DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING:

TIRUPATI-517502

R-23-SchemeofInstructionseffectivefromtheacademicyear2023-2024

ProgrammeScheme

SRI VENKATESWARA UNIVERSITY COLLEGE OF ENGINEERING (AUTONOMOUS)

SRI VENKATESWARA UNIVERSITY

TIRUPATI-517502 (A.P), INDIA.

SRIVENKATESWARAUNIVERSITYCOLLEGEOFENGINEERING:TIRUPATI–517502

DepartmentofElectronicsandCommunicationEngineering-SchemeofInstruction-(CBCS)effectivefromtheAcademicYear2023-2024

M.Tech(PG)(ElectronicsandCommunicationEngineering) Specialization: Communication Systems (CM)

I Semester

S.No.	Category	CourseCode	CourseTitle	SchemeofInstruction(Hours/Week)				No.of Credits	SchemeofEvaluation		
				Lecture	Tutorial	Practical	Total		Sessional Marks	SemesterEnd Examination Marks	Total
1	PCC	CM11C	AdvancedDigitalSignalProcessing (CommontoSignalProcessingSP11C)	3	1	0	4	4	40	60	100
2	PCC	CM12C	WirelessandMobileCommunication	3	1	0	4	4	40	60	100
3	PCC	CM13C	DSPArchitecture (CommontoSignalProcessingSP13C)	3	1	0	4	4	40	60	100
4	PEC	CM14C	ProgrammeElective-I	3	0	0	3	3	40	60	100
5	PEC	CM15C	ProgrammeElective-II	3	0	0	3	3	40	60	100
6	PCC	CM16L	AdvancedDigitalSignalProcessingLab (CommontoSignalProcessingSP16L)	0	0	3	3	1.5	40	60	100
7	PCC	CM17L	WirelessandMobileCommunicationLab	0	0	3	3	1.5	40	60	100
8	MAC	CM18C	ResearchMethodologyandIPR	3	0	0	3	3	40	60	100
Total				18	3	6	27	24	320	480	800

ListofProgrammeElectiveCourseI(CM14C)	**ListofProgrammeElectiveCourseII(CM15C)**
1. OpticalNetworks	1. CognitiveRadio
2. StatisticalInformationProcessing	2. VoiceandDataNetworks (CommontosignalProcessingSP15C)
3. WirelessSensorNetworks (CommontosignalProcessingSP14C)	3. SecuredCommunication
4. HighPerformanceNetworks	**4.** ElectromagneticInterferenceandCompatibility

II Semester

S.No.	**Category**	Course Code	CourseTitle	SchemeofInstruction(Hours/Week)				No.of Credits	SchemeofEvaluation		
				Lecture	Tutorial	Practical	Total		Sessional Marks	SemesterEnd Examination Marks	Total
1	PCC	CM21C	AntennasandRadiatingSystems	3	1	0	4	4	40	60	100
2	PCC	CM22C	AdvancedCommunicationNetworks	3	1	0	4	4	40	60	100
3	PEC	CM23C	ProgrammeElectiveCourse-III	3	0	0	3	3	40	60	100
4	PEC	CM24C	ProgrammeElectiveCourse-IV	3	0	0	3	3	40	60	100
5	PCC	CM25L	AntennasandRadiatingSystemsLab	0	0	3	3	1.5	40	60	100
6	PCC	CM26L	AdvancedCommunicationNetworksLab	0	0	3	3	1.5	40	60	100
7	VAC	CM27C	CyberSecurity	2	0	2	4	3	100	-	100
8	PCC	CM28M	MiniProjectwithSeminar	0	0	4	4	2	100	-	100
Total				**14**	**2**	**12**	**28**	**22**	**440**	**360**	**800**

ListofProgrammeElectiveCoursesIII(CM23C)	**ListofProgrammeElectiveCourses IV(CM24C)**
1.SatelliteCommunication	1.RandomprocessesandQueueingmodels. (Common to Signal Processing SP24C)
2.IoT and Applications (CommontosignalProcessingSP23C)	2.PatternRecognitionandMachineLearning (Common to Signal ProcessingSP21C)
3.RFandMicrowaveCircuit Design	3.Programmable Networks-SDN, NFV
4.MIMO Systems	4.Remote Sensing (CommontoSignal ProcessingSP24C)

