M.TECH - Electronics and Communication Engineering (Advanced Communication Technology)

Choice Based Credit System (CBCS) and Outcome Based Education (OBE)

(Effective from the academic year2022-23)

SEMESTER-I

ADVANCED ENGINEERING MATHEMATICS			
Course Code	**MVJ22MATE11**	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40 Hours Theory	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning objectives: This course will enable students:

- Understand the concept of vector space and linear transformations.
- Understand the concept of eigen values and eigen vectors, Numerical techniques for orthogonal basis for a vector space.
- Understand the concept of probability distributions in analyzing the probability models arising in engineering field.
- Understand the concept of Random processes

MODULE-1	
Linear Algebra-I : Introduction to vector spaces and sub-spaces, definitions, illustrative example. Linearly independent and dependent vectors- Basis-definition and problems. Linear transformations-definitions. Matrix form of linear transformations-Illustrative examples	**8hrs**
MODULE-2	
Linear Algebra-II : Computation of Eigen values and Eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process.	**8hrs**
MODULE-3	
Calculus of Variations: Concept of functional – Euler's equation. Functional dependent on first and higher order derivatives, Functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries.	**8hrs**
MODULE-4	
Probability Theory: Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Poisson, Gaussian and Erlang distributions examples	**8hrs**
MODULE-5	

Engineering Applications on Random processes: Classification. Stationary, WSS and Ergodic random process. Auto-correlation function-properties, Gaussian random process	**8hrs**

Text Books:	
1	**'Linear Algebra and its Applications', David CLay, Steven R Lay and J J McDonald, Pearson Education Ltd., 5th Edition, 2015**
2	**'Advanced Engineering Mathematics', E. Kreyszig, Wiley, 10th edition, 2015**
3	**'Probability, Statistics and Random Process', T Veerarajan, TataMc-GrawHillCo.,3rd Edition,2016**

Reference Books:	
1	**'Introduction to Linear Algebra', Gilbert Strang, Wellesley-Cambridge Press, 5th Edition,2016**
2	**'Schaum's Outlines of Theory and Problems of Matrix Operations', Richard Bronson, McGraw-Hill,1988**
3	**'Probability and Random Process with application to Signal Processing', Scott L Miller, Donald G Childers, Elsevier Academic Press, 2nd Edition, 2013**

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.

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.	Explain
CO2	Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems.	Understand
CO3	Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.	Analyze
CO4	Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications.	Analyze
CO5	Analyze random process through parameter-dependent variables in various random processes	Design and analyze

Program Outcomes for this Course:

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

Mapping of COS and POs

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

ADVANCED DIGITAL SIGNAL PROCESSING			
Course Code	**MVJ22LAC12**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:2:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L + 13 P**	**Total Marks**	**100**
Credits	**04**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

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

MODULE-1	
Introduction to Digital Signal Processing: Review of Discrete time signals and systems and frequency analysis of discrete time linear time invariant systems, implementation of discrete time systems, correlation of discrete time systems Sampling, decimation by a factor 'D', Interpolation by a factor 'I', sampling rate conversion by a factor 'I/D', Implementation of sampling rate conversion, Multistage implementation of sampling rate conversion.	**8hrs**
MODULE-2	
Multirate Digital Signal Processing: Multirate signal processing and its applications, Design of Digital filters, Design of FIR filters, Design of IIR filters, frequency transformations, Digital filter banks, two channel Quadrature mirror filter banks, M channel QMF bank.	**8hrs**
MODULE-3	
Linear prediction and Optimum Linear Filters: Random signals, Correlation Functions and Power Spectra, Innovations Representation of a Stationary Random Process. Forward and Backward Linear Prediction. Solution of the Normal Equations. The Levinson-Durbin Algorithm. Properties of the Linear Prediction-Error Filters.	**8hrs**
MODULE-4	
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.	**8hrs**
MODULE-5	

Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman & 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.	**8hrs**

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

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

PRACTICAL COMPONENT OF IPCC:

Conduct the experiments using MATLAB/Scilab/TMS320C5XDSP Processors

Sl. No	**Experiments**
1	Generate various fundamental discrete time signals
2	Basic operations on signals (Multiplication, Folding, Scaling).
3	Find out the DFT &IDFT of a given sequence without using 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.
11	Estimation of power spectrum using parametric methods (Yule Walker &Burg).
12	Time-Frequency Analysis with the Continuous Wavelet Transform.

Assessment Details (both CIE and SEE)

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

CIE for the theory component of IPCC

1. Two Tests each of **50 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60marks, marks scored will be proportionally scaled down to **30marks**.

CIE for the practical component of IPCC

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

SEE for IPCC

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

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

- The question paper will have ten questions. Each question is set for50marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

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

practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical Component of IPCC, the total marks of all questions should not bemorethanthe20marks.

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

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

6	An ability to recognize the need to engage in independent and life-long learning in various Communication domain.	PO6

Mapping of COS and POs

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

ADVANCED COMMUNICATION SYSTEM-1			
Course Code	MVJ22LAC13	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40 L	**Total Marks**	100
Credits	04	**Exam Hours**	03

Course Learning objectives: This course will enable students:

- 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 band pass 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.	**8hrs**
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.	**8hrs**
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.	**8hrs**
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	**8hrs**
MODULE-5	
Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, some applications of DS	**8hrs**

spread spectrum signals, generation of PN sequences, Frequency hopped spread spectrum signals, Time hopping SS, Synchronization of SS systems.	

Text Books:	
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**

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:

- Three Unit Tests each of **50 Marks.**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs.
- The sum of three tests, two assignments/skill Development Activities, will bescaleddownto50marks.

