**Semester- I**

| RANDOM PROCESS AND PROBABILITY THEORY | | | |
|---|---|---|---|
| Course Code | **MVJLAT11** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- Understanding the concepts of basic probability and random variables.
- Demonstrate the ability to define and characterize random variables using CDF, PDF.
- Learning how to characterize probability models and function of random variables
- Analyze and classify random processes
- Learning how to apply the concepts to Poisson and Gaussian processes

**Module-1**

**Introduction to probability theory:** Experiments, Sample space, Events, Axioms, Assigning probabilities, Joint and conditional, Baye's theorem, Independence, Discrete random variables, Engineering example

**RBT Levels:** L2, L3

**Module-2**

**Random variables, Distributions, Density functions:** CDF, PDF, Gaussian random variable, Uniform, Exponential, Laplace, Gamma, Erlang. Chi-square, Rayleigh, Rician and Cauchy types of random variables.

**RBT Levels:** L3

**Module-3**

**Operation on a single random variable:** Expected valuc, EV of random variables, EV of functions of random variables, Central moments, Conditional expected values.

**RBT Levels:** L3

**Module-4**

**Characteristics functions:** Probability generating functions, Moment generating function, Engineering applications, Scalar quantization, Entropy and source coding

**Pairs of random variables:** Joint PDF, Joint probability mass functions, Conditional distribution, Density and mass functions, EV involving pairs of random variables, Independent random variables, Complex random variables, Engineering application.

**RBT Levels:** L3

**Module-5**

**Random process:** Definition and characterization, Mathematical tools for studying random processes, Stationery and Ergodic random processes, Properties of ACF. Example of Random Processes.

**RBT Levels:** L3, L4

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Books**


1. S.L.Miller and D.C.Childers, "Probability and random processes: application to signal processing and communication", Academic press/Elsevier 2004,
2. A.Papoullis and S.U.Pillai, "Probability, random variables and stochastic processes", McGraw Hill 2002


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

- https://nptel.ac.in/

**Semester- I**

| DIGITAL SIGNAL PROCESSING FOR COMMUNICATION | | | |
|---|---|---|---|
| Course Code | **MVJLAT12** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:2:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory +10 hours Lab | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |

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

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

## Module - 1

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

**RBT Levels:** L2, L3

## Module – 2

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

## Module – 3

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

## Module – 4

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

## Module – 5

**Wavelet Transforms:** The Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future. Continuous Wavelet and Short Time Fourier Transform: Wavelet Transform, Mathematical preliminaries, Properties of wavelets. Discrete Wavelet Transform: Haar scaling functions, Haar wavelet function, Daubechies Wavelets.

**PRACTICAL COMPONENT OF IPCC**

Conduct the experiments using MATLAB/Scilab/TMS 320 C5X DSP Processors

| | |
|---|---|
| 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 in built 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. |
| | |

**Suggested Learning Resources:**

**Textbooks:**

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

**Reference Books:**

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

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

https://nptel.ac.in/

**Course outcome (Course Skill Set)**

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

| Sl. No | Course Outcomes | Blooms Level |
|---|---|---|
| CO 1 | Able to analyze and implement the frequency analysis & correlation of discrete-time linear time invariant systems. | L4 |
| CO 2 | Able to implement sampling rate conversion by decimation & Interpolation process and design digital filter banks | L4 |
| CO 3 | Able to analyze forward and backward linear prediction of a stationary random process using Levinson-Durbin Algorithm | L4 |
| CO 4 | Able to understand and analyze adaptive filters and its application using LMS algorithm & RLS algorithm. | L4 |
| CO 5 | Able to understand parametric & non-parametric methods for power spectrum estimation. | L2 |

**Semester- I**

| ADVANCED COMMUNICATION SYSTEMS | | | |
|---|---|---|---|
| Course Code | **MVJLAT13** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

- To know modulation techniques.
- To study the demodulation techniques.
- To Have a min-depth knowledge of band limited channels and equalizers
- To understand spread spectrum.

**Module-1**

**Signal Representation:** Low pass representation of bandpass signals, Low pass representation of bandpass random process. 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

**RBT Levels: L2, L3**

**Module-2**

**Demodulation:** Vector Channel, Vector Channel + AWGN, Performance parameters, Optimum Coherent Detection for power limited and Bandlimited schemes, Optimal Coherent detection for schemes with memory, Optimal Non-Coherent detection for schemes without and with memory (FSK, DPSK, DQPSK), Comparison of detection schemes.

**RBT Levels: L3**

**Module-3**

**Bandlimited Channels:** Bandlimited channel characterization, signaling through band limited linear filter channels, Sinc, RC, Duobinary and Modified Duobinary signaling schemes, Optimum receiver for channel with ISI and AWGN. Linear Equalizers: Zero forcing Equalizer, MSE and MMSE, Baseband and Passband Linear Equalizers. Performance of ZFE and MSE.

**RBT Levels: L3**

**Module-4**

**Non-Linear Equalizers:** Decision -feedback equalization, Predictive DFE, Performance of DFE Adaptive equalization: Adaptive linear equalizer, adaptive decision feedback equalizer, Adaptive Fractionally spaced Equalizer (Tap Leakage Algorithm), Adaptive equalization of Trellis-coded signals

**RBT Levels: L3**

**Module-5**

**Spread spectrum signals for digital communication:** Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS spread spectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS, Synchronization of SS systems

**RBT Levels: L3, L4**

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

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

**Continuous Internal Evaluation:**

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of 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.