III Semester

S.No.	Category	Course Code	CourseTitle	SchemeofInstruction(Hours/Week)				No.of Credits	SchemeofEvaluation		
				Lecture	Tutorial	Practical	Total		Sessional Marks	Semester End Examination Marks	Total
1	OEC	CM31C	OpenElectiveCourse (Through MOOCS)	0	0	0	0	3	100	-	100
2	PCC	CM32I	Industrial/ResearchInternship (Min of 4 Weeks)	0	0	0	0	3	100	-	100
3	PCC	CM33D	DissertationWorkPhase-I	0	0	24	24	12	40	60	100
Total				**0**	**0**	**20**	**20**	**18**	**240**	**60**	**300**

IV Semester

S.No.	Category	Course Code	CourseTitle	SchemeofInstruction(Hours/Week)				No.of Credits	SchemeofEvaluation		
				Lecture	Tutorial	Practical	Total		Sessional Marks	SemesterEnd Examination Marks	Total
1	PCC	CM41D	DissertationWorkPhase-II andViva-Voce	0	0	20	20	10+06= 16	40	60	100
Total				**0**	**0**	**20**	**20**	**16**	**40**	**60**	**100**

M.Tech.(Electronics&CommunicationEngineering)
Curriculum Structure
Specialization:Communicationsystems(CM)

VisionofTheInstitute

The Vision of Sri Venkateswara University College of Engineering is to be the leaderinthecreationanddevelopmentofgloballycompetitivehumancapital inEngineeringEducationforTechnological,EconomicalandSocial EnrichmentoftheSociety,throughitsopenandflexibleAcademicPrograms.

MissionofTheInstitute

- *To be recognized as a premier institution offering Engineering Education programs, training human resources oriented to problem solving and system development.*
- *To carry out research in Engineering and Technology relevant to all segments of society.*
- *To assume leadership in sustainable technological growth of the Indian society.*
- *To be a natural destination for excellence and diversity in thought and practice.*

Department of Electronics& Communication EngineeringVision

To be a lead department imparting quality and value embedded highereducationandresearchemphasizingfreedomoflearningandpractice.

Mission

1. *Transforming students into full-fledged professionals and to become leaders in dynamic global environment.*
2. *Augmentingknowledgeandtechnologiesinrapidlyadvancingfieldsof Electronics and Communication Engineering.*
3. *PromotingindepthresearchandcreateCentreofexcellenceinthrustareas.*

ProgramOutcomes(POs)forPGprograms

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability attitude and behaviour that students acquire through the program.

The POs essentially indicate what the students can do fromsubject-wise knowledge acquired by them during the program. As such, POs define the professional profile of a graduate of PG Engineering Program.

NBA has defined the following three POs for a graduate of PG Engineering Program:

1. **PO1***: An ability to independently carry out research/investigation and development work to solve practical problems.*
2. **PO2***: An ability to write and present a substantial technical report/document.*
3. **PO3***: Students should be able to demonstrate a degree of mastery overtheareaasperthespecializationoftheprogram.Themasteryshouldbeata levelhigherthantherequirementsintheappropriatebachelorprogram.*

ProgramSpecificOutcomes(PSOs):

M.Tech.inCommunicationSystemsgraduateswillbeableto:

1. **PSO1***.Integrateknowledgetoidentify,formulate,solvecomplexproblems and meet the challenges in the domain of communication and networking.*
2. **PSO 2.***Use the concepts of communications, networking and signal processingtosimulatealgorithmsinvirtualplatformsandimplementthem in real time environment.*

ProgramEducationalObjectives(PEOs):

M.Tech.inCommunicationSystemsProgram,graduateswillbeableto:

.**PEO 1.***Apply the concepts of mathematics and engineering principles in the domain of communication and networking and analyze advantages and disadvantages of using the various communication technologies.*

.**PEO 2.***Solve numerical problems and write algorithms using communication and networking platforms and different software tools to evolve viable communication systems.*

.**PEO 3.***Inculcate professional ethics, integrity and social responsibility, enhance communication skills, and practice effective teamwork to pursue research or attain a career in the domain of Communication Engineering.*

CM11C:Advanced Digital Signal Processing
(Common to signal processing)

