MVJ College of Engineering, Whitefield, Bangalore

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination 2019-20

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

Effective from the academic year 2019-20

I SEMESTER M.TECH- (Digital Electronics & Communication)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	BSC	MVJ19DEC11	Applied mathematics for Electronics Engineers	MATHEMATICS	3	2	0	3	50	50	100	4
2	PCC	MVJ19DEC12	Advanced Digital Signal Processing	ECE	3	2	0	3	50	50	100	4
3	PCC	MVJ19DEC13	Advanced Communication System	ECE	3	2	0	3	50	50	100	4
4	PCC	MVJ19DEC14	Advanced Embedded System	ECE	3	2	0	3	50	50	100	4
5	PCC	MVJ19IPR15	Research Methodology and IPR	ECE	2	0	0	3	50	50	100	2
6	PCC	MVJ19DECL16	Advanced Digital Signal Processing Lab	ECE	0	2	2	3	50	50	100	2
7	PCC	MVJ19DECL17	Advanced Communication Systems Lab	ECE	0	2	2	3	50	50	100	2
				Total	14	12	4	21	350	350	700	22
Note: BSC: Basic Science, PCC: Professional Core Course												

II SEMESTER M.TECH- (Digital Electronics & Communication)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	PCC	MVJ19DEC21	Advanced Communication Networks	ECE	3	2	0	3	50	50	100	4
2	PCC	MVJ19DEC22	Antenna Theory and Design	ECE	3	2	0	3	50	50	100	4
3	PCC	MVJ19DEC23	Error control and coding	ECE	3	2	0	3	50	50	100	4
4	PE	MVJ19DEC24X	Professional Elective 1	ECE	3	2	0	3	50	50	100	4
5	PE	MVJ19DEC25X	Professional Elective 2	ECE	3	2	0	3	50	50	100	4
6	PCC	MVJ19DECL26	Advanced Embedded System Lab	ECE	0	2	2	3	50	50	100	2
7	Sem	MVJ19DEC27	Technical Seminar	ECE	0	0	4	-	100	-	100	2
				Total	15	12	6	18	400	300	700	24
Note: PCC: Professional Core Course, PE: Professional Elective , Sem : Seminar												

S No	Professional Elective 1	Course Title	S No	Professional Elective 2	Course Title
1	MVJ19DEC241	Wireless Sensor Networks	1	MVJ19DEC251	Cryptography and Network Security
2	MVJ19DEC242	Nano electronics	2	MVJ19DEC252	Statistical Signal Processing
3	MVJ19DEC243	Micro Electro Mechanical Systems	3	MVJ19DEC253	Multimedia Over Communication links

III SEMESTER M.TECH- (Digital Electronics & Communication)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	PCC	MVJ19DEC31	LTE 4G Broadband	ECE	3	2	0	3	50	50	100	4
2	PE	MVJ19DEC32X	Professional Elective 3	ECE	3	0	0	3	50	50	100	3
3	OE	MVJ19DEC33X	Open Elective	ECE	3	0	0	3	50	50	100	3
4	Proj	MVJ19DECP34	Minor Project	ECE	0	0	4	3	50	50	100	2
5	Proj	MVJ19DECP35	Major Project Phase-1	ECE	0	0	4	3	100	-	100	2
6	Int	MVJ19DECI36	Internship	ECE	-	-	-	3	50	50	100	7
				Total	9	2	8	18	350	250	600	21
Note: PCC: Professional Core Course, PE: Professional Elective , OE :Open Elective Proj: Project Work, Int : Internship												

S No	Professional Elective 3	Course Title	S No	Open Elective	Course Title
1	MVJ19DEC321	Advances in Image Processing	1	MVJ19DEC331	Real Time Systems
2	MVJ19DEC322	Array Signal Processing	2	MVJ19DEC332	Pattern Recognition & Machine Learning
3	MVJ19DEC323	RF and Microwave Circuit Design	3	MVJ19DEC333	IoT

IV SEMESTER M.TECH- (Digital Electronics & Communication)

S No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	Proj	MVJ1DECP41	Major Project Phase-2	ECE	-	-	6	3	50	50	100	19
				Total			6	3	50	50	100	19
Note: Proj : Project work												

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Course Code	MVJ19DEC11	Course Title	APPLIED MATHEMATICS FOR ELECTTRONICS ENGINEERS	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- To learn principles of advanced engineering mathematics through linear algebra and calculus of variations.
- To understand probability theory and random process that serve as an essential tool for applications of electronics and communication engineering sciences.

Module-1	15Hrs

Linear Algebra-I:- Introduction to vector spaces and sub-spaces, definitions, illustrative examples and simple problems. Linearly independent and dependent vectors-definition and problems. Basis vectors, dimension of a vector space. Linear transformations- definition, properties and problems. Rank Nullity theorem (without proof). Matrix form of linear transformations-Illustrative examples.(Text Book:1).

Module-2	15Hrs

Linear Algebra-II:- Computation of Eigen values and Eigen vectors of real symmetric matrices-Given's method. Orthogonal vectors and orthogonal bases. Gram-Schmidt orthogonalization process. QR decomposition, singular value decomposition, least square approximations.(Text Book:1).

Module-3	15Hrs

Calculus of Variations:- Concept of functional-Eulers equation. functional dependent on first and higher order derivatives, functional on several dependent variables. Isoperimetric problems-variation problems with moving boundaries.(Text Book:1).

Module-4	15Hrs

Probability Theory:- Review of basic probability theory. Definitions of random variables and probability distributions, probability mass and density functions, expectation, moments, central moments, characteristic functions, probability generating and moment generating functions-illustrations. Binomial, Poisson, Exponential, Gaussian and Rayleigh distributions-examples.(Text Book: 3)

Module-5	15Hrs
Engineering Applications on Random processes:- Classification. Stationary, WSS and ergodic random process. Auto correlation function-properties, Gaussian random process.(Text Book: 3**)**	
Course outcomes:	
CO1	Understand vector spaces, basis, linear transformations and the process of obtaining matrix of linear transformations arising in magnification and rotation of images.
CO2	Apply the technique of singular value decomposition for data compression, least square approximation in solving inconsistent linear systems
CO3	Utilize the concepts of functional and their variations in the applications of communication systems, decision theory, synthesis and optimization of digital circuits.
CO4	Learn the idea of random variables (discrete/continuous) and probability distributions in analyzing the probability models arising in control systems and system communications
CO5	Analyze random process through parameter-dependent variables in various random processes
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	David C.Lay, Steven R. Lay and J.J.McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.
2.	E. Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley, 2015.
3.	Scott L.Miller, DonaldG. Childers: “Probability and Random Process with application to Signal Processing”, Elsevier Academic Press, 2nd Edition, 2013.
4.	Richard Bronson: “Schaum’s Outlines of Theory and Problems of Matrix Operations”, McGraw-Hill, 1988.
5.	Elsgolts, L.:”Differential Equations and Calculus of Variations”, MIR Publications, 3rd Edition, 1977.
6.	T.Veerarajan: “Probability, Statistics and Random Process“, 3rd Edition, Tata McGraw Hill Co.,2008.
7.	http://nptel.ac.in/courses.php?disciplineId=111

8.	http://www.class-central.com/subject/math(MOOCs)
9.	http://ocw.mit.edu/courses/mathematics/

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Course Code	MVJ19DEC12	Course Title	ADVANCED DIGITAL SIGNAL PROCESSING	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- The student comprehends mathematical description and modeling of discrete time random signals
- Estimate the various spectral components present in the received signal using different spectral estimation methods such as Parametric and Non parametric.
- Design and implement an optimum adaptive filter using LMS and RLS algorithms.
- Understand the concepts and mathematical representations of Wavelet transforms.

Module-1	15Hrs

DISCRETE RANDOM SIGNAL PROCESSING: Wide sense stationary process – Ergodic process – Mean – Variance - Auto-correlation and Auto- correlation matrix - Properties - Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem–Finite Data records, Simulation of uniformly distributed/Gaussian distributed white noise – Simulation of Sine wave mixed with Additive White Gaussian Noise.