**Suggested Learning Resources:**

**Text Book:**

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

**Reference Books:**

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

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

https://nptel.ac.in/

**Course outcome (Course Skill Set)**

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

| Sl. No | Description | Blooms Level |
|---|---|---|
| CO1 | Ability to explain the concept of low pass and Band pass signals representations at the Transmitter, the process of Detection and Estimation at the receiver in the Presence of AWGN only. | L2 |
| CO2 | Able to Evaluate Receiver performance for various types of single carrier symbol Modulations through ideal and AWGNN on-band limited and band limited channels. | L2 |
| CO3 | Analyze and demonstrate the model of discrete time channel with ISI & the Model of discrete time channel by equalizer. | L2 |
| CO4 | 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. | L3, L4 |
| CO5 | Design and Evaluate Non band limited and Non power limited spread spectrum systems for communications in a Jamming environment, multi user situation and Low power intercept environment | L3, L4 |

**Semester- I**

| ADVANCED COMMUNICATION LABORATORY | | | |
|---|---|---|---|
| Course Code | **MVJLATL161** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:T/SDA) | 0:4:0 | SEE Marks | 50 |
| Credits | 02 | Exam Hours | 03 |

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

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

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| Sl.No. | Experiments |
|---|---|
| 1 | Measurement of Bit Error Rate using Binary Data. |
| 2 | Efficiency of Direct Sequence Spread Spectrum Technique. |
| 3 | Simulation of Frequency Hopping (FH) Spread- Spectrum. |
| 4 | Measurement of effect of Inter Symbol Interference. |
| 5 | Design of FSK system. |
| 6 | BPSK Modulation and Demodulation techniques. |
| 7 | DPSK Modulation and Demodulation techniques. |
| 8 | 4-QAM Modulation and Demodulation techniques. |
| 9 | OFDM Transmitter and Receiver design. |
| 10 | Performance evaluation of CDMA system. |
| 11 | BER performance of QPSK modulation with AWGN and Rayleigh multipath fading. |
| 12 | DPCM Generation and Detection. |
| 13 | Measurement of losses in a given optical fibre (propagation loss, bending loss) and numerical aperture. |
| 14 | Analog and digital (with TDM) communication link using optical fibre |

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

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

**Continuous Internal Evaluation (CIE):**

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

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

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

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

| ELECTRONICS AND COMMUNICATION LABORATORY | | | |
|---|---|---|---|
| Course Code | **MVJLAT162** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:T/SDA) | 0:4:0 | SEE Marks | 50 |
| Credits | 02 | Exam Hours | 03 |

**Course Objectives:**

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

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

**Course out comes (Course Skill Set):**

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

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

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

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

**Continuous Internal Evaluation (CIE):**

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

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

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

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIEmarks 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:**

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

**Professional Elective- I**

| ADVANCED MACHINE LEARNING AND DEEP LEARNING | | | |
|---|---|---|---|
| Course Code | **MVJLAT141** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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

**Module-1**

**Introduction to Machine Learning**: Introduction, Training, Rote Learning, Learning Concepts, General-to-Specific Ordering, Version Spaces, Candidate Elimination, Inductive Bias, Decision-Tree Induction, The Problem of Overfitting, The Nearest Neighbor Algorithm, Learning Neural Networks, Supervised Learning, Unsupervised Learning, Reinforcement Learning.

**RBT Levels:** L2, L3

**Module-2**

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

**RBT Levels:** L3

**Module-3**

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

**RBT Levels:** L3

**Module-4**

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

**RBT Levels:** L3

**Module-5**

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

**RBT Levels:** L3, L4

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Books**

1. Artificial Intelligence Illuminated - Ben Coppin
2. Deep Learning - Ian Goodfellow, Yoshua Bengio, Aaron Courville
3. Fundamentals of Deep Learning – Nikhil Budama
4. Neural Networks and Deep Learning – Charu Aggarwal
5. Hands-on Deep Learning Algorithms with Python – Sudharsan Ravichandran

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

https://nptel.ac.in/

**Course outcome (Course Skill Set)**

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

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

| ADVANCED COMPUTER NETWORKING | | | |
|---|---|---|---|
| Course Code | **MVJLAT142** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 3 | Exam Hours | 3 |

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

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

**Module-1**

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

**RBT Levels:** L2

**Module-2**

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

**RBT Levels:** L2, L3

**Module-3**

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

**RBT Levels:** L2, L3

**Module-4**

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

**RBT Levels:** L2, L3

**Module-5**

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

**RBT Levels:** L3, L4

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books:**


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


**Reference books:**


1. Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition, Tata McGraw Hill, 2007.
2. James F Kurose, Keith W Ross, Computer Networking- A Top-down Approach Featuring the Internet, 7th Edition, 2017, Pearson Education.

Alberto Leon Garcia, Indra Widjaja, Communication Networks-Fundamental Concepts and Key Architectures, Fifth reprint 2002 , Tata McGraw Hill.


