelet transform.			

Module-4
Lifting scheme: Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme, lifting scheme in the z- domain, mathematical preliminaries for polyphase factorization, Dealing with Signal Boundary
Module-5
Applications: Image Compression: EZW Coding, SPIHT, Wavelet Difference Reduction Compression Algorithm, Denoising, speckle removal, edge detection and object isolation, audio compression, communication applications – scaling functions as signalling pulses, Discrete Wavelet Multitone Modulation. **Beyond Wavelet:** Ridge lets and curve lets: Ridge let transform and Digital Curve let transform, Curve let construction, Properties and applications.

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Course Outcome: After successful completion of this course, students should able to;

1. Classify various wavelet transform and explain importance of it.
2. Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT).
3. Explain the properties and application of wavelet transform.
4. Develop and realize computationally efficient wavelet-based algorithms for signal and image processing.
5. Explain brief features and strength of transform beyond wavelet.

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Textbooks:

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

Advanced Computer Architecture

Course Code	22LEC335	CIE Marks	50
Lecture Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Number of Lecture Hours	40 hours Theory	Exam Hours	**03**
Credits – 03			
Module-1			
Parallel Computer Models: The State of Computing, Multiprocessors and multicomputers, Multivector and SIMD computers. **Program and Network Properties**: Conditions of parallelism, Program Partitioning & Scheduling, Program Flow Mechanisms.			
Module-2			
Principles of Scalable Performance: Performance Metrics and Measures, Parallel Processing Applications, Speedup Performance Laws, Scalability Analysis and Approaches. **Processors & Memory Hierarchy**: Advanced processor technology, Super Scalars & Vector Processors, Memory Hierarchy Technology, Virtual Memory Technology.			
Module-3			
Bus, Cache and Shared Memory: Bus Systems, Cache Memory Organizations, Shared Memory Organizations, Sequential & Weak Consistency Model. **Pipelining & Superscalar Technologies**: Linear Pipeline Processors, Nonlinear Pipeline Processors, Instruction Pipeline Design, Arithmetic Pipeline Design, Superscalar Pipeline Design.			
Module-4			

Multivector & SIMD Computers: Vector Processing principles, Multivector Multiprocessors, Compound Vector Processing, SIMD Computer Organization **Scalable, Multithreaded and Data Flow Computers**: Latency Hiding Techniques, Principles of Multithreading, Fine Grain Multi Computers, Scalable and Multithreaded Architectures, Data Flow and Hybrid Architecture.
Module-5
Parallel Models, Languages and Compilers: Parallel Programming Models, Parallel Languages & Compilers, Dependence Analysis and Data Arrays, Code Optimization and Scheduling, Loop Parallelization and Pipelining. **Parallel Program Development and Environments**: Parallel Programming Environments, Synchronization and Multi Processor Modes, Shared Variable Program Structures.

Course outcomes:

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

1. Understand the basic concepts for parallel processing
2. Analyze program partitioning and flow mechanisms
3. Apply pipelining concept for the performance evaluation
4. Learn the advanced processor architectures for suitable applications
5. Understand parallel Programming

Question paper pattern:

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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub question covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

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. Three Tests to be conducted with each of 20 Marks
2. Two assignments each of 20 Marks or One Skill Development Activity of 40 marks to attain Cos and POs

The sum three Tests and two assignments/one Skill Development Activity will be scaled down to 50 marks

CIE question paper is designed to attain the different levels of Bloom's taxonomy as per the COs 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.
4. There will be two full questions (with a maximum of four sub questions) from each module.
5. Each full question will have sub questions covering all the topics under a module.
6. The students will have to answer five full questions, selecting one full question from each module.

Textbook:

1. 'Advanced Computer Architecture: Parallelism, Scalability, Programmability', Kai Hwang & Narendra Jotwani, McGraw Hill Education, ISBN:978-93-392-2092-1, 3rdEdition,2016

Reference Books:
1. 'Computer Architecture, Pipelined and Parallel Processor Design', M.J. Flynn, Narosa Publishing, 2002.
2. 'Parallel programming in C with MPI and OpenMP', Michael J Quinn, Tata McGraw Hill, 2013.
3. 'An Introduction to Parallel Computing: Design and Analysis of Algorithms', Ananth Grama, Pearson, 2ndEdition, 2004.

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PROJECT WORK PHASE - 1			
Course Code	**22LEC34**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:6:0)	SEE Marks	-
Total Hours of Pedagogy	40 hours Practical	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.

- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake problem identification, formulation and solution.
3. Design engineering solutions to complex problems utilising a systems approach.
4. Communicate with engineers and the community at large in written an oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

SOCIETAL PROJECT			
Course Code	**22LEC35**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:6:0)	SEE Marks	-
Total Hours of Pedagogy	40 hours Practical	Total Marks	100
Credits	03	Exam Hours	-

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.

- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology to workout/proposing viable solutions for societal problems.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

1. Demonstrate a sound technical knowledge of their selected project topic.
2. Undertake societal problem identification, formulation and solution.
3. Design engineering solutions to complex societal problems utilising a systems approach.
4. Communicate with engineers and the community at large in written an oral forms.
5. Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of **50:25:25**.

NOTE: Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

RBT Level: L3, L4, L5, L6

INTERNSHIP			
Course Code	**22LECI36**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	06 weeks Internship Completed during the intervening vacation of II and III semesters.	SEE Marks	50
Total Hours of Pedagogy		Total Marks	100
Credits	06	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Internship provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objectives are further,
- To put theory into practice.
- To expand thinking and broaden the knowledge and skills acquired through course work in the field.

- To relate to, interact with, and learn from current professionals in the field.
- To gain a greater understanding of the duties and responsibilities of a professional.
- To understand and adhere to professional standards in the field.
- To gain insight to professional communication including meetings, memos, reading, writing, public speaking, research, client interaction, input of ideas, and confidentiality.
- To identify personal strengths and weaknesses.
- To develop the initiative and motivation to be a self-starter and work independently

Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree.

Students under the guidance of internal guide/s and external guide shall take part in all the activities regularly to acquire as much knowledge as possible without causing any inconvenience at the place of internship.

Seminar: Each student is required to

- Present the seminar on the internship orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity, credibility, judgment, intuition.
- Acquire the knowledge of administration, marketing, finance and economics

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of **50:25:25**.

Semester End Examination

SEE marks for the Internship Report (30 Marks), Seminar (15 Marks) and Question and Answer Session (15 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

NOTE: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

RBT Level: L3, L4, L5, L6

SEMESTER -IV

PROJECT WORK PHASE - 2			
Course Code	**22LEC41**	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	(0:8:0)	SEE Marks	100
Total Hours of Pedagogy	40 hours Practical	Total Marks	200
Credits	18	Exam Hours	3

Course Learning objectives: This course will enable students to:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- Develop interactive, communication, organisation, time management, and presentation skills.
- Impart flexibility and adaptability.

- Inspire independent and team working.
- Expand intellectual capacity, credibility, judgement, intuition.
- Adhere to punctuality, setting and meeting deadlines.
- Instil responsibilities to oneself and others.
- Train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase-2: Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1 to complete the Project work. Each student / batch of students shall prepare project report as per the norms avoiding plagiarism and present a seminar.

Seminar: Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through power point slides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of **50:25:25.**

Semester End Examination

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms. SEE marks for the project report (50 marks), seminar (25 marks) and question and answer session (25 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed

by the University.	**RBT Level: L3, L4, L5, L6**