Chapter 2(Text Book1)

Activity: Generate various Discrete random signals usingMATLAB

Module-2	15Hrs

Power Spectrum Estimation: Non parametric Methods for Power Spectrum Estimation - Bartlett Method, Welch Method, Blackman and Tukey Methods. Parametric Methods for Power Spectrum Estimation: Relationship between the auto correlation and the model parameters, Burg Method for the AR Model parameters.

Chapter 12(Text Book1)

Activity: Compute the power spectrum using the Spectrum Analyzer

Module-3	15Hrs
ADAPTIVE FILTERS: Recursive estimators - Kalman filter - Linear prediction – Forward prediction and Backward prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations. Text Book1 **Activity: Identify the coefficients of an unknown system using an adaptive filter**	
Module-4	15Hrs
MULTIRATE DIGITAL SIGNAL PROCESSING: FIR Adaptive filters - Newton's steepest descent method -Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization - Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS – Sliding window RLS - Simplified IIR LMS Adaptive filter. Chapter 10(Text Book 1) **Activity:** Perform Down sampling and Up sampling using MATLAB	
Module-5	15Hrs
WAVELET TRANSFORMS: The Age of Wavelets, The origin of Wavelets, Wavelets and other reality transforms, History of wavelets, Wavelets of the future. Continuous Wavelet and Short Time Fourier Transform: Wavelet Transform, Mathematical preliminaries, Properties of wavelets. Discrete Wavelet Transform: Haar scaling functions, Haar wavelet function. Chapters 1, 3 & 4 (Text Book 3) **Activity: Perform continuous Wavelet Analysis**	
Course outcomes:	
CO1	Understand various discrete random signals.
CO2	Understand Spectral Estimation Concepts..
CO3	Implement adaptive signal processing algorithm.
CO4	Understand advanced signal processing techniques, including multi-rate processing and time-frequency analysis techniques.
CO5	Understand the concepts of Wavelet Transforms.
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	JohnG. Proakis, Dimitris G.Manolakis,"Digital Signal Processing, Principles, Algorithms and Applications", Third edition, Pearson-2007.
2.	K.P Soman, Ramachandran ,, Resmi .N"Insight into Wavelets- from Theory to Practice", - PHI Third Edition-2010
3.	Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.
4.	S. Kay," Modern spectrum Estimation theory and application", Prentice Hall, Englehood Cliffs, NJ1988
5.	https://nptel.ac.in/courses/108105055/
6.	.http://www.nptelvideos.in/2012/12/advanced-digital-signal-processing.html

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Course Code	MVJ19DEC13	Course Title	ADVANCED COMMUNICATION SYSTEM	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- To learn digital modulation techniques, power spectra and ISI.
- To understand Communication through band limited linear filter channels an synchronization.
- To study Spread spectrum digital communication.
- To learn fading multipath channels in digital communication.
- To model MIMO systems.

Module-1	15Hrs

Digital modulation techniques: Digital modulation formats, Coherent binary modulation techniques, Coherent quadrature – modulation techniques, Non-coherent binary modulation techniques, Comparison of binary and quaternary modulation techniques, M-ray modulation techniques, Power spectra, Bandwidth efficiency, M-array modulation formats viewed in the light of the channel capacity theorem, Effect of inter symbol interference, Bit verses symbol error probabilities,

Synchronization, Applications. Chapter 7(Text Book2) **Activity: Perform DPSK and QPSK**	
Module-2	15Hrs
Communication through band limited linear filter channels: Optimum receiver for channel with ISI and AWGN, Linear equalization, Decision - feedback equalization, Reduced complexity ML detectors, Iterative equalization and decoding - Turbo equalization. Adaptive equalization Chapter 10(Text Book1) **Activity**: **Generate AWGN noise Using MATLAB**	
Module-3	15Hrs
Spread spectrum signals for digital communication: Model of spread spectrum digital communication system, Direct sequence spread spectrum signals, Frequency hopped spread spectrum signals, CDMA, Time hopping SS, Synchronization of SS systems. Chapter 13(Text Book1) **Activity:Analyse Spread Spectrum in MATLAB**	
Module-4	15Hrs
Digital communication through fading multipath channels: Characterization of fading multipath channels, the effect of signal characteristics on the choice of a channel model, Frequency non selective, Slowly fading channel, Diversity techniques for fading multipath channels, Digital signals over a frequency selective, Slowly fading channel, Coded wave forms for fading channels, Multiple antenna systems. Chapter 14(Text Book1) **Activity: Simulate Multipath fading Channels**	
Module-5	15Hrs
MIMO spatial multiplexing and channel modeling: Multiplexing capability of deterministic MIMO channels, Physical modeling of MIMO channels, Modeling of MIMO fading channels. Chapter 7 (Text Book3) **Activity: Learn MIMO Toolbox using MATLAB.**	
Course outcomes:	
CO1	Understand the fundamentals as well as advanced concepts in digital communications.
CO2	Design the signals for band limited channels and its characteristics.
CO3	Understand different spread spectrum signals and its synchronization.
CO4	Understand the characteristics about Multipath fading channels

CO5	Develop and evaluate the performance of MIMO scheme to meet specified rate in a given multipath environment.
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	John G. Proakis and MasoudSalehi, "Digital Communications", Tata McGraw-Hill, 4th Edition, 2014
2.	Simon Haykin, "Digital Communications", John Wiley India Pvt., Ltd, 2008
3.	David Tse, PramodViswanath, "Fundamentals of Wireless Communication",1e,Cambridge University Press(2005), ISBN:0521845270
4.	Sam Shanmugam, —Digital and Analog Communication Systems‖, John Wiley India Pvt. Ltd., 2012.
5.	Simon Haykin, —An introduction to Analog and Digital Communication‖, John Wiley India Pvt. Ltd., 2006.
6.	.https://nptel.ac.in/courses/117105144/
7.	https://nptel.ac.in/courses/108102096/
8.	http://www.nptelvideos.in/2012/12/digital-communication.html

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Course Code	MVJ19DEC14	Course Title	ADVANCED EMBEDDED SYSTEM	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Understand the basic hardware components and their selection method based on the characteristics and attributes of an embedded system
- Describe the hardware software co-design and firmware design approaches.
- Explain the architectural features of ARM CORTEX M3, a 32 bit micro controller including

memory map, interrupts and exceptions

- Program ARM CORTEX M3 using the various instructions, for different applications

Module-1	15Hrs

Embedded System: Embedded vs General computing system, classification, application and purpose of ES. Core of an Embedded System, Memory, Sensors, Actuators, LED, Opto coupler, Communication Interface, Reset circuits, RTC, WDT, Characteristics and Quality Attributes of Embedded Systems .

Text Book1: Selected Topics from Chapter -1, 2, 3.

Activity: Perform 8 Bit LED and Switch Interface

Module-2	15Hrs

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

Text Book1: Selected Topics From Chapter-7, 9, 12, 13.

Activity: Simulate basic programs in embedded system development environment (IDE)

Module-3	15Hrs

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

Text Book2: Chapter 1, 2, 3

Activity: Interrupt performance characteristics of ARM

Module-4	15Hrs

Instruction Sets: Assembly basics, Instruction list and description, useful instructions, Memory Systems, Memory maps, Cortex M3 implementation overview, pipeline and bus interface.

Text Book2: Chapter-4, 5, 6.

Activity: Interface EPROM with ARM controller

Module-5	15Hrs

Exceptions, Nested Vector interrupt controller design, Systick Timer, Cortex-M3 Programming using assembly and C language, CMSIS (Text Book2: Chapter-7, 8, 10).