Instruction Hours/week: (L-T-P-C): 3-1-0-4 **Credits : 4**
Sessional Marks:40 **Semester-EndExamination:60**

CourseDescription: *Thiscoursewillproviderigorousfoundationsin Digital filter structures, Multirate signal processing, Linear prediction,Adaptive filters and Spectral estimation. This course emphasizes the use of digital signal processing techniques for designing digital systems used in Communications, Control, Media Applications etc.*

Prerequisites: *SignalsandSystems,DigitalSignalProcessing.*

CourseObjectives: *Toenablethestudentto*

1. *UnderstandtodevelopFIR&IIRfilterstructuresdependinguponthe given applications.*
2. *UnderstandtheoryofMultirateDSP,solvenumericalproblemsandwrite algorithms.*
3. *Understandtheoryofpredictionandsolutionofnormalequations.*
4. *Understand the different types of adaptive filters used in signal processing applications.*
5. *Discussdifferentmethodsofspectrumestimationandanalysis.*

CourseOutcomes: *Aftercompletionofthecourse,studentwillbeableto*

1. *Learnandimplementthedigitalfilterstocomputationalcomplexityproblems.*
2. *AnalyzemultirateDSPsystemsandDesignadecimatorandintegrator including multi-stages.*
3. *Applytheoryofpredictionandfindsolutionofnormalequations*
4. *Designdifferenttypesoffilterssuchas Adaptivefilters,polyphasefilters, Wiener filters, ARMA lattice-ladder filters, etc.*
5. *Estimatethepowerspectrumbyusingdifferentmethods.*

Contents:

Unit1

Digital filter structures: *Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel structures, all pass realization of IIR transfer functions, Sine- cosine generator, Computational complexity offilter structures.*

Unit2

Multirate Digital Signal Processing*: Decimators and Interpolators, Sampling rate conversion, multistage decimator& interpolator, poly phase filters, Quadrature mirror filter (QMF) banks, Conditions forperfect reconstruction, digital filter banks, Applications in sub-band coding.*

Unit3

LinearPredictionandOptimumLinearFilters*:InnovationsRepresentationofaStationaryRandomProcess,ForwardandBackward linear prediction, Solution of the Normal Equations, Properties of linear prediction-Error Filter, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.*

Unit4

Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, The Least-Mean-Square (LMS) algorithm, Normalized LMS (NLMS), The Leaky LMS, Recursive Least Square (RLS) algorithm.

Unit5

Power Spectral Estimation:*Estimation of Spectra from Finite Duration Observations of a Signal, Periodogram, Use DFT in power Spectral Estimation, Bartlett, Welch and Blackman, Tukey methods, Comparison of performance of Non-Parametric Power Spectrum Estimation Methods.*

Parametric Methods of Power Spectrum Estimation:*Relationship between Auto-Correlation and Model Parameters, Yule-Walker, Burg and Unconstructrained Least Squares Methods, Moving Average (MA) and ARMA Models Minimum Variance Method, Eigen analysis Algorithms for Spectrum Estimation.*

TextBooks*:*

1. **John G. Proakis***and***Dimitris G. Manolakis,***Digital Signal Processing: Principles,AlgorithmsandApplications, 5thEdition,***ISBN-13: 9780137348657, Published** *by Pearson, 2021.*
2. *John G. Proakis, Digital Signal Processing Principles, Algorithms, and Applications, Prentice Hall International Inc, 4th Edition, 2012.*
3. *Sanjit Kumar Mitra, Digital Signal Processing- A Computer Based Approach, 4th edition, McGraw Hill Education, 2011.*
4. *D.G.Manolakis,V.K.IngleandS.M.Kogon,"StatisticalandAdaptive Signal Processing", McGraw Hill, 2000.*

References:

1. *N. **J.**FliegMultirateDigitalSignalProcessing:MultirateSystems-Filter Banks – Wavelets,1st Edition, John Wiley and Sons Ltd, 1999.*

2. *Sanjit Kumar Mitra, and Yonghong Kuo. Digital Signal Processing: A Computer-Based Approach, 4 th. Edition McGraw-Hill Higher Education,New York, 2013.*
3. *M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & Sons Inc., 2002.*
4. *Simon Haykin,"Adaptive Filter Theory",4th Edition,PrenticeHall,2001.*

