**M.TECH IN DIGITAL COMMUNICATION AND NETWORKING**
**(LDN)**
**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
(Effective from the academic year 2022-23)

**SEMESTER -I**

| **ADVANCED DIGITAL SIGNAL PROCESSING** | | | |
|---|---|---|---|
| Course Code | **22LDN12** | CIE Marks | 50 |
| Teaching Hours/Week (L:P: SDA) | 3:2:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory + 10-12 Lab slots | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |

**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 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** | |
|---|---|
| **Introduction to Digital Signal Processing:** Review of Discrete time signals and systems and frequency analysis of discrete time linear time invariant systems, implementation of discrete time systems, correlation of discrete time systems Sampling, 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. (Text 1, Text2) **RBT Level: L1, L2, L3, L4** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| **MODULE-2** | |
|---|---|
| **Multirate Digital Signal Processing:** Multirate signal processing and its applications, Design of Digital filters, Design of FIR filters, Design of IIR filters, frequency transformations, Digital filter banks, two channel quadrature mirror filter banks, Mchannel QMF bank. (Text 1, Text 2) **RBT Level: L1, L2, L3, L4** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| **MODULE-3** | |
|---|---|
| **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) **RBT Level: L1, L2, L3, L4** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| **MODULE 4** | |
|---|---|
| **Adaptive filters:**<br>**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) **RBT Level: L1, L2, L3, L4** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| MODULE 5 |
|---|
| **Power Spectrum Estimation:**<br>**Non parametric Methods for Power Spectrum Estimation** - Bartlett Method, Welch Method, Blackman &Tukey Methods.<br>**Parametric Methods for Power Spectrum Estimation:** Relationship between the auto correlation and themodel 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)<br>**RBT Level: L1, L2** |

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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 (YuleWalker &Burg). |
| 12 | Time-Frequency Analysis with the Continuous Wavelet Transform. |
| 13 | 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 3 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)

**Suggested Learning Resources:**

**Text Books**

1. Digital Signal Processing Principles, Algorithms, and Applications by John G. Proakis, Prentice-Hall International Inc., 4th Edition, 2012.
2. Theory and Application of Digital Signal Processing by Lawrence R. Rabiner and Bernard Gold.

**Reference Books**

1. Oppenheim, Alan V. Discrete-time signal processing. Pearson Education India, 1999.
2. Mitra, Sanjit Kumar, and Yonghong Kuo. Digital signal processing: a computer-based approach. Volume 2. New York: McGraw-Hill Higher Education, 2006.

**Web links and Video Lectures (e-Resources):**

- **https://ekeeda.com/degree-courses/electrical-engineering/advanced-digital-signal-processing**
- **https://dss-kiel.de/index.php/teaching/lectures/lecture-advanced-digital-signal-processing**

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

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

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Able to analyze and implement the frequency analysis & correlation of discrete-time linear time invariant systems. | Analyze |
| CO2 | Able to implement sampling rate conversion by decimation & Interpolation process and design digital filter banks | Analyze |
| CO3 | Able to analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm | Analyze |
| CO4 | Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm. | Analyze |
| CO5 | Able to understand parametric & non-parametric methods for power spectrum estimation. | Understand |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| WIRELESS COMMUNICATION | | | |
|---|---|---|---|
| Course Code | **22LDN13** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |

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

- To apply knowledge about capacity of wireless channel and enhance it using MIMO.
- To understand channel impairment and its mitigation using space-time block and Trellis codes.
- To understand advanced MIMO system like layered space time codes, MU-MIMO System and MIMO OFDM systems.

**Module-1**

**CAPACITY OF WIRELESS CHANNELS:** The crowded spectrum, need for high data rate, MIMO systems – Array Gain, Diversity Gain, Data Pipes, Spatial MUX, MIMO System Model. MIMO System Capacity – channel known at the TX, Channel unknown to the TX – capacity of deterministic channels, Random channels and frequency selective channels. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and Talk, YouTube videos |

**Module-2**

**RADIO WAVE PROPAGATION:** Radio wave propagation – Macroscopic fading- free space and outdoor, small scale fading, fading measurements – Direct pulse measurements, spread spectrum correlation channel sounding frequency domain channel sounding, Antenna Diversity – Diversity combining methods. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**SPACE TIME BLOCK CODES:** Delay Diversity scheme, Alamouti space time code – Maximum likelihood decoding maximum ratio combining. Transmit diversity space time block codes for real signal constellation and complex signal constellation - decoding of STBC. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**SPACE TIME TRELLIS CODES:** Space time coded systems, space time code word design criteria, design of space time T C on slow fading channels, design of STTC on Fast Fading channels, performance analysis in slow and fast fading channels, effect of imperfect channel estimation and Antenna correlation on performance, comparison of STBC & STTC. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**LAYERED SPACE TIME CODES:** LST transmitter – Horizontal and Vertical LST receiver – ML Rx, Zero forcing Rx; MMSE Rx, SIC Rx, ZF V-blast Rx- MMSE V-blast Rx, Iterative Rx - capacity of MIMO – OFDM systems – capacity of MIMO multi user systems. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity |

| | |
|---|---|
| **Learning Process** | based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Books**


1. Mohinder Jankiraman, Space-time codes and MIMO systems, Artech House, Boston, London . www.artech house.com,ISBN1-58053-865-7-2004
2. Paulraj Rohit Nabar, Dhananjay Gore, Introduction of space time wireless communication systems, CambridgeUniversity Press, 2003.
3. David Tse and Pramod Viswanath, ―Fundamentals of Wireless Communication‖, Cambridge University Press, 2005.
4. Sergio Verdu ― Multi User Detection‖ Cambridge University Press, 1998


**Web links and Video Lectures (e-Resources):**

**Massive Open Online Courses:**

1. Introduction to Wireless and Cellular Communications- By Prof.R. David Koilpillai | IIT Madras
2. Fundamentals of MIMO Wireless Communication- By Prof. Suvra Sekhar Das | IIT Kharagpur
3. Principles of Signal Estimation for MIMO/ OFDM Wireless Communication-By Prof. Aditya K. Jagannatham | IIT Kanpur

**Skill Development Activities Suggested**

- Miniprojects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Any new software tool can be used to implement the theory concepts.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Comprehend the significance and role of this course in the present contemporary world | Understand |
| CO2 | Apply the knowledge about the importance of MIMO in today's communication | Apply |
| CO3 | Analyze the various methods for improving the data rate of wireless communication system. | Analyze |
| CO4 | Understand advanced concepts in MIMO like space time block code, trellis code etc. | Understand |

**Program Outcome of this course**

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

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | - | | - | - | - | - |
| **CO2** | - | - | - | - | - | - |
| **CO3** | - | | - | - | - | - |
| **CO4** | - | - | - | - | - | - |

## ADVANCED COMMUNICATION NETWORKS

| | | | |
|---|---|---|---|
| Course Code | **22LDN14** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:2 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 3 | Exam Hours | 3 |

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

- To Build an understanding of the fundamental concepts of basic networking.
- To Introduce the student to advanced internetworking concepts.
- To Understand the concepts to control the congestion , allocate resources and to provide QOS
- To Familiarize with the concepts of network security, authentication protocols and firewalls.
- To Identify the traditional and advanced application layer protocols.

**Module-1**

**Foundation**: Building a Network, Applications, Requirements, Network Architecture, Implementing Network Software, Performance, Basic Networking (IP), Routing, Implementation and Performance (Text 1: Chapter 1.1, 1.2, 1.3, 1.4, 1.5, 3.2, 3.3, 3.4). **RBT Level: L1,L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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). **RBT Level: L1,L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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). **RBT Level: L1, L2,L3,L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**End-to End data**: Presentation formatting, **Multimedia Data Network Security:** Security attacks, Cryptographic building blocks, Key Predistribution, Authentication protocols, Transport Layer Security [TLS, SSL, HTTPS], IP Security, Wireless Security, Firewalls (Text 1: Chapter 7.1, 7.2, 8.1, 8.2, 8.3,8.4.3,8.4.4,8.4.5, 8.5). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Applications: Traditional Applications:** Electronic Mail (SMTP, POP, IMAP, And 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) **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Books**

**Textbooks:**

1. 'Computer Networks: A System Approach', Larry Peterson and Bruce S Davis, 5th Edition, Elsevier -2014.
2. 'Internetworking with TCP/IP, Principles, Protocols and Architecture', Douglas E Comer, 6th Edition, PHI – 2014

**Reference Books:**

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

**Web links and Video Lectures (e-Resources):**

https://cseweb.ucsd.edu/classes/wi19/cse124-a/courseoverview/compnetworks.pdf

**Skill Development Activities Suggested**

- Develop a website and hosting it on the web.
- Present an email architectural and implementation solution for a small sized enterprise.
- Mini Projects can be suggested to improve the programming skills.
- Online certification course can be suggested on the related area.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Classify network services, protocols, architectures and fundamentals of Internetworking. | Understand |
| CO2 | Knowledge on Advanced Internetworking applications and their protocols, and ability to work on their own applications (e.g. Client Server applications, Web Services). | Understand |
| CO3 | To analyze various techniques for Congestion avoidance and Resource Allocation. | Analyze |
| CO4 | Understand the concept of Network Security through cryptographic blocks, authentication protocols, security and firewalls. | Understand |
| CO5 | Gain the knowledge of application layer protocols. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| ADVANCED EMBEDDED SYSTEMS | | | |
|---|---|---|---|
| Course Code | **22LDN15** | CIE Marks | 50 |
| Teaching Hours/Week (L:P: SDA) | 2:0:2 | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 3 | Exam Hours | 3 |

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

- To perform effectively as entry level Embedded Systems professionals.
- To develop and maintain applications written using Embedded C.
- To design and develop a hardware platform encompassing a microcontroller and peripherals.

| **Module-1** | |
|---|---|
| **Embedded System:** Embedded Vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems (Text 1: Selected Topics from Ch -1, 2, 3). **RBT Level: L1, L2** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| **Module-2** | |
|---|---|
| Hardware Software Co-Design, embedded firmware design approaches, computational models, embedded firmware development languages, Integration and testing of Embedded Hardware and firmware, Components in embedded system development environment (IDE), Files generated during compilation, simulators, emulators and debugging (Text 1: Selected Topics from Ch-7, 9, 12, 13). **RBT Level: L1, L2, L3, L4** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| **Module-3** | |
|---|---|
| ARM-32 bit Microcontroller: Thumb-2 technology and applications of ARM, Architecture of ARM Cortex M3, Various Units in the architecture, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence (Text 2: Ch 1, 2, 3). **RBT Level: L1, L2, L3, L4** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| **Module-4** | |
|---|---|
| Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface (Text 2: Ch-4, 5, 6). **RBT Level: L1, L2** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| **Module-5** | |
|---|---|
| Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex- M3 Programming using assembly and C language, CMSIS (Text 2: Ch-7, 8, 10). **RBT Level: L1, L2, L3** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Text Books**

1. Introduction to embedded systems', K. V. Shibu, TMH education Pvt.Ltd.,2009
2. The Definitive Guide to the ARM Cortex-M3', Joseph Yiu, Newnes,(Elsevier),2nd edn, 2010.

