VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING

M. Tech Communication Engineering

(M.Tech MCE)

Curriculum

(*2022-2023 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists and researchers of highest competence, who would engage in sustainable development to cater the global needs of industry and society.

MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

- Create and maintain an environment to excel in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines which pioneer for sustainable growth.
- Equip our students with necessary knowledge and skills which enable them to be lifelong learners to solve practical problems and to improve the quality of human life.

M. Tech. Communication Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry

3. Graduates will function in their profession with social awareness and responsibility

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country

5. Graduates will be successful in pursuing higher studies in engineering or management

6. Graduates will pursue career paths in teaching or research

M. Tech Communication Engineering

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_03: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_11: Having a good cognitive load management skills related to project management and finance

M. Tech Communication Engineering

ADDITIONAL PROGRAMME OUTCOMES (APOs)

APO_02: Having Sense-Making Skills of creating unique insights in what is being seen or observed (Higher level thinking skills which cannot be codified)

APO_03: Having design thinking capability

APO_04: Having computational thinking (Ability to translate vast data in to abstract concepts and to understand database reasoning

APO_07: Having critical thinking and innovative skills

APO_08: Having a good digital footprint

M. Tech Communication Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech. (Communication Engineering) programme, graduates will be able to

PSO1: Apply advanced concepts of Communication Engineering to design and develop more efficient next generation communication systems.

PSO2: Use modern technologies in both hardware, software to solve real-world multidisciplinary problems

PSO3: Independently carry out research on diverse communication strategies to address practical problems and present a substantial technical report.

Master of Technology in Communication Engineering

School of Electronics Engineering

Programme Credit Structure	**Credits**
Discipline Core Courses	24
Skill Enhancement Courses	05
Discipline Elective Courses	12
Open Elective Courses	03
Project/ Internship	26
Total Graded Credit Requirement	70

Discipline Core Courses **24**

		L	T	P	C
MECE501L	Mathematics for Communication Engineering	3	0	0	3
MECE502L	Advanced Digital Communication	3	0	0	3
MECE502P	Advanced Digital Communication Lab	0	0	2	1
MECE503L	Advanced Digital Signal Processing	3	0	0	3
MECE503P	Advanced Digital Signal Processing Lab	0	0	2	1
MECE504L	RF and Microwave Circuit Design	3	0	0	3
MECE504P	RF and Microwave Circuit Design Lab	0	0	2	1
MECE505L	Fiber Optic Communication and Networks	3	0	0	3
MECE506L	High Performance Communication Networks	3	0	0	3
MECE507L	Modern Wireless Communication Systems	3	0	0	3

Skill Enhancement Courses **05**

MENG501P	Technical Report Writing	0	0	4	2
MSTS501P	Qualitative Skills Practice	0	0	3	1.5
MSTS502P	Quantitative Skills Practice	0	0	3	1.5

Discipline Elective Courses **12**

MECE601L	Advances in Wireless Networks	2	0	0	2
MECE601P	Advances in Wireless Networks Lab	0	0	2	1
MECE602L	Advanced Antenna Engineering	3	0	0	3
MECE603L	Mobile Adhoc Networks	3	0	0	3
MECE604L	Modeling of Wireless Communication Systems	3	0	0	3
MECE605L	Modern Satellite Communication	3	0	0	3
MECE606L	Coding for MIMO Communication	3	0	0	3
MECE607L	Advanced Wireless Sensor Networks	2	0	0	2
MECE607P	Advanced Wireless Sensor Networks Lab	0	0	2	1
MECE608L	Microwave Integrated Circuits	3	0	0	3
MECE609L	Image processing and Feature Extraction	3	0	0	3
MECE610L	Multirate Systems	3	0	0	3
MECE611L	Adaptive Signal Processing	3	0	0	3
MECE612L	Optical Broadband Access Networks	3	0	0	3
MECE613L	RF MEMS	3	0	0	3
MECE614L	Foundations of Machine Learning	3	0	0	3
MECE615L	Information and Network Security	3	0	0	3

Open Elective Courses **03**

Engineering Disciplines | Social Sciences

Project and Internship **26**

MECE696J	Study Oriented Project	02
MECE697J	Design Project	02
MECE698J	Internship I/ Dissertation I	10
MECE699J	Internship II/ Dissertation II	12

Course Code	Course Title	L	T	P	C
MECE501L	Mathematics for Communication Engineering	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To build the strong foundation in Mathematics in students needed for the field of Communication Engineering.
2. To provide the mathematics fundamentals necessary to formulate, solve and analyse complex engineering problems.
3. To apply reasoning by the contextual knowledge to engineering practice.

Course Outcomes:

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

1. Apply matrix theory in Communication Engineering problems.
2. Calculate gradients, derivatives and its applications
3. Apply the constrained optimization for approximate solutions.
4. Do statistical modelling and analysis of Communication Systems
5. Apply Markovian process and distinguish the utility of queuing models.

Module:1	Basic Matrix Concepts	6 hours

Linear equations and matrix representations, Determinants. Vector spaces- Basis and dimension, Norms and inner-products, The Cauchy- Schwarz inequality, Direction of vectors, weighted inner products, Expectation as an inner product, Hilbert and Banach spaces, orthogonal subspaces, null space, column space, row space. Projection matrices.

Module:2	Matrix Factorizations and applications	9 hours

The LU factorization-Methods of Crout and Cholesky factorization, unitary matrices and the QR factorization, Eigen values, Eigen vectors, EVD, whitening, Pseudo inverses and the SVD, numerically sensitive problems, Rank-reducing approximations.

Module:3	Some Special Matrices and their Applications	4 hours

Circulant matrices, Toeplitz matrices. Kronecker Products - Some applications of Kronecker products.

Module:4	Derivatives and gradients	4 hours

Derivatives of vectors and scalars, products of matrices, powers of a matrix, Modifications for derivatives of complex vectors and matrices, first order systems

Module:5	Theory of Constrained optimization	5 hours

Basic definitions, definitions of constrained optimization, equality constraints: Lagrange multipliers.

Module:6	Probability and random processes	7 hours

Random vectors, transformations, joint moments, joint characteristic function, correlation, covariance matrices - properties. Vector Gaussian, Q-function, Circular complex Gaussian, various transformations, Gaussian random vectors, Rayleigh, Rician, Nagakami distributions, probability of error upper bounds for M-ary modulations.

Module:7	Markov Chains Queuing theory	8 hours

Markov Process, Markov chains, Birth-Death process- Characteristics of queuing models –Kendall's notation - Transient and Steady States and Difference

equations related to Poisson Queue systems – Single server and Multiple Server Poisson queue Models with Finite and Infinite capacity.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1	Todd.K. Moon and Wynne Stirling, Mathematical methods and algorithms for signal processing, 2000, Prentice Hall, 2000. New York.
2	John G. Proakis, Masoud Salehi, Digital Communications, 2008, 5th edition, McGrawHill.
3	T.Veerarajan, Probability, Statistics and Random Processes, 2009, 3rd edition, McGrawHill.

Reference Books

1. Gilbert Strang, Introduction to Linear Algebra, 2009, 4th edition, Wellesley-Cambridge press.
2. E. Larsson, P. Stoica, Space time block coding for wireless communications, 2003, Cambridge University press.
3. P.P. Vaidyanadhan, Multirate systems and filter banks, 1993, Pearson India. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, Statistical and adaptive signal processing: Spectral estimation, signal modelling, adaptive filtering and array processing, 2005, Artech House.
4. Athanasios Papoulis, S Pillai , Probability, Random Variables and Stochastic Processes, 2014 (reprint), 4th Edition, McGraw-Hill.
5. Kishor S. Trivedi, Probability and Statistics with Reliability, Queuing, and Computer Science Applications, 2016, 2nd Edition, John-Wiley & Sons.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE502L	Advanced Digital Communication	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To introduce the concept of digital base-band data transmission through a band limited channel.
2. To familiarize the student with concept of binary and M-ary band-pass modulation schemes.
3. To introduce the advanced channel coding techniques to minimize the probability of error.

Course Outcomes:

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

1. Design matched filter for detection of digital signals in the presence of white Gaussian noise.
2. Design waveforms to overcome ISI in band-limited channels.
3. Design equalization circuits to overcome the effect of channel distortion.
4. Compute probability of error for binary digital modulation schemes in the presence of AWGN.
5. Extend the binary modulation schemes to M-ary modulation for symbols.
6. Design turbo and LDPC codes to overcome the effect of noise in the channel.

Module:1	Introduction to Detection and Estimation Theory	6 hours

Detection of known signals in noise, Correlation receiver, Matched filter receiver, Detection of signals with unknown phase in noise. Minimum mean square error estimator, Maximum a posteriori estimator, Maximum likelihood estimation, Cramer Rao bound (CRB) for parameter estimation.

Module:2	Baseband Transmission Techniques	5 hours

Digital transmission through band limited channels, Power spectrum of digitally modulated signals, Signal design for band limited channels, Band limited signal design for zero ISI, Band limited signal design for controlled ISI.

Module:3	Baseband Reception Techniques	6 hours

Probability of error in detection of digital PAM, Eye pattern, Channel equalization, Linear Equalizers, Adaptive equalizers, Decision feedback equalizers, Fractionally spaced equalizers.

Module:4	Binary Bandpass Modulation Schemes	7 hours

Binary modulation schemes, Coherent and non-coherent detection of binary modulation schemes, Performance analysis of binary modulation schemes under AWGN channel, Minimum Shift Keying (MSK), Gaussian Minimum Shift Keying (GMSK).

Module:5	M-ary Bandpass Modulation Schemes	7 hours

M-ary Phase Shift Keying, M-ary Quadrature Amplitude Modulation, M-ary Frequency Shift Keying, Performance analysis of M-ary modulation schemes under AWGN channel, Non-coherent detection of M-ary orthogonal signals, Carrier and timing recovery, Synchronization, Applications.

Module:6	Trellis and Turbo Codes	6 hours

Convolutional codes, Viterbi Decoder for convolutional codes, Set partitioning, Trellis codes, Turbo encoders, Turbo decoders, MAP decoder and Max-Log-Map decoder, Irregular and Asymmetric turbo codes.