CM12C: Wireless and Mobile Communication

Instruction Hours/week : (L-T-P-C): 3-1-0-4 **Credits : 4**

Sessional Marks :40 **Semester-EndExamination:60**

Course Description: *This course provides a comprehensive overview and advanced knowledge of modern mobile and wireless communication systems. Building on the prior knowledge on digital communications, students develop further understanding on the challenges and opportunities brought by the wireless medium in designing current and future wireless communication systems and networks*

CourseObjectives:

1. *To provide the students with an understanding of the cellular concepts, frequency reuse, handoff strategies.*
2. *To enable the students to analyze and understand wireless and mobile cellular communication systems over stochastic fading channels.*
3. *To provide the students with an understanding of Co-channel and Non-Co channel Interference.*
4. *To give students an understanding of cell coverage for signal and traffic diversity techniques and mobile antennas.*
5. *To give the students an understanding of frequency management, channel assignment and types of handoff.*

Contents

UNIT 1

CellularCommunicationFundamentals:Cellularsystemdesign,Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, frequency management and channel assignment.GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, GPRS, IS 95, Forward Link and Reverse links.

UNIT2

Spectral efficiency analysis based on calculations for Multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning (Link budget and power spectrum calculations)

UNIT3

Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings.SmallScaleFadingandMultipathPropagation,Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small-Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading.

UNIT4

Equalization,Diversity:Equalizersinacommunicationsreceiver,Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving.

UNIT5

5G Architecture Add Network, 5G Radio, Access Technologies, Security for 5G Communications, 5G challenges and future scope.

CourseOutcomes:*Uponcompletionofthecourse,studentswillbeableto*

1. *Design appropriate mobile communication systems by applying frequency-reuse concept, and analyze its effects on interference,system capacity, handoff techniques.*
2. *Distinguishvariousmultiple-accesstechniquese.g.FDMA,TDMA, CDMA, and their advantages and disadvantages.*
3. *Analyze path loss and interference for wireless telephony and their influences on a mobile communication system's performance.*
4. *Analyze and design CDMA system with the knowledge of forward and reverse channel details, advantages and disadvantages of it.*
5. *Understandtechnologieslike2G,3G,4G,5G,etc.*

TEXTBOOKS:

1. *T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI, 2002.*
2. *WilliamC.Y.Lee,"MobileCellularTelecommunicationsAnalogand Digital Systems", 2nd edition, TMH, 1995.*
3. *AjitSingh,"5GSimplified",ShroffPublishers,2019.*

REFERENCES:

1. *V.K.Garg, J.E.Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.*
2. *V.K.Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4th edition, 2009.*
3. *Asha Mehrotra, "A GSM system Engineering" Artech House Publishers Bosten, London,1997.*

CM13C: DSP Architecture
(Common To Signal Processing)

Instruction Hours/week : (L-T-P-C): 3-1-0-4 Credits : 4
Sessional Marks :40 Semester-EndExamination:60

Course Description:*This course explains fundamental concepts of Digital Signal Processing and implementation of various applications on Advanced Processor.Helpsstudentstounderstandarchitectureofadvanced Digital SignalProcessorandhowtoprogramitforsignalprocessingapplications.*

CourseObjectives:

1. *Todescribefeaturesandarchitecturalimprovementsof DSPprocessors.*
2. *Introduceaddressingmodesandinstructiondescriptionof TMS320C6x processors.*
3. *Todemonstratedatarepresentationin DSPProcessorsandFIRfilters.*
4. *To demonstrate the usefulness of the adaptive filters and learn techniques of code optimization.*

CourseOutcomes:

1. *Attheendofthiscourse,studentswillbeableto*
2. *Identifyandformalizearchitecturallevelcharacterizationof P-DSP hardware*
3. *Abilitytodesign,programming(assemblyandC),andtestingcodeusing Code Composer Studio environment*
4. *DeploymentofDSPhardwareforControl,AudioandVideoSignalprocessing applications*
5. *Understandingofmajorareasandchallengesin DSPbasedembedded systems*

SyllabusContents:

Unit1

Programmable DSP Hardware: Processing Architectures (von Neumann, Harvard), DSP core algorithms (FIR, IIR, Convolution, Correlation, FFT),IEEEstandardforFixedandFloatingPointComputations,Special

Architectures Modules used in Digital Signal Processors (like MAC unit, Barrel shifters), On-Chip peripherals, DSP benchmarking.