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

https://nptel.ac.in/

**Course outcome (Course Skill Set)**

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

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

| ADVANCED ENGINEERING ECTROMAGNETICS | | | |
|---|---|---|---|
| Course Code | **MVJLAT143** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 3 | Exam Hours | 3 |

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

- To introduce the basic mathematical concepts related to electromagnetic vector fields.
- To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.
- To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
- To impart knowledge on the concepts of Faraday 's law, induced emf and Maxwell 's equations.
- To impart knowledge on the concepts of Concepts of electromagnetic waves and Transmission lines

**Module-1**

**Vector Analysis:** Review of vector algebra, Review of cartesian, Cylindrical and spherical coordinate systems, Introduction to del (operator, Use of del operator as gradient, divergence, curl). Smith Chart: Description and detailed analysis

**RBT Levels:** L2

**Module-2**

**Electrostatic fields:** Introduction to coulomb's law, Gaussian law and its applications in determination of field of spherical and cylindrical geometries, Laplace's and poission's equation in various coordinate systems. Effect of dielectric on capacitance, Boundary conditions at electric interfaces, Method of images and its applications.

**RBT Levels:** L2, L3

**Module-3**

**Magnetostatics:** Introduction to ampere's law, Magnetic vector potential, Magnetic forces, Boundary conditions at magnetic interfaces.

**RBT Levels:** L2, L3

**Module-4**

**Time Varying Fields and Maxwell's Equations:** Continuity of charge, Concept of displacement current, Maxwell's equation in integral and differential form: for static fields, for time varying fields, for free space, for good conductors, for harmonically varying fields, Poynting theorem: Energy stored and radiated power, Complex Poynting vector, Properties of conductor and dielectrics, Wave equations for free space, Wave equations for conductors.

**RBT Levels:** L2, L3

**Module-5**

**Uniform Plane Waves:** Introduction, Uniform plane wave propagation: Wave equations, Transverse nature of uniform plane waves, Perpendicular relation between E and H, EM waves in charge free, Current free dielectric, Reflection by ideal conductor: Normal incidence, reflection and transmission with normal incidence at another dielectric, Plane wave in lossy dielectric, Wave impedance and propagation constant, Depth of penetration, Surface impedance and surface resistance, Application of EM propagation through Transmission Lines and Rectangular Waveguides

**RBT Levels:** L3, L4

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Textbooks:**

- Kraus, J.D., Electromagnetics, McGraw-Hill (2006).
- Sadiku, M.N.O, Elements of Electromagnetics, Oxford University Press (2009).

**Reference Books:**

- Hayt, W.H., Engineering Electromagnetics, Tata McGraw Hill (2008).
- Jordan, E.C. and Balmain K.G., Electromagnetic Waves and Radiating Systems, Prentice Hall of India (2008).
- Paramanik, A, Electromagnetism: Theory and Applications, Prentice Hall of India (2006)

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

- https://nptel.ac.in/

**Skill Development Activities Suggested**

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

**Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Appraise need analysis for different coordinate systems in electromagnetics and their interrelations. | Explain |
| CO2 | Apply vector calculus to solve field theory problems. | Understand |
| CO3 | Calculate electric and magnetic fields in different coordinates for various charge and current configurations. | Analyze |
| CO4 | Exhibit the concept of time varying fields and demonstrate different aspects of plane wave in dielectric and conducting media. | Understand |
| CO5 | Realize the analogy of wave with transmission line and determine the transmission line performance. | Understand |

| POWER CONVERTERS | | | |
|---|---|---|---|
| Course Code | **MVJLAT144** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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

**Module-1**

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

**RBT Levels:** L3

**Module-2**

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

**RBT Levels:** L3

**Module-3**

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

**RBT Levels:** L3, L4

**Module-4**

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

**RBT Levels:** L3

**Module-5**

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

**RBT Levels:** L3

**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 (passed) andearned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from

each module.

4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Books**

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

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

https://nptel.ac.in/

**Course outcome (Course Skill Set)**

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

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

**Professional Elective-II**

| ADVANCED EMBEDDED SYSTEMS | | | |
|---|---|---|---|
| Course Code | **MVJLAT151** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning Objectives:**

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

**Module - 1**

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

**RBT Levels:** L2, L3

**Module - 2**

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

**RBT Levels:** L3

**Module - 3**

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

**RBT Levels:** L3

**Module - 4**

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

**RBT Levels:** L3

**Module - 5**

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

**RBT Levels:** L3, L4

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**

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

**Reference Books**

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

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

https://nptel.ac.in/

**Course outcome (Course Skill Set)**

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

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

| ADVANCED WIRELESS COMMUNICATION | | | |
|---|---|---|---|
| Course Code | **MVJLAT152** | CIE Marks | 50 |
| Teaching Hours/Week(L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 3 | Exam Hours | 3 |

**Course Learning objectives:**

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

**Module-1**

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

**RBT Levels:** L2

**Module-2**

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

**RBT Levels:** L2, L3

**Module-3**

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

**RBT Levels:** L2, L3

**Module-4**

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

**RBT Levels:** L2, L3

**Module-5**

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

**RBT Levels:** L3, L4

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Books**


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


**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set)**

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

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

| MULTIMEDIA AND APPLICATIONS | | | |
|---|---|---|---|
| Course Code | **MVJLAT153** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 3 Hours |