**Reference Books:**

1. Embedded systems - A contemporary design tool', James K. Peckol, John Wiley, 2008

**Web links and Video Lectures (e-Resources):**

- http://www.embeddedtechnology.com/
- https://www.edx.org/learn/embedded-systems
- http://www.realtime-info.be/magazine/98q4/1998q4_p014.pdf

**Skill Development Activities Suggested**

Students have to conduct the following experiments as a part of CIE marks along with other Activities:

**ARM Cortex M3 Programs** - Programming to be done using Keil uVision 4 and download the program on to a M3 evaluation board such as NXP LPC1768 or ATMEL ARM

a. Write an Assembly language program to calculate the sum and display the result for the addition of first ten numbers. SUM = 10+9+8+..... +1
b. Write an Assembly language program to store data in RAM
c. Write a C program to output the "Hello World" message using UART
d. Write a C program to operate a buzzer using Cortex M3
e. Write a C program to display the temperature sensed using Cortex M3.
f. Write a C program to control stepper motor using Cortex M3.

- Programming Assignments/Miniprojects can be given to improve programming skills.
- Online course certification on embedded systems may be suggested.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system. | Understand |
| CO2 | Explain the hardware software co-design and firmware design approaches. | Analyze |
| CO3 | Understand the suitability of the instruction sets of ARM processors to design of embedded systems. | Analyze |
| CO4 | Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32-bit microcontroller including memory map, interrupts and exceptions. | Understand |
| CO5 | Apply the knowledge gained for Programming ARM CORTEX M3 for different applications. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| COMMUNICATION NETWORK LABORATORY | | | |
|---|---|---|---|
| Course Code | **22LDNL17** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 1:2:0 | SEE Marks | 50 |
| Credits | 2 | Exam Hours | 100 |

**Course objectives:**

The course objectives include learning about computer network organization and implementation, obtaining a theoretical understanding of data communication and computer networks, and gaining practical experience in installation, monitoring, and troubleshooting of current LAN systems.

| Sl. No | Experiments |
|---|---|
| 1 | Write a program to archive Traffic management at Flow level by implementing Closed Loop Control technique. (Leaky Bucket Algorithm) |
| 2 | Write a program to implement dynamic routing strategy in finding optimal path for data transmission. (Bellman ford algorithm). |
| 3 | Write a program to implement Link State Routing (Dijkstra Algorithm). |
| 4 | Write a program for providing security for transfer of data in the network. (RSA Algorithm) |
| 5 | Write a program for encrypting 64 bit playing text using DES algorithm. |
| 6 | Apply the RSA algorithm on a text file to produce cipher text file. |
| 7 | Develop a mechanism to setup a security channel using Diffie-Hellman Key Exchange between client and server |
| 8 | Implement secure hash algorithm for Data Integrity. Implement MD5 and SHA-1 algorithm, which accepts a string input, and produce a fixed size number - 128 bits for MD5; 160 bits for SHA-1, this number is a hash of the input. Show that a small change in the input results in a substantial change in the output. |
| | **Demonstration Experiments ( For CIE ) if any** |
| 9 | Simulate a 3 node point to point network with duplex links between them. Set the Queue size and vary the bandwidth and find the number of packets dropped. |
| 10 | Simulate a four-node point-to-point network, and connect the links as follows: n0->n2, n1- >n2 and n2->n3. Apply TCP agent changing the parameters and determine the number of packets sent/received by TCP/UDP |
| 11 | Simulate to Plot Congestion for Different Source/Destination |
| 12 | Simulate to Determine the Performance with respect to Transmission of Packets |

**Note: Conduct the experiments using C/NS2/Qualnet/OPNET/OMNET simulation tools**

**Course outcomes (Course Skill Set):**

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

1. Apply key Internet applications and their protocols, and ability to develop their own applications (e.g. Client Server applications, Web Services) using the sockets API.
2. Design and evaluate application layer protocol.
3. Analyze the vulnerabilities in any computing system and hence be able to design a security solution.
4. Identify the security issues in the network and resolve it.
5. Evaluate security mechanisms using rigorous approaches, including theoretical.

**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 8$^{th}$ week of the semester and the second test shall be conducted after the 14$^{th}$ 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

**Suggested Learning Resources:**

- http://www.ciscopress.com/articles/
- GeeksforGeeks | A computer science portal for geeks
- https://www.amazon.com/Computer-Networking-James-Kurose-Keith/dp/0273768964

| BOS recommended ONLINE courses | |
|---|---|
| Course Code | **22AUD18/ 22AEC18** |

| Sl. No. | Course code | Course Title | National Coordinator | Instructor |
|---|---|---|---|---|
| 1 | 22AUD18/ 22AEC18 | Design Thinking - A Primer ( 4 Weeks) | NPTEL | Prof. Ashwin Mahalingam, Prof. Bala Ramadurai IIT Madras |
| 2 | | Computer Networks and Internet Protocol (12 Weeks) | NPTEL | Prof. Soumya Kanti Ghosh & Prof. Sandip Chakraborty IITKGP |
| 3 | | Advanced IOT Applications (8 Weeks) | NPTEL | Prof. T V Prabhakar IISc |
| 4 | | Spread Spectrum Communications and Jamming (12 Weeks) | NPTEL | Prof. Debarati Sen IITKGP |
| 5 | | Optical Wireless Communications for Beyond 5G Networks and IoT (12 Weeks) | NPTEL | Prof. Anand Srivastava IIITD |
| 6 | | Employment Communication A Lab based course (8 Weeks) | NPTEL | Prof. Seema Singh IIT KGP |
| 7 | | Embedded System Design with ARM (8 Weeks) | NPTEL | Prof. Indranil Sengupta and Kamalika Dutta IITKGP |

**Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses):**

**Audit Courses:** These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

**Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialization as well allied fields that leads to employable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

**M.TECH IN DIGITAL COMMUNICATION AND NETWORKING (LDN)**

**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
(Effective from the academic year 2022-23)

**SEMESTER -II**

| **ADVANCED COMMUNICATION SYSTEMS** | | | |
|---|---|---|---|
| Course Code | **22LDN21** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- To understand the concept of low pass and Band pass signals during modulation at the Transmitter.
- To analyze the Receiver performance for various types of single carrier symbol modulations through ideal and AWGN channels.
- To apply single carrier equalizers for various modulation schemes and detection methods for defined channel models
- To understand the concepts of synchronization for carrier and symbol timing recovery at receiver.
- To understand the concepts of spread spectrum systems for communications in a Jamming, multiuser and low power intercept environment.

**Module-1**

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

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**DEMODULATION**: Vector Channel, Vector Channel +AWGN, Performance parameters, Optimum Coherent Detection for power limited and Band limited schemes, Optimal Coherent detection for schemes with memory, Optimal Non– Coherent detection for schemes without and with memory (FSK, DPSK,DQPSK), Comparison of detection schemes [Text 1, Chapter 4: 4.1, 4.2.- 4.2.2,4.3, 4.4, 4.5.1, 4.5.2, 4.5.5 and 4.6]. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**BANDLIMITED CHANNELS:** Band limited channel characterization, signaling through band limited linear filter channels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes.
**Linear Equalizers**: Zero forcing Equalizer, MSE and MMSE. **Non-Linear Equalizers**: Decision - feedback

equalization, Predictive DFE, Performance of DFE [Text 1, Chapter 9].

**Adaptive equalization**: Adaptive linear equalizer, adaptive decision feedback equalizer, [Text 1, Chapter 10]. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**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, Binary signalling over frequency non selective Rayleigh fading channel [Text 1, Chapter 13]. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**SPREAD SPECTRUM SIGNALS FOR DIGITAL COMMUNICATION**: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS spread spectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS, Synchronization of SS systems[Text 1, Chapter 12: 12.1, 12.2 (except 12.2.1),12.2.2, 12.2.5, 12.3, 12.4, 12.5]. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Books**

1. 'Digital Communications', John G. Proakis, Masoud Salehi, Pearson Education, ISBN:978-9332535893, 5th edition, 2014
2. Digital Communications: Fundamentals and Applications: Fundamentals & Applications', Bernard Sklar, Pearson Education,ISBN:9788131720929, 2nd edition, 2009
3. 'Digital Communications Systems', Simon Haykin, Wiley,ISBN:9788126542314, 1st edition, 2014

**Web links and Video Lectures (e-Resources):**

**Massive Open Online Courses:**

1. Modern Digital Communication Techniques-By Prof. Suvra Sekhar Das | IIT Kharagpur
2. Principles of Signal Estimation for MIMO/ OFDM Wireless Communication**-By Prof. Aditya K. Jagannatham | IIT Kanpur**

**Skill Development Activities Suggested**

- Miniprojects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Any new software tool can be used to implement the theory concepts.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Explain the concept of low pass and Bandpass signals representations at the Transmitter, process of Detection and Estimation at the receiver in the presence of AWGN only. | Understand |
| CO2 | Evaluate Receiver performance for various types of single carrier symbol modulations through ideal and AWGN Non-bandlimited and bandlimited channels. | Apply |
| CO3 | Design 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. | Analyze |
| CO4 | Explain the concepts of multi-channel signaling scheme and synchronization for carrier and symbol timing recovery at receiver. | Understand |
| CO5 | Design and Evaluate Non band limited and Non power limited spread spectrum systems for communications in a Jamming environment, multiuser situation and low power intercept environment. | Analyze |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| ANTENNA THEORY AND DESIGN | | | |
|---|---|---|---|
| Course Code | **22LDN22** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory + 10-12 Lab slots | Total Marks | 100 |
| Credits | 4 | Exam Hours | 3 |

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

- To classify different types of antennas
- To define and illustrate various types of array antennas
- To design antennas like Yagi-Uda, Helical antennas and other broad band antennas
- To describe different antenna synthesis methods
- To apply methods like Method of Moments, Pocklington's integral equation, Source modeling.