Unit2

Structural and Architectural Considerations: Parallelism in DSP processing, Texas Instruments.TMS320 Digital Signal Processor Families, Fixed Point TI DSP Processors: TMS320C1X and TMS320C2X Family,TMS320C25 –Internal Architecture, Arithmetic and Logic Unit, Auxiliary Registers, Addressing Modes (Immediate, Direct and Indirect, Bit-reverseAddressing), Basics of TMS320C54x and C55x Families in respect of Architecture improvements and new applications fields, TMS320C5416 DSP Architecture, Memory Map, Interrupt System, Peripheral Devices, Illustrative Examplesfor assembly coding.

Unit3

VLIW Architecture: Current DSP Architectures, GPUs as an alternative toDSP Processors, TMS320C6X Family, Addressing Modes, Replacement of MAC unit by ILP, Detailed study of ISA, Assembly Language Programming, Code Composer Studio, Mixed Cand Assembly Language programming, On- chip peripherals, Simple applications developments as an embedded environment.

Unit4

Multi-core DSPs: Introduction to Multi-core computing and applicability forDSPhardware,Conceptofthreads,introductiontoP-thread,mutexand similarconcepts,heterogeneousandhomogenousmulti-coresystems,Shared Memory parallel programming –OpenMP approach of parallel programming, PRAGMA directives, OpenMP Constructs for work sharing likeforloop,sections,TITMS320C6678(EightCoresubsystem).

Unit5

FPGA based DSP Systems: Limitations of P-DSPs, Requirements of Signal processing for Cognitive Radio (SDR), FPGA based signal processing design-case study of a complete design of DSP processor,High Performance Computing using P-DSP: Preliminaries of HPC, MPI, OpenMP, multicore DSP as HPC infrastructure.

References:

1. *M.Sasikumar,D.Shikhare,RaviPrakash,"IntroductiontoParallelProcessing", 1st Edition, PHI, 2006.*
2. *FayezGebali,"AlgorithmsandParallelComputing",1st Edition,John Wiley & Sons, 2011*
3. *RohitChandra,RameshMenon,LeoDagum,DavidKohr,DrorMaydan,*

JeffMcDonald,"ParallelProgramminginOpenMP",1stEdition,Morgan Kaufman,2000.
4. *AnnMelnichuk,LongTalk,"MulticoreEmbeddedsystems",1stEdition, CRC Press,2010.*
5. *WayneWolf,"HighPerformanceEmbeddedComputing:Architectures, Applications and Methodologies", 1st Edition, Morgan Kaufman, 2006.*
6. *E.S.Gopi, "Algorithmic Collections for Digital Signal Processing Applications Using MATLAB", 1st Edition, Springer Netherlands, 2007.*

CM14C:ProgramElective-I
1. OpticalNetworks

Instruction Hours/week : 3(L) Credits : 3
Sessional Marks :40 Semester-endExamination:60

Course Description:*Optical fibers have several advantages over conventional copper cables. Optical communication enjoys high bandwidth and thus useful for transmitting huge information securely and with less repeaters to longer distances. The performance of optical system is superior to conventional communication and thus has widespread use in industry.*

Course Objectives:*Optical Communication has got greater applicabilityand students of Communication discipline should master the subject. This course will enable the students:*
1. *Tounderstanddeeplythefundamentalaspectsofopticalcommunication*
2. *Toanalyzethetypesoffibersandunderstandtheperformancebycomparison*
3. *Todesignopticalreceiversofopticalsystems*
4. *TosimulatetheperformancethroughparameterslikeBERandS/NRatio*
5. *Toapplytheprinciplesofopticalcommunicationtonetworks.*

CourseOutcomes:
Attheendofthiscourse,studentswillbeableto
1. *ContributeintheareasofopticalnetworkandWDMnetworkdesign.*
2. *Implementsimpleopticalnetworkandunderstandfurthertechnology developments for future enhanced network.*

SyllabusContents:

Unit1
SONET/SDH: optical transport network, IP, routing and forwarding, multiprotocol label switching.
WDM network elements: optical line terminals and amplifiers, optical add/dropmultiplexers, OADM architectures, reconfigurable OADM,optical cross connects.