Activity: Simple Assembly Language program for Addition, Subtraction using ARM

Course outcomes:

CO1	Understand the basic hardware components and their selection method based on the

	characteristics and attributes of an embedded system.
CO2	Explain the hardware software co-design and firmware design approaches.
CO3	Acquire the knowledge of the architectural features of ARM CORTEX M3, a 32 bit microcontroller including memory map, interrupts and exceptions.
CO4	Apply the knowledge gained for Programming ARM CORTEX M3 for different applications.
CO5	Understand the concepts of interrupts and Exception
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	K. V. Shibu, "Introduction to embedded systems", TMH education Pvt. Ltd. 2009.
2.	Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, 2nd edn, Newnes, (Elsevier), 2010.
3.	James K. Peckol, "Embedded systems- A contemporary design tool", John Wiley, 2008.
4.	Rajkamal, ‘Embedded system-Architecture, Programming, Design’, TMH,2011.
5.	https://nptel.ac.in/courses/108102045/
6.	http://www.nptelvideos.in/2012/11/embedded-systems.html
7.	https://nptel.ac.in/courses/106105159/

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Course Code	MVJ19IPR15	Course Title	RESEARCH METODOLOGY AND IPR	
Contact Hours	30	L : T : P :: 30 : 0 : 0	Credits	02

Course objective is to:

- To give an overview of the research methodology and explain the technique of defining a

research problem.

- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.

Module-1	6 Hrs

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India.

Module-2	6 Hrs

Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed

Module-3	6 Hrs

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. Design of Sample Surveys: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Module-4	6 Hrs

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout Interpretation and Report Writing (continued): of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Module-5	6 Hrs
Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, CopyrightAct,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO.	
Course outcomes:	
CO1	Discuss research methodology and the technique of defining a research problem.
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review.
CO3	Explain various research designs and their characteristics.
CO4	Explain the art of interpretation and the art of writing research reports.
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"
2.	Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

3.	Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
4.	Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
5.	Mayall, “Industrial Design”, McGraw Hill, 1992. Niebel, “Product Design”, McGraw Hill, 1974.
6.	Asimov, “Introduction to Design”, Prentice Hall, 1962.
7.	https://nptel.ac.in/courses/110105139/
8.	https://nptel.ac.in/courses/109105112/
9.	https://www.cipil.law.cam.ac.uk/annual-international-intellectual-property-lecture

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Course Code	MVJ19DECL16	Course Title	ADVANCED DIGITAL SIGNAL PROCESSING LAB	
Contact Hours		L : T : P :: 0 :30 : 30	Credits	02

Course objective is to:

- This laboratory course enables students to get practical Experience in Digital Signal processing, analysis and realization of LTI systems.

Laboratory Sessions

1. Generate various fundamental discrete time signals.
2. Basic operations on signals (Multiplication, Folding, Scaling).
3. Find out the DFT & IDFT of a given sequence without using inbuilt instructions.
4. Interpolation & decimation of a given sequence.
5. Experimental Verification of Diode Characteristics in A) Forward Bias B) Reverse Bias.
6. Generation of DTMF (Dual Tone Multiple Frequency) signals.
7. Estimate the PSD of a noisy signal using periodogram and modified periodogram .
8. Estimation Of PSD using different methods (Bartlett, Welch, Blackman-Tukey)
9. Design of Chebychev Type I,II Filters.
10. Cascade Digital IIR Filter Realization.
11. Parallel Realization of IIR filter
12. Estimation of power spectrum using parametric methods (yule-walker & burg)
13. Design of LPC filters using Labour-intensive algorithm.
14. Time-Frequency Analysis with the Continuous Wavelet Transform
15. Signal Reconstruction from Continuous Wavelet Transform Coefficients.

Course outcomes:

On the completion of this laboratory course, the students will be able to have hands on experience on,

CO1	Design of various Filter
CO2	Realization of various Filter

CO3	Signal Manipulations.
CO4	Analysis and reconstruction of Wavelet Transforms

Conduct of Practical Examination:

All laboratory experiments are to be included for practical examination. Students are allowed to pick one experiment from the lot.

Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.

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Course Code	MVJ19DECL17	Course Title	ADVANCED COMMUNICATION LAB	
Contact Hours	30	L : T : P :: 0 : 30 : 30	Credits	02

Course objective is to:

1. Radiation pattern of antennas.
2. Determining gain and directivity of a given antenna.
3. Working of Klystron source.
4. S-parameters of some microwave passive devices.

Laboratory Sessions

1. Matlab/C implementation to obtain the radiation pattern of an antenna..
2. Study of radiation pattern of different antennas.
3. Determine the directivity and gains of Horn/ Yagi/ dipole/ Parabolic antennas.
4. Impedance measurements of Horn/Yagi/dipole/Parabolic antennas.
5. Study of radiation pattern of E& H plane horns.
6. Significance of Pocklington's integral equation.
7. Study of digital modulation techniques using CD4051 IC.
8. Conduct an experiment for Voice and data multiplexing using optical fiber.
9. Determination of the modes transit time, electronic timing range and sensitivity of Klystron source.

10. Determination of VI characteristics of GUNN diode, and measurement of guide wave length, frequency.
11. Determination of coupling coefficient and insertion loss of directional couplers and Magic tee.
12. Design of LPC filter using Levinson-Durbin algorithm.
13. Build a hardware pseudo-random signal source and determine statistics of the generated signal source.

Course outcomes:

On the completion of this laboratory course, the students will be able to have hands on experience on,.

CO1	Plot the radiation pattern of some antennas using Matlab and wave guide setup.
CO2	Obtain the S-parameters of Magic tee and directional couplers.
CO3	Test the IC CD4051 for modulation techniques.

Conduct of Practical Examination:

All laboratory experiments are to be included for practical examination. Students are allowed to pick one experiment from the lot.

Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.

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Course Code	MVJ19DEC21	Course Title	Advanced Communication Networks	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Develop an awareness towards current practice in Networking
- Learn various aspects involved in wireless networks
- Develop an awareness regarding the Packet Processing ,Routing issues in computer networks
- Understand some of the shortest path routing protocols
- Develop an awareness towards the network control and traffic management

- Understand the congestion control and flow control mechanisms

Module-1	15 Hrs
Functional Elements and Current Practice in Networking: Networking as Resource Sharing, Analogy with the Operating System of a Computer, The Functional Elements: Multiplexing, Switching, Routing, Network Management,Traffic Controls and Timescales, Current Practice: Network Infrastructure,Networking Architectures, Telephone and ISDN Networks, X.25 and Frame Relay Networks, The Internet, Asynchronous Transfer Mode (ATM) Networks. (Text 1)	
Module-2	15 Hrs
Wireless Networks: Bits over a Wireless Network, TCP Performance over Wireless Links, Adaptive and Cross-Layer Techniques, Random Access: Aloha,S-Aloha, and CSMA/CA, Wireless Local Area Networks, Wireless Ad Hoc Networks, Link Scheduling and Network Capacity, Scheduling Constraints,Centralized Scheduling, Capacity of a WANET, Wireless Sensor Networks: An Overview.(Text 1)	
Module-3	15 Hrs
Packet Processing: Addressing and Address Lookup, Addressing, Addressing in IP Networks: Subnets and Classless Inter domain Routing, Efficient Longest Prefix Matching: Level-Compressed Tries, Hardware-Based Solutions, Packet Classification Routing: Engineering Issues, Shortest Path Routing of Elastic Aggregates,Elastic Aggregates and Traffic Engineering, Optimal Routing, Algorithms for Shortest Path Routing: Dijkstra’s Algorithm, The Bellman–Ford Algorithm, Routing Protocols, Distance Vector Protocols, Link State Protocols.(Text 1)	
Module-4	15 Hrs
Traffic Management: Introduction, framework for traffic management, traffic models, traffic classes, traffic scheduling (Text 3). Control of Networks: Objectives and methods of control, routing optimization in circuit and datagram networks, Queuing models in circuit and datagramnetworks (Text 2).	
Module-5	15 Hrs
Congestion and flow control: Congestion control ,Window congestion control, Rate congestion control, control problems in ATM Networks (Text 2),flow control model, flow control classification, open loop flow control, closed loop flow control (Text 3).	
Course outcomes:	
CO1	Choose appropriate Network Infrastructure and Networking Architectures which suits

	current practice in networking
CO2	Identify the suitable random access methods which suits wireless networks
CO3	Identify IP configuration for the network with suitable routing mechanisms.
CO4	Analyze and develop various network traffic management and control techniques.
CO5	Analyze and develop various congestion and flow control
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	Anurag Kumar, D. Manjunath, Joy Kuri, "Communication Networking : An Analytical Approach", Morgan Kaufmann publications, ISBN: 0-12-428751-4, 2004.
2.	J. Walrand and P. Varaya, "High performance communication networks", Harcourt Asia (Morgan Kaufmann), 2000.
3.	S. Keshav "An Engineering Appproach to Computer Networking", Pearson Education, ISBN: 978-81-317-1145-3, 2011.
4.	S. Keshav, "An Engineering approach to Computer Networking", Pearson Reference Book: Education, 1997.
5.	Andrew S Tanenbaum , "Computer Networks", 4th edition , Pearson Education

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Course Code	MVJ19DEC22	Course Title	ANTENNA THEORY AND DESIGN	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Introduce and discuss different types of Antennas, various terminologies,excitations.
- Study different types of Arrays, Pattern-multiplication, Feeding techniques.
- Calculate gain of aperture antennas, Reflector antennas and analyze general feed model.