**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. TEXT(1) **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Arrays:** Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Nonuniformly 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. TEXT(1) **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. TEXT(1)
**RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. TEXT(1) **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

| | |
|---|---|
| **Antenna in systems & Measurements:** Receiving properties of antennas, Antenna temperature & radiometry. **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. TEXT(1).<br>**RBT Level: L1, L2, L3** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

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

| Sl. No | Experiments |
|---|---|
| 1 | MATLAB/C implementation to obtain the radiation pattern of an antenna |
| 2 | Study of radiation pattern of different antennas. |
| 3 | Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas. |
| 4 | Impedance measurements of Horn antennas. |
| 5 | Study of radiation pattern of E plane horns |
| 6 | Significance of Pocklington's integral equation. |
| 7 | Determine the directivity and gains of dipole antennas. |
| 8 | Impedance measurements of Yagi antennas. |
| 9 | Determine the directivity and gains of Parabolic antennas. |
| 10 | Study of radiation pattern of E plane horns |

**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 experimentsshall be conducted for 50 marks and scaled down to 05 marks**.**

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

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**SEE for IPCC**

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

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

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

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

**Suggested Learning Resources:**

**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=fIbdW0NGIU0
https://nptel.ac.in/courses/117107035

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

- Different types of antenna synthesis or technical seminar on advanced types of antennas.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Classify different types of antennas | Understand |
| CO2 | Define and illustrate various types of array antennas | Understand |
| CO3 | Design antennas like Yagi-Uda, Helical antennas and other broad band antennas | Analyze |
| CO4 | Describe different antenna synthesis methods | Understand |
| CO5 | Apply methods like Method of Moments, Pocklington's integral equation, Source modeling. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

# Professional Elective 1

| WIRELESS SENSOR NETWORKS | | | |
|---|---|---|---|
| Course Code | **22LDN231** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Learn the basic concepts of Wireless sensor networks architecture and protocols.
- Understand the challenges in designing a Wireless sensor networks.
- Understand the function of Data link and Network layer Protocols.
- Understand the function of Transport layer Protocols.
- Analyze wireless sensor network system for different applications under consideration

**Module-1**

**INTRODUCTION:** Sensor Mote Platforms, WSN Architecture and Protocol Stack (Chap.1Text 1).
**WSN Applications:** Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications (Chap. 2 Text 1). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**FACTORS INFLUENCING WSN DESIGN:** Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption (Chap. 3 Text 1). **Physical Layer:** Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards (Chap. 4 of Text 1).
**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**MEDIUM ACCESS CONTROL:** Challenges for MAC, CSMA Mechanism, Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access (Chap. 5 of Text 1). **Network Layer:** Challenges for Routing, Data-centric and Flat Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols (Chap. 7 of Text 1). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Transport Layer:** Challenges for Transport Layer, Reliable Multi Segment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol, Event-to-Sink Reliable Transport (ESRT) Protocol, GARUDA
(Chap.8 Text 1).
**Application Layer:** Source Coding (Data Compression), Query Processing, Network Management (Chap. 9 Text 1). **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**SPREAD SPECTRUM SIGNALS FOR DIGITAL COMMUNICATION**: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS spread

spectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS, Synchronization of SS systems[Text 1, Chapter 12: 12.1, 12.2 (except 12.2.1),12.2.2, 12.2.5, 12.3, 12.4, 12.5].

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

**1.** Three Unit Tests each of **20 Marks**

2. 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

**Suggested Learning Resources:**

**Books:**

1. Wireless Sensor Networks, Ian F. Akyildiz and Mehmet Can Vuran, John Wiley & Sons Ltd. ISBN 978-0-470-3601-3 (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):**

**Massive Open Online Courses:**

https://archive.nptel.ac.in/courses/106/105/106105160/#- **Wireless** Ad Hoc and **Sensor Networks** -BY Prof. SUDIP MISHRA,IITKGP

**Skill Development Activities Suggested**

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Implement Networking concepts using NS2/NS3/OMNET/OPNET/QUALNET software tool.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Acquire knowledge of characteristics of mobile/wireless communication channels | Understand |
| CO2 | Apply statistical models of multipath fading | Apply |
| CO3 | Understand the multiple radio access techniques, radio standards and communication protocols to be used for wireless sensor | Understand |
| CO4 | Design wireless sensor network system for different applications under consideration. | Analyze |
| CO5 | Understand the hardware details of different types of sensors and select right type of sensor for various applications. | Understand |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| NANOELECTRONICS | | | |
|---|---|---|---|
| Course Code | **22LDN232** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

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

**Module-1**

**Introduction:** Overview of nanoscience and engineering. Development milestones in microfabrication and electronic industry. 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 nano systems. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

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

**Carbon Nanostructures:** Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Methods of measuring properties:** atomic, crystallography, microscopy, spectroscopy
**Applications:** Injection lasers, quantum cascade lasers, single-photon sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIPs, NEMS, MEMS. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**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:**


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

**Web links and Video Lectures (e-Resources):**

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

**Skill Development Activities Suggested**

- Seminar on recent applications of Carbon nano tubes

**Course outcome (Course Skill Set)**

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

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

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| CRYPTOGRAPHY AND NETWORK SECURITY | | | |
|---|---|---|---|
| Course Code | **22LDN233** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

**Course outcomes:** This course will enable students to:

- Understand the basics of symmetric key.
- Use basic cryptographic algorithms to encrypt the data.
- Generate some pseudorandom numbers required for cryptographic applications.
- Provide authentication and protection for encrypted data.
- Understand the techniques and features of Email, IP and Web security.

**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 Structure, AES Key Expansion (Text 1: Chapter 2: Section 1 & 2, Chapter 4: 2 & 4). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**More Number Theory:** Prime Numbers, Fermat's and Euler's theorem, Testing for Primality, The Chinese Remainder theorem, Discrete Logarithms. (Text 1: Chapter 7: Section 1, 2, 3, 4, 5).

Principles of Public-Key Cryptosystems, The RSA algorithm, Diffie - Hellman Key Exchange, Elliptic Curve Arithmetic, Elliptic Curve Cryptography (Text 1: Chapter 8 , Chapter 9: Section 9.1, 9.3, 9.4).

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

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

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**One-Way Hash Functions:** Background, Snefru, N-Hash, MD4, MD5, Secure Hash Algorithm [SHA], Oneway hash functions using symmetric block algorithms, Using public key algorithms, Choosing a one-way hash functions, Message Authentication Codes.

Digital Signature Algorithm, Discrete Logarithm Signature Scheme

(Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4).

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity |

| | |
|---|---|
| **Learning Process** | based method, Seminar |

**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) (Text 1: Chapter 18: Section 18.1 to 18.4).
**Web Security**: Web Security Considerations, SSL (Text 1: Chapter 15: Section 15.1, 15.2).

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

**1.** Three Unit Tests each of **20 Marks**

**2.** 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

**Suggested Learning Resources:**

**Textbooks:**

**1.** "Cryptography and Network Security Principles and Practice", William Stallings, Pearson Education Inc., ISBN: 978-93325-1877-3, 6th Edition, 2015

**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, 200

**Web links and Video Lectures (e-Resources):**

- https://nptel.ac.in/courses/106105162
- Cryptography & Network Security, IIT Kharagpur, Prof. Sourav Mukophadhyay

**Skill Development Activities Suggested**

- Online certification course on probability and random process.
- Miniprojects can be suggested on the related area.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the basics of symmetric key. | Understand |
| CO2 | Use basic cryptographic algorithms to encrypt the data. | Apply |
| CO3 | Generate some pseudorandom numbers required for cryptographic applications. | Apply |
| CO4 | Provide authentication and protection for encrypted data. | Apply |
| CO5 | Understand the techniques and features of Email, IP and Web security. | Understand |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| OPTICAL COMMUNICATION AND NETWORKING | | | |
|---|---|---|---|
| Course Code | **22LDN234** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

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

**Module-1**

**Introduction to optical networks:** Optical Networks, optical packet switching, **Propagation of signals in optical fiber:** Different losses, Nonlinear effects, Solitons. **Optical Components (Part-1):** Couplers, Isolators, and Circulators (1.3, 1.6, 2.1 up to 2.6, 3.1, 3.2 of Text). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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 (5.1up 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).

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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).

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Control and Management (Part-1):** Network management functions, management framework, Information model, management protocols, **Layers within the optical layer.** Control and Management (Part-2): Performance and fault management, Impact of transparency, BER measurement, Optical trace, Alarm management, Configuration management, Optical Safety (8(introduction), 8.1, 8.3, 8.5 (introduction), 8.5.1 up to 8.5.4, 8.6, 8.7 of Text). **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Textbooks:**

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

**Reference Books:**

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

**Web links and Video Lectures (e-Resources):**

https://onlinecourses.nptel.ac.in/noc20_ph07/preview
https://www.classcentral.com/course/swayam-optical-communications-6699

**Skill Development Activities Suggested**

- Mini Projects can be suggested to improve the programming skills.
- Online certification courses can be suggested in the related area.