**Course objectives:**

**This course will enable students to:**

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

**Module-1**

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

**RBT Levels:** L2

**Module-2**

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

**RBT Levels:** L3

**Module-3**

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

**RBT Levels:** L3

**Module-4**

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

**RBT Levels:** L3

**Module-5**

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

**RBT Levels:** L3, L4

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books:**


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


**Reference Books:**


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


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

- https://nptel.ac.in/

**Semester Course outcome (Course Skill Set)**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Deploy the right multimedia communication models. | L3, L4 |
| CO2 | Apply QoS to multimedia network applications with efficient routing techniques. | L3 |
| CO3 | Discuss the various standards and quality aspects of digital video formats used for multimedia application. | L2 |
| C04 | Solve the security threats in the multimedia networks. | L3 |
| C05 | Develop the real-time multimedia network applications. | L4 |

| PROCESS CONTROL | | | |
|---|---|---|---|
| Course Code | **MVJLAT154** | CIE Marks | 50 |
| Teaching Hours/Week (L:P:SDA) | 3:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Learning objectives:**

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

**Module-1**

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

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

**RBT Levels:** L2

**Module-2**

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

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

**RBT Levels:** L2, L3

**Module-3**

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

**RBT Levels:** L2, L3

**Module-4**

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

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

**RBT Levels:** L3, L4

**Module-5**

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

**RBT Levels:**L3, L4

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

The weightage of Continuous Internal Evaluation (CIE) is 50% andfor 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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 scaleddown 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Books**

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

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

- https://nptel.ac.in/

**Skill Development Activities Suggested**

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

**Course outcome (Course Skill Set)**

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

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

| SOFTWARE DEFINED RADIO | | | |
|---|---|---|---|
| Course Code | **MVJLAT21** | CIEMarks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:2) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 HoursTheory | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |

**Course Objectives:** The students will be able to

- Define Software Defined Radio and its core principles
- Understand the different components and how they interact in an SDR system.
- Explore various applications of SDR, such as wireless communication, signal processing, and spectrum sensing.
- Understand the benefits of SDR over traditional radio systems, such as flexibility, reconfigurability, and cost-effectiveness.

| **Module-1** | |
|---|---|
| **Introduction:** The requirement for software defined radio, the benefits of multi standard terminals, operational requirements, business models for software defined radio, new base station and network architectures, smart antenna systems. | **8Hrs** |
| **Module-2** | |
| **Basic Architecture of a Software Defined Radio:** Software defined radio architectures; Ideal Software defined radio architectures, Required hardware specifications, Digital aspects of a Software Defined radio, Current technology limitations. | **8Hrs** |
| **Module-3** | |
| **Flexible RF receiver architectures:** Receiver architecture options, implementation of a digital receiver: frequency up conversion using under sampling, achieving processing gain using oversampling, Noise figure, Receiver sensitivity, ADC spurious signals. | **8Hrs** |
| **Module-4** | |
| **Multi-Band and General Coverage Systems:** Multiband Flexible receiver design, the problem of the Diplexer, Achieving Image rejection, Dynamic range enhancement, feedback and feed forward techniques. | **8Hrs** |
| **Module-5** | |
| **Flexible transmitters and Power amplifiers:** Analog quadrature up conversion, quadrature up conversion with interpolation, Interpolated band pass up conversion, PLL based transmitters, Active All-pass filter, Use of high pass and low pass filters, Polyphase filtering. | **8Hrs** |

**LABORATORY EXPERIMENTS**
**To be conducted using MATLAB Software and an active Learning Module – ADALM PLUTO**

1. To implement Analog Modulation and analyse transmission and reception of signals.
2. To implement Frequency Modulation and analyse transmission and reception of signals.
3. Simulating ASK, BPSK, and QPSK and analysing real-time transmission and reception of signals.

4. Implementing OFDM.
5. Simulating multipath fading and interference.
6. Implementing equalization techniques.

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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.

The students will have to answer five full questions, selecting one full question from each module.

**SuggestedLearningResources:**

**TextBooks**


1. P Kenington, "RF and Baseband Techniques for Software Defined Radio", Artec House,2005
2. Jouko Vanakka, "Digital Synthesizers and Transmitter for Software Radio", Springer,2005.
3. Wally H. W. Tuttlebee, "Software Defined Radio: Baseband Technologies for 3G Handsets and Base stations", John Wiley & sons, 2003.


**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set):**
At the end of the course the student will be able to:

| Sl. No. | Description | BloomsLevel |
|---|---|---|
| CO1 | Understand requirements, benefits and different models for Software Defined Radio | |
| CO2 | Understand in detail about Software Defined Radio Architecture for performance optimization. | |
| CO3 | Acquire complete knowledge regarding functioning of different blocks associated with Software Defined Radio. | |
| CO4 | Design circuits at different multirate signaling technique for frequency conversion and sampling issues. | |

| ERROR CONTROL CODING | | | |
|---|---|---|---|
| Course Code | **MVJLAT22** | CIEMarks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 HoursTheory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Objectives:** This course will enable students:

- 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.<br>**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. | **8Hrs** |
| **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. | **8Hrs** |
| **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.<br>Low-Density Parity-Check Codes and a brief introduction to Polar Codes. | **8Hrs** |
| **Module-4** | |
| **BCH codes:** Binary primitive BCH codes, Decoding procedures, Implementation of Galois field arithmetic. Primitive BCH codes over GF (q)<br>**Reed -Solomon codes** and Network Coding.<br>**Majority Logic decodable codes:** One -step majority logic decoding, Multiple step majority logic. | **8Hrs** |

| Module-5 | |
|---|---|
| **Convolution codes:** Encoding of convolutional codes: Systematic and Nonsystematic Convolutional Codes, Feedforward encoder inverse, A catastrophic encoder, Structural properties of convolutional codes: state diagram, state table, state transition table, tree diagram, trellis diagram. Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**