Module:7	**LDPC Codes**		**6 hours**
Regular LDPC codes, Gallager construction of LDPC codes, Gallager based decoding algorithm for LDPC codes and its analysis, LDPC threshold, Irregular LDPC codes.			
Module:8	**Contemporary Issues**		**2 hours**
	Total lecture hours:		**45 hours**
Text Book(s)			
1.	Simon S. Haykin, Michael Moher, Communication Systems, 2012, 5th Edition, Wiley, India.		
2.	Shu Lin, Daniel J. Costello, Error Control Coding, 2011, 2nd Edition, Pearson Education, UK.		
Reference Books			
1.	Marvin K. Simon, Sami M. Hinedi, William C. Lindsey, Digital Communication Techniques: Signal Design and Detection, 2015, 1st Edition, Pearson Education, India.		
2.	Richard J. Tervo, Practical Signals Theory with MATLAB Applications, 2013, 1st Edition, Wiley, India.		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE502P	Advanced Digital Communication Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To study the various line coding and channel coding techniques
2. To analyze various baseband and bandpass signals for effective communication

Course Outcome:

At the end of the course students will be able to

1. Construct and analyse various line coding and channel coding techniques
2. Design the circuits for band pass modulators and evaluate their performance

	Indicative Experiments	
1	Simple digital communication system: Simulate a simple communication system which transmits a text message from the source to the destination. Also, observe signals at different points of this communication system.	4 hours
2	Line Coding: Write a code which uses the below mentioned line coding techniques to generate the baseband signal for the given text message. Also, transmit the generated base band signal through AWGN channel. Analyse the effect of channel noise on the reconstructed signal. (a) Unipolar (b) Polar (c) Bipolar (d) Differential coding (Mark and Space)	4 hours
3	Bandpass Modulation: Write a code which uses below mentioned band pass modulation techniques to generate the modulated signal for the given text message. Transmit the modulated signal through AWGN channel. Detect the transmitted message using the suitable rules. Plot the necessary graphs. (a) BASK (b) BPSK (c) BFSK (d) DPSK	4 hours
4	Probability of error analysis (a) Consider a bit sequence of length 10,000. Modulate it with BPSK, BASK, BFSK. Transmit the signal through AWGN channel. Vary the SNR. Compare the theoretical and simulated probability of error. (b) Consider a bit sequence of length 10,000. Modulate it with BPSK, QPSK and 8-PSK. Transmit the signal through AWGN channel. Vary the SNR. Compare the theoretical and simulated probability of error. (c) Consider a bit sequence of length 10,000. Modulate it with 16-QAM and 64-QAM. Transmit the signal through AWGN channel. Vary the SNR. Compare the theoretical and simulated probability of error. (d) Consider a bit sequence of length 10,000. Modulate it with MSK. Transmit the signal through AWGN channel. Vary the SNR. Compare the theoretical and simulated probability of error.	6 hours
5	Channel coding (a) Write a code to build the (3, 1, 3) repetition encoder. Map the encoder output to BPSK symbols. Transmit the symbols through AWGN channel. Investigate the error correction capability of the (3, 1, 3) repetition code by comparing its BER performance with	6 hours

	and without using error correction code. (b) Write a code to compare the BER performance and error correction capability of (3, 1, 3) and (5, 1, 5) repetition codes. Assume BPSK modulation and AWGN channel. Also, compare the simulated results with the theoretical results. (c) Write a code to compare the performance of hard decision and soft decision Viterbi decoding algorithms. Assume BPSK modulation and AWGN channel. (d) Write a code to perform Trellis coded modulation for M-QAM and M-PSK systems using Ungerboeck set partitioning principle.	
6	Digital Modulation using Simulink: Build the transceiver chain for the following modulation schemes with Simulink. Observe signals at different points of communication system. (a) M-PAM (b) M-PSK (c) M-QAM	6 hours
	Total Laboratory Hours	**30 hours**
Mode of Assessment: Continuous Assessment and Final Assessment Test		

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE503L	Advanced Digital Signal Processing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To build advanced concepts in digital signal processing applicable for processing and analyzing random process.
2. To familiarize with Signal Modelling and development of recursion techniques.
3. To design optimal filters using IIR and FIR filtering techniques.

Course Outcomes:

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

1. Interpret the random processes in terms of stationarity, statistical independence and correlation.
2. Evaluate the theoretical and practical aspects of signal modelling based on computer algorithms.
3. Apply the mathematical concepts to design effective lattice system for random signal processing.
4. Design and implement the optimum filters using Weiner and Kalman techniques.
5. Extend the concepts of adaptive algorithms to non- stationary signals.
6. Apply different algorithms for computation of power spectral density for the random signals.

Module:1	Introduction	6 hours

Discrete-Time Signal Processing: Discrete-Time Signals, Discrete-Time Systems, Time-Domain Descriptions of LSI Filters, Discrete-Time Fourier Transform, and z-Transform, Special Classes of Filters, Filter Flow graphs, The DFT and FFT. Linear and Circular convolution.

Module:2	Discrete Time Random Processes	8 hours

Random Variables: Definitions, Ensemble Averages, Jointly Distributed Random Variables, Joint Moments, Independent, Uncorrelated and Orthogonal Random Variables, Linear Mean Square Estimation, Gaussian Random Variables Parameter Estimation: Bias and Consistency.

Random Processes: Review, auto-covariance and autocorrelation Matrices, Ergodicity, White Noise, Power Spectrum, Filtering Random Processes, Spectral Factorization.

Special Types of Random Processes: Autoregressive Moving Average Processes, Autoregressive Processes, Moving Average Processes, Harmonic Processes.

Module:3	Signal Modelling	7 hours

Introduction, The Least Squares (Direct) Method, The Padé Approximation, Prony's Method-Pole-Zero Modeling, Shank's Method. Stochastic Models: Autoregressive Moving Average Models, Autoregressive Models, Moving Average Models

Module:4	The Levinson –Durbin Recursion	5 hours

The Levinson-Durbin Recursion: Development of the Recursion, The Lattice Filter, Properties

Module:5	Optimal filters	6 hours

The FIR Wiener Filter: Filtering, Linear Prediction, Noise Cancellation, Lattice Representation for the FIR Wiener Filter.

The IIR Wiener Filter: Non-causal IIR Wiener Filter, The Causal IIR Wiener Filter, Causal Wiener Filtering, Causal Linear Prediction, Wiener Deconvolution.

Module:6	**Introduction Adaptive Filters**	**5 hours**
Discrete Kalman Filter, steepest descent algorithm, LMS, RLS		
Module:7	**Spectrum Estimation**	**6 hours**
Non Parametric Methods Periodogram, The Modified Periodogram, Bartlett's Method, Welch's Method, Blackman-Tukey Approach: Periodogram Smoothing, Performance Comparisons. Parametric Methods- Autoregressive Spectrum Estimation, Moving Average Spectrum Estimation, Autoregressive Moving Average Spectrum Estimation.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	Mitra, Sanjit Kumar, Yong hong Kuo, Digital signal processing: a computer-based approach, 2013, 4th Edition, McGraw-Hill, New York.
2.	Monson H. Hayes, Statistical digital signal processing and modeling, 2012, 1st Edition, Wiley, India.
Reference Books	
1.	Richard G. Lyons, Understanding digital signal processing, 2011, 3rd Edition, Pearson Education, India.
2.	http://freevideolectures.com/Course/3042/Advanced-Digital-Signal-Processing

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE503P	Advanced Digital Signal Processing Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To learn the usage of appropriate tools for realizing signal processing modules

Course Outcome:

At the end of the course, students will be able to

1. Implement the sampling and reconstruction process using the DSP processor
2. Design and implement the various systems using the imbibed signal processing concepts

	Indicative Experiments	
1	Real time experiments using TMS6713 Processor a) Interfacing a function generator with TMS 6713 Processor through codec with sampling rate of 96 KHz and display of the signal as a graph in CC-Studio in a time window of 256 samples. b) Interfacing a function generator with TMS 6713 Processor through codec with sampling rate of 96 KHz and display of the magnitude spectrum of signal as a graph in CC-Studio for a time window of 256 samples by applying FFT for the samples. c) FIR-filtering (low/high/bandpass) of an audio input obtained through microphone interface and output the result in the loud speaker. d) IIR-filtering (low/high/bandpass) of an audio input obtained through microphone interface and output the result in the loud speaker.	10 hours
2	Simulation Experiments using Matlab (a) Decimation and Interpolation of Band limited speech signal and frequency domain analysis. (b) Generation of various Random Processes MA, AR, ARMA. (c) Implementation of FIR and IIR Wiener Filter for separating the desired signal corrupted by AWGN and MSE calculation. (d) Implementation of digital Kalman filter. (e) ECHO Cancellation. (f) Power spectrum estimation parametric method. (g) Power spectrum estimation non parametric method. (h) Implementation of Adaptive filter using LMS recursive algorithm.	20 hours
	Total Laboratory Hours	**30 hours**

Mode of Assessment: Continuous Assessment and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE504L	RF and Microwave Circuit Design	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To have the essential knowledge of high frequency parameters.
2. To familiarize the student with concept of high frequency network analysis and design.
3. To have the ability to design microwave passive and active networks.
4. To get acquitted with emerging trends in microwave IC design concepts.

Course Outcomes:

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

1. Distinguish active & passive microwave devices & components used in Microwave communication systems.
2. Analyze microwave networks with S-parameters.
3. Design power dividers and low pass filters.
4. Analyze the multi- port RF networks, RF transistor amplifiers and stability.
5. Generate Microwave signals and design microwave amplifiers.
6. Understand the concepts of Microwave Resonators, Oscillators and Mixers.

Module:1	Microwave Fundamentals	5hours

Microwave frequencies (IEEE Standards), Smith Chart: Basic impedance & admittance chart, calculation of VSWR, Reflection coefficient, design of impedance matching circuits using lumped elements and distributed elements.

Module:2	Microwave Network Analysis	7hours

Scattering parameters, S-matrix and properties, S-matrix analysis of two port network with overall input and output reflection coefficients and Signal flow graph. Scattering parameter analysis of 2-port, 3-port and 4-port devices.

Module:3	Microwave Low Pass Filter Design	6 hours

Low Pass Filter design (Butterworth and Chebyshev) - Insertion loss method: Richard's Transformation, Kuroda's identities, Stepped impedance low pass filter.

Module:4	Microwave Transistors and Stability	6 hours

Characteristics of microwave transistors, various types of two port power gains, tests for unconditional stability of an amplifier, stability circles.

Module:5	Microwave Amplifier Design	7 hours

Single stage amplifier design for maximum gain and specific gain, design of low noise amplifiers, characteristics of power amplifiers.

Module:6	Microwave Resonators	5 hours

Transmission line resonators, Waveguide resonators and Dielectric resonators

Module:7	Microwave Oscillators and Mixers	7hours

Oscillators: Condition for oscillations in a one port network oscillator and two port network oscillators and oscillator phase noise.

Mixer: Characteristics of mixer, image frequency, single ended diode mixer, single ended FET mixer.

Module:8	Contemporary Issues	2 hours

		Total lecture hours:	**45 hours**
Text Book(s)			
1.	D. M. Pozar, Microwave engineering, 2012, 4th Edition, John Wiley, India.		
2.	G. Gonzalez, Microwave Transistor Amplifiers Analysis and Design, 2012, 2nd Edition, Prentice Hall, India		
Reference Books			
1.	Reinhold Ludwig, Pavel Bretchko, RF Circuit Design: Theory and Applications, 2014, 1st Edition, Prentice Hall, India.		
2.	http://www.microwaves101.com/		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE504P	RF and Microwave Circuit Design Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To apply the theoretical knowledge and explore the designing principles of various RF and Microwave circuits.