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:

- The SEE question paper will be set for100 marks and the marks scored will beproportionatelyreducedto50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have 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

Course Learning Outcomes: After the completion of the course, students 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.	Explain
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.	Understand
CO3	Analyze and demonstrate the model of discrete time channel with ISI & the Model of discrete time channel by equalizer.	Analyze
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.	Analyze
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.	Design and analyze

Program Outcomes for this Course:

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

Mapping of COS and POs

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

ADVANCED ENGINEERING ELECTROMAGNETICS			
Course Code	MVJ22LAC14	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40 L	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning objectives: This course will enable students:

- 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	**8hrs**
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.	**8hrs**
MODULE-3	
Magnetostatics: Introduction to ampere’s law, Magnetic vector potential, Magnetic forces, Boundary conditions at magnetic interfaces.	**8hrs**
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.	**8hrs**
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	**8hrs**

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	

Text Books:	
1	**Kraus, J.D., Electromagnetics, McGraw-Hill (2006).**
2	**Sadiku, M.N.O, Elements of Electromagnetics, Oxford University Press (2009).**

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

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:

- Three Unit Tests each of **50 Marks.**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will bescaleddownto50marks.

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:

- The SEE question paper will be set for100 marks and the marks scored will beproportionatelyreducedto50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have 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

Course Learning Outcomes: After the completion of the course, students 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

Program Outcomes for this Course:

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

Mapping of COS and POs

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

ADVANCED COMMUNICATION NETWORKS			
Course Code	**MVJ22LAC15**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- To know the networking concepts.
- To study the networking protocols.
- To have an in-depth knowledge of congestion control and resource allocation
- To have knowledge on security.

MODULE-1	
Foundation: Building a Network, Applications, Requirements, Network Architecture, Implementing Network Software, Performance.	**8hrs**
MODULE-2	
Advanced Internetworking: The Global Internet, Multicast, Multicast addresses, Multicast, Multiprotocol Label Switching (MPLS) End-to-End protocols: Simple Demultiplexer (UDP), Reliable Byte Stream (TCP).	**8hrs**
MODULE-3	
Congestion Control and Resource Allocation: Allocating Resources, Issues in Resource a location, Queuing Disciplines, TCP Congestion Control, Congestion-Avoidance Mechanisms, Quality of Service.	**8hrs**
MODULE-4	
Applications: Traditional Applications: Electronic Mail (SMTP, POP, IMAP, MIME), World Wide Web (HTTP), Multimedia Applications, Infrastructure Services (Domain Name System (DNS), Network Management (SNMP), Overlay Networks.	**8hrs**
MODULE-5	
End-to End data: Presentation formatting, Multimedia Data Network Security: Security attacks, Cryptographic building blocks, Key Pre distribution, Authentication protocols, Firewalls.	**8hrs**

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

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

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:

- Three Unit Tests each of **50 Marks.**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will bescaleddownto50marks.

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:

- The SEE question paper will be set for100 marks and the marks scored will beproportionatelyreducedto50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have 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

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

Sl. No.	Description	POs

1	An ability to independently carry out research/investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should beat a level higher than the requirements in the appropriate bachelor program.	PO3
4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in various Communication domain.	PO6

Mapping of COS and POs

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

RESEARCH METHODOLOGY & IPR			
Course Code	**MVJ22RM16**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights

MODULE-1	
Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. **Defining the Research Problem:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.	**8hrs**
MODULE-2	
Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.	**8hrs**
MODULE-3	

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. **Data Collection**: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.	**8hrs**
MODULE-4	
Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests.	**8hrs**
MODULE-5	
Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. **Intellectual Property:** The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, TradeMarkAct, 1999, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act 1999, Copyright Act, 1957, The Protection of Plant Varieties and Farmers' Rights Act, 2001, The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO), WIPO and WTO.	**8hrs**

Text Books:	
1	**Research Methodology: Methods and Techniques', C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018**
2	**'Research Methodology a step-by-step guide for beginners., Ranjit Kumar, SAGE Publications, 3rd Edition, 2011**
3	**Study Material (For the topic Intellectual Property under module 5) Professional Programme**

	Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books:	
1	**'Research Methods: the concise knowledge base', Trochim, Atomic Dog Publishing, 2005**
2	**'Conducting Research Literature Reviews: From the Internet to Paper', Fink A, Sage Publications, 2009**

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:

- Three Unit Tests each of **50 Marks.**
- Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will bescaleddownto50marks.

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:

- The SEE question paper will be set for100 marks and the marks scored will beproportionatelyreducedto50.
- The question paper will have ten full questions carrying equal marks.
- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have 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

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl.	**Description**	**Blooms**

No.		Level
CO1	Discuss research methodology and the technique of defining a research problem.	Understand
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.	Analyze
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	Analyze
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	Understand
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR.	Apply

ADVANCED DIGITAL SIGNAL PROCESSING LABORATORY

Course Code	MVJ22LACL17	CIE Marks	50
Teaching Hours/Week(L:T:P:S)	0:2:0	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.

Sl. No.	Experiments
1	Generate various fundamental discrete time signals
2	Basic operations on signals (Multiplication, Folding, Scaling).
3	Find out the DFT & IDFT of a given sequence without using 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.
11	Estimation of power spectrum using parametric methods (Yule Walker & Burg).
12	Time-Frequency Analysis with the Continuous Wavelet Transform.
13	Signal Reconstruction from Continuous Wavelet Transform Coefficients.

Conduct the experiments using MATLAB/ Scilab /TMS320C5X DSP Processors

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

1. Able to generate discrete time signals and perform DFT, IDFT on the signals.
2. Able to estimate the PSD using different methods.
3. Able to design and realize FIR and IIR filters.
4. Able to estimate power spectrum using Parametric methods.
5. Able to analyze in Time and Frequency domain and reconstruct the signal using Wavelet Transform.

SEMESTER-II

ADVANCED COMMUNICATION SYSTEMS-2			
Course Code	MVJ22LAC21	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40L	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning objectives: This course will enable students:

- To describe models for fading channels, and concepts of diversity in time, antenna and frequency.
- To understand concepts of multi-channel signaling (including OFDM) scheme and synchronization for carrier and symbol timing recovery at receiver.
- To Understand the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.
- Develop & analyze multiplexing capability and modelling of MIMO channels
- Develop and evaluate the performance of a MIMO scheme to meet specified rate in a given multipath environment.