**Course outcome (Course Skill Set)**

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

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

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| PROBABILITY THEORY and RANDOM PROCESS | | | |
|---|---|---|---|
| Course Code | **22LDN235** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

**Course learning objectives:** This course will enable students to:

- To understand Discrete and Continuous Random variables, Random Processes and their applications in Electronic Transmissions.
- To apply concepts of Probability to solve problems in communication Engineering.
- To find functional relationship between random inputs and outputs with the use of Random Process Techniques
- Analyze about the correlation Functions.

**Module-1**

**Probability and Random Variable Probability:** Set theory, Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability Definitions and Axioms, Mathematical Model of Experiments, Joint Probability, Conditional Probability, Total Probability, Bayes' Theorem, and Independent Events, Bernoulli's trials. The Random Variable: Definition of a Random Variable, Conditions for a Function to be a Random Variable, Discrete and Continuous, Mixed Random Variable. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Distribution and density functions and Operations on One Random Variable Distribution and density functions:** Distribution and Density functions, Properties, Binomial, Poisson, Uniform, Exponential Gaussian, Rayleigh and Conditional Distribution, Methods of defining Conditioning Event, Conditional Density function and its properties, problems. **Operation on One Random Variable:** Expected value of a random variable, function of a random variable, moments about the origin, central moments, variance and skew, characteristic function, moment generating function, transformations of a random variable, monotonic transformations for a continuous random variable, non monotonic transformations of continuous random variable, transformations of Discrete random variable. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**Multiple Random Variables and Operations on Multiple Random Variables Multiple Random Variables:** Vector Random Variables, Joint Distribution Function and Properties, Joint density Function and Properties, Marginal Distribution and density Functions, conditional Distribution and density Functions, Statistical Independence, Distribution and density functions of Sum of Two Random Variables and Sum of Several Random Variables, Central Limit Theorem - Unequal Distribution, **Equal Distributions Operations on Multiple Random Variables:** Expected Value of a Function of Random Variables, Joint Moments about the Origin, Joint Central Moments, Joint Characteristic Functions, and **Jointly Gaussian Random Variables:** Two Random Variables case and N Random Variable case, Properties, Transformations of Multiple Random Variables. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Stochastic Processes-Temporal Characteristics:** The Stochastic process Concept, Classification of Processes, Deterministic and Nondeterministic Processes, Distribution and Density Functions, **Statistical Independence and concept of Stationarity:** First-Order Stationary Processes, Second Order and Wide-Sense Stationarity, Nth-Order and Strict-Sense Stationarity, Time Averages and 1 Ergodicity, Mean-Ergodic Processes, Correlation-Ergodic Processes Autocorrelation Function and Its Properties, Cross-Correlation Function and Its Properties, Covariance Functions and its properties, Gaussian Random Processes. **Linear system Response:** Mean and Mean-squared value, Autocorrelation, Cross-Correlation Functions.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Stochastic Processes-Spectral Characteristics:** The Power Spectrum and its Properties, Relationship between Power Spectrum and Autocorrelation Function, the Cross-Power Density Spectrum and Properties, Relationship between Cross-Power Spectrum and Cross-Correlation Function. **Spectral characteristics of system response:** power density spectrum of response, cross power spectral density of input and output of a linear system. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**TEXT BOOKS:**

1. Probability, Random Variables & Random Signal Principles -Peyton Z. Peebles, TMH, 4th Edition, 2001.
2. Probability and Random Processes-Scott Miller, Donald Childers,2nd Edn, Elsevier,2012

**Skill Development Activities Suggested**

- Online certification course on probability and random process.
- Miniprojects can be suggested on the related area.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | understand Discrete and Continuous Random variables, Random Processes and their applications in Electronic Transmissions | Understand |
| CO2 | To apply concepts of Probability to solve problems in communication Engineering. | Apply |
| CO3 | To find functional relationship between random inputs and outputs with the use of Random Process Techniques | Apply |
| CO4 | Analyze about the correlation Functions | Analyze |

**Program Outcome of this course**

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

**Mapping of COS and POs:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | - | | - | - | | - |
| **CO2** | - | | - | - | | - |
| **CO3** | - | | - | - | | - |
| **CO4** | - | | - | - | | - |

# Professional Elective 2

| MULTIMEDIA OVER COMMUNICATION LINKS | | | |
|---|---|---|---|
| Course Code | **22LDN241** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

- Gain fundamental knowledge in understanding the basics of different multimedia networks, applications, media types like text and image.
- Analyze media types like audio and video and gain knowledge on multimedia systems.
- Analyze Audio compression techniques required to compress Audio.
- Analyze compression techniques required to compress video.
- Gain fundamental knowledge about the Multimedia Communications in different Networks.

**Module-1**

**Multimedia Communications:** Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology. (Chapter 1,Text 1)

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Information Representation:** Introduction, Text, Images, Audio and Video.
**Distributed multimedia systems:** Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems. (Chap. 2- Sections 2.2, 2.3, 2.4 and 2.5 of Text 1
Chap. 4 - Sections 4.1 to 4.5 of Text 2) **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

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

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

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

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| Module-5 | |
|---|---|
| **Multimedia Communication Across Networks:** Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks. Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2) **RBT Level: L1, L2, L3** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Textbooks:**


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


**Reference Books:**


1. Raif steinmetz, Klara Nahrstedt, "Multimedia: Computing, Communications and Applications", Pearson education, 2002, ISBN -9788177584417.


**Web links and Video Lectures (e-Resources):**

https://onlinecourses.nptel.ac.in/noc20_ph07/preview
https://www.classcentral.com/course/swayam-optical-communications-6699

**Skill Development Activities Suggested**

1. Features of Promodel Package and Input Modeling
2. Simulation of Manufacturing System I
3. Simulation of Manufacturing System II
4. Simulation of Service Operations I
5. Simulation of Service Operations II

Suggested Simulation Packages;

- Promodel

**Note: A minimum of 5 exercises to be executed covering the entire syllabus in SDA**

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand basics of different multimedia networks and applications | Understand |
| CO2 | Analyze media types like audio and video to represent in digital form. | Analyze |
| CO3 | Understand different compression techniques to compress audio & video. | Understand |
| CO4 | Describe the basics of Multimedia Communication Across Networks | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | - | - | - | | | |
| **CO2** | - | - | - | | | - |
| **CO3** | - | - | - | | - | - |
| **CO4** | - | - | - | | - | - |

| STATISTICAL SIGNAL PROCESSING | | | |
|---|---|---|---|
| Course Code | **22LDN242** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

- Understand random processes and its properties
- Understand the basic theory of signal detection and estimation
- Identifytheengineeringproblemsthatcanbeputintotheframeofstatisticalsignal processing
- Solvetheidentifiedproblemsusingthestandardtechniqueslearnedthroughthiscourse.
- Makecontributionstothetheoryandthepracticeofstatisticalsignalprocessing.

**Module-1**

**Random Processes:** Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes (Text1).**RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Signal Modeling:** Least squares method, Pade approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion (Text1). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**Spectrum Estimation:** Non parametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation (Text1). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Optimal and Adaptive Filtering:** FIR and IIR Wiener filters, Discrete Kalman filter, **FIR Adaptive filters:** Steepest descent, LMS, LMS-based algorithms, adaptive recursive filters, RLS algorithms (Text 1). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Array Processing:** Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beam-forming, linearly constrained minimum-variance beam-formers,side-lobe cancellers.(Text2). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Text Books**


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


**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

- Mathematical modeling of signals: linear vs. nonlinear, deterministic signals, random signals, unknown parameters.
- Mathematical modeling of noise: white Gaussian noise, coloured Gaussian noise, general Gaussian noise, IID non-Gaussian noise.
- Specific algorithms for estimation, detection, and spectral estimation: parameter estimation, signal extraction, adaptive filtering, sinusoidal estimation, matched filters, estimator-correlator, spectral estimation via Fourier and high-resolution methods.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Design statistical DSP algorithms to meet desired needs | Analyze |
| CO2 | Apply vector space methods to statistical signal processing problems | Apply |
| CO3 | Identify the engineering problems that can be put into the frame of statistical signal processing | Understand |
| CO4 | Understand Wiener filter theory and design discrete and continuous Wiener filters | Understand |
| CO5 | Understand Kalman Filter theory and design discrete Kalman filters | Understand |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| HIGH SPEED COMMUNICATION NETWORKS | | | |
|---|---|---|---|
| Course Code | **22LDN243** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Develop an in-depth understanding, in terms of architecture, protocols and applications of major high-speed networking technologies.
- Compare and contrast high speed access and admission control, shaping and scheduling algorithms.
- Discuss queuing and congestion control for high speed architectures.

**Module-1**

**HIGH SPEED NETWORK ARCHITECTURE:** Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL, **High Speed LANs:** Emergence of High-Speed LANs, Gigabit Ethernet, WDM systems, Optical LANs, SONET.

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**ADMISSION AND ACCESS CONTROL:**CAC for ATM VBR Services - Worst-Case Traffic Model and CAC, Effective Bandwidth, Lucent's CAC, NEC's CAC, Tagged-Probability-Based CAC, CAC for Integrated Services Internet - Guaranteed Quality of Service, Controlled-Load Service, ATM Traffic Contract and Control Algorithms - Traffic Contract, PCR Conformance, SCR, and BT, Cell Delay Variation Tolerance, Generic Cell Rate Algorithm. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**SHAPING AND SCHEDULING**: An ATM Shaping Multiplexer - Regularity Condition-Dual Leaky Bucket, Algorithm, Implementation Architecture, Finite Bits Overflow Problem, An Integrated Packet Shaper - Basics, Integrating Traffic Shaping and WFI Scheduling, Logical Structure and implementation of the WFI Packet Shaper Packet Scheduling – FIFO, RR, Stop-and-Go, HRR, EDD, Rate-Controlled Static Priority, GPS-WFQ, Virtual Clock, Self-Clocked Fair Queuing, Worst-case Fair Weighted Fair Queuing, Scheduling Algorithm - Shaped Virtual Clock Algorithm, Core-Stateless Shaped Virtual Clock Algorithm.

**RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**QUEUING & BUFFER MANAGEMENT:** Conceptual Framework and Design Issues, Sequencer - Store Cells in Logical Queues, Sort Priorities Using a Sequencer, Priority Content-Addressable Memory - Searching by the PCAM Chip, Connecting Multiple PCAM Chips, RAM-Based Searching Engine - Hierarchical Searching, Timestamp Overflow, Design of the RSE, RSE Operations, Write-in Operation, Reset Operation, Search Operation, General Shaper - Scheduler - Slotted Updates of System Virtual Time, Implementation Architecture, Timestamp Aging Problem Buffer Management: A Look at ATM Networks - Self-Calibrating Pushout, TCP/IP over ATM_UBR, Dynamic Threshold with Single Loss Priority, A Look at the Internet - Tail Drop, Drop on Full, Random Early Detection, **Differential Dropping:** RIO, FRED, SRED, LQD.

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**FLOW AND CONGESTION CONTROL** : Window-Based Flow Control, Rate-Based Flow Control, Predictive Control Mechanism, ATM Networks - Backlog Balancing Flow Control - ABR Flow Control, TCP/IP Networks - TCP Congestion Control - Other TCP Variants - TCP with Explicit Congestion Notification, Rate-Based Flow Control Scheme. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Books**


1. H. Jonathan Chao and XiaoleiGuo, "Quality of Service Control in High-Speed Networks", John Wiley & Sons, Inc., First Edition, 2002.
2. William Stallings, "High Speed Networks and Internet", Pearson Education, Second Edition, 2002.
3. Jean Walrand and PravinVariaya, "High Performance Communication Networks", Morgan kaufmann Publishers, Second Edition, 2000.
4. Leon Garcia and Widjaja, "Communication Network", Tata McGraw Hill, New Delhi, Second Edition, 2003.


**Web links and Video Lectures (e-Resources):**

**Massive Open Online Courses:**

**1.**https://www.classcentral.com/course/swayam-communication-networks-58423 - Communication NetworksBy G**outam Das, IIT Kharagpur .**

2.Lecture Series on Data Communication by Prof.A. Pal, Department of Computer Science Engineering,IIT Kharagpur. For more details on NPTEL visit http://nptel.iitm.ac.in

**Skill Development Activities Suggested**

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Industrial Visit or Seminar on any new topic.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Differentiate architectures of Frame Relay, ATM, Gigabit Ethernet and SONET | Understand |
| CO2 | Apply techniques involved to support real-time traffic and congestion control | Apply |
| CO3 | Evaluate different techniques employed to support high speed architectures | Analyze |
| CO4 | Select the right framework required to solve the issues involved in high speed networks. | Understand |
| CO5 | Compare the different mechanisms available for provision of QoS in high speed architectures. | Understand |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| APPLIED CYBER SECURITY | | | |
|---|---|---|---|
| Course Code | **22LDN244** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

- Understand the basics of cyber security.
- Understand the basics architecture of cyber security.
- Understand the basics of ethical Hacking.
- Understand the concepts of web Hacking.
- Understand the concepts of Computer Forensics and encryption Forensics.

**Module-1**

**Introduction Cyber network security concepts**: **Security Architecture, antipattern:** signature based malware detection versus polymorphic threads, document driven certification and accreditation, policy driven security certifications. **Refactored solution:** reputational, behavioral and entropy based malware detection. **The problems:** cyber antipatterns concept, forces in cyber antipatterns, cyber anti pattern templates, cyber security antipattern catalog (Text-1: Chapter1 & 2). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Cyber network security concepts contd**. : Enterprise security using Zachman framework Zachman framework for enterprise architecture, primitive models versus composite models, architectural problem solving patterns, enterprise workshop, matrix mining, mini patterns for problem solving meetings. (Text-1: Chapter 3 ). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**Introduction To Hacking**: Introduction to Hacking – Important Terminologies – Penetration Test – Vulnerability Assessments versus Penetration Test – Pre-Engagement – Rules of Engagement -Penetration Testing Methodologies – OSSTMM – NIST – OWASP – Categories of Penetration Test – Types of Penetration Tests – Vulnerability Assessment Summary -Reports(Text-2: Chapter 1 ). **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Web Hacking** – Attacking the Authentication – Brute Force and Dictionary Attacks – Types of Authentication – Log-In Protection Mechanisms – Captcha Validation Flaw – Captcha RESET Flaw – Manipulating User-Agents to Bypass Captcha and Other Protection (Text-2: Chapter 12 ). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

Introduction to Computer Forensics-what is Forensics? The Growing Problem of Computer Crime What Exactly Is Computer Forensics?

Encryption & Forensics Cryptographic Integrity Services , Cryptographic Privacy Services , Time Stamping (Text 3 Chapter 1 and Chapter 4) **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Books**


1. Thomas J. Mowbray, ―Cyber Security – Managing Systems, Conducting Testing, and Investigating Intrusions‖, Wiley.
2. Rafay Baloch, "Ethical Hacking and Penetration Testing Guide", CRC Press, 2014.
3. Warren G. Kruse II and Jay G. Heiser, "Computer Forensics: Incident Response Essentials", Addison Wesley, 2002.


**Web links and Video Lectures (e-Resources):**

- https://onlinecourses.nptel.ac.in/noc22_cs13.
- https://onlinecourses.swayam2.ac.in/cec20_cs15

**Skill Development Activities Suggested**

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Industrial Visit or Seminar on any new topic.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the basics of cyber security. | Understand |
| CO2 | Understand the basics architecture of cyber security | Apply |
| CO3 | Understand the basics of ethical Hacking | Understand |
| CO4 | Understand the concepts of web Hacking | Apply |
| CO5 | Understand the concepts of Computer Forensics and encryption Forensics. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| SIMULATION, MODELLING AND ANALYSIS | | | |
|---|---|---|---|
| Course Code | **22LDN245** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (2:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 25 Hours Theory + 10-12 Slots of Skill Development Activities | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Define the basics of simulation modelling and replicating the practical situations in organizations
- Generate random numbers and random variates using different techniques.
- Develop simulation model using heuristic methods.
- Analysis of Simulation models using input analyzer, and output analyzer.
- Explain Verification and Validation of simulation model.

**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)

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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)

**RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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)

**RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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)

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Text Books**

1. Averill Law, "Simulation modeling and analysis", McGraw Hill 4th edition, 2007.

**Reference Books:**

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

**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

1. Features of Promodel Package and Input Modeling
2. Simulation of Manufacturing System I
3. Simulation of Manufacturing System II
4. Simulation of Service Operations I
5. Simulation of Service Operations II

Suggested Simulation Packages;

- Promodel

**Note: A minimum of 5 exercises to be executed covering the entire syllabus in SDA**

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Describe the role of important elements of discrete event simulation and modeling paradigm | Understand |
| CO2 | Conceptualize real world situations related to systems development decisions, originating from source requirements and goals. | Analyze |
| CO3 | Develop skills to apply simulation software to construct and execute goal-driven system models. | Analyze |
| CO4 | Interpret the model and apply the results to resolve critical issues in a real world environment. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|
| **CO1** | - | - | - | - | | |
| **CO2** | - | - | - | - | | - |
| **CO3** | - | - | - | | | - |
| **CO4** | - | - | - | - | | - |

| MINI PROJECT WITH SEMINAR | | | |
|---|---|---|---|
| Course Code | **22LDN25** | 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 Learning objectives:** This course will enable students to:

- 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, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To 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.

**Mini Project With Seminar:** This may be hands-on practice, survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc. Each student of the project batch 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:

1. Present the mini-project and be able to defend it.
2. 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.
3. Habituated to critical thinking and use problem solving skills.
4. Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
5. Work in a team to achieve common goal.
6. 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, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio **50:25:25**. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course. **RBT Level: L3, L4, L5, L6**

| ADVANCED COMMUNICATION LABORATORY | | | |
|---|---|---|---|
| Course Code | **22LDNL26** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | (1:2:0) | SEE Marks | 50 |
| Credits | 02 | Exam Hours | 03 |

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

- Understand and plot the radiation pattern of specified antennas using MATLAB and wave guide setup.
- Determine characteristics of a given antenna.
- Compute the S-parameters of Magic tee and directional couplers.
- Test the IC CD4051 for modulation techniques.
- 5. Understand the multiplexing techniques using OFC kit.

| 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. |
| | **Demonstration Experiments ( For CIE ) if any** |
| 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. |

**Note: Conduct the experiments using MATLAB/Scilab/any antenna simulation tool**

**Course outcomes (Course Skill Set):** 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.

**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 $8^{th}$ week of the semester and the second test shall be conducted after the $14^{th}$ 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