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

**Reference Books:**


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


**Weblinks and Video Lectures (e-Resources):**

• 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 |

| MASSIVE MIMO NETWORKS | | | |
|---|---|---|---|
| Course Code | **MVJLAT23** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Objectives:** This course will enable students:

- To introduce the fundamentals of Massive MIMO systems.
- To explore system design and channel modeling.
- To analyze spectral and energy efficiency gains.
- To understand pilot contamination and its mitigation techniques.

| **Module-1** | |
|---|---|
| **Massive MIMO Networks:** Definition of Massive MIMO, Correlated Rayleigh Fading, System Model for Uplink and Downlink, Basic Impact of Spatial Channel Correlation, Channel Hardening and Favorable Propagation, Local Scattering Spatial Correlation Model. | **8Hrs** |
| **Module-2** | |
| **The Massive MIMO Propagation Channel:** Favorable Propagation and Capacity, Measures of Favorable Propagation, Favorable Propagation: Rayleigh Fading and Line-of-Sight Channels: Independent Rayleigh Fading, Uniform Random Line-of-Sight, Urns-and-Balls Model for UR-Line-of-Sight. | **8Hrs** |
| **Module-3** | |
| **Channel Estimation:** Uplink Pilot Transmission, MMSE Channel Estimation, Impact of Spatial Correlation and Pilot Contamination, Computational Complexity and low-Complexity Estimators, Data-aided channel estimation and Pilot Decontamination. | **8Hrs** |
| **Module-4** | |
| **Energy and Hardware Efficiency:** Transmit Power Consumption, Circuit Power Consumption Model, Network Design for Maximal Energy Efficiency, Transceiver Hardware Impairments, Channel Estimation, Spectral Efficiency with Hardware impairments. | **8Hrs** |
| **Module-5** | |
| **Practical Deployment Considerations:** Power Allocation, Spatial Resource allocation, Channel Modeling, Millimeter Wavelength Communications, Heterogeneous Networks. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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. Emil Bjornson, Jakob Hoydis and Luca Sanguinetti (2017), "Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency", Foundations and Trends, Now, 2017.
2. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo, "Fundamentals of Massive MIMO", Cambridge University Press 2016.


**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set):**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Understand and explain massive MIMO networks. | Understand |
| CO2 | Explain the concepts underlining the deployment of single and multicell massive MIMO systems. | Understand |
| CO3 | Analyze massive MIMO propagation channels and their capacity bounds | Analyze |

| | | | |
|---|---|---|---|
| CO4 | Analyze channel estimation techniques for multi cell system. | Analyze | |
| CO5 | Examine channel estimation techniques for single cell system. | Apply | |

| 5G and beyond | | | |
|---|---|---|---|
| Course Code | **MVJLAT24** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Understand the essential principles of 5G communications
- Describe the Radio-Interface Architecture.
- Analyze transport channel processing.
- Analyze 5G spectrum and frame structures.

| Module-1 | |
|---|---|
| **What is 5G?** - 3GPP and the Standardization of Mobile Communication, The New Generation—5G/NR.<br>**5G Standardization** - Overview of Standardization and Regulation, ITU-R Activities From 3G to 5G, 3GPP Standardization.<br>**Spectrum for 5G** - Spectrum for Mobile Systems, Frequency Bands for NR. | **8Hrs** |
| **Module-2** | |
| **LTE—An Overview** - LTE Release 8—Basic Radio Access, LTE Evolution, Spectrum Flexibility, Multi-Antenna Enhancements, Densification, Small Cells, and Heterogeneous Deployments, Device Enhancements, Device-to-Device Communication, New Scenarios, Transmission Scheme, Bandwidth Parts, and Frame Structure for NR. | **8Hrs** |
| **Module-3** | |
| **Radio-Interface Architecture** - Overall System Architecture, Quality-of-Service Handling, Radio Protocol Architecture, User-Plane Protocols, Control-Plane Protocols, Mobility.<br>**Channel Sounding -** Downlink Channel Sounding—CSI-RS, Downlink Measurements and Reporting, Uplink Channel Sounding—SRS. | **8Hrs** |
| **Module-4** | |
| **Transport-Channel Processing** – Overview, Channel Coding, Rate-Matching and Physical-Layer Hybrid-ARQ Functionality, Scrambling, Modulation, Layer Mapping, Uplink DFT-Precoding, Multi-Antenna Precoding. | **8Hrs** |
| **Module-5** | |
| **Scheduling** - Dynamic Downlink Scheduling, Dynamic Uplink Scheduling.<br>**Random Access -** Four-step random-access procedure, Random Access Beyond Initial Access, Two-Step RACH.<br>Multi-Antenna Transmission and Retransmission Protocols – Introduction. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**

**1.** "5G NR - The Next Generation Wireless Access Technology", Erik Dahlman, Stefan Parkvall, Johan Skold, 2nd edition, Academic Press.

**Reference Books:**

1. Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, John Wiley & Sons 2015, ISBN: 9781118867525.
2. 5G Core Networks Powering Digitization, Stephen Rommer, Academic Press,2019 ISBN: 978- 0-08-1030009-7.