- Define, describe, and illustrate principle behind antenna synthesis.
- Introduction of Method of moments, Pocklington’ s integral equation, Source modelling.

Module-1	15 Hrs

Antenna Fundamentals and Definitions: Radiation Mechanisms, Overview, EM Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole,Radiation patterns, Directivity and Gain, Antenna impedance, Radiation efficiency,Antenna polarization.

Module-2	15 Hrs

Arrays: Array factor for linear arrays, Uniformly excited equally spaced linear arrays, Pattern multiplication, Directivity of linear arrays, Nonuniformly excited equally spaced linear arrays, Mutual coupling.Antenna Synthesis: Formulation of the synthesis problem, Synthesis principles, Line sources shaped beam synthesis, Linear array shaped beam synthesis, Fourier series, Woodward - Lawson sampling method,Comparison of shaped beam synthesis methods, low side lobe narrow main beam synthesis methods, Dolph Chebyshev linear array, Taylor line source method

Module-3	15 Hrs

Resonant Antennas: Wires and Patches, Dipole antenna, Yagi-Uda antennas, Micro-strip antenna.
Broadband antennas: Traveling wave antennas Helical antennas,Biconical antennas, Sleeve antennas, and Principles of frequency independent antennas, Spiral antennas, and Log - periodic antennas.

Module-4	15 Hrs

Aperture antennas: Techniques for evaluating gain, Reflector antennas-Parabolic reflector antenna principles, Axi-symmetric parabolic reflector antenna, Offset parabolic reflectors, Dual reflector antennas, Gain calculations for reflector antennas, Feed antennas for reflectors, Field representations, Matching the feed to the reflector, General feed model,Feed antennas used in practice.

Module-5	15 Hrs

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

Course outcomes:

CO1	Classify different types of antennas
CO2	Define and illustrate various types of array antennas
CO3	Design antennas like Yagi-Uda, Helical antennas and other broad band antennas
CO4	Describe different antenna synthesis methods

CO5	Apply methods like MOM
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	Stutzman and Thiele, "Antenna Theory and Design", 2nd Edition, John Wiley, 2010.
2.	C. A. Balanis, "Antenna Theory Analysis and Design", John Wiley, 2nd Edition 2007.
3.	J. D. Krauss, "Antennas and Wave Propagation", McGraw Hill TMH, 4th Edition, 2010.
4.	A.R.Harish, M.Sachidanada, "Antennas and propagation", Pearson Education, 2015. 27

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Course Code	MVJ19DEC23	Course Title	ERROR CONTROL CODING	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

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

Module-1	15 Hrs
Information theory: Introduction, Entropy, Source coding theorem, discrete memoryless channel, Mutual Information, Channel Capacity Channel coding theorem.(Chap. 5 of Text 1)	

Introduction to algebra: Groups, Fields, binary field arithmetic,Construction of Galois Fields GF (2m) and its properties, (Only statements of theorems without proof) Computation using Galois filed GF (2m) arithmetic, Vector spaces and Matrices.(Chap. 2 of Text 2)	
Module-2	15 Hrs
Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, Single Parity Check Codes (SPC),Repetition codes, Self dual codes, Hamming codes, Reed-Muller codes. Product codes and Interleaved codes. (Chap. 3 of Text 2)	
Module-3	15 Hrs
Cyclic codes: Introduction, Generator and parity check polynomials,Encoding of cyclic codes, Syndrome computing and error detection,Decoding of cyclic codes, Error trapping Decoding, Cyclic hamming codes, Shortened cyclic codes.(Chap. 4 of Text2)	
Module-4	15 Hrs
BCH codes: Binary primitive BCH codes, Decoding procedures,Implementation of Galois field arithmetic. (Chap. 6 (6.1,6.2,6.7) of Text 2 Primitive BCH codes over GF (q), Reed -Solomon codes. (Chap. 7 (7.2,7.3) of Text 2) Majority Logic decodable codes: One -step majority logic decoding,Multiple-step majority logic. (Chap. 8 (8.1,8.4) of Text 2)	
Module-5	15 Hrs
Convolution codes: Encoding of convolutional codes: Systematic and Nonsystematic Convolutional Codes, Feedforward encoder inverse, A catastrophic encoder, Structural properties of convolutional codes:state diagram, state table, state transition table, tree diagram, trellis diagram.Viterbi algorithm, Sequential decoding: Log Likelihood Metric for Sequential Decoding.(11.1,11.2, 12.1,13.1 of Text 2)	
Course outcomes:	
CO1	Analyse a discrete memoryless channel, given the source and transition probabilities.
CO2	Apply the concept of modern linear algebra for the error control coding technique
CO3	Construct and Implement efficient LBC, Cyclic codes etc encoder and decoders.
CO4	Apply decoding algorithms for efficient decoding of Block codes
CO5	Apply decoding algorithms for efficient decoding of Convolutional codes
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	David C.Lay, Steven R.Lay and J.J.McDonald: “LinearAlgebra and its Applications”,5th Edition, Pearson Education Ltd., 2015
2.	Elsgolts, L.:” Differential Equations and Calculus of Variations”, MIR Publications, 3rd Edition, 1977.
3.	T.Veerarajan: “Probability, Statistics and Random Process “,3rd Edition,Tata Mc-Graw Hill Co.,2016.
4.	Gilbert Strang: Introduction to Linear Algebra, 5thEdition, Wellesley-Cambridge Press., 2016
5.	Richard Bronson: “Schaum’ s Outlines of Theory and Problems of Matrix Operations”, McGraw-Hill, 1988.
6.	Scott L.Miller,DonaldG.Childers: “Probability and Random Process with application to Signal Processing”, Elsevier Academic Press,2nd Edition,2013.
7.	E. Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley,2015.

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Course Code	MVJ19DEC241	Course Title	Wireless Sensor Networks	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Design wireless sensor network system for different applications under consideration.
- Understand the hardware details of different types of sensors and select right type of sensor for various applications.
- Understand radio standards and communication protocols to be used for wireless sensor.

Module-1	15 Hrs

Introduction: Sensor Mote Platforms, WSN Architecture and Protocol Stack (Chap. 1Text 1)
WSN Applications:Military Applications, Environmental Applications, Health Applications, Home Applications, Industrial Applications, (Chap. 2 Text 1)

Module-2	15 Hrs

Factors Influencing WSN Design: Hardware Constraints Fault Tolerance Scalability Production Costs WSN Topology, Transmission Media,Power Consumption, (Chap. 3 Text 1)

Physical Layer: Physical Layer Technologies, Overview of RF Wireless Communication, Channel Coding (Error Control Coding),Modulation, Wireless Channel Effects, PHY Layer Standards (Chap. 4 of Text 1)

Module-3	15 Hrs

Medium Access Control: Challenges for MAC , CSMA Mechanism,Contention-Based Medium Access, Reservation-Based Medium Access, Hybrid Medium Access(Chap. 5 of Text 1)

Network Layer: Challenges for Routing, Data-centric and Flat-Architecture Protocols, Hierarchical Protocols, Geographical Routing Protocols (Chap. 7 of Text 1)

Module-4	15 Hrs

Transport Layer: Challenges for Transport Layer, Reliable Multi-Segment Transport (RMST) Protocol, Pump Slowly, Fetch Quickly (PSFQ) Protocol, Congestion Detection and Avoidance (CODA) Protocol , Event-to-Sink Reliable Transport (ESRT) Protocol,GARUDA (Chap. 8 Text 1)