**Suggested Learning Resources:**

**Books:**


1. 1.'Digital Communications', John G. Proakis, Masoud Salehi, Pearson Education, ISBN:978-9332535893, 5th edition, 2014
2. Digital Communications: Fundamentals and Applications: Fundamentals & Applications', Bernard Sklar, Pearson Education,ISBN:9788131720929, 2nd edition, 2009
3. 'Digital Communications Systems', Simon Haykin, Wiley,ISBN:9788126542314, 1st edition, 2014

| BOS recommended ONLINE courses | |
|---|---|
| Course Code | **22AUD27** |

| Sl.No. | Course code | Course Title | National Coordinator | Instructor |
|---|---|---|---|---|
| 1 | 22AUD27 | Introduction To Internet Of Things (12 Weeks) | NPTEL | Prof. Sudip Misra IIT Kharagpur |
| 2 | | Basics of software defined Radios (4 Weeks) | NPTEL | Prof. Meenakshi Rawat IIT Roorkee |
| 3 | | Principles of Signal Estimation for MIMO/ OFDM Wireless Communication (12 Weeks) | NPTEL | Prof. Aditya K. Jagannatham IIT Kanpur |
| 4 | | Programming In Java ( 12 Weeks) | NPTEL | Prof. Debasis Samanta IIT Kharagpur |
| 5 | | Fiber Optic Communication Technology (12 Weeks) | NPTEL | Prof. Deepa Venkitesh IIT Madras |
| 6 | | Introduction to Wireless and Cellular Communications (12 Weeks) | NPTEL | Prof. R. David Koilpillai IIT Madras |
| 7 | | Introduction to Computer and Network Performance Analysis using Queuing Systems (4 Weeks) | NPTEL | Prof. Varsha Apte IIT Bombay |
| 8 | | LaTeX & XFig - typesetting software (06 Weeks) | AICTE | Prof Kannan Moudgalya, Principal Investigator of Spoken Tutorial Project Indian Institute of Technology Bombay |

**Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses):**

**Audit Courses:** These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

**Ability Enhancement Courses**:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads toemployable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

**M.TECH IN DIGITAL COMMUNICATION AND NETWORKING**
**(LDN)**

**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
(Effective from the academic year 2022-23)

**SEMESTER -III**

| **LTE 4G BROADBAND** | | | |
|---|---|---|---|
| Course Code | **22LDN31** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory+10 Hours SDA | Total Marks | 100 |
| Credits | 04 | Exam Hours | 3 |

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

- Understand the basics of LTE standardization phases and specifications.
- Explain the system architecture of LTE and E-UTRAN, the layer of LTE, based on the use of OFDMA and SC-FDMA principles.
- Analyze the role of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer, for transferring the EPS bearer.
- Analyze the main factors affecting LTE performance including mobile speed and transmission bandwidth.

**Module-1**

**LTE Standardization**: 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.

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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, Radio Resource Control (RRC), X2 Interface Protocols, Understanding the RRC ASN.1 Protocol Definition, Early UE Handling in LTE. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity |

| | |
|---|---|
| **Learning Process** | based method, Seminar |

**Module-4**

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

**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. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Performance:** Layer 1 Peak Bit Rates, Terminal Categories Link Level Performance, Link Budgets Spectral Efficiency Latency, LTE Reframing to GSM Spectrum Dimensioning. **LTE-Advanced:** LTE-Advanced and IMT-Advanced, Requirements, 3GPP LTE-Advanced Study Phase, Carrier Aggregation, Downlink Multi-antenna Enhancements, Uplink Muli-antenna Techniques.

**RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Text Book**:

1. 'LTE for UMTS Evolution to LTE-Advanced', Harri Holma 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, Issam Toufik, and Matthew Baker, John Wiley &Sons Ltd, 2009.

**Web links and Video Lectures (e-Resources):**

Introduction to 3G/4G standards

- **https://nptel.ac.in/courses/117104099**

Data flow, radio resource management, and mobility management pdf.

**https://ajaybolar.weebly.com/uploads/1/0/1/0/10106930/module_5_ppt_wireless_cellular_and_lte_4g__broadband.pdf**

**Skill Development Activities Suggested**

- Online course certification on LTE domain.
- Miniprojects can be suggested on the related area.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Describe the system architecture and the function standard specified components of the system of LTE 4G. | Understand |
| CO2 | Comprehend the Multiple Access process incorporated in the radio physical layer | Understand |
| CO3 | 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 | Analyze |
| CO4 | Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios. | Apply |
| CO5 | Test and Evaluate the Performance of resource management and packet data processing and transport algorithms. | Analyze |

**Program Outcome of this course**

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

**Mapping of COS and POs:**

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

# Professional Elective 3

| COGNITIVE RADIO NETWORKS | | | |
|---|---|---|---|
| Course Code | **22LDN321** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- 1.Understand the basic components of cognitive radio and its architecture.
- 2.Analyze various spectrum sensing techniques for different models.
- 3.Understand the Optimization Techniques applied in Dynamic Spectrum Allocation.
- 4.Understand the different issues regarding Dynamic Spectrum Access and Spectrum Trading.

| **Module-1** | |
|---|---|
| **INTRODUCTION TO COGNITIVE RADIOS:** Cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio. **RBT Level: L1, L2** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |
| **Module-2** | |
| **SPECTRUM SENSING:** Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market). **RBT Level: L1, L2, L3** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |
| **Module-3** | |
| **OPTIMIZATION TECHNIQUES OF DYNAMIC SPECTRUM ALLOCATION:** Linear programming, convex programming, non-linear programming, integer programming, dynamic programming, stochastic programming. **RBT Level: L1, L2, L3** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |
| **Module-4** | |
| **DYNAMIC SPECTRUM ACCESS AND MANAGEMENT:** Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols. **RBT Level: L1, L2** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |
| **Module-5** | |
| **ECTRUM TRADING:** Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential). **RBT Level: L1, L2** | |
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1.Three Unit Tests each of **20 Marks**

2.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

**Suggested Learning Resources:**

**Books**


1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
3. Bruce Fette, "Cognitive radio technology", Elsevier, 2nd edition, 2009.
4. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.
5. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
6. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.


**Web links and Video Lectures (e-Resources):**

- https://www.youtube.com/watch?v=FCDZV2U6xxE- By Prof. Aditya K. Jagannatham | GIAN- IIT Kanpur

**Skill Development Activities Suggested**

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Industrial Visit or Seminar on any new topic.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the fundamental concepts of cognitive radio networks. | Understand |
| CO2 | Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it. | Apply |
| CO3 | Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies | Understand |
| CO4 | Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimization techniques for better spectrum exploitation. | Understand |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| WDM OPTICAL NETWORKS | | | |
|---|---|---|---|
| Course Code | **22LDN322** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Illustrate the networking aspects of opticalNetwork.
- Understand principles of light transmission in optical fibers.
- Understand optical fiber communication system.
- Understand the concept of WDM concepts and components of optical fibers.
- Describe Advanced Techniques and Devices for Optical Networking.

**Module-1**

**Introduction with Brief History:** Optical Networking Principles, Role of the Optical Networking, Optical Network Structure, WDM as a foundation of Optical Networking, Principles of Multilayer Networks.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Enabling Technologies for Optical Networks:** Light Transmission in Optical Fibers Signal Impairments Along the Lightpath Optical Transmitters and Modulators Optical Receivers Optical Amplifiers Optical Switching Elements. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**Optical Networks Design :** Core Optical Networks Metro Optical networks Access Optical Networks Wavelength Routing and Assignment Traffic Grooming and Protection Multilayer Network Structure.

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Advanced Techniques and Devices for Optical Networking:** Techniques for Space and Spectral Signal Processing – MIMO and OFDM Elastic Modulation Coding as a Networking Tool Optical Devices for design ROADM and PXC design Wavelength Agile Devices Wavelength Convertors. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**tical Network Management and Routing Principles :** Functions of Network Control and Management Impairment Aware Routing Optical Circuit Switching Optical Packet Switching Optical Burst Switching Energy Awareness in Optical Networking Network Modeling Tools Network Design Guidelines.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill 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

**Suggested Learning Resources:**

**Textbook:**

1. Cvijetic, M., Djordjevic. I. B.: Advanced Optical Communication Systems and Networks, Artech House 2012

**Web links and Video Lectures (e-Resources):**

- https://www.youtube.com/watch?v=rIaiBmzxNEQ
- https://www.youtube.com/watch?v=uBAp-zBJho4
- https://www.udemy.com/course/dwdm-networks-tutorial/

**Skill Development Activities Suggested**

- Optical Network Management and Routing Principles.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Illustrate the networking aspects of optical Network. | Apply |
| CO2 | Understand principles of light transmission in optical fibers. | Understand |
| CO3 | Understand optical fiber communication system. | Understand |
| CO4 | Understand the concept of WDM concepts and components of optical fibers. | Understand |
| CO5 | Describe Advanced Techniques and Devices for Optical Networking. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| PATTERN RECOGNITION AND MACHINE LEARNING | | | |
|---|---|---|---|
| Course Code | **22LDN323** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Develop the mathematical tools required for the pattern recognition.
- Enable the student with basic knowledge on the techniques to build an intellectual machine for making decisions behalf of humans.
- Understand the techniques on how to make learning by a model, how it can be evaluated, what are all different algorithms to construct a learning model.

**Module-1**

**Introduction:** Definition of PR, Applications, Datasets for PR, Different paradigms for PR, Introduction to probability, events, random variables, Joint distributions and densities, moments, Estimation minimum risk estimators, problems. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Representation:** Data structures for PR, Representation of clusters, proximity measures, size of patterns, Abstraction of Data set, Feature extraction, Feature selection, Evaluation **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

Nearest Neighbor based classifiers & Bayes classifier: Nearest neighbor algorithm, variants of NN algorithms, use of NN for transaction databases, efficient algorithms, Data reduction, prototype selection, Bayes theorem, minimum error rate classifier, estimation of probabilities, estimation of probabilities, comparison with NNC, Naive Bayes classifier, Bayessian belief network. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Machine Learning Basics:** Learning Algorithms, Capacity, Overfitting and Underfitting, Hyper parameters and Validation Sets, Estimator, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Stochastic Gradient Decent, building a Machine Learning Algorithm, Challenges Motivating Deep Learning. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Optimization for Training Deep Models:** How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms. Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates.

**Convolutional Networks:** The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill 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

**Suggested Learning Resources:**

**TextBooks**

1. "Pattern Recognition (An Introduction)", V Susheela Devi, M Narsimha Murthy, Universities Press, 2011.
2. "Pattern Recognition & Image Analysis", Earl Gose, Richard Johnson baugh, Steve Jost, PH,1996.
3. "Deep Learning", Lan Good fellow and Yoshua Bengio and Aaron Courville, MIT Press,2016.