Unit2

Control and management: network management functions, optical layer services and interfacing, performance and fault management, configuration management, optical safety.

Unit3

NetworkSurvivability:protectioninSONET/SDH& clientlayer,opticallayer protection schemes

Unit4

WDMnetworkdesign:LTDandRWAproblems,dimensioningwavelength routingnetworks,statisticaldimensioningmodels.

Unit5

Access networks: Optical time division multiplexing,synchronization,header processing,buffering, burst switching, test beds, Introduction toPON, GPON, AON.

References:

1. *RajivRamaswami,Sivarajan,Sasaki,"OpticalNetworks:APractical Perspective",MK,Elsevier,3rd edition,2010.*
2. *C.SivaRamMurthyandMohanGurusamy,"WDMOpticalNetworks:Concepts Design, and Algorithms", PHI, EEE, 2001.*

CM14C:ProgramElective-I
2. StatisticalInformationProcessing

Instruction Hours/week : 3(L) Credits : 3
Sessional Marks :40 Semester-endExamination:60

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Characterize and apply probabilistic techniques in modern decision systems, such as information systems, receivers, filtering andstatistical operations.*
2. *Demonstratemathematicalmodellingandproblemsolvingusingsuch models.*
3. *Comparatively evolve key results developed in this course for applicationstosignalprocessing,communicationssystems.*
4. *Develop frameworks based in probabilistic and stochastic themes for modelling and analysis of various systems involving functionalities in decision making, statistical inference, estimation and detection.*

SyllabusContents:

Unit1

Review of random variables: Probability Concepts, distribution and density functions, moments, independent, uncorrelated and orthogonal random variables; Vector-space representation of Random variables, Vector quantization,Tchebaychefinequalitytheorem,CentralLimittheorem, Discrete&ContinuousRandomVariables.

Random process: Expectations, Moments, Ergodicity, Discrete-Time Random ProcessesStationaryprocess,autocorrelationandautocovariance functions, Spectral representation of random signals, Properties of power spectraldensity,GaussianProcessandWhitenoiseprocess.

Unit2

Randomsignalmodelling:MA(q),AR(p), ARMA(p,q)models, HiddenMarkov Model&its applications ,Linear System with random input,Forward and Backward Predictions, Levinson Durbin Algorithm.

Unit3

Statistical Decision Theory: Bayes' Criterion, Binary Hypothesis Testing, M-aryHypothesis Testing, Minimax Criterion, Neyman-Pearson Criterion, Composite Hypothesis Testing.

ParameterEstimationTheory:Maximum LikelihoodEstimation,Generalized Likelihood Ratio Test ,Some Criteria for Good Estimators, Bayes' Estimation Minimum Mean-Square Error Estimate, Minimum, Mean Absolute Value of Error Estimate Maximum A Posteriori Estimate,Multiple Parameter Estimation Best Linear Unbiased Estimator ,Least-Square Estimation Recursive Least-Square Estimator.

Unit4

Spectralanalysis:Estimatedautocorrelationfunction,Periodogram,Averagingtheperiodogram(BartlettMethod),Welchmodification,Parametric method, AR(p) spectral estimation and detection of Harmonic signals.

Information Theory and Source Coding: Introduction, Uncertainty, Information and Entropy, Source coding theorem, Huffman, ShanonFano, Arithmetic,Adaptive coding,RLE,LZW Data compaction,,LZ-77, LZ-78. Discrete Memory less channels, Mutual information, channelcapacity, Channel coding theorem, Differential entropy and mutual information for continuous ensembles.

Unit5

ApplicationofInformationTheory:Group,Ring&Field,Vector,GF

addition,multiplicationrules.IntroductiontoBCHcodes,Primitiveelements ,Minimalpolynomials,GeneratorpolynomialsintermsofMinimal polynomials,SomeexamplesofBCHcodes,&Decoder,Reed-Solomoncodes &Decoder,ImplementationofReedSolomonencodersanddecoders.