Prerequisites: Band limited channels

MODULE-1	
Point-to-Point Communication-Detection in a Rayleigh Fading Channel, Time Diversity, Antenna Diversity, Frequency Diversity. **Fading**–Large scale, small scale, signal time spreading- in time domain and frequency domain. Time variance of the channel caused by motion- in time domain, Doppler-shift domain, degradation categories due to time variance, viewed in the doppler shift domain, Mitigating the degradation effects of fading.	**8hrs**
MODULE-2	
Fading Contd.: Small scale multipath propagation- factors influencing small scale fading, Doppler shift, Small scale multipath measurements, Parameters of mobile multipath channels, Types of small scale fading, Simulation of Clarke and Gans Fading model**.** **Multicarrier Signaling**: Multicarrier Communications in AWGN channel- Single carrier vs Multicarrier, OFDM-Matrix representation, FFT Implementation, Peak to Average Power Ratio. **Wideband Systems**: CDMA	**8hrs**
MODULE-3	
Capacity of wireless channel: AWGN channel capacity, Linear time invariant Gaussian channel, Capacity of Fading Channels.	**8hrs**
MODULE-4	
MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels, Physical modeling of MIMO channels, Modeling of MIMO fading channels.	**8hrs**
MODULE-5	

MIMO capacity and multiplexing architectures: The VBLAST architecture, Fast fading MIMO channel, Capacity with CSI at receiver, Performance gains, Full CSI, Performance gains in a MIMO channel, Receiver architectures – (Linear decorrelator, Successive cancellation, Linear MMSE receiver), Information theoretic optimality, Connections with CDMA multiuser detection and ISI equalization, Slow fading MIMO channel.	**8hrs**

Text Books:	
1	'Digital Communications Fundamentals and applications', Bernad Sklar, Pearson Education, ISBN:8178083736,2nd edition, 2004
2	'Fundamentals of Wireless Communication', David Tse, Pramod Viswanath, Cambridge University Press, ISBN:0521845270,1st edition, 2005
3	'Wireless Communications', Theodore S. Rappaport, Cambridge University Press, ISBN:8120323815,2nd edition, 2005
4	'Wireless Communications', Andrea Goldsmith, Cambridge University Press, ISBN:9780521837163,2nd edition, 2005

Reference Books:	
1	'Digital Communication Systems', Simon Haykin, Wiley, ISBN:978-0471-64735-5,2014
2	'Digital Communications', John G. Proakis, Masoud Salehi, Pearson Education, ISBN:9789332535 893,5th edition,2014

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.

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	To describe models for fading channels, and concepts of diversity in time, antenna and frequency.	Explain
CO2	Explain the concepts of multi-channel signaling (including OFDM) scheme and Synchronization for carrier and symbol timing recovery at receiver.	Understand
CO3	Evaluate the capacity and degradation in performance of various symbol signaling schemes in a multipath fading environment.	Analyze
CO4	Develop & analyze multiplexing capability and modelling of MIMO channels.	Analyze
CO5	Develop and evaluate the performance of a MIMO scheme to meet Specified rate in a given multipath environment.	Analyze

Program Outcomes for this Course:

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

Mapping of COS and POs

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

ANTENNA THEORY AND DESIGN			
Course Code	MVJ22LAC22	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:2:0:Y	**SEE Marks**	50
Total Hours of Pedagogy	40L + 13P	**Total Marks**	100
Credits	04	**Exam Hours**	03

Course Learning objectives: This course will enable students:

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

Prerequisites: Electromagnetic theory.

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. **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, Field representations, Matching the feed to the reflector, General feed model, Feed antennas used in practice.	**8hrs**
MODULE-5	
Antenna in systems & Measurements: Receiving properties of antennas, Antenna temperature & radiometry.	**8hrs**

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

Text Books:	
1	Antenna Theory Analysis and Design', C.A. Balanis, John Wiley, 2nd Edition, 2007

Reference Books:	
1	Antennas and Wave Propagation', J.D. Krauss, McGraw Hill TMH,4thEdition, 2010.
2	Antenna and Wave Propagation, K.D.Prasad, Satya Prakashan, New Delhi,2021.

PRACTICAL COMPONENT OF IPCC:

Conduct the experiments using MATLAB/Scilab/any antenna simulation tool

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE.

A student shall be deemed to have satisfied the academic requirements (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.

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	To classify different types of antennas.	Understand
CO2	To define and illustrate various types of array antennas.	Understand
CO3	To design antennas like Yagi-Uda, Helical antennas and other broadband Antennas.	Understand
CO4	To describe different antenna synthesis methods and apply methods like Method of Moments, Pocklington's integral equation, Source modelling	Understand
CO5	To measure s-parameter, Radiation and Gain of various antenna.	Analyze

Program Outcomes for this Course:

Sl. No.	Description	POs
1	An ability to independently carry out research/investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should beat a level higher than the requirements in the appropriate bachelor program.	PO3

4	An ability to create, select, apply appropriate techniques, resources and modern tools to solve complex engineering activities with an understanding of their limitations.	PO4
5	An ability to apply Professional ethics, responsibilities and norms of the engineering.	PO5
6	An ability to recognize the need to engage in independent and life-long learning in various Communication domain.	PO6

Mapping of COS and POs

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

Professional Elective – 1

WIRELESS SENSOR NETWORKS			
Course Code	MVJ22LAC231	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40L	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning 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.

Prerequisites: Wireless Communication concepts.

MODULE-1	
Introduction: Sensor Mote Platforms, WSN Architecture and Protocol Stack, **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. **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	
Wireless Sensor and Actor Networks: Characteristics, Sensor Actor coordination, Actor Actor coordination, WSAN protocol stack, Wireless Multimedia Sensor Networks, Grand Challenges.	**8hrs**

Text Book:

1	Wireless Sensor Networks, Ian F. Akyildiz and Mehmet Can Vuran, John Wiley & Sons Ltd. ISBN978-0-470-3601-3(H/B),2010

Reference Book:	
1	Wireless Sensor Networks: Signal Processing and Communications Perspectives', Ananthram Swami, et.al, John Wiley &Sons Ltd., ISBN978-0470-03557-3, 2007.