Application Layer: Source Coding (Data Compression), Query Processing, Network Management (Chap. 9 Text 1)

Module-5	15 Hrs

Time Synchronization: Challenges for Time Synchronization ,Network Time Protocol, Timing-Sync Protocol for Sensor Networks(TPSN), Reference-Broadcast Synchronization (RBS),Adaptive Clock Synchronization (ACS)(Chap. 11 of Text1)

Localization; Challenges in Localization, Ranging Techniques, Range-Based Localization Protocols, Range-Free Localization Protocols.(Chap. 12 Text 1)

Course outcomes:

CO1	Acquire knowledge of characteristics of mobile/wireless communication Channels.
CO2	Apply statistical models of multipath fading
CO3	Understand the multiple radio access techniques
CO4	Understand various protocols and process involved in Transport Layer.
CO5	Analyse synchronisation and localization

Question paper pattern

Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions

Reference Books:

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

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Course Code	MVJ19DEC242	Course Title	NANOELECTRONICS	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Enhance basic engineering science and technological knowledge of nanoelectronics.
- Explain basics of top-down and bottom-up fabrication process, devices and systems.
- Describe technologies involved in modern day electronic devices.
- Appreciate the complexities in scaling down the electronic devices in the future.

Module-1	15 Hrs

Introd uction: Overview of nanoscience and engineering.Development milestones in microfabrication and electronic industry. Moores' law and continued miniaturization, Classification of anostructures, Electronic properties of atoms and solids:Isolated atom, Bonding between atoms, Giant molecular solids,Free electron models and energy bands, crystalline solids,Periodicity of crystal lattices, Electronic conduction, effects of nanometer length scale, Fabrication methods: Top down processes, Bottom up processes methods for templating the growth of nanomaterials, ordering of nanosystems (Text 1).

Module-2	15 Hrs

Characterization: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk and surface diffraction techniques,spectroscopy techniques: photon,radiofrequency, electron, surface analysis and dept profiling:electron, mass, Ion beam, Reflectrometry, Techniques for property measurement: mechanical, electron, magnetic, thermal properties(Text1)

Module-3	15 Hrs
Inorganic semiconductor nanostructures: overview of semiconductor physics. Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super-lattices, band offsets, electronic density of states (Text1). Carbon Nanostructures:Carbon molecules, Carbon Clusters, Carbon Nanotubes, application of Carbon Nanotubes (Text 2).	
Module-4	15 Hrs
Fabrication techniques: Requirements of ideal semiconductor,epitaxial growth of quantum wells, lithography and etching, cleavededge over growth, growth of vicinal substrates, strain induced dots and wires, electrostatically induced dots and wires, Quantum well width fluctuations, thermally annealed quantum wells, semiconductor nanocrystals, collidal quantum dots, self-assembly echniques. Physical processes: modulation doping, quantum hall effect,resonant tunneling, charging effects, ballistic carrier transport, Inter band absorption, intra band absorption, Light emission processes, phonon bottleneck, quantum confined stark effect, nonlinear effects,coherence and dephasing, characterization of semiconductor nanostructures: optical electrical and structural (Text1).	
Module-5	15 Hrs
Methods of measuring properties: atomic, crystollography, microscopy, spectroscopy (Text 2). Applications: Injection lasers, quantum cascade lasers, singlephoton sources, biological tagging, optical memories, coulomb blockade devices, photonic structures, QWIP’ s, NEMS, MEMS (Text1).	
Course outcomes:	
CO1	Know the principles behind Nanoscience engineering and Nanoelectronics.
CO2	Apply the knowledge to prepare and characterize nanomaterials.
CO3	Know the effect of particles size on mechanical, thermal, optical and electrical properties of nanomaterials.
CO4	Design the process flow required to fabricate state of the art transistor technology.
CO5	Analyze the requirements for new materials and device structure in the future technologies
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:

1.	Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, “Nanoscale Science and Technology”, John Wiley, 2007.
2.	Charles P Poole, Jr, Frank J Owens, “Introduction to Nanotechnology”, John Wiley, Copyright 2006, Reprint 2011.
3.	Ed William A Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J Iafrate, “Hand Book of Nanoscience Engineering and Technology”, CRC press,2003.

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Course Code	MVJ19DEC243	Course Title	MICRO ELECTRO MECHANICAL SYSTEMS	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Know an overview of microsystems, their fabrication and application areas.
- Teach working principles of several MEMS devices.
- Develop mathematical and analytical models of MEMS devices
- Know methods to fabricate MEMS devices
- Expose the students to various application areas where MEMS devices can be used

Module-1	15 Hrs

Overview of MEMS and Microsystems:MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.

Module-2	15 Hrs

Working Principles of Microsystems:Introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics.Engineering Science for Microsystems Design and Fabrication: Introduction, Atomic Structure of Matters, Ions and Ionization,Molecular Theory of Matter and Inter-molecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics,Electrochemistry.

Module-3	15 Hrs

Engineering Mechanics for Microsystems Design:Introduction, Static Bending of Thin Plates,

Mechanical Vibration,Thermomechanics, Fracture Mechanics, Thin Film Mechanics, Overview on Finite Element Stress Analysis.	
Module-4	15 Hrs
Scaling Laws in Miniaturization: Introduction, Scaling in Geometry, Scaling in Rigid-Body Dynamics, Scaling in Electrostatic Forces, Scaling of Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer.	
Module-5	15 Hrs
Overview of Micro-manufacturing:Introduction, Bulk Micro-manufacturing, Surface Micromachining, The LIGA Process, Summary on Micromanufacturing. Microsystem Design: Introduction, Design Considerations, Process Design, Mechanical Design, Using Finite Element Method.	
Course outcomes:	
CO1	Understand the technologies related to Micro Electro Mechanical Systems.
CO2	Describe the design and fabrication processes involved with MEMS devices.
CO3	Analyse the MEMS devices and develop suitable mathematical models
CO4	Understand the various application areas for MEMS devices
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	Tai-Ran Hsu, MEMS and Micro systems: Design, Manufacture and Nanoscale Engineering, 2nd Ed, John Wiley & Sons, 2008. ISBN: 978-0-470-08301-7
2.	Hans H. Gatzen, Volker Saile, JurgLeuthold, Micro and Nano Fabrication: Tools and Processes, Springer, 2015.
3.	Dilip Kumar Bhattacharya, Brajesh Kumar Kaushik, Micro electromechanical Systems (MEMS), Cenage Learning.

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Course Code	MVJ19DEC251	Course Title	CRYPTOGRAPHY AND NETWORK SECURITY	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Understand the basics of symmetric key and public key cryptography.
- Understand some basic mathematical concepts and pseudorandom number generators required for cryptography.
- Authenticate and protect the encrypted data.
- Enrich knowledge about Email, IP and Web security.

Module-1	15 Hrs

Foundations: Terminology, Steganography, substitution ciphers and transpositions ciphers, Simple XOR, One-Time Pads,Computer Algorithms (Text 2: Chapter 1: Section 1.1 to 1.6)

SYMMETRIC CIPHERS: Traditional Block Cipher structure, Data encryption standard (DES), The AES Cipher. (Text 1: Chapter 2:Section2.1, 2.2, Chapter 4)

Module-2	15 Hrs

Introduction to modular arithmetic, Prime Numbers, Fermat's and Euler's theorem, primality testing, Chinese Remainder theorem, discrete logarithm. (Text 1: Chapter 7: Section 1, 2, 3, 4,5)

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

Module-3	15 Hrs

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

Module-4	15 Hrs

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

Discrete Logarithm Signature Scheme (Text 2: Chapter 18: Section 18.1 to 18.5, 18.7, 18.11 to 18.14 and Chapter 20: Section 20.1, 20.4)	
Module-5	15 Hrs
E-mail Security: Pretty Good Privacy-S/MIME (Text 1: Chapter 17: Section 17.1, 17.2). **IP Security:** IP Security Overview, IP Security Policy,Encapsulation Security Payload (ESP), Combining security Associations. (Text 1: Chapter 18: Section 18.1 to 18.4). **Web Security:** Web Security Considerations, SSL (Text 1: Chapter 15: Section 15.1, 15.2). 1.	