References:

1. *PapoulisandS.U.Pillai,"Probability,RandomVariablesandStochastic Processes",4th Edition, McGraw-Hill, 2002.*
2. *D.G.Manolakis,V.K.IngleandS.M.Kogon,"StatisticalandAdaptive Signal Processing", McGraw Hill, 2000.*
3. *Mourad Barkat,"SignalDetection andEstimation",ArtechHouse,2nd Edition, 2005.*
4. *RG.Gallager,"Informationtheoryandreliablecommunication",Wiley, 1st edition, 1968.*
5. *F.J.MacWilliamsandN.J.A.Sloane, "TheTheoryofError-Correcting Codes",NewYork,North-Holland,1977.*
6. *RosenK.H,"ElementaryNumberTheory",Addison-Wesley,6th edition, 2010.*

CSPE13:ProgramElective-I
3. WirelessSensorNetworks

Instruction Hours/week: 3(L) **Credits : 3**
Sessional Marks :40 **Semester-endExamination:60**

Course Description:*This course offers an insight into the concepts of mobile and wireless data communication technologies. The objective of this course is to enable the student to understand the emerging technologies of wireless and mobile communications and simulate them.*

CourseObjectives:

1. *Tounderstandthenewtrendsin mobile/wirelesscommunications networks.*
2. *Tounderstandmultipleradioaccesstechniques.*
3. *Toanalyzevariousroutingalgorithmsusedinmobile/wirelessnetworks.*
4. *Toidentifytheissuesintransportandapplicationlayers.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Designwirelesssensornetworksystemfordifferentapplicationsunderconsideration.*
2. *Understandthehardwaredetailsofdifferenttypesofsensorsandselect righttypeofsensorforvariousapplications.*
3. *Understand radio standards and communication protocols to be used for wireless sensor network based systems and application.*

4. *Useoperatingsystemsandprogramminglanguagesforwirelesssensornodes,performanceofwirelesssensornetworkssystemsandplatforms.*
5. *Handlespecialissuesrelatedtosensorslikeenergyconservationand security challenges.*

SyllabusContents:

Unit1

Introductionandoverviewofsensornetworkarchitectureandits applications, sensornetwork comparison with Ad Hoc Networks, Sensor node architecture with hardware and software details.
Hardware: Examples like mica2, micaZ, telosB, cricket, Imote2, tmote, btnode, and Sun
SPOT,Software(OperatingSystems):tinyOS,MANTIS,Contiki,andRetOS.

Unit2

Programming tools: C, nesC. Performance comparison of wireless sensor networks simulation and experimental platforms like open source (ns-2) and commercial (QualNet, Opnet)

Unit3

Overview of sensor network protocols (details of atleast 2 important protocol perlayer):Physical,MACandrouting/Networklayerprotocols,node discovery protocols, multi-hop and cluster based protocols, Fundamentals of 802.15.4,Bluetooth,BLE(Bluetoothlowenergy),UWB.

Unit4

Data dissemination and processing; differences compared with other database management systems, data storage; query processing.

Unit5

Specializedfeatures:Energypreservationandefficiency;securitychallenges; fault-tolerance, Issues related to Localization, connectivity and topology, Sensor deployment mechanisms; coverage issues; sensor Web; sensorGrid, Open issues for future research, and Enabling technologies in wireless sensor network.

References:

1. *1.H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, India, 2012.*
2. *C.S.Raghavendra,K.M.Sivalingam,andT.Znati,Editors,"Wireless SensorNetworks",SpringerVerlag,1stIndianreprint,2010.*
3. *F.ZhaoandL.Guibas,"WirelessSensorNetworks:AnInformation Processing Approach", Morgan Kaufmann, 1stIndian reprint, 2013.*

4. *YingshuLi, MyT. Thai, Weili Wu, "Wireless sensor Network and Applications", Springer*
5. *Seriesonsignalsandcommunicationtechnology,2008.*

CM14C:ProgramElective-I
4. HighPerformanceNetworks

Instruction Hours/week: 3(L) **Credits : 3**
Sessional Marks :40 **Semester-endExamination:60**

Course Description:*This course provides an introduction to voice and data networking technologies, including public and private voice services, Ethernet and Internet data technologies, network security, business applications and net work management. The structure, regulation, andhistory of the telecom and data network industry will be discussed as well.*