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.

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	Acquire knowledge of Wireless sensor network architecture and protocols.	Understand
CO2	Apply various transport layer protocols.	Apply
CO3	Understand the multiple radio access techniques, radio standards and Communication protocols to be used for wireless sensor.	Understand
CO4	Design wireless sensor network system for different applications under consideration.	Analyze
CO5	Understand the hardware details of different types of sensors and select right type of sensor for various applications.	Understand

Program Outcomes for this Course:

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

Mapping of COS and POs

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

NANO ELECTRONICS			
Course Code	MVJ22LAC232	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40L	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning objectives: This course will enable students:

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

MODULE-1	
Introduction to Physics of the solid state: Structure, Energy bands, Localized particles **Generic methodologies for nanotechnology:** classification and fabrication: Introduction and classification, Summary of the electronic properties of atoms and solids, effects of the nanometer length scale, Fabrication methods: Top-down processes, bottom-up processes methods for templating the growth of nanomaterials, ordering of nano systems.	**8hrs**
MODULE-2	
Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques, spectroscopy techniques: photon, radiofrequency, electron, surface analysis and dept profiling: electron, mass, Ion beam, Reflectometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties.	**8hrs**
MODULE-3	
Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, and electronic density of states. **Carbon Nanostructures:** Introduction, carbon molecules, carbon clusters, carbon nanotubes, applications of carbon nanotubes.	**8hrs**
MODULE-4	
Fabrication techniques: requirements of ideal semiconductor, epitaxial growth of quantum wells, lithography and etching, cleaved-edge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, colloidal quantum dots, self-assembly techniques. **Physical processes:** modulation doping, quantum hall effect, resonant tunnelling, charging effects, ballistic carrier transport, Interband absorption, intra band absorption, Light emission	**8hrs**

processes, phonon bottleneck, quantum confined stark effect, nonlinear effects, coherence and dephasing, characterization of semiconductor.	
MODULE-5	
Methods of measuring properties: atomic, crystallography, microscopy, spectroscopy **Applications:** Injection lasers, quantum cascade lasers, single photon sources, biological tagging, optical memories, Coulomb blockade devices, photonic structures.	**8hrs**

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

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

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.

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

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

Mapping of COS and POs

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

BIOMEDICAL SIGNAL PROCESSING			
Course Code	**MVJ22LAC233**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- Model a biomedical system.
- Understand various methods of acquiring bio signals.
- Understand various sources of bio signal distortions and its remedial techniques.
- Analyze ECG and EEG signal with characteristic feature points.
- Understand use of bio signals in diagnosis, patient monitoring and physiological investigation.

Prerequisites: Basic Signal Processing, Basic concepts on biomedical instruments.

MODULE-1	
Introduction to Computers in Medicine, overview of electric activities of biological cells, Electric characteristics of cell membrane, Electric Data Acquisition.	**8hrs**
MODULE-2	
Electrocardiogram: Introduction and overview, function and structure of the heart, signal of cardiovascular system, cardiovascular diseases and ECG, Processing and feature extraction of ECG.	**8hrs**
MODULE-3	
Electroencephalogram: Introduction and overview, Brain and its functions, EEG signal of the brain, Evoked Potentials, Diseases of central nervous system and EEG, EEG for assessment of Anesthesia, Processing and feature extraction of EEG.	**8hrs**
MODULE-4	
Electromyogram: Introduction and overview, muscle, signal of muscles, neuromuscular diseases and EMG, other applications of EMG, processing and feature extraction of EMG. Other biomedical signals.	**8hrs**
MODULE-5	
Introduction to X-Ray, X-Ray Detection, Biomedical CT Scanners, Magnetic Resonance Imaging: Physical and physiological principles of MRI, MR Imaging, Processing and feature extraction of MRI, Ultrasound Imaging: Introduction, Why Ultrasound Imaging, Generation and Detection of Ultrasound waves, Optical Microscopy, Infrared Imaging.	**8hrs**

Text Books:	
1	'Biomedical Digital Signal Processing', Willis J Tompkins, Prentice Hall of India,1996.
2	'Biomedical Signal and Image Processing', Kayvan Najarian, Robert Splinter, second edition, 2012 by Taylor & Francis Group.

Reference Books:	
1	'Biomedical Signal Processing (in IV parts)', R Challisand R I Kitney, Medical and Biological Engg. and current computing, 1990-91.
2	Special issue on 'Biological Signal Processing', Proc. IEEE1972.
3	'Bio medical Signal Processing', Arnon Cohen, Volumes I&II, CRC Press.
4	'Time, frequency and Wavelets in Biomedical Signal Processing', Metin Akay, IEEE Press, 1999.

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.

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	Describe models for a biomedical system.	Explain
CO2	Understand various methods of acquiring bio signals.	Understand
CO3	Understand various sources of bio-signal distortions and its remedial techniques.	Analyze
CO4	Analyze ECG and EEG signal with characteristic feature points	Analyze
CO5	Understand use of bio signals in diagnosis, patient monitoring and physiological investigation.	Understand

Program Outcomes for this Course:

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

Mapping of COS and POs

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

Professional Elective – 2

OPTICAL COMMUNICATION AND NETWORKING			
Course Code	MVJ22LAC241	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40L	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning objectives: This course will enable students:

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

Prerequisites: Advanced Communication Systems-1

MODULE-1	
Introduction to optical networks: Optical Networks, optical packet switching, Propagation of signals in Optical fiber: Different losses, Non-linear effects, Solitons. **Optical Components:** Couplers, Isolators and Circulators.	**8hrs**
MODULE-2	
Optical Components: Multiplexers and Filters, Optical Amplifiers, detectors. **Modulation-Demodulation:** Formats, Ideal receivers, Practical direct detection receivers, Optical preamplifiers, Bit error rates, Coherent detection.	**8hrs**
MODULE-3	
Transmission System Engineering: System model, Power penalty, Transmitter, Receiver, Crosstalk. Client Layers of optical layer: SONET/SDH: Multiplexing, layers, Frame structure. Asynchronous Transfer Mode: ATM functions, Adaptation layers, Quality of Service (QoS) and flow control, Signaling and Routing.	**8hrs**
MODULE-4	
WDM network elements: Optical line terminals, Optical line amplifiers, Optical Add/ Drop Multiplexers, Optical cross-connects. **WDM Network Design:** Cost trade-offs, LTD and RWA problems, Routing and wavelength assignment, Wavelength conversion.	**8hrs**
MODULE-5	
Control and Management: Network management functions, management framework, Information model, management protocols, Layers within the optical layer, Control and Management: Performance and fault management, Impact of transparency, BER measurement,	**8hrs**

Optical trace, Alarm management, Configuration management, Optical Safety.	