Course Outcome:

At the end of the course, students will be able to

1. Design and implement the various Microwave Filters
2. Design and analyse the various microwave devices and amplifiers

Indicative Experiments		
1	Analysis and Design Equal and Unequal Wilkiason Power division using Electromagnetic Simulation for L and S- Band Applications.	4 hours
2	Development of Wideband Phase Shifter for L and S band Applications.	3 hours
3	Design and Development of Microwave Filters. (a) Low Pass Filter (b) Band Pass Filter (c) High Pass Filter	5 hours
4	Design and Development of Microwave Coupler. (a) Branch line Coupler (90^o hybrid coupler) (b) Rat Race Coupler (180^o hybrid coupler)	5 hours
5	Design and Development of Microwave Resonators. (a) Half wavelength (b) Quarter Wavelength	5 hours
6	Design and Perform the Electromagnetic Simulation of High Pass Filter Using Steeped impedance and Richard Transform Method.	4 hours
7	Design and Analysis of Narrow band Microwave Amplifier for L and S Band applications using Specific Gain and Maximum Gain Method.	4 hours
	Total Laboratory Hours	**30 hours**

Mode of Assessment: Continuous Assessment and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE505L	Fiber Optic Communication and Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To acquaint the basic concepts of active and passive devices and its application in fiber optic networks.
2. To introduce the different types of optical amplifiers SOA, EDFA and RA with respect to operation principle and its applications.
3. To familiarize the theory of non-linearity and optics of anisotropic media and about the nonlinear effects like SRS, SBS, SPM, XPM, FWM and Solitons.
4. To introduce modulators like Electro optic and Acousto optic modulators used in optical transmission

Course Outcomes:

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

1. Apply the active, passive devices and optical amplifiers in optical networks.
2. Understand how nonlinear effects like SRS, SBS, SPM, XPM, FWM and Solitons can be used in optical fiber communications.
3. Explain the difference between modulators like Electro optic and Acousto optic modulators used in optical transmitters.
4. Analyze the receiver sensitivity and receiver noise, BER and eye pattern.
5. Determine Power and Rise time budgets and understand the different topologies of optical networks, WDM technology, CDMA and SCM.
6. Understand the SONET and Fiber to the home networks and Design, analyze and evaluate fiber optical communication links

Module:1	Network Elements	7 hours

Optical and photonic device technology: Couplers, isolators, circulators, multiplexers and filters, active and passive optical switches, optical cross connects, wavelength selective cross connects, wavelength converters, filters: dielectric, AWG and fiber Bragg grating (FBG) devices, nonlinear optical fibers

Module:2	Optical Amplifiers	3 hours

SOA, EDFA, Raman amplifier

Module:3	Nonlinear Effects	7 hours

Phenomenological theory of nonlinearities, optics of anisotropic media, harmonic generation, mixing and parametric effects, two-photon absorption, saturated absorption and nonlinear refraction. Rayleigh, Brillouin and Raman scattering, self-focusing and self-phase-modulation, cross phase modulation, four-wave mixing, solitons.

Module:4	Optical Modulators	3 hours

Electro-optic effect and acousto optic effects, EO and AO modulators.

Module:5	Detection and receiver design	7 hours

Receiver sensitivity, bit error rate, eye pattern, minimum received power, quantum limit of photo detection. Receiver design: Front end, linear channel, decision circuit, integrated receivers. Noise in detection circuit: shot noise, thermal noise, concept of carrier to noise analysis.

Module:6	Network Architectures, Topologies and Multi-Channel Systems	8 hours

The end to end transmission path, loss and dispersion budgets in network designing, optical signal flow and constraints, design of star, bus, mesh and ring topologies, multiplexing and

multiple access schemes: TWDM/MA, sub carriers, CDMA, capacity allocation for dedicated connections, demand assigned connections.		
Module:7	**Optical Networks**	**8 hours**
Optical networks architecture, SONET/SDH optical network, WDM optical networks, wavelength-routed optical network, routing algorithms, network monitoring and management, fault and security management, routing protocols, intelligent optical network (ION), FDDI, FTTH, business drivers for next-generation optical networks.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	Gerd Keiser, Optical Fiber Communications, 2013, 5th Edition, McGraw-Hill, India.
2.	Cvijetic, M., Djordjevic. I. B., Advanced Optical Communication Systems and Networks, 2013, 1st Edition, Artech House, London.
Reference Books	
1.	R. Ramaswami, K.N. Sivarajan, Morgan Kaufmann, Optical Networks A practical perspective, 2013, 2nd Edition, Pearson Education, India.
2.	G. P Agrawal, Fiber Optic Communication Systems, 2012, 4th Edition, Wiley, India.
3.	C. Siva Ram Murthy, Mohan Gurusamy, WDM optical networks concepts design and algorithms, 2015, 1st Edition, Pearson Education, India.
4.	G. P. Agrawal, Nonlinear Fiber Optics, 2012, 5th Edition, Academic Press, US.
5.	John M Senior, Optical Fiber Communication – principle and practices, 2014, 3rd Edition, PHI, India.
6.	Ivan Kaminov, Tingye Li, Alan E.Wilner, Optical Fiber Telecommunications VI B Systems and Networks, 2013, 6th Edition, Academic Press, India.

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE506L	High Performance Communication Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To familiarize with OSI, TCP/IP reference model and various high speed networks.
2. To understand the protocols as well as design and performance issues associated with the functioning of LANs and WLANs.
3. To introduce Quality of Service protocols and their importance in analysing network performance.

Course Outcomes:

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

1. List and explain the functions of the OSI, TCP/IP reference models.
2. Understand and analyze the performance of various high speed networks.
3. Explain the importance of various congestion and traffic management techniques related to packet switching networks
4. Understand and analyze the performance of link level protocols.
5. Analyze the behavior of TCP and UDP protocols over WLAN.
6. Understand the performance of queuing models and issues related to QoS protocols.

Module:1	Network Services and Layered Architectures	8 hours

Networking principles, Applications, Traffic characterization, Network elements, Basic network mechanisms, Open data network model, OSI, TCP, UDP and IP Models, Network architectures, Network bottlenecks.

Module:2	High Speed Networks	8 hours

Packet switching networks, Frame relay networks, ATM, High speed LAN, Ethernet, WLAN, DWDM, OBS, OPS.

Module:3	Congestion and Traffic Management	6 hours

Congestion control in data networks, Effects of congestion, Traffic management, Congestion control in packet switching networks

Module:4	Link level Flow, Error and Traffic Control	7 hours

Need for flow and error control, Link control mechanisms, ARQ performance, TCP flow and congestion control.

Module:5	UDP-TCP/IP Protocol Stack over WLAN Network	6 hours

UDP behaviour over WLAN, Effect of access based on RTS/CTS, Behaviour of TCP over WLAN, Influence of errors in UDP and TCP.

Module:6	Integrated and Differentiated Services	4 hours

Integrated Services Architecture (ISA), Queuing discipline, Random early detection, Differentiated services.

Module:7	Quality of Service Protocols	4 hours

Protocol for QoS support, Resource reservation: RSVP, MPLS, Real Time Transport Protocol, Self-Configuring techniques, Multichannel protocols.

Module:8	Contemporary Issues	2 hours

	Total lecture hours:		**45 hours**
Text Book(s)			
1.	William Stallings, High-speed Networks and Internets, 2012, 2nd Edition, Pearson Education, United Kingdom.		
2.	Jean Warland, Pravin Varaiya, High Performance Communication Networks, 2011, 2nd Edition, Harcourt and Morgan Kauffman Publishers, London.		
Reference Books			
1.	Leon Gracia, Widjaja, Communication Networks, 2011, 1st Edition, McGraw Hill, New York, USA.		
2.	Ramjee Prasad, Luis Munoz, WLANs and WPANs Towards 4G Wireless, 2013, 1st Edition, Artech House, London.		
3.	http://www.2.ensc.sfu.ca\~ljilja\ensc835\fall03\		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE507L	Modern Wireless Communication Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To introduce the fundamentals and limitations of wireless channels imposed on communication systems.
2. To understand the principles and importance of spread spectrum and multicarrier communication in the context of wireless communication.
3. To identify the role of diversity and MIMO techniques in combating the effect of fading and maximizing the capacity.
4. To cognize the most recent trends in the broad area of wireless communication.

Course Outcomes:

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

1. Describe the effect of large scale fading on signal transmission
2. Characterize and model the wireless channel in terms of small scale fading parameters
3. Design and implement diversity coding techniques to overcome the effect of fading
4. Apply the theory of probability and random processes in the design of baseband CDMA system
5. Design the transmitter and receiver blocks of OFDM for better transmission through multipath channel
6. Design and solve specific problems in advanced technologies like massive MIMO, HetNet, millimeter wave communication, standards like LTE, LTE-A and Design spatial multiplexing schemes and low-complexity receivers to maximize the spectral efficiency

Module:1	Large-Scale Path Loss	6 hours

Propagation of EM signals in wireless channel, Reflection, Diffraction and scattering, Free space propagation model, Two ray ground reflection model, Log-distance path loss model, Log-normal shadowing, Outdoor propagation models, Longley-Rice model, Okumura model, Hata model, COST-231, Link power budget analysis.

Module:2	Small-Scale Fading and Multipath	4 hours

Parameters of mobile multipath channels, Types of small scale fading, Rayleigh and Rician distributions, Jakes Doppler spectrum.

Module:3	Diversity Techniques	5 hours

Condition for deep fading, Probability of error analysis under fading channel, Time diversity, Repetition codes, Frequency diversity, Spatial diversity techniques, Analysis of BER of multi antenna system, Diversity order.

Module:4	Spread Spectrum Techniques	6 hours

Introduction to spread spectrum, Orthogonal spreading codes, Benefits of spreading (Jamming Margin, Graceful degradation, Universal frequency reuse, Multipath diversity), Multi user CDMA, Performance analysis of CDMA downlink with multiple users, Performance analysis of CDMA uplink with multiple users, Asynchronous CDMA, Near far problem, Power control, CDMA receiver synchronization, Introduction to MC-CDMA.

Module:5	OFDM	8 hours

Introduction to multicarrier modulation, Importance of cyclic prefix, Adaptive modulation and coding techniques. OFDM issues, PAPR, Frequency and timing offset, ICI mitigation techniques, Introduction to SC-FDMA-PAPR analysis with localized and interleaved schemes.

Module:6	**Physical Layer Aspects of LTE and LTE-A**	**5 hours**
Requirements and targets of LTE, Introduction to downlink physical layer design, Transmission resource structure, Synchronization and cell search, Reference signals and channel estimation, Cell specific reference signal generation, UE specific reference signal generation, Downlink physical data and control channels, Link adaptation, Introduction to uplink physical layer design, Carrier aggregation, HARQ, Relaying strategies and benefits.		
Module:7	**MIMO and Recent Trends**	**9 hours**
Spatial multiplexing, Decomposition of MIMO channel, Pre-coding, Optimal MIMO power allocation, MIMO beamforming, Nonlinear MIMO receivers-V-BLAST, D-BLAST, Requirements of 5G, Drawbacks of OFDM, Introduction to Filter Bank Multicarrier System (FBMC), Massive MIMO, Millimeter wave technology, Dense network, Cognitive radio technology, Smart antennas, Multi-hop relay networks.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	Aditya K. Jagannatham, Principles of Modern Wireless Communications Systems, 2015, 1st Edition, McGraw-Hill Education, India.
Reference Books	
1.	Simon Haykin, Michael Moher, Modern Wireless Communications, 2011, 1st Edition, Pearson Education, India.
2.	http://nptel.ac.in/courses/117104099/

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE601L	Advances in Wireless Networks	2	0	0	2
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To teach the basics of wireless networks and its services from 1G to 5G.
2. To acquaint with 3GPP based wireless IP networks and its architecture.
3. To teach the operation of LTE network, IMS architecture, inter networking concepts, addressing and registration process in wireless networks.
4. To teach the significance of mobility management in next generation network and its QoS challenges.