**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in

**Course outcome (Course Skill Set):**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Describe the concepts of 5G networks and its architecture. | Understand |
| CO2 | Demonstrate M2M and D2D Communication. | Understand |
| CO3 | Elucidate 5G NR technology. | Analyze |
| CO4 | Analyze the management of 5G Network. | Analyze |
| CO5 | Analyze the 5G spectrum opportunities and challenges. | Analyze |

| RECONFIGURABLE INTELLIGENT SURFACES FOR COMMUNICATION AND SENSING | | | |
|---|---|---|---|
| Course Code | **MVJLAT251** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

Course Objectives: This course will enable students:

- Understand the Fundamentals of RIS Technology.
- Analyze RIS-Aided Communication Systems.
- Explore RIS Applications in Wireless Sensing.
- Familiarize with Emerging Research and Standards.

| **Module-1** | |
|---|---|
| **IRS in the Near-Field:** From Basic Principles to Optimal Design: Introduction, Basic Principles, Near Field Channel Model, Phase Shift Design, Energy Efficiency. Intelligent Reflecting Surfaces, Non-terrestrial Networks, Revamping Non-terrestrial Networks Using Intelligent Reflecting Surfaces. | **8Hrs** |
| **Module-2** | |
| **IRS Hardware Architectures:** Introduction, Concept, Principle, and Composition of IRS, Operation Mode of IRS, Hardware Configuration of IRS, Practical Design Considerations for Reconfigurable Intelligent Surfaces, Intelligent Reflecting Surface Architecture, Physical Limitations of IRSs. | **8Hrs** |
| **Module-3** | |
| **Channel Modelling in RIS-Empowered Wireless Communications:** Introduction, A General Perspective on RIS Channel Modelling, Physical Channel Modelling for RIS-Empowered Systems at mmWave Bands, Physical Channel Modelling for RIS-Empowered Systems at Sub-6 GHz Bands, SimRIS Channel Simulator, Performance Analysis Using SimRIS Channel Simulator. | **8Hrs** |
| **Module-4** | |
| **IRS-Aided Cellular Networks and Deep Learning-Based Design:** Introduction, System Model, Problem Formulation, Phase Shifts Optimization.<br>**Distributed Multi-IRS-assisted 6G Wireless Networks:** System Model, Channel Characterization and Performance Analysis.<br>**RIS-Assisted UAV Communications:** The Role of UAVs in the Future Mobile Networks and their Unique Characteristics, Challenges of UAV Communications, Integration Paradigms and Use Cases. | **8Hrs** |
| **Module-5** | |

| | |
|---|---|
| **Optical Wireless Communications Using Intelligent Walls:** Introduction, Optical IRS: Background and Applications, Case Study: High Performance IRS-Aided Indoor LiFi **Application and Future Direction of RIS:** RIS-assisted High-Frequency Communication, RIS-assisted RF Sensing and Imaging, RIS-assisted-UAV Communication, RIS-assisted Wireless Power Transfer. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**

1. "Intelligent Reconfigurable Surfaces (IRS) for Prospective 6G Wireless Networks", Muhammad Ali Imran, Lina Mohjazi, Lina Bariah, Sami Muhaidat, Tie Jun Cui, Qammer H Abbasi, © 2020 John Wiley & Sons, Inc.

**Weblinks and Video Lectures (e-Resources):**

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

**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 fundamental principles and architecture of Reconfigurable Intelligent Surfaces (RIS) and their role in next-generation wireless communication systems. | Understand |
| CO2 | Analyze electromagnetic wave propagation and RIS-based channel modeling for both communication and sensing applications. | Analyze |
| CO3 | Examine the integration of RIS with emerging paradigms such as mm Wave, THz, MIMO, NOMA, and 6G communication systems. | Analyze |
| CO4 | Investigate the role of RIS in wireless sensing and localization tasks including target detection, tracking, and environmental awareness. | Analyze |

| WIRELESS SENSOR NETWORKS | | | |
|---|---|---|---|
| Course Code | **MVJLAT252** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Objectives:** This course will enable students:

- Learn the basic concepts of Wireless sensor networks architecture and protocols.
- Understand the challenges in designing a Wireless sensor network.
- 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. | **8Hrs** |
| **Module-2** | |
| **FACTORS INFLUENCING WSN DESIGN:** Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media, Power Consumption. Physical Layer: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding), Modulation, Wireless Channel Effects, PHY Layer Standards. | **8Hrs** |
| **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. | **8Hrs** |
| **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. Application Layer: Source Coding (Data Compression), Query Processing, Network Management. | **8Hrs** |
| **Module-5** | |
| **SPREAD SPECTRUM SIGNALS FOR DIGITAL COMMUNICATION:** Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, | **8Hrs** |

| | |
|---|---|
| some applications of DS spread spectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS, Synchronization of SS systems. | |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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. 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.