Course outcomes:	
CO1	Use basic cryptographic algorithms to encrypt the data.
CO2	Generate some pseudorandom numbers required for cryptographic applications.
CO3	Provide authentication and protection for encrypted data.
CO4	Understand various algorithms required for cryptographic
CO5	Understand authenticate and Protect data

Question paper pattern
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions

Reference Books:	
1.	William Stallings , “Cryptography and Network Security Principles and Practice”, Pearson Education Inc., 6th Edition, 2014, ISBN: 978-93-325-1877-3
2.	Bruce Schneier, “Applied Cryptography Protocols, Algorithms, and Source code in C”, Wiley Publications, 2nd Edition, ISBN: 9971-51-348-X
3.	Cryptography and Network Security, Behrouz A. Forouzan, TMH,2007.
4.	Cryptography and Network Security, Atul Kahate, TMH, 2003.

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Course Code	MVJ19DEC252	Course Title	Statistical Signal Processing	
Contact Hours	50	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

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

Module-1	15 Hrs

Random Processes: Random variables, random processes,white noise, filtering random processes, spectral factorization,ARMA, AR and MA processes(Text 1).

Module-2	15 Hrs

Signal Modeling:Least squares method, Padé approximation,Prony's method, finite data records, stochastic models,Levinson-Durbin recursion; Schurrecursion;Levinsonrecursion(Text 1).

Module-3	15 Hrs

Spectrum Estimation: Nonparametric methods, minimumvariance spectrum estimation, maximum entropy method,parametric methods, frequency estimation, principal components spectrum estimation(Text 1).

Module-4	15 Hrs

Optimal and Adaptive Filtering: FIR and IIR Wiener filters,Discrete Kalman filter, FIR Adaptive filters: Steepest descent,LMS, LMS-based algorithms (Text 1).

Module-5	15 Hrs

Array Processing:Array fundamentals, beam-forming, optimum array processing, performance considerations, adaptive beamforming,linearly constrained minimum-variance beam-formers, side-lobe cancellers. (Text 2).

Course outcomes:

CO1	Characterize an estimator.

CO2	Design statistical DSP algorithms to meet desired needs
CO3	Apply vector space methods to statistical signal processing problems.
CO4	Understand Wiener filter theory and design discrete and continuous Wiener filters
CO5	Understand Kalman Filter theory and design discrete Kalman filters
CO6	Use computer tools (such as Matlab) in developing and testing stochastic DSP algorithms

Question paper pattern

Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions

Reference Books:

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

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Course Code	MVJ19DEC253	Course Title	MULTIMEDIA OVER COMMUNICATION LINKS	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

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

Module-1	15 Hrs

Multimedia Communications: Introduction, Multimedia information representation, multimedia networks, multimedia applications, Application and networking terminology.(Chap. 1 of Text1) Information Representation: Introduction, Text, Images.(Chap. 2- Sections 2.2 and 2.3 of Text 1)	
Module-2	15 Hrs
Information Representation: Audio and Video.(Chap. 2 - Sections 2.4 and 2.5 of Text 1) Distributed multimedia systems: Introduction, main Features of a DMS, Resource management of DMS, Networking, Multimedia operating systems. (Chap. 4 - Sections 4.1 to 4.5 of Text 2)	
Module-3	15 Hrs
Multimedia Processing in Communication: Introduction,Perceptual coding of digital Audio signals, Transform Audio Coders, Audio Sub band Coders. (Chap. 3 - Sections 3.1,3.2, 3.6, 3.7 of Text 2)	
Module-4	15 Hrs
Multimedia Communication Standards: Introduction, MPEG approach to multimedia standardization, MPEG-1, MPEG-2,Overview of MPEG-4. (Chap. 5 - Sections 5.1 to 5.4 and 5.5.1 of Text 2)	
Module-5	15 Hrs
Multimedia Communication Across Networks: Packet audio/video in the network environment, Video transport across generic networks, Multimedia Transport across ATM Networks.(Chap. 6 - Sections 6.1, 6.2, 6.3 of Text 2).	
Course outcomes:	
CO1	Understand basics of different multimedia networks and applications.
CO2	Analyze media types like audio and video to represent in digital form.
CO3	Understand different compression techniques to compress audio.
CO4	Understand different compression techniques to compress audio video.
CO5	Describe the basics of Multimedia Communication Across Networks
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	Fred Halsall, “ Multimedia Communications ” , Pearson education, 2001,ISBN - 9788131709948.
2.	K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “ Multimedia Communication

	Systems”, Pearson education, 2004. ISBN -9788120321458.
3.	Raif steinmetz, Klara Nahrstedt, “ Multimedia: Computing, Communications and Applications”, Pearson education, 2002, ISBN -9788177584417.

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Course Code	**MVJ19DECL16**	Course Title	Advanced Embedded System Lab	
Contact Hours		L : T : P : 20 : 20	Credits	02

Course objective is to:

- This laboratory course enables students to get practical Experience in ARM cortex programming and interfacing of external devices with ARM controller.

Laboratory Sessions

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

1. Write an Assembly language program to calculate the sum and display the result for the addition of first ten numbers. SUM = 10+9+8+.....+1
2. Write an Assembly language program to store data in RAM
3. Write a C program to output the “Hello World” message using UART
4. Write a C program to operate a buzzer using Cortex M3
5. Write a C program to display the temperature sensed using Cortex M3.
6. Write a C program to control stepper motor using Cortex M3.
7. Interrupt performance characteristics of ARM and FPGA
8. Implementing zigbee protocol with ARM
9. Interfacing LED and PWM.
10. Mailbox.

Course outcomes:

On the completion of this laboratory course, the students will be able to have hands on

CO1	Develop Assembly language programs for different applications using ARM- Cortex M3

	Kit and Keil uVision-4 too
CO2	Understand the interfacing of various external devices
CO3	Develop embedded system for any application
Conduct of Practical Examination:	
All laboratory experiments are to be included for practical examination. Students are allowed to pick one experiment from the lot. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.	

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Course Code	MVJ19DEC31	Course Title	LTE 4G Broadband	
Contact Hours	60	L : T : P :: 40 : 0 : 20	Credits	04

Course objective is to:

- Explain the system architecture of LTE and E-UTRAN as per the standards
- Understand the Multiple Access process incorporated in the radio physical layer.
- Associate MAC of LTE radio interface protocols to set up, reconfigure and release the Radio Bearer and for transferring to the EPS bearer.
- Explain the mobility principles and procedures in the idle and active state.
- Analyse the main factors affecting LTE performance including mobile speed and transmission bandwidth.

Module-1	15 Hrs

Evolution Beyond Release 8, LTE-Advanced for IMT-Advanced, LTE Specifications and 3GPP Structure.

System Architecture Based on 3GPP SAE: Basic System Architecture Configuration with only E-UTRAN Access Network,

System Architecture with E-UTRAN and Legacy 3GPP Access Networks,

System Architecture with E-UTRAN and Non-3GPP Access Networks, IMS Architecture, PCC and QoS.

Module-2	15 Hrs

Introduction to OFDMA, SC-FDMA and MIMO in LTE:

LTE Multiple Access Background, OFDMA Basics, SC-FDMA Basics MIMO Basics.

Physical Layer: Transport Channels and their Mapping to the Physical Channels,Modulation, Uplink User Data Transmission, Downlink User Data Transmission, Uplink Physical Layer Signaling Transmission, PRACH Structure, Downlink Physical Layer Signaling Transmission.

Module-3	15 Hrs

Physical Layer Procedures, UE Capability Classes and Supported Features

Physical Layer Measurements and Parameter Configuration.

LTE Radio Protocols:

Protocol Architecture, The Medium Access Control The Radio Link Control Layer, Packet Data Convergence Protocol.

Module-4	15 Hrs

Radio Resource Control (RRC): X2 Interface Protocols Understanding the RRC ASN.1 Protocol Definition, Early UE Handling in LTE. Mobility:

Mobility

Manin Idle State, Intra-LTE Handovers 190, Inter-system Handovers Differences in E-UTRAN and UTRAN Mobility.