Course Outcomes:

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

1. Understand the different types of wireless standards and its services.
2. Comprehend the principles of 3GPP Packet Data Network Architecture, Packet Data Protocol (PDP) and accessing IP network through PS domain.
3. Comprehend the architecture of LTE network, protocol architecture and inter working with other RATs.
4. Comprehend the architecture of IP Multimedia Subsystem (IMS) and addressing procedure of IMS.
5. Analyze the mobility management IP based 3GPP and LTE networks.
6. Examine the QoS in Wireless IP networks.
7. Evaluate the performance of routing protocol, handover procedure and throughput of different network (3G and 4G Network) using Qualnet and NetSim tools.

Module:1	Evolution of Wireless Standards	4 hours

Evolution of wireless networks and services, Introduction to 1G/2G/3G/4G/5G, Motivation for IP based wireless networks, Long Term Evolution (LTE), Technologies for LTE, Evolutions from LTE to LTE-A - WiMAX Evolution (IEEE 802.16 family), Cognitive radio (IEEE 802.22).

Module:2	Wireless IP Network Architecture	6 hours

3GPP packet data networks, Network architecture, Packet Data Protocol (PDP), Context, Configuring PDP addresses on mobile stations, Accessing IP networks through PS domain.

Module:3	LTE Network Architecture	3 hours

LTE network architecture, Roaming architecture, Protocol architecture, Bearer establishment procedure, Inter, Working with other RATs

Module:4	IP Multimedia Subsystem	4 hours

IP Multimedia Subsystem (IMS), IMS architecture, Mobile station addressing for accessing the IMS, Registration and deregistration with the IMS, End-to-End signaling flows

Module:5	Mobility Management in IP and 3GPP	6 hours

Basic issues in mobility management, Location management, Mobility management in IP networks, MIPv4 regional registration, SIP-based mobility management, Cellular IP, HAWAII, Mobility management in 3GPP packet networks, Packet Mobility Management (PMM), Context- paging initiated by Packet-Switched Core Network

Module:6	Mobility Management in LTE Networks	2 hours

Intra-LTE mobility, Inter-RAT mobility, Mobility over X2 interface

Module:7	Quality of Service	3 hours

QoS challenges in wireless IP Networks, QoS in 3GPP, QoS architecture, Management and classes, QoS attributes, Management of End-to-End IP QoS, EPS bearers and QoS in LTE networks.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Jyh-Cheng Chen, Tao Zhang, IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols, 2012, 2nd Edition, John Wiley & Sons, New Jersey.
2.	StefaniaSesia, IssamToufik, Matthew Baker, LTE – The UMTS Long Term Evolution From Theory to Practice, 2011, 2nd Edition, John Wiley & Sons, New Jersey.
Reference Books	
1.	Ayman ElNashar, Mohamed El-saidny, Mahmoud Sherif, Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach, 2014, 1st Edition, John Wiley & Sons, New Jersey.
2.	Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, 2015, 1st Edition, Wiley Publications, United States.
3.	Savo Glisic, Advanced Wireless Networks: 5G Technology, 2016, 1st Edition, Wiley Publications, United States.
4.	http://www.cse.wustl.edu/~jain/cse574-14/index.html

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Mode of Assessment: Continuous Assessment and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE601P	Advances in Wireless Networks Lab	0	0	2	1
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To teach the basics of wireless networks and its services from 1G to 5G.
2. To acquaint with 3GPP based wireless IP networks and its architecture.
3. To teach the operation of LTE network, IMS architecture, inter networking concepts, addressing and registration process in wireless networks.
4. To teach the significance of mobility management in next generation network and its QoS challenges.

Course Outcomes:

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

1. Understand the different types of wireless standards and its services.
2. Comprehend the principles of 3GPP Packet Data Network Architecture, Packet Data Protocol (PDP) and accessing IP network through PS domain.
3. Comprehend the architecture of LTE network, protocol architecture and inter working with other RATs.
4. Comprehend the architecture of IP Multimedia Subsystem (IMS) and addressing procedure of IMS.
5. Analyze the mobility management IP based 3GPP and LTE networks.
6. Examine the QoS in Wireless IP networks.
7. Evaluate the performance of routing protocol, handover procedure and throughput of different network (3G and 4G Network) using Qualnet and NetSim tools.

List of Challenging Experiments (Indicative)

1.	Implement any two scheduling methods in LTE networks for various traffics and scenarios. Also, propose an improved scheduling from any one of those scheduling methods.	3 hours
2.	Develop UMTS architecture to route packet data from the user equipment to the IP network and evaluate the network performance in terms of throughput, delay and jitter.	3 hours
3.	Design an UMTS network to perform handoff between UE in a UMTS network within a single SGSN and between two SGSNs	3 hours
4.	Evaluate the performance of the following routing protocols for low and high speed wireless networks: (a) Bordercast Resolution Protocol (BRP) (b) Location Aided Routing (LAR) Protocol (c) Zone Routing Protocol (ZRP)	3 hours
5.	Design a 3G network to route data between same PLMN but between two different SGSN nodes and two different PLMN UMTS network	3 hours
6.	Design an UMTS network to study the routing effects of OSPF ver. 2 on core network components (HLR, GGSN and SGSN)	3 hours
7.	Design a HSDPA network and evaluate its performance in terms of throughput, delay and jitter.	3 hours
8.	Design a WiMAX network to evaluate the performance of mobility models, namely, file based mobility and random way point mobility.	3 hours
9.	To analyse the performance (Energy Consumption and Delay) of discontinuous reception in LTE networks (3GPP TS 36) for VoIP traffic.	3 hours
10.	To analyse the performance (throughput, delay, jitter and packet loss	3 hours

	rate) of LTE network under Type I and Type II relay.			
			Total laboratory hours	**30 hours**
Mode of Assessment: Continuous Assessment and Final Assessment Test				
Recommended by Board of Studies	28-07-2022			
Approved by Academic Council	No. 67	Date	08-08-2022	

Course Code	Course Title	L	T	P	C
MECE602L	Advanced Antenna Engineering	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To provide the essential knowledge of the antenna parameters and measurements.
2. To design antenna array using synthesize techniques.
3. To design the single element microstrip antenna and array with feeder network
4. To introduce the types of high impedance surface antennas for various applications.

Course Outcomes:

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

1. Understand the radiation mechanism of antenna and to solve the numerical problems related to antenna parameters.
2. Design and interpret non uniform excitation coefficients using array synthesis techniques for minimum side lobe level.
3. Design and analyze rectangular and circular microstrip antenna with power divider network.
4. Understand the importance of defected ground structures and metamaterial surfaces and design high impedance surfaces.
5. Exploit the antennas for wireless communication and radar applications.
6. Comprehend the working of antenna for Software defined and cognitive radio and acquire knowledge on different computational techniques.

Module:1	Antenna Fundamentals	7 hours

Radiation Mechanism, antennas used in various applications and selection criteria, Antenna measurements using anechoic chamber - Radiation pattern, Radiation Intensity, Power gain, Directivity, impedance, Radiation efficiency, Polarization

Module:2	Antenna Array Synthesis	8 hours

Fourier Transform - Woodward-Lawson Sampling - Schelkunoff Method- Dolph-Tchebyscheff - Taylor Line Source Method

Module:3	Microstrip Antennas	6 hours

Basic characteristics, feeding methods, Methods of analysis – Transmission line model and cavity model - Design of Rectangular patch, Circular patch –Microstrip antenna array and feed network.

Module:4	Antenna Design Techniques	6 hours

Antenna Design using Artificial Impedance Surface Metamaterial- Electromagnetic Band Gap-Defective Ground Structure - High Impedance Surface

Module:5	Antenna Applications –I	6 hours

Integrated Antenna for wireless personal communication, mobile communication- Antenna design consideration for MIMO diversity systems - medical therapy

Module:6	Antenna Applications- II	6 hours

Antenna for Software Defined Radio – Cognitive Radio- Electronic Warfare- Ground penetrating Radar

Module:7	Computational Electromagnetic for Antennas	4 hours

Method of moments (MoM), Finite element method (FEM), Finite difference time domain method (FDTD)

Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	C.A. Balanis, Antenna Theory: Analysis and Design, 2016, 4th edition, Wiley, India
2.	C.A. Balanis, Modern Antenna Handbook, 2012, 1st Edition, Wiley, India
Reference Books	
1.	W.L. Stutzman and G.A. Thiele, Antenna Theory and design, 2012, 3rd Edition, Wiley, India
2.	J. D. Kraus, Antennas and Wave propagation, 2012, 4th Edition, McGraw Hill, India.
3.	Sanjay Kumar, Saurabh Shukla, Wave Propagation and Antenna Engineering, 2016, 1st Edition PHI, India
4.	www.antenna-theory.com

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE603L	Mobile Adhoc Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To acquaint the fundamental of adhoc wireless networks and cellular networks.
2. To design contention-based MAC protocols and routing protocols for adhoc networks.
3. To recognize the QoS frameworks, network security issues, energy management and paraphrase the mobile adhoc network towards WSN, VANET, WPAN.

Course Outcomes:

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

1. Comprehend and analyze the deployment consideration and issues in adhoc network.
2. Classify the contention-based MAC protocols based on reservation and scheduling mechanism.
3. Compute the routing table for unicast routing protocols.
4. Comprehend and analyze the multicast routing protocols.
5. Recognize the quality of service solutions, security issue and energy management in adhoc networks.
6. Comprehend and analyze the architecture and data processing of wireless sensor network.

Module:1	Introduction	6 hours

Introduction to Cellular and Ad hoc wireless networks, Applications of ad hoc networks, Issues in ad hoc wireless networks, Medium access scheme, Routing, Multicasting, Transport layer protocols, Pricing scheme, Quality of Service provisioning, Self-organization, Security, Address and security discovery, Energy management, Scalability, Deployment considerations, Ad hoc wireless Internet

Module:2	MAC Protocols	8 hours

Issues in designing a MAC Protocol for ad hoc wireless networks, design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classification of MAC Protocols, Contention based Protocols, Contention based Protocols with Reservation mechanism, Contention Based MAC Protocols with Scheduling Mechanisms, Other MAC protocols

Module:3	Routing Protocols	8 hours

Design issues and classification, Table-driven, On-demand and Hybrid routing protocols, Routing protocols with efficient flooding mechanisms, Hierarchical and Power-aware routing protocol

Module:4	Multicast Routing Protocols	8 hours

Design issues and operation, Architecture reference model, Classification, Tree-based and Mesh-based protocols, Energy-Efficient multicasting, Multicasting with Quality of Service guarantee, Application dependent multicast routing

Module:5	Quality of Service and Security Issues	4 hours

Issues and challenges in providing QoS, Classification of QoS solutions, MAC layer solutions, Network layer solutions, QoS frameworks, Network security issues

Module:6	Energy Management	4 hours

Need, Classification of battery management schemes, Transmission power management schemes, System power management schemes.