**Reference Books:**

1. 'Pattern Classification', Duda R. O., P.E. Hart, D.G. Stork, John Wiley and sons, 2000.
2. "Pattern Recognition and machine Learning", Chirstopher Bishop,2007.

**Web links and Video Lectures (e-Resources):**

- https://link.springer.com › book
- https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf
- http://cgm.cs.mcgill.ca/~godfried/teaching/pr-web.html

**Skill Development Activities Suggested**

- ProgrammingAssignments/MiniProjectscanbegiventoimproveprogrammingskills.
- Online course certification related to this domain may be included.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Explain pattern recognition principals. | Understand |
| CO2 | Develop algorithms for Pattern Recognition. | Understand |
| CO3 | Design the nearest neighbor classifier. | Analyze |
| CO4 | Identify the deep learning algorithms which are more appropriate for various types of learning tasks . | Understand |
| CO5 | Implement deep learning algorithms and Execute performance metrics of Deep Learning Techniques. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| COMMUNICATION SYSTEM DESIGN USING DSP ALGORITHMS | | | |
|---|---|---|---|
| Course Code | **22LDN324** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Understand communication systems, including algorithms that are particularly suited to DSP implementation.
- Understand Software and hardware tools, as well as FIR and IIR digital filters and the FFT.
- Discuss modulators and demodulators for classical analog modulation methods such as amplitude modulation (AM), double-sideband suppressed-carrier amplitude modulation (DSBSC-AM), single sideband modulation (SSB), and frequency modulation (FM).
- Explore digital communication methods leading to the implementation of a telephone-line modem.

**Module-1**

**Introduction :** Digital filters, Discrete time convolution and frequency responses, **FIR filters** - Using circular buffers to implement FIR filters in C and using DSP hardware, Interfacing C and assembly functions, Linear assembly code and the assembly optimizer. **IIR filters** - realization and implementation, FFT and power spectrum estimation: DTFT window function, DFT and IDFT, FFT, Using FFT to implement power spectrum. (Chapter 3 and Chapter 4 ) **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Analog modulation scheme:** Amplitude Modulation - Theory, generation and demodulation of AM, Spectrum of AM signal. Envelope detection and square law detection. Hilbert transform and complex envelope, DSP implementation of amplitude modulation and demodulation.
**DSBSC:** Theory generation of DSBSC, Demodulation, and demodulation using coherent detection and Costas loop. Implementation of DSBSC using DSP hardware.
**SSB:** Theory, SSB modulators, Coherent demodulator, Frequency translation, Implementation using DSP hardware. (Text 1, 2 - Chapter 5, 6 and Chapter 7) **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**Frequency modulation:** Theory, Single tone FM, Narrow band FM, FM bandwidth, FM demodulation, Discrimination and PLL methods, Implementation using DSP hardware.
**Digital Modulation scheme:** PRBS, and data scramblers: Generation of PRBS, Self -synchronizing data scramblers, Implementation of PRBS and data scramblers. RS-232C protocol and BER tester: The protocol, error rate for binary signaling on the Gaussian noise channels, Three bit error rate tester and implementation(Chapter 8, 9 and Chapter 10) **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**PAM and QAM:** PAM theory, baseband pulse shaping and ISI, Implementation of transmit filter and interpolation filter bank. Simulation and theoretical exercises for PAM, Hardware exercises for PAM.
**QAM fundamentals:** Basic QAM transmitter, 2 constellation examples, QAM structures using passband shaping filters, Ideal QAM demodulation, QAM experiment. QAM receivers-Clock recovery and other frontend sub-systems. Equalizers and carrier recovery systems(Chapter 11, 13 and Chapter 14)
**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Experiment for QAM receiver frontend.** Adaptive equalizer, Phase splitting, Fractionally spaced equalizer. Decision directed carrier tracking, Blind equalization, Complex cross coupled equalizer and carrier tracking experiment.

**Echo cancellation for full duplex modems:** Multicarrier modulation, ADSL architecture, Components of simplified ADSL transmitter, A simplified ADSL receiver, Implementing simple ADSL Transmitter and Receiver(Chapter 15 and Chapter 16) **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**TextBooks**


1. "Tretter, Steven A., "Communication System Design Using DSP Algorithms With Laboratory Experiments for the TMS320C6713™ DSK", Springer USA, 2008.


**Reference Books:**


1. Robert. O. Cristi, "Modern Digital signal processing", Cengage Publishers, India, 2003.
2. S. K. Mitra, "Digital signal processing: A computer based approach", 3rd edition, TMH, India, 2007.
3. E.C. Ifeachor, and B. W. Jarvis, "Digital signal processing: A Practitioner's approach", Second Edition, Pearson Education, India, 2002,
4. Proakis, and Manolakis, "Digital signal processing", 3rd edition, Prentice Hall, 1996.


**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

- Experiments for the TMS320C6713™ as suggested in the Text book.

**Note:** A minimum of 5 exercises to be executed covering the entire syllabus in SDA

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Implement FIR, IIR digital filtering and FFT methods | Understand |
| CO2 | Implement DSP algorithms on TI DSP processors | Analyze |
| CO3 | Implement modulators and demodulators for AM,DSBSC-AM,SSB and FM | Understand |
| CO4 | Design digital communication methods leading to the implementation of a line communication system. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| ERROR CONTROL CODING | | | |
|---|---|---|---|
| Course Code | **22LDN325** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

- Understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel.
- Apply modern algebra and probability theory for the coding.
- Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes.
- Detect and correct errors for different data communication and storage systems.
- Analyze and implement different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm.

**Module-1**

**Information theory**: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem (Chap. 5 of Text 1).

**Introduction to algebra:** Groups, Fields, binary field arithmetic, Construction of Galois Fields GF (2m) and its properties, (Only statements of theorems without proof) Computation using Galois field GF (2m) arithmetic, Vector spaces and Matrices (Chap. 2 of Text 2). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Linear block codes:** Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes(Chap. 3 of Text 2). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**Cyclic codes:** Introduction, Generator and parity check polynomials, Encoding of cyclic codes, Syndrome computing and error detection, Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes (Chap. 4 of Text2). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**BCH codes:** Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. (6.1,6.2,6.7 of Text 2) Primitive BCH codes over GF (q),

**Reed -Solomon codes** (7.2,7.3 of Text 2).

**Majority Logic decodable codes:** One -step majority logic decoding, Multiplestep majority logic (8.1,8.4 of Text 2). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

| | |
|---|---|
| **Process** | |

**Module-5**

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

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**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

**ference Books:**

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

**Web links and Video Lectures (e-Resources):**

**Skill Development Activities Suggested**

- NPTEL Course on Information Theory and Coding

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the concept of the Entropy, information rate and capacity for the Discrete memoryless channel. | Apply |
| CO2 | Apply modern algebra and probability theory for the coding. | Apply |
| CO3 | Compare Block codes such as Linear Block Codes, Cyclic codes, etc. and Convolutional codes. | Apply |
| CO4 | Detect and correct errors for different data communication and storage systems. | Apply |
| CO5 | Analyze and implement different Block code encoders and decoders, and also convolutional encoders and decoders including soft and hard Viterbi algorithm. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

# Professional Elective 4

| REAL TIME SYSTEMS | | | |
|---|---|---|---|
| Course Code | **22LDN331** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

- Analyze Real time operating systems.
- Distinguish a real-time system with other systems.
- Describe the functions of Real time operating systems
- Demonstrate embedded system applications.
- Design a Real Time operating system.

**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.(TEXT 1). **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. (TEXT 1) **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. (TEXT 1). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Hardware for Real-Time Systems:** Basic Processor Architecture, Memory Technologies, Architectural Advancements, Peripheral Interfacing, Microprocessor versus Microcontroller, Distributed Real-Time Architectures. (TEXT 2). **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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.(TEXT 1) **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Textbooks:**


1. '"Real-Time Embedded Systems and Components", Sam Siewert, Cengage Learning India Edition, 2007.
2. "Real-Time Systems Design and Analysis", Phillip A. Laplante, John Wiley & Sons, 2004.


**ference 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.


**Web links and Video Lectures (e-Resources):**

- https://youtube.com/playlist?list=PL5Q2soXY2Zi9xidyIgBxUz7xRPS-wisBN

**Skill Development Activities Suggested**

- Design Scheduling Algorithms.
- Analysing Device Driver Programming

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Analyze Real time operating systems. | Analyze |
| CO2 | Distinguish a real-time system with other systems. | Apply |
| CO3 | Describe the functions of Real time operating systems | Apply |
| CO4 | Demonstrate embedded system applications. | Apply |
| CO5 | Design a Real Time operating system. | Analyze |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| RF MEMS | | | |
|---|---|---|---|
| Course Code | **22LDN332** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Identify MEMS devices for a given application.
- Formulate fabrication steps for passive and active MEMS devices.
- Design micro machined passive components.
- Model MEMS filters and Phase shifters.
- Analyze reliability issues in MEMS structures.

**Module-1**

**Review: Introduction to MEMS:** Fabrication for MEMS transducers and actuators, Microsensing for MEMS, Materials for MEMS. **MEMS materials and fabrication techniques:** Metals, Semiconductors, Thin films, Materials for polymer MEMS, Bulk machining for Silicon based MEMS, Surface machining for Silicon based MEMS, Micro stereo-lithography for polymer MEMS. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**RF MEMS Switches and micro-relays:** Switch parameters, Basics of switching, Switches for RF and Microwave applications, Actuation mechanisms, Micro-relays and micro-actuators, Dynamic of switch operations, MEMS switch design and design consideration, MEMS inductors and capacitors.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**Micro machined RF filters and phase shifters:** RF filters, Modelling of mechanical filters, Micro-mechanical filters, SAW filters - Basic, Design consideration. Bulk acoustic wave filters, Micro-machined filters for millimetre wave frequencies. Micro-machined phase shifters, Types and limitations, MEMS and Ferroelectric phase shifters, Applications. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Micro machined transmission line and components:** Micro machined transmission line: Losses in transmission line, coplanar lines, Micro shield and membrane supported lines, Micro shield components, Micro machined waveguides,Micro machined directional couplers and Mixers, Resonators and Filters.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**Micromachined antennas:** Design, Fabrication and measurements, basic characteristics of microstrip antenna, design parameters of microstrip antenna,

**Integration and packaging for RF MEMS:** Roles and types of MEMS packages, Flip chip techniques, Multichip module packaging and Wafer bonding, Reliability issues and thermal issues.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Text Book:**

1. RF MEMS and their Applications', Vijay K Varadan, K. J. Vinoy and K.A. Jose, Wiley India Pvt. Ltd., ISBN - 10 : 8126529911, 2011.