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

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

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.

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

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

Mapping of COS and POs

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

STATISTICAL SIGNAL PROCESSING			
Course Code	MVJ22LAC242	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40L	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning objectives: This course will enable students:

- Understand random processes and its properties.
- Understand the basic theory of signal detection and estimation.
- Identify the engineering problems that can be put into the frame of statistical signal processing
- Solve the identified problems using the standard techniques learned through this course.
- Make contributions to the theory and the practice of statistical signal processing.

Prerequisites: Basic Signal Processing concepts

MODULE-1	
Random Processes: Random variables, random processes, white noise, filtering random processes, spectral factorization, ARMA, AR and MA processes.	**8hrs**
MODULE-2	
Signal Modeling: Least squares method, Pade approximation, Prony's method, finite data records, stochastic models, Levinson-Durbin recursion; Schur recursion; Levinson recursion.	**8hrs**
MODULE-3	
Spectrum Estimation: Non-parametric methods, minimum-variance spectrum estimation, maximum entropy method, parametric methods, frequency estimation, principal components spectrum estimation.	**8hrs**
MODULE-4	
Optimal and Adaptive Filtering: FIR and IIR Wiener filters, Discrete Kalman filter, FIR Adaptive filters: Steepest descent, LMS, LMS-based algorithms, adaptive recursive filters, RLS algorithms.	**8hrs**
MODULE-5	
Array Processing: Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beam-forming, linearly constrained minimum-variance beam-formers, side-lobe cancellers.	**8hrs**

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

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:

3. Three Unit Tests each of 50 Marks.
4. 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:

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

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

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

Mapping of COS and POs

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

MATLAB for Advanced Applications			
Course Code	MVJ22LAC243	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	3:0:0:0	**SEE Marks**	50
Total Hours of Pedagogy	40L	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course Learning objectives: This course will enable students:

- Solve ordinary differential equations and perform calculus operations using MATLAB
- Implement and Analyze Neural Network Models
- Design fuzzy logic systems and implement applications using the graphical user interface tools in MATLAB
- Analyze and Process Digital Signals and digital filters using MATLAB
- Model wireless communication channels and generate various fading channels for MIMO systems using MATLAB

Prerequisites: MATLAB basic concepts, Advanced Communication System-1

MODULE-1	
MATLAB for Numerical Computing: Executing a function, function subprograms, Types of functions, function handles, errors and warning, matlab debugger. Matlab Graphics-2D plots, Multiple plots, Sub plots, specialized 2D plots, 3D plots Ordinary Differential Equation solvers, Calculus using Symbolic mathematics, simplification functions.	**8hrs**
MODULE-2	
MATLAB Applications in Neural Networks: Generation of Input-Output Training data, creating a Neural Network, training a Multilayer perceptron, Generation of Input-Output Test Data, Simulating Network, Preprocessing and Post processing Inputs and Outputs, Using Graphical User Interface for creating Multilayered Neural Network. Implementation of ANN based Control, Creating RBF Neural Network.	**8hrs**
MODULE-3	
MATLAB Applications in Fuzzy Logic Systems: Fuzzy operations, fuzzy Inference systems-fuzzification of input variables, applications of fuzzy operators, mapping of degree of matching to fuzzy outputs, aggregation of outputs, defuzzification, Washing Machine problem, Building systems with Graphical User Interface-FIS editor, Membership function editor, Rule editor, Rule viewer, surface viewer, Fuzzy controller example-fuzzy controller for water bath system.	**8hrs**
MODULE-4	
MATLAB Applications in Digital Signal Processing: Classification and representation of basic discrete signals, operations on discrete signals, multirate signal processing functions, Convolution, Fast Fourier transform, Inverse Fast Fourier Transform, Digital filter Design-IIR filter design and FIR digital filter design, Filter design and analysis tool-IIR and FIR using FDA tool.	**8hrs**

MODULE-5	
MATLAB Applications in Wireless Communication: Free space path loss model, outdoor propagation model Hata model and okumura model, generate Raleigh channels, Rician fading channels, Time domain FWGN channel model, Generation of correlated MIMO fading channel, Ergodic Channel Capacity, Ergodic Channel Capacity for Various Antenna Configuration.	**8hrs**

Text Books:	
1	Raj kumar Bansal, Ashok Kumar Goel and Manoj Kumar Sharma, MATLAB and its Applications in Engineering, Pearson India Education Services Pvt Ltd, 2017.
2	Yong Soo Cho, Jaekwon Kim, Won Young Yang, Chung G. Kang, MIMO-OFDM Wireless Communications with MATLAB, John Wiley & Sons Pvt Ltd, 2010.

Reference Books:	
1	Chapman Stephen J, MATLAB Programming for Engineers, New Delhi Cengage Learning India 2008.
2	Rudra Pratap,Getting Started with MATLAB-Oxford University Press-2017, ISBN: 978-0-19-060206-2.
3	C.F. Van Loan and K.-Y.D. Fan, Insight Through Computing: A MATLAB Introduction to Computational Science and Engineering, SIAM, 2010.
4	Bhagali a c., Digital Signal Processing with Matlab Programs, Kolhapur Mahalakshmi Pub 2001.
	Stormy Attaway, MATLAB: A Practical Introduction to Programming and Problem Solving, Elsevier, 2022.