Module:7	Wireless Sensor Networks	5 hours

Wireless Sensor Networks: Architecture, Data dissemination, Data gathering, MAC Protocols, Location discovery, Quality of a sensor network, Issues and current trends in MANETs, VANETs, WSN, 6LoWPAN		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	C. Siva Ram Murthy, B. S. Manoj, Ad-Hoc Wireless Networks: Architectures and Protocols, 2012, 1st Edition, Prentice Hall, New Jersey.
Reference Books	
1.	C-K. Toh, AdHoc Mobile Wireless Networks: Protocols and Systems, 2011, 1st Edition, Prentice Hall, New Jersey.
2.	Mohammad Ilyas, The Handbook of AdHoc Wireless Networks, 2012, 1st Edition, CRC press, Florida.
3.	Minoru Etoh, Next Generation Mobile Systems 3G and Beyond, 2011, 1st Edition, Wiley Publications, New Jersey.
4.	Savo Glisic, Advanced Wireless Communications 4G Technologies, 2013, 1st Edition, Wiley Publications, New Jersey.
5.	http://www.ece.rochester.edu/courses/ECE586/index.htm
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test	

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE604L	Modeling of Wireless Communication Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To understand the necessity of modeling and simulation approach.
2. To provide an introduction to different error sources, impairments and performance metrics.
3. To determine the type and appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium.
4. To understand different queuing models for communication and networking applications.

Course Outcome:

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

1. Apply simulation approach to evaluate the performance of a communication system
2. Apply the theory of random processes in modelling the wireless communication system
3. Estimate the bit error rate using Monte Carlo simulations and validate the simulations using bounds and approximations
4. Evaluate the performance of communication system in terms of performance metrics like bit error rate, outage probability etc.
5. Model multipath fading channels that are used in the performance analysis of wireless standards like GSM, WCDMA, LTE, Wi-Fi, WiMAX etc.
6. Apply queueing models to design cellular network with given quality of service constraints.

Module:1	Introduction to simulation approach	4 hours

Simulation approach, Advantages and limitations, Methods of performance evaluation, Error sources in simulation, Role of simulation in communication systems.

Module:2	Fundamentals of Random Variables and Random Processes for Simulation	6 hours

Introduction to random variables (continuous and discrete), Univariate and Bivariate models, Transformation of random variables, Moments, Central moments, Characteristic function, Moment generating function, Stationarity, Wide sense stationary, Ergodicity, auto correlation, Power spectral density, Cross correlation, Sampling of stationary random processes.

Module:3	Bounds and approximations	3 hours

Chebyshev's inequality, Chernoff bound, Union bound, Central limit theorem, Approximate computation of expected values.

Module:4	Monte Carlo simulations	6 hours

Variations of Monte Carlo Simulation, Random number generation, Generating independent random sequences, Generation of correlated random sequences, Testing of random number generators.

Module:5	System Modeling	8 hours

Modeling the information sources, Source coding, Channel coding, Baseband modulation, Multiplexing, Multiple access, Band pass modulation, Detection, Equalization, Carrier and timing recovery for BPSK and QPSK, Performance analysis of communication system under noisy channel conditions.

Module:6	Channel Modeling	8 hours

Large scale fading models, Small scale fading models, Types of fading, Parameters

characterizing fading, Rayleigh fading, Jakes model, Clarke's model, Path loss models for LTE and Wi-Max networks, Performance analysis of communication systems under fading channel, Performance analysis of communication systems with MIMO.		
Module:7	**Queuing Modeling**	**8 hours**
Markovian models, Basic queuing models, M/G/1 queuing system, Pollaczek-Khinchine formula, Network of queues, Fundamentals of teletraffic theory, blocked call cleared system, blocked call delayed system, Queuing theory for teletraffic modeling.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	William H. Tranter, K. Sam Shanmugan, T. S Rappaport, Kurt L. Kosbar, Principles of Communication System Simulation with Wireless Applications, 2011, 1st Edition, Prentice Hall Press, USA.
2.	M. N. Sadiku, S. M. Musa, Performance Analysis of Computer Networks, 2013, 1st Edition, Springer, Switzerland.
Reference Books	
1.	John G. Proakis, Masoud Salehi, Gerhard Bauch, Contemporary Communication Systems using MATLAB, 2013, 3rd Edition, Nelson Engineering, Canada.
2.	http://web.stanford.edu/class/ee359/lectures.html
3.	http://www.cse.wustl.edu/~jain/cse567-15/index.html
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test	

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE605L	Modern Satellite Communication	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To exemplify in depth knowledge of Satellite communication system.
2. To have a detailed understanding of the critical RF parameters in satellite transceiver and their effects on performance.
3. To have a detailed understanding of the fundamental theory and concepts of the Global Positioning and inertial navigation System.

Course Outcomes:

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

1. Design the orbital and functional metrics of satellite communication systems.
2. Design the link budget for satellite services and analyze various parameters of transmitted and received signals through satellite.
3. Analyze user position using GPS pseudo-range data and error sources for GPS position calculations.
4. Analyze strap down inertial navigation systems including coordinate frames, attitude representation, and mechanization in various coordinate frame.
5. Develop a location based service using external data sources and services, web mapping and aspects of mobile technology.
6. Analyze the estimation techniques for integration of remote sensing sensors in an optimal navigation system.

Module:1	Introduction to Satellite Communication	7 hours

Overview of satellite communications, Types of satellites, Kepler's three laws of planetary motion, Orbital elements, Look angle determination, Orbital pert

Module:2	Launch and Satellite Systems	6 hours

Launch vehicles, Launching techniques, Orbital effects in satellite communication systems performance, Satellite subsystems, Satellite constellations

Module:3	Global Navigation Satellite System	7 hours

Global Navigation Satellite Systems, Basic concepts of GPS, Space segment, Control segment, user segment, GPS constellation, GPS measurement characteristics, Selective availability, Anti spoofing (AS). Applications of satellite and GPS for 3D position, Velocity, determination as function of time, Regional navigation systems

Module:4	Inertial Navigation	7 hours

Introduction to Inertial Navigation, Inertial sensors, Navigation coordinates, System implementations, System, Level error models, introduction to Differential GPS, LADGPS, WADGPS, WAAS, GEO Uplink Subsystem (GUS), Clock steering algorithms, GEO orbit determination

Module:5	Location Applications	2 hours

Distress and safety, Cospas, Sarsat, Inmarsat distress system, Location-based service, Problems

Module:6	Sensors, Remote Sensing Systems and Techniques	8 hours

Overview of sensors, Optical sensors: cameras, Non-Optical sensor, Image processing, Image interpretation, System characteristics.
Introduction to remote sensing systems, Commercial imaging, Digital globe, GeoEye, Meteorology, Meteosat, Land observation, Landsat, Remote sensing data

Module:7	**Broadcast Systems**	**6 hours**
Introduction, Satellite radio systems, XM satellite radio inc., Sirius satellite radio, World space, Direct multimedia broadcast, MBCO and TU multimedia, European initiatives, Direct To Home (DTH) television, Implementation issues, DTH Services, representative DTH Systems, Military multimedia broadcasts, US Global Broadcast Service (GBS), Business TV(BTV), GRAMSAT, Specialized services, Email, Video conferencing, Internet.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	Mohinder S. Grewal, Lawrence R. Weill, Angus P. Andrews, Global Positioning Systems, Inertial Navigation, and Integration, 2011, 1st Edition, John Wiley & Sons, New Jersey.
2.	T. Pratt, C.W. Boastian, Jeremy Allnutt, Satellite Communication, 2013, 2nd Edition, John Wiley & Sons, New Jersey.
Reference Books	
1.	Madhavendra Richaria, Mobile Satellite Communications: Principles and Trends, 2014, 2nd Edition, John Wiley & Sons, New Jersey.
2.	D. Roddy, Satellite Communications, 2011, 4th Edition, McGraw Hill, New York.
3.	W.L. Pritchard, H.G Suyderhoud, Satellite Communication Systems Engineering, 2011, 2nd Edition, Pearson Education, United Kingdom.
4.	Tri T. Ha, Digital Satellite Communications, 2011, 2nd Edition, McGraw Hill, New York.
5.	http://www.satcom.co.uk/
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test	

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE606L	Coding for MIMO Communication	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To understand the importance of MIMO for next generation networks.
2. To identify the role of different diversity formats and spatial multiplexing in combating the effect of fading and maximizing transmission capacity.
3. To provide an introduction to advanced MIMO concepts like multi-user MIMO, massive MIMO and SM-MIMO for next generation communication.

Course Outcomes:

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

1. Characterize and model the MIMO wireless channel
2. Design and implement diversity coding techniques to overcome the effect of fading
3. Design optimal power allocation algorithms to maximize the system capacity
4. Assemble different forms of diversity to improve the error performance
5. Design low-complexity, linear and non-linear receivers
6. Evaluate the performance of concatenated codes for MIMO communication

Module:1	Introduction to MIMO and Wireless Channel	6 hours

Introduction, Multi antenna systems, Array gain, Diversity gain, Data pipes, Spatial multiplexing, Wireless channel, MIMO system model.

Module:2	Diversity Techniques	6 hours

Diversity, Types, Selection diversity, Scanning diversity, Maximum ratio combining, Equal gain combining, Calculation of SNR.

Module:3	Capacity of MIMO Channel	6 hours

MIMO system capacity, Channel unknown to the transmitter, Channel known to the transmitter, Water pouring principle, Capacity when channel is known to the transmitter, Deterministic channels.

Module:4	Space Time Block Coding	6 hours

Transmit diversity with two antennas: Alamouti scheme, STBC for real signal constellation, STBC for complex signal constellation, Decoding of STBC-OSTBC, Capacity of OSTBC.

Module:5	Space Time Trellis Codes	7 hours

Space Time Coded system, Design of space time trellis coded on slow fading channel, Error probability of slow fading channel, Design of space time trellis codes on fast fading channels, Error probability of fast fading channels, Comparison of STBC and STTC.

Module:6	Layered Space Time Codes	6 hours

LST transmitters: Types of encoding, Horizontal encoding, Vertical encoding, Diagonal encoding, Layered Space-Time coding design criteria, Performance analysis of HLST, VLST and DLST systems, Code design criteria, Receivers for LST systems, Iterative receivers.

Module:7	Concatenated Codes and Iterative Decoding	6 hours

Development of concatenated codes, Concatenated codes for AWGN and MIMO channels, Turbo coded modulation for MIMO channels, Concatenated space-time block coding.