Module-5	15 Hrs

Radio Resource Management:

Overview of RRM Algorithms, Admission Control and QoS Parameters,Downlink Dynamic Scheduling and Link Adaptation, Uplink Dynamic Scheduling and Link Adaptation, Interference Management and Power Settings, Discontinuous Transmission and Reception (DTX/DRX), RRC Connection Maintenance.

Performance:

Layer 1 Peak Bit Rates, Terminal Categories Link Level Performance, Link Budgets Spectral

Efficiency Latency, LTE Reframing to GSM Spectrum Dimensioning.	
Course outcomes:	
CO1	Understand the system architecture and the function standard specified components of the system of LTE 4G
CO2	Analyze the role of LTE radio interface protocols and EPS Data convergence protocols to set up, reconfigure and release data and voice from a number of users.
CO3	Demonstrate the UTRAN and EPS handling processes from set up to release including mobility management for a variety of data call scenarios.
CO4	Test and Evaluate the Performance of resource management and packet data processing and transport algorithms.
CO5	Test and Evaluate the Performance and transport algorithms.
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

Reference Books:	
1.	LTE for UMTS Evolution to LTE-Advanced ' Harri Holma and Antti Toskala, Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.

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Course Code	MVJ19DEC21	Course Title	Advances in Image Processing	
Contact Hours	50	L : T : P :: 40 : 0 : 10	Credits	03

Course objective is to:

- Acquire fundamental knowledge in understanding the representation of the digital image and its properties.
- Equip with some pre-processing techniques required to enhance the image for further analysis purpose.
- Select the region of interest in the image using segmentation techniques.

- Represent the image based on its shape and edge information.
- Describe the objects present in the image based on its properties and structure.

Module-1	10 Hrs

The image, its representations and properties: Image representations a few concepts, Image digitization, Digital image properties, Color images.

Module-2	10 Hrs

Image Pre-processing: Pixel brightness transformations,geometric transformations, local pre-processing.

Module-3	10 Hrs

Segmentation: Thresholding; Edge-based segmentation – Edge image thresholding, Edge relaxation, Border tracing, Hough transforms; Region – based segmentation – Region merging, Region splitting, Splitting and merging, Watershed segmentation,Region growing post-processing.

Module-4	10 Hrs

Shape representation and description: Region identification;Contour-based shape representation and description – Chain codes, Simple geometric border representation, Fourier transforms of boundaries, Boundary description using segment sequences, B-spline representation; Region-based shape representation and description – Simple scalar region descriptors,Moments, Convex hull.

Module-5	10 Hrs

Mathematical Morphology: Basic morphological concepts, Four morphological principles, Binary dilation and erosion, Skeletons

Course outcomes:

CO1	Understand the representation of the digital image and its properties
CO2	Apply pre-processing techniques required to enhance the image for its further analysis.
CO3	Use segmentation techniques to select the region of interest in the image for analysis
CO4	Represent the image based on its shape and edge information.
CO5	Describe the objects present in the image based on its properties and structure.
CO6	Use morphological operations to simplify images, and quantify and preserve the main shape characteristics of the objects.

Question paper pattern

Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions

Reference Books:	
1.	Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis,and Machine Vision”, Cengage Learning, 2013, ISBN: 978-81-315-1883-0
2.	Geoff Doughertry, Digital Image Processing for Medical Applications, Cambridge university Press, 2010
3.	S.Jayaraman, S Esakkirajan, T.Veerakumar, Digital Image Processing, Tata McGraw Hill, 2011.

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Course Code	MVJ19DEC322	Course Title	Array Signal Processing	
Contact Hours	50	L : T : P :: 40 : 0 : 10	Credits	03

Course objective is to:

- Understand various aspects of array signal processing.
- Explain the Concepts of Spatial Frequency along with the Spatial Samplings.
- Describe array design methods and direction of arrival estimation techniques

Module-1	10 Hrs

Spatial Signals: Signals in space and time, Spatial Frequency Vs Temporal Frequency, Review of Co-ordinate Systems,Maxwell’s Equation, Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system – Wave number vector, Slowness vector.

Module-2	10 Hrs

Wave number-Frequency Space Spatial Sampling: Spatial Sampling Theorem-Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.

Module-3	10 Hrs

Sensor Arrays: Linear Arrays, Planar Arrays, Frequency – Wave number Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.

Module-4	10 Hrs

Uniform Linear Arrays: Beam pattern in θ, u and ψ -space,Uniformly Weighted Linear Arrays.

Beam Pattern Parameters: Half Power Beam Width, Distance to First Null, Location of side lobes

and Rate of Decrease,Grating Lobes, Array Steering.	
Module-5	10 Hrs
Array Design Methods: Visible region, Duality between Time -Domain and Space -Domain Signal Processing, Schelkunoff ' s Zero Placement Method, Fourier Series Method with windowing, Woodward -Lawson Frequency-Sampling Design.Non parametric method -Beam forming, Delay and sum Method, Capons Method.	
Course outcomes:	
CO1	Understand the important concepts of array signal processing
CO2	Understand the various Sensor array design techniques
CO3	Understand the various Linear array design techniques
CO4	Understand the basic principle of direction of arrival estimation techniques
CO5	Apply various design techniques using Fourier Series Method Woodward -Lawson Frequency-Sampling Design.Non parametric method -Beam forming
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions.	

Reference Books:	
1.	Harry L. Van Trees " Optimum Array Processing Part IV of Detection,Estimation, and Modulation Theory" John Wiley & Sons, 2002, ISBN:9780471093909.
2.	Don H. Johnson Dan E. Dugeon, " Array Signal Processing: Concepts and Techniques", Prentice Hall Signal Processing Series, 1st Edition ,ISBN-13: 978-0130485137.
3.	Petre Stoica and Randolph L. Moses " Spectral Analysis of Signals" Prentice Hall, 2005,ISBN: 0-13-113956-8.
4.	Sophocles J. Orfanidis, "Electromagnetic Waves and Antennas", ECE Department Rutgers University, 94 Brett Road Piscataway, NJ 08854-8058. http://www.ece.rutgers.edu/~orfanidi/ewa/

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Course Code	MVJ19DEC323	Course Title	RF and Microwave Circuit	
Contact Hours	50	L : T : P :: 40 : 0 : 10	Credits	03

Course objective is to:

- Understand waves propagating in Networks.
- Use the Smith Chart for various applications.
- Understand the basic considerations in active networks.
- Design active networks.
- Understand RF/MW Frequency Mixer and Phase Shifter Design

Module-1	10 Hrs

Wave propagation in networks: Introduction, Reasons for Using RF/Microwaves, Applications, RF Waves, RF and Microwave circuit design, Introduction to Components Basics,Analysis of Simple Circuit in Phasor Domain, RF Impedance Matching, Transmission Media, High Frequency Parameters,Formulation of S-parameters, Properties of S-Parameters,Transmission Matrix, Generalized S-parameters.

Module-2	10 Hrs

Smith chart and its Applications: Introduction, Smith Chart, Derivation of Smith Chart, Smith Chart Circular and Radial Scales, Application of Smith chart.

Module-3	10 Hrs

Basic consideration in active networks: Stability Considerations, Gain Considerations and Noise Considerations.

Module-4	10 Hrs

RF/Microwave Amplifiers: Small Signal Design: Introduction, Types of amplifier, Design of different types of amplifiers

RF/Microwave Frequency Conversion: Mixers: Introduction, Mixer Types, Conversion Losses for SSB Mixers,SSB versus DSB mixers, One diode mixers, Two diode Mixers.

Module-5	10 Hrs

RF/Microwave Control Circuit Design: Introduction, PN Junction Devices, Phase shifters, Digital phase shifters,Semiconductor phase shifters, PIN diode attenuators. **RF and Microwave IC design:** MICs, MIC materials, Types of MICs, Hybrid verses Monolithic ICs, Chip mathematics

Course outcomes:	
CO1	Discuss and analyse waves propagation in Networks
CO2	Apply the Smith Chart for finding various parameters in transmission lines
CO3	Analyse the basic considerations in active networks
CO4	Describe and design active networks.
CO5	Design RF/MW Frequency Mixers and phase shifters

Question paper pattern
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions

Reference Books:	
1.	Matthew M. Radmanesh, "RF and Microwave Electronics Illustrated",Pearson Education edition, 2004.
2.	Reinhold Ludwig, and Pavel Bretchko, "RF circuit design theory and applications", Pearson Education edition, 2004.