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:

5. Three Unit Tests each of 50 Marks.
6. 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:

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

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

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	Apply MATLAB for solving ordinary differential equations and calculus problems.	Apply
CO2	Analyze and Implement Neural network models through MATLAB.	Analyze
CO3	Apply fuzzy logic models for various applications using MATLAB.	Apply
CO4	Analyze and process digital signals and digital filters using MATLAB toolboxes	Analyze
CO5	Design different indoor and outdoor propagation models and MIMO fading channels through MATLAB.	Apply

Program Outcomes for this Course:

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

Mapping of COS and POs

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

ADVANCED COMMUNICATION LAB			
Course Code	MVJ22LACL26	**CIE Marks**	50
Teaching Hours/Week (L:P:T:S)	0:2:0:0	**SEE Marks**	50
Total Hours of Pedagogy		**Total Marks**	100
Credits	02	**Exam Hours**	03

Course Learning objectives: This course will enable students:

- Achieve high levels of spectrum usage efficiency through QAM.
- Enable each sub stream's data rate to be lower than would be required by a single stream of similar bandwidth.
- Digitally represent analog signals.
- Know how occupy numerous signals in a single transmission channel by optimizing the use of bandwidth.
- Increase the amount of data that can be transmitted over a single optical fiber.

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.

Note: Conduct any ten experiments using any simulation tool kits

Course Learning Outcomes: After the completion of the course, students will be able to:

- Achieve high levels of spectrum usage efficiency through QAM.
- Enable each sub stream's data rate to be lower than would be required by a single stream of similar bandwidth.
- Digitally represent analog signals.
- Know how occupy numerous signals in a single transmission channel by optimizing the use of bandwidth.
- Increase the amount of data that can be transmitted over a single optical fiber.

Microwave Devices and Applications			
Course Code	**MVJ22LAC31**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- Describe the microwave properties and its transmission media.
- Describe microwave devices for several applications.
- Understand the concept of smith Chart.
- Understand the different types of Microwave Amplifiers.
- Understand the concepts of Microwave Circuit Design

MODULE-1	
Introduction to Microwaves: History of Microwaves, Microwave Frequency bands, General Applications of Microwaves, Advantages of Microwaves **Analysis of Microwave Transmission Lines**: Transmission line equations & solutions, Analysis of simple circuit in Phasor Domain, High Frequency Parameters, Formulation of S Parameters, Properties of S Parameters, Transmission Matrix, Generalized s parameters.	**8hrs**
MODULE-2	
Microwave Passive components: Directional Coupler, Magic Tee, Wave-guide Corners, Bends, Twists, Attenuator, Circulator, Isolator. **Microwave Active components:** Tunnel diode, Varactor diodes, Step recovery diodes, Schottky Barrier diodes, PIN diodes, Gunn Diodes, IMPATT and TRAPATT diodes, Parametric Amplifiers, Microwave Transistors, Microwave oscillators and Mixers. Microwave tubes: Klystron and Travelling Wave tubes.	**8hrs**
MODULE-3	
Smith Chart and its Applications: Introduction, smith Chart, Derivation of Smith Chart, Smith Chart Circular and Radical scales, Application of smith Chart.	**8hrs**
MODULE-4	
RF Microwave Amplifiers: Small signal Design: Introduction, Types of Amplifiers, Design of different types of Amplifiers. **RF/Microwave frequency Conversion**: Mixers: Introduction, Mixer types, Conversion losses for SSB Mixers, SSB Versus DSB Mixers, One diode Mixer, Two diode Mixer.	**8hrs**
MODULE-5	

RF and Microwave Control Circuit Design: Introduction, PN Junction Devices, Phase Shifters, Digital Phase shifters, Semiconductor Phase Shifters, PIN Diode attenuators. **RF and Microwave IC Design:** MIC, MIC Materials, Types of MIC, Hybrid Versus Monolithic IC.	**8hrs**

Text Books:	
1	**Radio Frequency and Microwave Electronics (Illustrated) , Mathew M. Radmanesh, Pearson India, 2015.**

Reference Books:	
1	**RF Circuit design theory and applications' Reinhold Ludwig, and Pavel Bretchko, Pearson Education edition, 2004.**

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:

- Three Unit Tests each of 50 Marks.
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks. CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

2. The question paper will have ten full questions carrying equal marks.

3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

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

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

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	Design and analyze microwave transmission lines.	Explain
CO2	Identify various passive microwave components for different applications.	Understand
CO3	Design and analyze Characteristic impedance using smith Chart.	Analyze
CO4	Examine various amplifiers and Mixers for Microwave Circuit design.	Analyze
CO5	Design Microwave Circuit using Phase Shifters.	Design and analyze

Program Outcomes for this Course:

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

Mapping of COS and POs

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

PROFESSIONAL ELECTIVE-4

PATTERN RECOGNITION AND MACHINE LEARNING

Course Code	**MVJ22LAC321**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- Develop the mathematical tools required for the pattern recognition.
- Enable the student with basic knowledge on the techniques to build an intellectual machine for making decisions behalf of humans.
- Understand the techniques on how to make learning by a model, how it can be evaluated, what are all Different algorithms to construct a learning model.
- Enable the student to Identify the deep learning algorithm hicharemore appropriate for various types of learning tasks.
- Understand the student to Implement deep learning algorithms and Execute performance metrics of Deep Learning Techniques.

MODULE-1	
Introduction: Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory. **Distributions:** Binary and Multinomial Variables, The Gaussian Distribution, The Exponential Family, Nonparametric Methods.	**8hrs**
MODULE-2	
Supervised Learning - Linear Regression Models: Linear Basis Function Models, The Bias, Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison **Classification & Linear Discriminant Analysis:** Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Mode.	**8hrs**
MODULE-3	
Kernels: Dual Representations, Constructing Kernels, Radial Basis Function Network, Gaussian Processes. **Support Vector Machines:** Maximum Margin Classifiers, Relevance Vector Machines. **Neural Networks:** Feedforward Network, Network Training, Error Backpropagation	**8hrs**
MODULE-4	
Machine Learning Basics: Learning Algorithms, Capacity, Overfitting and Underfitting, Hyper parameters and Validation Sets, Estimator, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Stochastic Gradient Decent, building a Machine Learning Algorithm, Challenges Motivating Deep Learning.	**8hrs**
MODULE-5	

Optimization for Training Deep Models: How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms. Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates. **Convolutional Networks:** The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features	**8hrs**

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

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

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:

- Three Unit Tests each of 50 Marks.
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks. CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

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

- Each full question will have 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.