Module:8	Contemporary Issues	2 hours

	Total lecture hours:		**45 hours**
Text Book(s)			
1.	Aditya K. Jagannatham, Principles of Modern Wireless Communications Systems, 2015, 1st Edition, McGraw-Hill Education, India.		
Reference Books			
1.	A. B. Gershman, N. D. Sidiropoulus, Space-time Processing for MIMO Communications, 2011, 1st Edition, Wiley, NJ, USA.		
2.	A. Paulraj, R. Nabar, D Gore, Introduction to Space-Time Wireless Communications, 2013, 1st Edition, Cambridge University Press, UK.		
3.	Tolga M. Duman, Ali Ghrayed, Coding for MIMO Communication Systems, 2012, 1st Edition, John Wiley & Sons, West Sussex, England.		
4.	http://nptel.ac.in/syllabus/syllabus.php?subjectId=117104118		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE607L	Advanced Wireless Sensor Networks	2	0	0	2
Pre requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To gain knowledge in physical, MAC and routing layers of WSN (Wireless Sensor Networks).
2. To learn WSN standards.
3. To analyze the performance of WSN

Course Outcomes:

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

1. Understand the Architectures of WSNs.
2. Design Physical and MAC Layers.
3. Design Network layer in WSN.
4. Understand Clustering in WSN.
5. Interpret WSN Standards.
6. Design Localization process in WSN.
7. Understand and write code for Operating Systems in WSN.

Module:1	**Architectures of WSNs**	**3 hours**

Challenges and enabling technologies for Wireless Sensor Networks, Single-Node architecture, Hardware components, Energy consumption of sensor node, Sensor network scenarios

Module:2	**Physical and MAC Layers**	**5 hours**

Physical layer and transceiver design considerations in WSNs, MAC Protocols for WSNs: Schedule-based protocols, Random Access-based protocols, Sensor-MAC: Periodic listen and sleep operations, Schedule selection and coordination, Schedule synchronization, Adaptive listening, Access control and data exchange, Message passing.

Module:3	**Network layer in WSN**	**4 hours**

Challenges for routing, Data centric and flat architecture

Module:4	**Clustering in WSN**	**4 hours**

Hierarchical protocols, Geographical routing, QoS based protocols

Module:5	**WSN Standards**	**4 hours**

802.15.4 - PHY and MAC, Zigbee, 6LoWPAN

Module:6	**Localization in WSN**	**4 hours**

Challenges in localization, Ranging techniques, Range-based localization, Range-free localization.

Module:7	**Operating Systems in WSN**	**4 hours**

Introduction, WSN - operating system design issues, Examples of OS, TinyOS.

Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Book(s)

1	Holger Karl, Andreas Wiilig, Protocols and Architectures for Wireless Sensor Networks,

.	2011, 1st Edition, John Wiley & Sons, New Jersey.
2.	Kazem Sohraby, Daniel Minoli, Taieb Znati, Wireless Sensor Networks-Technology, Protocols, and Applications, 2012, 1st Edition, John Wiley & Sons, New Jersey.
Reference Books	
1.	Ian F. Akyildiz, Mehmet Can Vuran, Wireless Sensor Networks, 2011, 1st Edition, John Wiley & Sons, New Jersey.
2.	Anna Hac, Wireless Sensor Network Designs, 2013, 1st Edition, John Wiley & Sons, New Jersey.
3.	http://ebooks.cambridge.org/ebook.jsf?bid=CBO9781139030960

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Mode of Assessment: Continuous Assessment and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE607P	Advanced Wireless Sensor Networks Lab	0	0	2	1
Pre requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To gain knowledge in physical, MAC and routing layers of WSN (Wireless Sensor Networks).
2. To learn WSN standards.
3. To analyze the performance of WSN

Course Outcomes:

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

1. Understand the Architectures of WSNs.
2. Design Physical and MAC Layers.
3. Design Network layer in WSN.
4. Understand Clustering in WSN.
5. Interpret WSN Standards.
6. Design Localization process in WSN.
7. Understand and write code for Operating Systems in WSN.

List of Challenging Experiments (Indicative)

1.	Design of wireless sensor node and the components of a WSN.	2 hours
2.	Design of WSN for transmission and reception of data using two or more sensors.	2 hours
3.	Understand the role of a transceiver and analyze the effect of transmission range and antenna power level on the residual energy of a sensor node.	3 hours
4.	Design of range based localization techniques.	3 hours
5.	Design and demonstrate the role of duty cycle (sleep/wakeup) in determining the power consumption of a sensor node.	3 hours
6.	Analyze the effect of variable sensing rates and data transmission rate on the power consumption of a sensor node.	3 hours
7.	Performance analysis of CSMA/ CA (slotted, Un-slotted) MAC protocol.	3 hours
8.	Investigate the use of various real world sensors (Temperature, Humidity, light intensity, rain gauge etc.) and demonstrate the data acquisition from a sensor.	3 hours
9.	Design and analyze WSN algorithms for clustering of sensor nodes. Also, evaluate static clustering technique with respect to WSN life time and throughput.	4 hours
10.	Design and demonstrate the role of Gateways in inter cluster/cluster to sink data transmissions. Design and analyze the performance of any two routing techniques prescribed for WSN architecture (Energy aware routing- Location based routing: GF, GAF, GEAR, GPSR, Attribute based routing–Directed diffusion, Rumor routing, Geographic hash tables)	4 hours
	Total laboratory hours	**30 hours**

Mode of Assessment: Continuous Assessment and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE608L	Microwave Integrated Circuits	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To have the essential knowledge of various planar microstrip circuits.
2. To design and analyse various types of microwave planar circuits.
3. To acquaint the fabrication techniques and tolerances for MIC circuits.

Course Outcomes:

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

1. Comprehend the importance of various microstrip lines and the losses due to various microstrip discontinuities.
2. Understand the design of lumped elements for microwave circuits.
3. Design and analyze various microstrip resonators.
4. Design and analyze microstrip power dividers and couplers.
5. Design and analyze band pass filters.
6. Appreciate and evaluate the performance of various fabrication techniques for planar circuits.

Module:1	Planar Transmissions Lines	6 hours

Introduction, types of MICs and their technology, types of planar transmission lines, introduction to coupled microstrip lines, slot lines and co-planar waveguides.

Module:2	Microstrip Lines	6 hours

Fields of propagation in microstrip lines, design equations of microstrip lines (characteristic impedance and W/H relation), losses in microstrip lines, discontinuities in microstrip lines.

Module:3	Lumped elements for MICs	6 hours

Lumped microstrip components: Design of microstrip and chip inductors, capacitors, resistors. Quasi lumped microstrip elements: Open and short circuited stubs (quarter wavelength, half wavelength)

Module:4	Microstrip Resonators	7 hours

Microwave resonators: Quarter & Half wave length resonators, Ring resonators: types, advantages and applications, Patch resonators.

Module:5	Microstrip Power Dividers	7 hours

Even and Odd mode analysis of equal &unequal Wilkinson Power Divider, Even & Odd mode analysis of branch line coupler and 180^{o} hybrid coupler, Coupled line coupler and its S-matrix, Ring coupler and its S-matrix.

Module:6	Bandpass Filter Design	6 hours

Band Pass Filter: Insertion loss method, Conversion from low pass to band pass, Design of band pass filter using lumped elements, distributed elements, impedance inverters, coupled lines.

Module:7	MIC & MMIC Fabrication Technologies	5 hours

Hybrid MICs, Configuration, Dielectric substances, thick and thin film technology, LTCC, HTCC, Printed Circuit Board technology (PCB), Fabrication process of MMIC.

Module:8	Contemporary Issues	2 hours

	Total lecture hours:	**45 hours**
Text Book(s)		
1.	D. M. Pozar, Microwave engineering, 2012, 4th Edition, John Wiley, India.	
2.	Leo G. Maloratsky, RF & Microwave Integrated Circuits: Passive components and control devices, 2012, 1st Edition, Elsevier Inc., India.	
Reference Books		
1.	Ali A Behagi, RF and Microwave Circuit Design: Updated and Revised with 100 Keysight (Ads) Workspaces, 2017, 1st Edition, Techno Search, India.	
2.	Jia Sheng Hong, M. J. Lancaster, Microstrip Filters for RF/Microwave Applications, 2012, 2nd Edition, Wiley-Blackwell, India.	
3.	http://www.microwaves101.com/	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies	28-07-2022	
Approved by Academic Council	No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MECE609L	Image Processing and Feature Extraction	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To provide comprehensive understanding of digital image fundamentals.
2. To impart the principles of image enhancement and filtering techniques in spatial and frequency domain.
3. To introduce the core aspects of image segmentation and imbibe their utilization for real-time applications.
4. To provide knowledge on the feature extraction from images and classification

Course Outcomes:

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

1. Explore the basic elements of digital image processing.
2. Comprehend image sampling, DFT and apprehend the rational of image transforms.
3. Process the given images to enhance them in spatial and frequency domains.
4. Evaluate the theoretical and practical aspects of segmentation for dealing with computerized analysis.
5. Extract image features, identify and classify them.
6. Analyze the data usability for compaction aiding representation and description.

Module:1	Introduction to Image Processing	6 hours

Fundamental steps in DIP – Image Sampling and Quantization - Basic relationship between pixels.

Image Transform: Two dimensional Fourier Transform- Discrete cosine transform – Multi-resolution analysis – Haar Transform- Discrete Wavelet Transform.

Module:2	Image Enhancement	8 hours

Spatial Domain: Basic Gray level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters.

Frequency Domain: Smoothing frequency domain filters- Sharpening frequency domain filters- Homomorphic filtering.

Module:3	Image Segmentation	8 hours

Image segmentation Techniques- Points, Edge and Corner detector - Region based approach- Clustering- Morphological techniques

Module:4	Feature extraction Techniques	8 hours

Geometry Features - Moment based features - Boundary and Region descriptors, Texture descriptor - Hough transform – Canny edge detector - Principal Components.

Module:5	Object Detection and Recognition	5 hours

Approaches to Object Recognition- Template matching - Neural network approach to Object Recognition- Structural methods.

Module:6	Image and Video Compression techniques	4 hours

Lossy and lossless Techniques – JPEG – JPEG2000 – MPEG-1, MPEG-2,MPEG-4 AVC/ITU-T H.264 standards

Module:7	Video processing	4 hours

Back ground subtraction – Motion detection – Motion estimation - Video segmentation

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 2013, 3rd Edition, Pearson Education, New Delhi, India.
2.	Anil. K. Jain, Fundamentals of Digital Image Processing, 2012, 7th Edition, Prentice Hall, Delhi, India.
3.	Mark Nixon, Alberto Aguado, Feature Extraction & Image processing, 2012, 2nd Edition, Elsevier academic Press, Oxford, UK.
4.	Al Bovik, Handbook of Image and Video processing, 2013, 2nd edition, Elsevier Academic Press, Burlington, USA.
Reference Books	
1.	William K. Pratt, Digital Image Processing, 2014, 2nd Edition, John Wiley & Sons, New Jersey, USA.
2.	Richard Szeliski, Computer vision: Algorithm and Applications, 2013, 1st Edition, Springer-Verlog, London, UK.
3.	A. Murat Tekalp, Digital Video Processing, 2015, 2nd Edition, Prentice Hall, New Delhi, India.
4.	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, Digital Image Processing using MATLAB, 2014, 2nd Edition, Pearson Education, New Delhi, India.
5.	www.iprg.co.in

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE610L	Multirate Systems	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To introduce the concepts of multirate signal processing.
2. To demonstrate the applications of multirate signal processing for communication systems.
3. To introduce the fundamental framework of wavelets in multirate signal processing perspective.
4. To acquaint the recent trends and technologies in multirate systems.