**Weblinks and Video Lectures (e-Resources):**

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

**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 |

## MULTIMEDIA OVER COMMUNICATION LINKS

| | | | |
|---|---|---|---|
| Course Code | **MVJLAT253** | CIEMarks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 HoursTheory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course Objectives:** This course will enable students:

- 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. | **8Hrs** |
| **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. | **8Hrs** |
| **Module-3** | |
| **Multimedia Processing in Communication:** Introduction, Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders. | **8Hrs** |
| **Module-4** | |
| **Multimedia Communication Standards:** Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2, Overview of MPEG-4. | **8Hrs** |
| **Module-5** | |
| **Multimedia Communication Across Networks:** Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not

less than 50% of the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

**Continuous Internal Evaluation:**

6. Three Unit Tests each of 50 Marks.
7. 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:**

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

The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**


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


**Weblinks and Video Lectures (e-Resources):**

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

**Course outcome (Course Skill Set):**

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

| Sl. No. | Description | BloomsLevel |
|---|---|---|
| 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 | |

| WAVELET TRANSFORMS AND APPLICATIONS | | | |
|---|---|---|---|
| Course Code | **MVJLAT254** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

| **Module-1** | |
|---|---|
| **Continuous Wavelet Transform:** Continuous time frequency representation of signals, The Windowed Fourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, specifications, admissibility conditions, Continuous wavelet transform, CWT as a correlation, CWT as an operator, Inverse CWT. | **8Hrs** |
| **Module-2** | |
| **Discrete wavelet Transform:** Approximations of vectors in nested linear vector spaces, Example of an MRA, Formal definition of MRA, Construction of genera orthonormal MRA, a Wavelet basis for MRA, Digital filtering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm Filter bank implementation of DWT. | **8Hrs** |
| **Module-3** | |
| **Alternative wavelet representations-** Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets, biorthogonal analysis and synthesis, Filter bank implementation, Two dimensional Wavelets, filter bank implementation of two-dimensional wavelet transform. | **8Hrs** |
| **Module-4** | |
| **Lifting scheme:** Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme, lifting scheme in the z- domain, mathematical preliminaries for polyphase factorization, Dealing with Signal Boundary. | **8Hrs** |
| **Module-5** | |
| **Applications:** Image Compression: EZW Coding, SPIHT, Wavelet Difference Reduction Compression Algorithm, Denoising, speckle removal, edge detection and object isolation, audio compression, communication applications – scaling functions as signalling pulses, Discrete Wavelet Multitone Modulation.<br>**Beyond Wavelet:** Ridge lets and curve lets: Ridge let transform and Digital Curve let transform, Curve let construction, Properties and applications. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**


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


**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set):**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Classify various wavelet transform and explain importance of it | |
| CO2 | Describe Continuous Wavelet Transform (CWT) and Discrete Wavelet Transform (DWT). | |
| CO3 | Explain the properties and application of wavelet transform. | |
| CO4 | Develop and realize computationally efficient wavelet-based algorithms for signal and image processing | |
| CO5 | Explain brief features and strength of transform beyond wavelet. | |

# INTEGRATED SENSING AND COMMUNICATION

| | | | |
|---|---|---|---|
| Course Code | **MVJLAT261** | CIEMarks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 HoursTheory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

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

- Introduce the fundamentals of Integrated Sensing and Communication (ISAC) systems and their role in next-generation (6G and beyond) wireless networks.
- Explain key enabling technologies such as waveform design, MIMO, OFDM, and AI/ML integration for ISAC.
- Analyze system architectures and design considerations for real-world ISAC deployments.
- Explore application areas such as vehicular networks, UAVs, smart environments, and intelligent transportation.

| **Module-1** | |
|---|---|
| **ISAC:** a paradigm shift in wireless system design, Waveform design for ISAC, Integration of ISAC and other next-generation wireless technologies, ISAC and reconfigurable intelligent surfaces (RIS), ISAC with cm Wave and sub-THz frequencies.<br>**Holographic integrated sensing and communications:** RHS essentials, Hardware, Principles, Holographic beamforming scheme for ISAC, Holographic integrated sensing and communication problem formulation. | **8Hrs** |
| **Module-2** | |
| **Integrated ISAC and federated learning in wireless edge networks:** ISAC-aided FL design, Basic principles, Examples, FL-enhanced ISAC capacity, Basic principles, Examples, Challenges and prospects, Challenges. | **8Hrs** |
| **Module-3** | |
| **Communication-centric multi-metric ISAC waveform optimization:** Introduction, Radar metrics, Communication metrics, Joint radar-communication waveform optimization, Weighted sum optimization method, Euclidean distance optimization method, Threshold constrained optimization method, Decoupled optimization method, Case study, System model ISAC waveform optimization problems, Simulation results. | **8Hrs** |
| **Module-4** | |
| **Detection of integrated sensing and communications waveforms:** Introduction, ISAC system and JRC application, Design and detection of ISAC waveforms, Chirp-based ISAC waveforms, OFDM-based ISAC waveforms, OTFS-based ISAC waveforms, Non-coherent | **8Hrs** |

| | |
|---|---|
| discrete chirp Fourier transform (NC-DCFT) algorithm for ISAC waveform detection, ISAC waveform – data modulated LFM signal, DCFT method and modified DCFTs, Non-coherent DCFT algorithm, Random sampling for NC-DCFT. | |
| **Module-5** | |
| **Full duplex massive MIMO for integrated sensing and communications:** Introduction, Related literature, Full duplex massive MIMO system model, Transceiver architectures, Received signal models, Channel models, Downlink MIMO channels, End-to-end MIMO channel from signal reflections, Full duplex massive MIMO ISAC, Estimation of targets' parameters, FD-enabled ISAC optimization formulation | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**

**1.** Integrated Sensing and Communications for Future Wireless Networks - Principles, Advances and Key Enabling Technologies, 1st Edition - November 9, 2024, Aryan Kaushik, ISBN: 9780443221439, Elsevier