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

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

Mapping of COS and POs

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

RF MEMS			
Course Code	**MVJ22LAC322**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- Comprehend the need for micromachining and MEMS based systems for RF and micro wave applications
- Describe the micro machining techniques and their use in the fabrication of micro switches, capacitors and inductors
- Design MEMS based microwave components aimed at reducing insertion loss and increasing bandwidth.
- Realize high Q micromechanical filters for frequencies up to and beyond10 MHz, and micro machined surface acoustic wave (SAW) filters filling the gap up to 2 GHz.
- Describe the packaging approaches used for these RF MEMS devices

MODULE-1	
Review: Introduction to MEMS: Fabrication for MEMS transducers and actuators, Micro sensing for MEMS, Materials for MEMS. MEMS materials and fabrication techniques: Metals, Semiconductors, Thin films, Materials for polymer MEMS, Bulk machining for Silicon based MEMS, Surface machining for Silicon based MEMS, Micro stereo-lithography for polymer MEMS.	**8hrs**
MODULE-2	
RF MEMS Switches and micro-relays: Switch parameters, Basics of switching, Switches for RF and Microwave applications, Actuation mechanisms, Micro-relays and micro-actuators, Dynamic of switch operations; MEMS switch design and design consideration, MEMS inductors and capacitors.	**8hrs**
MODULE-3	
Micro machined RF filters and phase shifters: RF filters, Modelling of mechanical filters, Micro-mechanical filters, SAW filters - Basic, Design consideration. Bulk acoustic wave filters, Micro-machined filters for millimeter wave frequencies. Micro-machined phase shifters, Types and limitations, MEMS and Ferroelectric phase shifters, Applications.	**8hrs**
MODULE-4	
Micro machined transmission line and components: Micro machined transmission line: Losses in Transmission line, coplanar lines, Micro shield and membrane supported lines, Micro shield components, Micro machined waveguides, Directional couplers and Mixers, Resonators and Filters	**8hrs**
MODULE-5	

Micromachined antennas: design, Fabrication and measurements. Integration and packaging for RF MEMS. Roles and types of packages, Flip chip techniques, Multichip module packaging and Wafer bonding, Reliability issues and thermal issues.	**8hrs**

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

Reference Books:	
1	**'RF MEMS circuit design', J De Los Santos, Artech House, 2002.**
2	**'Transaction Level Modelling with System C: T L M concepts and applications for Embedded Systems', Frank Ghenassia, Springer, 2005.**
3	**'Networks on chips: Technology and Tools', Luca Beninid, Morgan Kaufmann Publishers, 2006.**

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:

- Three Unit Tests each of 50 Marks.
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks. CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

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

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

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

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

Mapping of COS and POs

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

5G-Radio Access Technologies

Course Code	**MVJ22LAC323**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- 5G channel modelling and use cases
- Get Idea on Multiple-input multiple-output (MIMO) systems
- To know about 5G architecture and Importance of 5G Technology
- To understand Device-to-de vice (D2D) communication and standardization
- Analyze the 5G radio-access technologies

MODULE-1	
5G Channel Modelling and Use Cases Modeling requirements and scenarios, Channel model requirements, Propagation scenarios, Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying, Cognitive radio: Architecture, spectrum sensing, Software Defined Radio(SDR).	**8hrs**
MODULE-2	
Multiple-input multiple-output (MIMO) systems: Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems. Diversity, exploiting multipath diversity, transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, Therake receiver, Combining techniques, Spatial Multiplexing.	**8hrs**
MODULE-3	
The 5G architecture Introduction, NFV and SDN, Basics about RAN architecture, High-level requirements for the 5G architecture, Functional architecture and 5G flexibility, Functional split criteria, Functional split alternatives, Functional optimization for specific applications, Integration of LTE and new air interface to fulfill 5G Requirements, Enhanced Multi-RAT coordinate features, Physical architecture and 5G deployment.	**8hrs**
MODULE-4	
Device-to-device(D2D) communications D2D: from 4G to 5G, D2D standardization: 4G LTE D2D, D2D in5G: research challenges, Radio resource management for mobile broadband D2D, RRM techniques for mobile broadband D2D, RRM and system design for D2D, 5G D2D RRM concept: an example, Multi-hop D2D communications for proximity and emergency, services, National security and public safety requirements in 3 GPP and METIS,	**8hrs**

Device discovery without and with network assistance.	
MODULE-5	
Access design principles for multi-user communications, Orthogonal multiple-access systems, Spread spectrum multiple-access systems, Capacity limits of multiple-access methods, Sparse code multiple access (SCMA), Interleave division multiple access(IDMA), Radio access for dense deployments, OFDM numerology for small-cell deployments, Small-cell sub-frame structure, Radio access for V2X communication, Medium access control for nodes on the move, Radio access for massive machine-type communication.	**8hrs**

Text Books:	
1	**Afif Osseiran, Jose F. Monserrat, Patrick Marsch, 5G Mobile and Wireless Communications Technology, Cambridge University Press, Second Edition, 2011**
2	**Erik Dahlman, Stefan Parkvall, Johan Sköld ,5G NR: The Next Generation Wireless Access Technology, Elsevier, First Edition, 2016**

Reference Books:	
1	**Jonathan Rodriguez Fundamentals of 5G Mobile Networks, Wiley, First Edition, 2010.**

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:

- Three Unit Tests each of 50 Marks.
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks. CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

- The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
- The question paper will have ten full questions carrying equal marks.

- Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
- Each full question will have 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.