Course Outcome:

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

1. Design decimator and interpolator in both time and frequency domain.
2. Design multirate filter banks with subsequent error analysis
3. Design Perfect Reconstruction (PR) filters employing analysis and synthesis scheme
4. Design and realize linear-phase PR Finite Impulse Response Filters using lattice structures
5. Design and implement cosine modulated PR systems
6. Analyze and synthesize different wavelet basis in Time-frequency space and design and realize systems using the imbibed multirate signal processing concepts

Module:1	Fundamentals of Multirate Systems	5 hours

Basic multirate operations, interconnection of building blocks, poly-phase representation, multistage implementation

Module:2	Multirate Filter Banks	8 hours

Maximally decimated filter banks: Errors created in the QMF bank, alias-free QMF system, power symmetric QMF banks. Poly-phase representation, Perfect reconstruction systems, alias-free filter banks

Module:3	Para-unitary Perfect Reconstruction Filter Banks	6 hours

Lossless transfer matrices, filter bank properties induced by paraunitary, two channel Para-unitary lattices, M-channel FIR Para-unitary QMF banks.

Module:4	Linear Phase Perfect Reconstruction QMF Banks	6 hours

Necessary conditions, lattice structures for linear phase FIR PR QMF banks, formal synthesis of linear phase FIR PR QMF lattice.

Module:5	Cosine Modulated Filter Banks	5 hours

Pseudo-QMF bank and its design, efficient poly-phase structures, properties of cosine matrices, cosine modulated perfect reconstruction systems.

Module:6	Wavelet Transform	6 hours

Short-time Fourier transform, Wavelet transform, discrete-time Orthonormal wavelets, continuous-time Orthonormal wavelets.

Module:7	Applications of multi-rate systems.	7 hours

Sub band coding, Trans-multiplexer, Conventional Digital Down Converters. Aliasing Digital Down Converters. Timing Recovery in a Digital Demodulator. Modem Carrier Recovery. Digitally Controlled Sampled Data Delay. Recursive All-pass Filter Delay Lines. Sigma-delta Decimating Filter. FM Receiver and Demodulator.

Module:8	Contemporary Issues	2 hours

	Total lecture hours:	**45hours**
Text Book(s)		
1.	P. P. Vaidyanathan, Multirate Systems and Filter Banks, 2012, 1st Edition, Pearson Education, New Delhi, India.	
Reference Books		
1.	Fredric J Harris, Multirate Signal Processing for Communication Systems, 2012, 1st Edition, Pearson Education, New Delhi, India.	
2.	Gilbert Strang, Truong Nguyen, Wavelets and Filter Banks, 2012, 1st Edition, Wellesley-Cambridge Press, Wellesley, USA.	
3.	N. J. Fliege, Multirate Digital Signal Processing, 2012, 1st Edition, John Wiley & Sons, New Jersey, USA.	
4.	https://www.ece.umd.edu/class/enee630.F2012/slides/part-1_sec1_2_handoutPreLec.pdf	
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test		
Recommended by Board of Studies	28-07-2022	
Approved by Academic Council	No. 67	Date 08-08-2022

Course Code	Course Title	L	T	P	C
MECE611L	Adaptive Signal Processing	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To introduce stochastic processes and models in LTI systems.
2. To understand the LMS algorithm for iteratively estimating the Wiener filter weights.
3. To familiarize prediction filter formulation and applications
4. To derive the Lattice filter architecture from the Levinson-Durbin algorithm.

Course Outcomes:

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

1. Derive the response of LTI system to stochastic processes.
2. Comprehend and derive the Wiener filter for signals with known properties.
3. Familiar with the Lattice filter implementation of the prediction filter.
4. Analyze the convergence Properties of steepest descent.
5. Apply LMS algorithm to the lattice structure to improve convergence times.
6. Use Recursive Least Squares algorithms in signal processing and Convergent with Unsupervised Adaptive filters applications.

Module:1	Adaptive Systems and Signal Analysis	6 hours

Signal Processing in unknown environments: System identification and Linear prediction-Stochastic Processes-Responses of LTI system to stochastic processes

Module:2	The Mean Square Error (MSE) Performance Criteria	8 hours

Introduction to Mean Square Error (MSE) and MSE Surface-Properties of the MSE Surface: The Normal Equations- Geometrical Properties of the Error Surfaces - Wiener filter.

Module:3	Linear Prediction and the Lattice Structure	6 hours

Levinson Durbin's Algorithm - Lattice Derivation-Forward and backward prediction-Adaptive lattice structures.

Module:4	The Method of Steepest Descent	6 hours

Iterative Solution of the Normal Equations- Weight Vector Solutions –Convergence Properties of Steepest Descent - Mean Square Error Propagation

Module:5	The Least Mean Squares (LMS) Algorithm	6 hours

Effects of Unknown Signal Statistics- Derivation of the LMS Algorithm- Convergence of the LMS Algorithm - LMS Mean Square Error Propagation-Normalized LMS Algorithm

Module:6	Recursive Least Squares Signal Processing	6 hours

Recursive Least squares (RLS) Adaptive Algorithms-Performance of RLS Adaptive Algorithms-Convergence of RLS versus LMS-QR RLS Algorithm.

Module:7	Unsupervised Adaptive filters	5 hours

Blind Equalizers –Sato Algorithm –Godard algorithms

Module:8	Contemporary Issues	2 hours

	Total lecture hours:	45 hours

Text Book(s)

1. Bernard Widrow, Samuel D. Stearns, Adaptive signal processing, 2012, 1st Edition, Pearson Education, New Delhi, India.
2. Simon Haykin, Adaptive Filter Theory, 2012, 4th Edition, Pearson Education, New Delhi,

	India.		
Reference Books			
1.	John R. Treichler, C. Richard Johnson, Michael G. Larimore, Theory and Design of Adaptive filters, 2012, 1st Edition, John Wiley & Sons, New Jersey, USA.		
2.	Behrouz Farhang, Boroujeny, Adaptive filters: Theory and Applications, 2013, 2nd Edition, John Wiley & Sons, New Jersey, USA.		
3.	Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, Statistical and Adaptive Signal processing, 2014, 1st Edition, The McGraw Hill Education, New Delhi, India.		
4.	http://www.cs.tut.fi/~tabus/course/ASP/Lectures_ASP.html		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE612L	Optical Broadband Access Networks	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To provide a deep insight on enabling technologies for access networks.
2. To understand broadband access networks.
3. To familiarize the concept of network topology and access techniques.
4. To introduce long reach optical access and metro networks and WiMAX.

Course Outcomes:

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

1. Understand various enabling technologies for broadband access networks.
2. Analyze various multiple access schemes for broadband wireless technology.
3. Know various optical network topologies.
4. Understand various enabling broad band wireless technologies.
5. Understand the concepts of long reach and metro optical network.
6. Understand wireless access networks, Wi-MAX and Deploy and test real-time implementation of optical broadband access networks.

Module:1	Introduction and Enabling Technologies	5 hours

The anatomy of an access network, the evaluation path typical access networks, broad band copper access network using ADSL2,VDSL2 Technology, fiber to the home/building (FTTH/B) access network, point to point Ethernet FTTH, passive optical network (PON) FTTH, wavelength division multiplexing (WDM) PON FTTH, hybrid fiber coax running DOCSIS protocol, wireless access network

Module:2	Enabling Techniques For Broad Band Access Networks	6 hours

Fiber in the access network: Fiber-DSL, hybrid fiber –coax, fiber –wireless, fiber to the home. basic optical access network components: Optical fiber, optical power splitter, wavelength routing devices

Module:3	Network Topology & Access Techniques	7 hours

FTTH network topologies: Point to point, point to multipoint, cost aspects. Multiple access techniques for a PON: Time division multiple access, subcarrier multiple access, optical code division multiple access, wavelength division multiple access. Radio over fiber, free space optical communication

Module:4	Enabling Broadband Wireless Technologies	7 hours

Modulation: Use of limited power, phase shift keying modulation, quadrature amplitude modulation, orthogonal frequency division multiplexing (OFDM). Coding techniques: Block Codes, convolution codes, turbo coding (TC), space time coding, coded modulation techniques. Adaptive modulation and coding (AMC). Multiple access techniques: Frequency division multiple access, time division multiple access, orthogonal frequency division multiple access, Combination of OFDM and CDMA system, carrier sense multiple access protocol.

Module:5	Long Reach Optical Access Networks	6 hours

Research challenges: Signal power compensation, optical source, burst mode receiver, upstream resource allocation. Demonstration of LR, PON-PLANET super PON, dynamic bandwidth assignment.

Module:6	Optical Access and Metro Networks	5 hours

Introduction, optical regional access network, Stanford university access network, metro

access ring integrated network, OBS access metro networks. STARGATE- architecture, discovery and registration, dynamic bandwidth allocation and application.		
Module:7	**Optical –Wireless Access Networks and WiMAX**	**7 hours**
RoF: Introduction, basic technologies, RoF application areas, networking concepts and techniques. Integration of EPON and WiMAX: Introduction, integrated architecture for EPON and WiMAX, design and operation issues. Introduction to WiMAX, point to point, multipoint WiMAX networks, WiMAX mesh mode, mobility in WiMAX networks		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	Abdallah Shami, Martin Maeir, Chadi Assi, Broadband Access Network Technologies and Deployment (Optical Networks), 2014, 1st Edition, Springer, India.
Reference Books	
1.	Leonid G. Kasovsky, Ning Cheng, Wei-tao Shaw, Shingwa Wong, Broad Band OpticalAccess Networks, 2012, 1st Edition, Wiley-Blackwell, India.
2.	Ivan Kaminov, Tingye Li, Alan E. Wilner, Optical Fiber Telecommunications VI B Systems and Networks, 2013, 6th Edition, Academic Press, India.
3.	http://www.cisco.com/c/en/us/solutions/collateral/service-provider/service-provider strategy/white_paper_c11-690395.html

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE613L	RF MEMS	3	0	0	3
Pre-requisite	Nil	Syllabus version			
		1.0			

Course Objectives:

1. To have the essential knowledge of various planar microstrip circuits.
2. To design and analyze various types of RF MEMS filters and resonator.
3. To acquaint the design of MEMS based circuits.