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Course Code	MVJ19DEC331	Course Title	Real Time Systems Design	
Contact Hours	50	L : T : P :: 40 : 0 : 10	Credits	03

Course objective is to:

- Understand basics of Real Time systems
- Distinguish a real-time system with other systems.
- Identify the functions of operating system
- Evaluate the need for Real time operating system.

- Design and develop embedded applications by means of real-time operating systems.

Module-1	10 Hrs

Introduction to Real-Time Embedded Systems: Brief history of Real Time Systems, A brief history of Embedded Systems.System Resources: Resource Analysis, Real-Time Service Utility,Scheduling Classes, The Cyclic Executive, Scheduler Concepts,Preemptive Fixed Priority Scheduling Policies, Real-Time OS, Thread Safe Re-entrant Functions.

Module-2	10 Hrs

Processing: Preemptive Fixed-Priority Policy, Feasibility, Rate Montonic least upper bound, Necessary and Sufficient feasibility,Deadline – Monotonic Policy,Dynamic priority policies.

I/O Resources: Worst-case Execution time, Intermediate I/O,Execution efficiency, I/O Architecture.

Memory: Physical hierarchy, Capacity and allocation, Shared Memory, ECC Memory, Flash file systems.

Module-3	10 Hrs

Multi-resource Services: Blocking, Deadlock and livestock, Critical sections to protect shared resources, priority inversion.

Soft Real-Time Services: Missed Deadlines, QoS, Alternatives to rate monotonic policy, Mixed hard and soft real-time services.

Module-4	10 Hrs

Embedded System Components: Firmware components, RTOS system software mechanisms, Software application components.

Debugging Components: Exceptions assert, Checking return codes,Single-step debugging, kernel scheduler traces, Test access ports,Trace ports, Power-On self test and diagnostics.

Module-5	10 Hrs

Performance Tuning: Basic concepts of drill-down tuning, hardware – supported profiling and tracing, Building performance monitoring into software, Path length.

High availability and Reliability Design: Reliability andAvailability, Similarities and differences, Reliability, Reliable software, Available software, Design tradeoffs, Hierarchical applications for Fail-safe design.

Course outcomes:

CO1	Analyze Real time operating systems.
CO2	Describe the functions of Real time operating systems.
CO3	Understand the multi resource and soft real time service.
CO4	Demonstrate embedded system applications.

CO5	Design a Real Time operating system
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	

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

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Course Code	MVJ19DEC332	Course Title	Pattern Recognition & Machine Learning	
Contact Hours	50	L : T : P :: 40 : 0 : 10	Credits	03

Course objective is to:

- Discusses main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems.
- Special emphasis will be given to regression, classification, regularization, feature selection and density estimation in supervised mode of learning.

Module-1	10 Hrs

Introduction: Probability Theory, Model Selection, The Curse of Dimensionality, Decision Theory, Information Theory

Distributions: Binary and Multinomial Variables, The Gaussian Distribution, The Exponential

Family, Nonparametric Methods.(Ch.: 1,2)	
Module-2	10 Hrs
Supervised Learning **Linear Regression Models:** Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression,Bayesian Model Comparison **Classification & Linear Discriminant** Analysis: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Mode(Ch. :3,4)	
Module-3	10 Hrs
Supervised Learning **Kernels:** Dual Representations, Constructing Kernels, Radial Basis Function Network, Gaussian Processes **Support Vector Machines**: Maximum Margin Classifiers,Relevance Vector Machines **Neural Networks:** Feed-forward Network, Network Training,Error Backpropagation(Ch:5,6,7)	
Module-4	10 Hrs
Unsupervised Learning: **Mixture Models**: K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures,Alternative View of EM. **Dimensionality Reduction:** Principal Component Analysis, Factor/Component Analysis, Probabilistic PCA, Kernel PCA,Nonlinear Latent Variable Models (Ch.: 9,12)	
Module-5	10 Hrs
Probabilistic Graphical Models: Bayesian Networks,Conditional Independence, Markov Random Fields, Inference in Graphical Models, Markov Model, Hidden Markov Models (Ch.:8,13)	
Course outcomes:	
CO1	Identify areas where Pattern Recognition and Machine Learning can offer a solution.
CO2	Solve problems in Regression and Classification
CO3	Understand Supervised Learning
CO4	Understand Unsupervised Learning
CO5	Apply Graphical Models.
Question paper pattern	
Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions	
Reference Books:	

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

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Course Code	MVJ19DEC333	Course Title	IoT	
Contact Hours	50	L : T : P :: 40 : 0 : 10	Credits	03

Course objective is to:

- Introduce concept of IOT and its applications in today's scenario.
- Understand IOT content generation and transport through networks
- Understand the devices employed for IOT data acquisition and communication access technologies.
- Introduce some use cases of IOT

Module-1	10 Hrs

What is IOT

Genesis, Digitization, Impact, Connected Roadways, Buildings,Challenges

IOT Network Architecture and Design

Drivers behind new network Architectures, Comparing IOT Architectures, M2M architecture, IOT world forum standard, IOT Reference Model, Simplified IOT Architecture.

Module-2	10 Hrs

IOT Network Architecture and Design

Core IOT Functional Stack, Layer1(Sensors and Actuators) ,Layer 2(Communications Sublayer), Access network sublayer,Gateways and backhaul sublayer, Network transport sublayer, IOT Network management.Layer 3(Applications and Analytics) – Analytics vs Control, Data vs Network Analytics IOT Data Management and Compute Stack.

Module-3	10 Hrs

Engineering IOT Networks

Things in IOT – Sensors, Actuators, MEMS and smart objects.Sensor networks, WSN, communication protocols for WSN Communications Criteria, Range Frequency bands, power consumption, Topology, Constrained Devices, Constrained Node Networks IOT Access Technologies, IEEE 802.15.4 Competitive Technologies – Overview only of IEEE 802.15.4g, 4e,

IEEE 1901.2a

Standard Alliances – LTE Cat0, Cat-M, NB-IOT

Module-4	10 Hrs

Engineering IOT Networks

IP as IOT network layer, Key Advantages, Adoption, Optimization, Constrained Nodes, Constrained Networks, IP versions,Optimizing IP for IOT.

Application Protocols for IOT – Transport Layer, Application Transport layer, Background only of SCADA, Generic web based protocols, IOT Application Layer

Data and Analytics for IOT – Introduction, Structured and Unstructured data, IOT Data Analytics overview and Challenges.

Module-5	10 Hrs

IOT in Industry (Three Use cases)

IOT Strategy for Connected manufacturing, Architecture for Connected Factory

Utilities – Power utility, IT/OT divide, Grid blocks reference model, Reference Architecture, Primary substation grid blockand automation.

Smart and Connected cities – Strategy, Smart city network Architecture, Street layer, city layer, Data center layer,services layer, Smart city security architecture, Smart street lighting.

Course outcomes:

CO1	Understand the basic concepts IOT Architecture
CO2	Understand devices employed in IOT.
CO3	Analyze the sensor data generated and map it to IOT protocol stack for transport.
CO4	Apply communications knowledge to facilitate transport of IOT data over various available communications media.
CO5	Design a use case for a typical application in real life ranging from sensing devices to analyzing the data available on a server to perform tasks on the device.

Question paper pattern

Covering the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 20 marks. Students have to answer five full questions

Reference Books:

1.	Cisco, IOT Fundamentals – Networking Technologies, Protocols, Use Cases for IOT, Pearson Education; First edition (16 August 2017). ISBN-10: 9386873745, ISBN-13: 978-

	9386873743 (2015), ISBN-10: 8173719543, ISBN-13: 978-8173719547
2.	Arshdeep Bahga and Vijay Madisetti, ‘Internet of Things – A Hands on Approach’, Orient Blackswan Private Limited - New Delhi; First edition