**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set):**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Explain the fundamental concepts and motivations behind integrated sensing and communication. | Understand |
| CO2 | Apply signal processing techniques for joint radar and communication tasks. | Apply |
| CO3 | Analyze ISAC system components such as MIMO, OFDM, and reconfigurable surfaces. | Analyze |
| CO4 | Design and evaluate ISAC-based solutions for various applications such as vehicular radar and smart cities. | Design |
| CO5 | Critically assess the trade-offs and challenges in deploying ISAC in 6G networks. | Evaluate |

| MICRO ELECTRO MECHANICAL SYSTEMS | | | |
|---|---|---|---|
| Course Code | **MVJLAT262** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

| **Module-1** | |
|---|---|
| **Overview of MEMS and Microsystems:** MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets. | **8Hrs** |
| **Module-2** | |
| **Working Principles of Microsystems:** Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics. Engineering Science for Microsystems Design and Fabrication:Introduction, Atomic Structure of Matters, Ions and Ionization, Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry. | **8Hrs** |
| **Module-3** | |
| **Engineering Mechanics for Microsystems Design:** Introduction, Static Bending of Thin Plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis. | **8Hrs** |
| **Module-4** | |
| Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer. | **8Hrs** |
| **Module-5** | |
| **Overview of Micro-manufacturing:** Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micro manufacturing. Microsystem Design: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**

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

**Reference Books:**

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

**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set):**

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

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | UnderstandthetechnologiesrelatedtoMicroElectroMechanicalSystems. | |
| CO2 | Relate to the scaling laws in miniaturization. | |
| CO3 | Analyze the MEMS devices and develop suitable mathematical models | |

| | | | |
|---|---|---|---|
| CO4 | Understand the various application areas for MEMS devices | | |
| CO5 | Describe the design and fabrication processes involved with MEMS devices | | |

| ADVANCES IN IMAGE PROCESSING | | | |
|---|---|---|---|
| Course Code | **MVJLAT263** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

| **Module-1** | |
|---|---|
| The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images. | **8Hrs** |
| **Module-2** | |
| **Image Pre-processing:** Pixel brightness transformations, geometric transformations, local pre-processing. | **8Hrs** |
| **Module-3** | |
| **Segmentation:** Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation, Region growing post-processing. | **8Hrs** |
| **Module-4** | |
| **Shape representation and description:** Region identification; Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors, Moments, Convex hull. | **8Hrs** |
| **Module-5** | |
| **Mathematical Morphology:** Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons and object marking, Morphological segmentations and watersheds. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**

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

**Reference Books:**

**1.** 'Digital Image Processing for Medical Applications', Geoff Doughertry, Cambridge university Press, 2010.

**2.** 'Digital Image Processing', S Jayaraman, S Esakkirajan, T Veerakumar, Tata McGraw Hill, 2011.

**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set):**
At the end of the course the student will be able to:

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | Able to understand the representation of the digital image and its properties. | Understand |
| CO2 | Able to Apply pre-processing techniques required to enhance the image for its further analysis. | Apply |
| CO3 | Able to understand segmentation techniques to select the region of interest in the image for analysis. | Understand |
| CO4 | Able to Understand the representation of the image based on its shape and edge information. | Understand |
| CO5 | Able to Understand the morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects. | Analyze |

| ANTENNA THEORY AND DESIGN | | | |
|---|---|---|---|
| Course Code | **MVJLAT264** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (3:0:0) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

Course 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 | **8Hrs** |
| **Module-2** | |
| **Arrays:** Array factor for linear arrays, uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, non uniformly excited equally spaced linear arrays, Mutual coupling.<br>**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. | **8Hrs** |
| **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. | **8Hrs** |
| **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, | **8Hrs** |

| | |
|---|---|
| Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice. | |
| **Module-5** | |
| **Antenna in systems & Measurements:** Receiving properties of antennas, Antenna temperature & radiometry.<br>**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. | **8Hrs** |

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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 subquestions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module.

**Suggested Learning Resources:**

**Text Books**

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

**Weblinks and Video Lectures (e-Resources):**

- https://nptel.ac.in/

**Course outcome (Course Skill Set):**
At the end of the course the student will be able to:

| Sl. No. | Description | Blooms Level |
|---|---|---|
| CO1 | 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 |

| ANENNA THEORY AND DESIGN LAB | | | |
|---|---|---|---|
| Course Code | **MVJLATL27** | CIE Marks | 50 |
| Teaching Hours/Week(L:T:P:S) | (0:0:4) | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 Hours Theory | Total Marks | 100 |
| Credits | 02 | Exam Hours | 03 |

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

1. MATLAB/C implementation to obtain the radiation pattern of an antenna.
2. Study of radiation pattern of different antennas.
3. Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.
4. Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.
5. Study of radiation pattern of E& H plane horns.
6. Significance of Pocklington's integral equation.
7. Measurement of radiation pattern of reflector antennas
8. Design and simulation of Microstrip antenna
9. Performance analysis of Log periodic antenna
10. Performance analysis of Helix antenna.

**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 (passed) and earned the credits allotted to each subject/ course if the student secures not less than 50% of 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 50 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:**

3. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
4. The question paper will have ten full questions carrying equal marks.
5. Each full question is for 20 marks. There will be two full questions (with a maximum of four

subquestions) from each module.

6. Each full question will have a sub-question covering all the topics under a module.

The students will have to answer five full questions, selecting one full question from each module.