**Reference books:**

1. 'RF MEMS circuit design', J De Los Santos, Artech House, 2002.
2. 'Transaction Level Modelling with System C: TLM concepts and applications for Embedded Systems', Frank Ghenassia, Springer, 2005.
3. 'Networks on chips: Technology and Tools', Luca Beninid, Morgan Kaufmann Publishers, 2006.

**Web links and Video Lectures (e-Resources):**

Link of 'RF MEMS and their Applications' text book.

- https://omidi.iut.ac.ir/SDR/2008/Projects/Fereydani_SDR_project/References/%5B5%5D%20RF%20MEMS%20And%20Their%20Applications.pdf

RF MEMS and Microwave imaging Lecture video link from nptel :

- https://freevideolectures.com/course/4367/nptel-microwave-theory-techniques/52

**Skill Development Activities Suggested**

- Assign students to observe the operation of RF MEMS switches and antennas using IE3D simulator.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Comprehend the need for micromachining and MEMS based systems for RF and microwave applications | Understand |
| CO2 | Describe the micromachining techniques and their use in the fabrication of micro switches, capacitors and inductors | Apply |
| CO3 | Design MEMS based microwave components aimed at reducing insertion loss and increasing bandwidth. | Analyze |
| CO4 | Realize high Q micromechanical filters for frequencies up to and beyond 10 MHz, and micromachined surface acoustic wave (SAW) filters filling the gap up to 2 GHz. | Apply |
| CO5 | Describe the packaging approaches used for these RF MEMS devices. | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| RF AND MICROWAVE CIRCUIT DESIGN | | | |
|---|---|---|---|
| Course Code | **22LDN333** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 |

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

- Discuss and analyze waves propagation in Networks
- Apply the Smith Chart for finding various parameters in transmission lines
- Analyze the basic considerations in active networks
- Describe and design active networks
- Design RF/MW Frequency Mixers and phase shifters

**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.

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Smith chart and its Applications:** Introduction, Smith Chart, Derivation of Smith Chart, Smith Chart Circular and Radial Scales, Application of Smith chart. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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;

**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. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Text Book:**

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

**ference Book:**

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

**Web links and Video Lectures (e-Resources):**

- https://www.digimat.in/nptel/courses/video/117105138/L01.html
- https://www.digimat.in/nptel/courses/video/108101112/L01.html

**Skill Development Activities Suggested**

- RF & Millimeter wave circuit design
- Microwave active circuit design

**Course outcome (Course Skill Set)**

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

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

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| INTERNET OF THINGS | | | |
|---|---|---|---|
| Course Code | **22LDN334** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Understand the challenges and history behind Internet of things.
- Design the network architecture and Layered structure of IoT.
- Understand the Things in IoT and the various Technologies involved.
- 4. Apply the concepts of IoT in three different use cases.

**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.

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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.

**RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**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. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**IoT in Industry (Three Use cases):**IoT Strategy for Connected manufacturing, Architecture for Connected Factory Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary

substation grid block and automation. Smart and Connected cities –Strategy, Smart city network Architecture, Street layer, city layer, Data center layer, services layer, Smart city security architecture, Smart Street lighting.

**RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1.Three Unit Tests each of **20 Marks**

2.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

**Suggested Learning Resources:**

**Books**

1.'CISCO, IoT Fundamentals – Networking Technologies, Protocols, Use Cases for IoT', David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Pearson Education, ISBN: 978-9386873743, First edition, 2017

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

**Web links and Video Lectures (e-Resources):**

**Massive Open Online Courses:**

1. Introduction to Internet of Things-**By Prof. Sudip Misra | IIT Kharagpur**
2. An Introduction to Programming the Internet of Things-COURSERA University of California, Irvine

**Skill Development Activities Suggested**

- Mini projects carried out in groups based on latest trends in Industry and continue work to prepare a research Article.
- Industrial Visit or Seminar on any new topic.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand the basic concepts IoT Architecture and devices employed. | Understand |
| CO2 | Analyse the sensor data generated and map it to IoT protocol stack for transport. t | Analyse |
| CO3 | Apply communications knowledge to facilitate transport of IoT data over various available communications media | Apply |
| CO4 | Design a use case for a typical application in real life ranging from sensing devices to analysing the data available on a server to perform tasks on the device | Apply |
| CO5 | Apply knowledge of Information technology to design of IoT applications (Operational Technology). | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| INTRODUCTION TO 5G (NR) | | | |
|---|---|---|---|
| Course Code | **22LDN335** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- The aim of this course is to let the students understand that air Interface is one of the most important elements that differentiate between 2G, 3G, 4G and 5G. While 3G was CDMA based, 4G was OFDMA based; this course reveals the contents of air interface for 5G.

**Module-1**

**5G channel modelling and use cases:** Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, **Relaying Multi-hop and cooperative communications:** Principles of relaying, fundamental of relaying, **Cognitive radio:** Architecture spectrum sensing, Software Defined Radio (SDR).

**RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-2**

**Multiple Input and Multiple Output (MIMO) Systems:** Introduction to Multi-antenna systems, Motivation, Types of multi-antenna Systems, MIMO vs. multi-antenna systems, Diversity, Exploiting multipath diversity, Transmit diversity, Cycle delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing. **RBT Level: L1, L2, L3, L4**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-3**

**The 5G architecture:** Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional split alternatives, Functional optimization for specific applications, Integration of LTE and new air interface to fulfill 5G Requirements, Enhanced Multi-RAT coordination features, Physical architecture and 5G deployment. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-4**

**Device-to-device (D2D) communications:** D2D: from 4G to 5G, D2D standardization: 4G LTE D2D, D2D in 5G: research challenges, Radio resource management for mobile broadband D2D, RRM techniques for mobile broadband D2D, RRM and system design for D2D, 5G D2D RRM concept: an example, Multi-hop D2D communications for proximity and emergency, services, National security and public safety requirements in 3GPP and METIS, Device discovery without and with network assistance. **RBT Level: L1, L2**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Module-5**

**The 5G radio-access technologies:** Access design principles for multi-user communications, Orthogonal multiple-access systems, Spread spectrum multiple-access systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access (IDMA), Radio access for dense deployments, OFDM numerology for small-cell deployments, Small-cell sub-frame structure, Radio access for V2X communication, Medium access control for nodes on the move, Radio access for massive machine-type communication.

Network deployment types, Ultra-dense network or densification, Moving networks, Heterogeneous networks, Interference management in 5G, Interference management in UDN, Interference management for moving relay nodes, Interference cancelation, mobility management in 5G, User equipment-controlled versus network-controlled handover, Mobility management in heterogeneous 5G networks. **RBT Level: L1, L2, L3**

| | |
|---|---|
| **Teaching-Learning Process** | Chalk and talk method, Power Point Presentation, You tube videos, Brain storming, Activity based method, Seminar |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

1. Three Unit Tests each of **20 Marks**
2. 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

**Suggested Learning Resources:**

**Books**


1. '5G Mobile and Wireless Communications Technology', Afif Osseiran, Jose F. Monserrat, Patrick Marsch , Cambridge University Press, Second Edition, 2011.
2. '5G NR: The Next Generation Wireless Access Technology', Erik Dahlman, Stefan Parkvall, Johan Sko¨ld, Elsevier ,First Edition , 2016.
3. 'Fundamentals of 5G Mobile Networks', Jonathan Rodriguez , Wiley , First Edition ,2010.


**Web links and Video Lectures (e-Resources):**

NPTEL

- https://nptel.ac.in/courses/108/105/108105134/

Udemy

- https://www.udemy.com/course/5g-mobile-networks-modern-wireless-communication-technology/

**Skill Development Activities Suggested**

- Assign students some basic experiments 5G communication link analysis with ray tracing using MATLAB
- Wireless connectivity in 5G era for WLAN.
- MIMO Wireless System Design for 5G using MATLAB
- 5G Waveforms generation using MATLAB
- Online course certification on 5G domain.
- Miniprojects can be suggested on the related area.

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understanding and explain the channel model of 5G | Understand |
| CO2 | Analyze use of MIMO in 5G and its techniques. | Analyze |
| CO3 | Understand device to device D2D communication and standardization. | Understand |
| CO4 | Study in depth functioning of 5G radio access technologies. | Understand |
| CO5 | Implement interference management, mobility management and security issues in 5G | Apply |

**Program Outcome of this course**

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

**Mapping of COS and POs**

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

| PROJECT WORK PHASE - 1 | | | |
|---|---|---|---|
| Course Code | **22LDN34** | 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 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 -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. **RBT Level: L3, L4, L5, L6**

| SOCIETAL PROJECT | | | |
|---|---|---|---|
| Course Code | **22LDN35** | 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 | **22LDNI36** | 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**

**M.TECH IN DIGITAL COMMUNICATION AND NETWORKING**
**(LDN)**

**Choice Based Credit System (CBCS) and Outcome Based Education (OBE)**
(Effective from the academic year 2022-23)

**SEMESTER -IV**

| **PROJECT WORK PHASE - 2** | | | |
|---|---|---|---|
| Course Code | **22LDN41** | 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**