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level
CO1	Understand and explain the channel models of 5G and the use cases for 5G.	Understand
CO2	Analyze use of MIMO in 5G and its techniques.	Understand
CO3	Draw and explain 5G architecture, its components and functional criteria.	Understand
CO4	Understand device to device (D2D) communication and standardization.	Understand
CO5	Study the in-depth functioning of 5G radio access technologies.	Apply

Program Outcomes for this Course:

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

Mapping of COS and POs

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

PROFESSIONAL ELECTIVE 3

ADVANCES IN IMAGE PROCESSING

Course Code	**MVJ22LAC331**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- Understand the representation of the digital image and its properties.
- Apply pre-processing techniques required to enhance the image for its further analysis.
- Use segmentation techniques to select Interest in the image for analysis.
- Represent the image based on its shape and edge information and also describe the objects present in the image based on its properties and structure.
- Use morphological operations to simplify images and quantify and preserve the main shape characteristics of the objects.

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, Water shed 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 segmentationsand watersheds.	**8hrs**

Text Books:

1	**'Image Processing, Analysis, and Machine Vision', Milan Sonka, Vaclav H lavac, 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 Mc Graw Hill, 2011.**

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:

- Three Unit Tests each of 50 Marks.
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks. CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.

7. The question paper will have ten full questions carrying equal marks.

8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.

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

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

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	Description	Blooms Level

CO1	Understand the representation of the digital image and its properties.	Understand
CO2	Apply pre-processing techniques required to enhance the image for its further analysis.	Understand
CO3	Use segmentation techniques to select the region of interest in the image for analysis.	Understand
CO4	Represent the image based on its shape and edge information and also describe the objects present in the image based on its properties and structure.	Understand
CO5	Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.	Apply

Program Outcomes for this Course:

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

Mapping of COS and POs

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

WAVELET TRANSFORMS AND APPLICATIONS			
Course Code	**MVJ22LAC332**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

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

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, biorthogonalwavelet 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 signaling pulses, Discrete Wavelet Multitone Modulation. **Beyond Wavelet:** Ridge lets and curve lets: Ridge let transform and Digital Curve let transform, Curve let construction, Properties and applications.	**8hrs**

Text Books:	
1	**WaveletTransforms–Introductionandapplications-RaguveerM.RaoandAjitS.Bopardikar--PearsonEducation, 2008**

Reference Books:	
1	**Insight into Wavelets from Theory to practice - K. P Soman, K. I. Ramachandran, PHI, 2006**
2	**Fundamentals of Wavelets: Theory, Algorithms and Applications- J C Goswamy and AK Chan, Wiley Inder science Publications, John Wiley and Sons, 1999.**

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:

- Three Unit Tests each of 50 Marks.
- Two assignments each of 20 Marks or one Skill Development Activity of 40 marks to attain the COs and POs.

The sum of three tests, two assignments/skill Development Activities, will be scaled down to 50 marks. CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

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

- Each full question will have 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.

Course Learning Outcomes: After the completion of the course, students will be able to:

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

Program Outcomes for this Course:

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

Mapping of COS and POs

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

VLSI DESIGN FOR SIGNAL PROCESSING			
Course Code	**MVJ22LAC333**	**CIE Marks**	**50**
Teaching Hours/Week (L:P:T:S)	**3:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 L**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Learning objectives: This course will enable students:

- Familiarize with essential DSP algorithms such as filtering (FIR and IIR)
- Gain proficiency in algorithmic strength reduction techniques for digital filters and transforms, aiming to optimize computational efficiency and resource utilization in signal processing applications
- Develop expertise in pipelining and parallel processing techniques specifically tailored for Infinite Impulse Response (IIR) filters
- Master the design and implementation of bit-level arithmetic architectures, including adders, multipliers, and shifters, with a focus on optimizing performance, area efficiency, and power consumption in digital circuits
- Explore and understand the principles and implementation methodologies of synchronous wave and asynchronous pipelining techniques in digital circuit design, emphasizing their impact on performance, timing, and design complexity

MODULE-1	
Introduction to DSP systems: Typical DSP algorithms, Data flow and Dependence graphs - critical path, Loop bound, iteration bound, Longest path matrix algorithm **Pipelining and Parallel processing of FIR filters:** Pipelining and Parallel processing for low power.	**8hrs**
MODULE-2	
Retiming – Definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application **Algorithmic strength reduction in filters and transforms:** 2-parallel FIR filter, 2- parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.	**8hrs**
MODULE-3	
Pipelining and parallel processing of IIR filters: Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power- of-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.	**8hrs**

MODULE-4	
Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters.	**8hrs**
MODULE-5	
Synchronous Wave and Asynchronous Pipelining: Numerical strength reduction – sub expression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single-phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol.	**8hrs**

Text Books:	
1	**"VLSI Digital Signal Processing Systems", Keshab K. Parhi, Wiley Eastern.**

Reference Books:	
1	**Digital Signal Processing for Multimedia Systems", Keshab K. Parhi and Takao Nishitani, Marcel Dekker.**
2	**"Pipelined Lattice and Wave Digital Recursive Filters", J. G. Chung and Keshab K. Parhi, Kluwer.**

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- 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.

Course Learning Outcomes: After the completion of the course, students will be able to:

Sl. No.	**Description**	**Blooms Level**
CO1	Illustrate the use of various DSP algorithms and addresses their representation using block diagrams, signal flow graphs and data-flow graphs	Explain
CO2	Use pipelining and parallel processing in design of high-speed /low-power applications	Understand
CO3	Apply unfolding in the design of parallel architecture	Analyze
CO4	Evaluate the use of look-ahead techniques in parallel and pipelined IIR Digital filters.	Analyze
CO5	Develop an algorithm or architecture or circuit design for DSP applications	Design and analyze

Program Outcomes for this Course:

Sl. No.	**Description**	**POs**
1	An ability to independently carry out research/investigation and development work to solve practical problems.	PO1
2	An ability to write and present a substantial technical report/document.	PO2
3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should beat a level higher than the requirements in the appropriate bachelor program.	PO3
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Mapping of COS and POs

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