Course Outcome:

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

1. Comprehend the importance of micro machines and various transducers.
2. Understand the fabrication techniques for MEMS circuits.
3. Discern the principles of various MEMS devices.
4. Design and analyze RF MEMS resonators.
5. Design and analyze RF MEMS filters.
6. Understand the MEMS based circuits.

Module:1	Evolution of Microsystems	2 hours

Benefits of micro systems, concept of micro machines/ micro systems, Scaling laws, nanomachines.

Module:2	Introduction to Sensors, Actuators and Mathematical Models	2 hours

Various domains and classification of transducers: electrostatic, piezoelectric, thermal sensing principles: electrostatic, resistive, chemical etc. SAW devices.

Module:3	Surface Bulk Micro Machining	5 hours

Overview of silicon processes techniques, micro machining techniques and special processes for MEMS, polymer MEMS, recent advances in MEMS fabrication.

Module:4	RF MEMS Devices	11 hours

Enabled circuit elements and models – RF/Microwave substrate properties, Micro machined – enhanced elements – capacitors, inductors, varactors, MEM switch – shunt MEM switch, low voltage hinged MEM switch approaches, push-pull series switch, folded –beam – springs suspension series switch, MEMS modeling – mechanical modeling, electromagnetic modeling.

Module:5	MEMS Resonators	4 hours

Transmission line planar resonators, cavity resonators, micromechanical resonators, film bulk acoustics wave resonators.

Module:6	RF MEMS filters and Oscillators	9 hours

A Ka-Band millimeter-wave Micro machined tunable filter, A High-Q 8 MHz MEM Resonators filter, RF MEMS Oscillators – fundamentals, A14GHz MEM Oscillator, A Ka-Band Micro machined cavity oscillator.

Module:7	RF MEMS Based Circuit Design	10 hours

Phase shifters – fundamentals, X-Band RF MEMS phase shifter for phased array applications, Ka-Band RF MEMS phase shifter for radar systems applications, Film bulk acoustic wave filters – FBAR filter fundamentals, FBAR filter for PCS application

Module:8	Contemporary Issues	2 hours

	Total Lecture hours:		**45 hours**
Text Book(s)			
1.	Hector J. De Los Santos, RF MEMS Circuit Design for Wireless Communications, 2012, 1st Edition, Artech House, India.		
2.	Stepan Lucyszyn, Advanced RF MEMS(The Cambridge RF and Microwave Engineering Series, 2012, 1st Edition, Cambridge University Press, India.		
Reference Books			
1.	Vijay K. Varadan, K. J. Vinoy, K.A. Jose, RF MEMS and their Applications, 2012, 1st Edition, John Wiley and sons, India.		
2.	Gabriel M. Rebeiz, RF MEMS Theory, Design & Technology, 2013, 1st Edition, Wiley Interscience, India.		
3.	http://ocw.mit.edu/index.htm		
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE614L	Foundations of Machine Learning	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To get acquainted with data processing
2. To understand the importance and significance of Machine Learning
3. To understand the diverse learning methods
4. To preface the essentials of deep learning

Course Outcomes:

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

1. To identify data discrepancies and eliminate noise, anomalies
2. To comprehend different steps involved in Machine Learning
3. To recognize the characteristics of ANN
4. To comprehend different types of learning
5. To implement different deep learning algorithms
6. To realize the impact of optimization in deep learning

Module:1	**Data Preprocessing**	**4 hours**

Basics of Vectors & Matrices – Overview: Data cleaning, Integration, Transformation & Reduction

Module:2	**Machine learning Essentials**	**9 hours**

Introduction, ML steps, data analysis for ML, generalization, regularization – L1, L2, applications

Module:3	**Introduction to Artificial Neural Networks**	**6 hours**

Models of neuron –Topology – characteristics of artificial neural networks – types of activation functions, ANN Architecture- Multilayer Perceptron – Back Propagation learning algorithm

Module:4	**Learning Methods**	**8 hours**

XOR Problem - Types of Learning – Supervised - Hebbian – Perceptron – Adaline, Unsupervised – Competitive learning NN, Kohonen SOM

Module:5	**Machine Learning Algorithms**	**6 hours**

Feature Selection - Normalization - Dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes - Clustering.

Module:6	**Introduction to Deep Learning**	**6 hours**

Convolution operation – Pooling – Efficient convolution algorithms- Reinforcement Learning

Module:7	**ML Framework - Toolbox**	**4 hours**

MATLAB-Python – Implementation-Computer Vision – Speech Recognition – Natural Language Processing applications

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Reference Books

1.	Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong, Mathematics for Machine Learning. Cambridge University Press 2020
2.	Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Prentice Hall of India, Third Edition 2014
3.	Simon Haykin, Neural Networks and Learning Machines, 2016, 3rd edition, Pearson Education Inc. India
4.	Kevin P Murphy. Machine Learning – A Probabilistic Perspective (Adaptive Computation and Machine Learning series). MIT Press 2012.
5	Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016.
6	Deep Learning: A Practitioner's Approach (English, Paperback, Josh Patterson, Adam Gibson)

Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE615L	Information and Network Security	3	0	0	3
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

1. To familiarize the basic concepts in security mechanism, classical and traditional Encryption techniques.
2. To teach the significance of public key mechanism, message authentication and digital signature in cryptography.
3. To acquaint the different types of network security and its significance.

Course Outcomes:

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

1. Comprehend and analyze OSI Security Architecture and Symmetric Key Encryption.
2. Comprehend the various mathematic techniques in cryptography including number theory, Finite Field, modulo operator and Discrete Logarithm.
3. Analyze block ciphers, Data Encryption Standard (DES), Advanced Encryption Standard (AES) and public key cryptography.
4. Analyze Diffie-Hellman key exchange, ElGamal Cryptosystem in asymmetric key cryptosystem and authentication schemes.
5. Understand the different types of network security protocols and its standards.
6. Know the various network security mechanisms.

Module:1	Introduction	6 hours

Need of Security – OSI Security architecture – Security attacks – Security mechanisms – Model for network security – Information security management lifecycle –Classical Techniques - Substitution – Transposition

Module:2	Mathematics of Cryptography	8 hours

Number Theory, Finite Fields, Fermat's and Euler's Theorems - Euler's Totient function - The Chinese Remainder Theorem, Discrete Logarithms, Elliptic and Hyper elliptic curve Arithmetic.

Module:3	Secret Key Cryptography	8 hours

Block ciphers and Data Encryption Standard (DES): Double DES – Triple DES. Advanced Encryption Standard (AES) – IDEA.

Module:4	Public Key Cryptography	8 hours

Principles of Public Key Cryptography - RSA – Elliptic Curve Cryptography (ECC) – Digital Signatures - Key Management: Diffie-Hellman key exchange - Elgammal cryptosystem - Kerberos. Hash Functions: SHA and MD5 - Message Authentication Codes: HMAC.

Module:5	Network Security Protocols and Standards	5 hours

Application level security: PGP, S/MIME, HTTPS and SET. Security in transport layer: SSL and TLS. Security in Network Layer: IPsec, Internet Key Exchange (IKE) and VPN.

Module:6	Network Periphery Security	4 hours

Fire walls – Scanning, filtering and blocking – Virus filtering – Content filtering – Spam - Wireless LAN: WEP and Honeypots.

Module:7	Cyber Crimes, Hackers and Forensics	4 hours

Cyber Crimes and Laws – Hackers – Dealing with the rise tide of Cyber Crimes – Forensics analysis.

Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	William Stallings, Cryptography and Network security: Principles and Practice, 2014, 5th Edition, Pearson Education, Noida, India.
2.	Joseph Migga Kizza, Computer Network Security, 2012, 1st Edition, Springer Science & Business Media, New York, USA.
Reference Books	
1.	Christof Paar, Jan Pelzl, Understanding Cryptography – A Textbook for Students and Practitioners, 2014, 1st Edition, Springer Science & Business Media, New York, USA.
2.	Behrouz A. Forouzan, Debdeep Mukhopadhyay, Cryptography & Network Security, 2013, 3rd Edition, The McGraw Hill Education, New Delhi, India.
3.	Charlie Kaufman, Radia Perlman, Mike Speciner, Network Security: Private Communication in a public World, 2016, 2nd Edition, Pearson Education, Noida, India.
4.	http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-857-network-and-computer-security-spring-2014/
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz and Final Assessment Test	

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE696J	**Study Oriented Project**				**02**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. The student will be able to analyse and interpret published literature for information pertaining to niche areas.
2. Scrutinize technical literature and arrive at conclusions.
3. Use insight and creativity for a better understanding of the domain of interest.

Course Outcome:

1. Retrieve, analyse, and interpret published literature/books providing information related to niche areas/focused domains.
2. Examine technical literature, resolve ambiguity, and develop conclusions.
3. Synthesize knowledge and use insight and creativity to better understand the domain of interest.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content	**(Project duration: One semester)**

This is oriented towards reading published literature or books related to niche areas or focussed domains under the guidance of a faculty.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE697J	**Design Project**				**02**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

1. Students will be able to design a prototype or process or experiments.
2. Describe and demonstrate the techniques and skills necessary for the project.
3. Acquire knowledge and better understanding of design systems.

Course Outcome:

1. Develop new skills and demonstrate the ability to upgrade a prototype to a design prototype or working model or process or experiments.
2. Utilize the techniques, skills, and modern tools necessary for the project.
3. Synthesize knowledge and use insight and creativity to better understand and improve design systems.
4. Publish the findings in the peer reviewed journals / National / International Conferences.

Module Content	**(Project duration: One semester)**

Students are expected to develop new skills and demonstrate the ability to develop prototypes to design prototype or working models related to an engineering product or a process.

Mode of Evaluation: Evaluation involves periodic reviews by the faculty with whom the student has registered. Assessment on the project – Report to be submitted, presentation and project reviews – Presentation in the National / International Conference on Science, Engineering Technology.

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE698J	**Internship I/ Dissertation I**				**10**
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field and also to give research orientation.

Course Outcome:

1. Considerably more in-depth knowledge of the major subject/field of study, including deeper insight into current research and development work.
2. The capability to use a holistic view to critically, independently and creatively identify, formulate and deal with complex issues.
3. A consciousness of the ethical aspects of research and development work.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Module Content	**(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

Recommended by Board of Studies	28-07-2022		
Approved by Academic Council	No. 67	Date	08-08-2022

Course Code	Course Title	L	T	P	C
MECE699J	Internship II/ Dissertation II				12
Pre-requisite	NIL	Syllabus version			
		1.0			

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Course Outcome:

Upon successful completion of this course students will be able to

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing.
5. Synthesize the results and arrive at scientific conclusions / products / solution.
6. Document the results in the form of technical report / presentation.

Module Content **(Project duration: one semester)**

1. Dissertation may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Dissertation should be individual work.
3. Carried out inside or outside the university, in any relevant industry or research institution.
4. Publications in the peer reviewed journals / International Conferences will be an added advantage.

Mode of Evaluation: Assessment on the project - Dissertation report to be submitted, presentation, project reviews and Final Oral Viva Examination.

Recommended by Board of Studies	28-07-2022		
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