CourseObjectives:
1. *Toprotocol,algorithms,trade-offsrationale.*
2. *Torouting,transport,DNSresolutions*
3. *Tonetworkextensionsandnextgenerationarchitecture.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto
1. *Applyknowledgeofmathematics,probability,andstatisticstomodeland analyze some networking protocols.*
2. *Design,implement,andanalyzecomputernetworks.*
3. *Identify,formulate,andsolvenetworkengineeringproblems.*
4. *Show knowledge of contemporary issues in high performance computer networks.Usetechniques,skills,andmodernnetworkingtoolsnecessary for engineering practice.*

SyllabusContents:

Unit1

TypesofNetworks,Networkdesignissues,Datainsupportofnetwork design. Networkdesign tools, protocols and architecture. Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications,Beyondbesteffort,schedulingandpolicingmechanism, integratedservices,andRSVP-differentiatedservices.

Unit2

VoIP system architecture, protocol hierarchy, Structure of a voice endpoint, Protocols forthe transport of voice media over IP networks. Providing IP qualityofserviceforvoice,signalingprotocolsforVoIP,PSTNgateways,VoIP applications.

Unit3

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN. MPLS-operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks-P2P connections.

Unit4

TrafficModeling:Little'stheorem,Needformodeling,Poissonmodeling,Non-poissonmodels, Network performance evaluation.

Unit5

Network Security and Management: Principles of cryptography, Authentication, integrity,key distribution and certification, Access control and fire walls, attacks and counter measures, security in many layers.Infrastructure for network management, The internet standard management framework –SMI, MIB, SNMP, Security and administration, ASN.1.

References:

1. *1.KershenbaumA.,"TelecommunicationsNetworkDesignAlgorithms", Tata McGraw Hill, 1993.*
2. *Larry Peterson & Bruce David, "Computer Networks: A System Approach", Morgan Kaufmann, 2003.*
3. *DouskalisB.,"IPTelephony:TheIntegrationofRobustVoIPServices", Pearson Ed. Asia, 2000.*
4. *WarlandJ.,VaraiyaP.,"High-PerformanceCommunicationNetworks", Morgan Kaufmann, 1996.*
5. *Stallings W., "High-Speed Networks: TCP/IP and ATM Design Principles", Prentice Hall, 1998.*
6. *LeonGarcia,Widjaja,"Communicationnetworks",TMH7th reprint 2002.*
7. *WilliamStalling,"Networksecurity,essentials",PearsoneducationAsia publication, 4th Edition, 2011.*

CM15C:ProgramElective-II
1. CognitiveRadio

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks :40 **Semester-endExamination:60**

Course Description:*To understand the fundamental concepts of cognitive radios networks and develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it. Technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models.*

CourseObjectives:

1. *Tounderstandthefundamentalconceptsofcognitiveradionetworksand develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.*
2. *Understand technologies to allow an efficient use of TVWS for radio communicationsbasedontwospectrumsharingbusiness models/policies*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Understandthefundamentalconceptsofcognitiveradionetworks.*
2. *Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.*
3. *Understand technologies to allow an efficient use of TVWS for radio communicationsbasedontwospectrumsharingbusiness models/policies*
4. *Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.*

SyllabusContents:

Unit1

Introduction to Cognitive Radios: Digital dividend, cognitive radio (CR) architecture, functions of cognitive radio, dynamic spectrum access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision,potentialapplicationsofcognitiveradio.

Unit2

Spectrum Sensing: Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models(spectrumofcommons,realtimesecondaryspectrummarket).

Unit3

Optimization Techniques of Dynamic Spectrum Allocation: Linearprogramming, convex programming, non-linear programming, integer programming,dynamicprogramming,stochasticprogramming.

Unit4

Dynamic Spectrum Access and Management: Spectrum broker,cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Unit5

Spectrum Trading: Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential).

Research Challenges in Cognitive Radio: Network layer and transport layer issues,cross-layerdesignforcognitiveradionetworks.

References:

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

CM15C:ProgramElective-II
2. Voice and Data Networks
(Common to signal processing)

Instruction Hours/week : 3(L) Credits : 3
Sessional Marks :40 Semester-endExamination:60

CourseDescription:*Thiscourseprovidesanintroductiontovoiceanddata networking technologies, including design and performance issues. And also focus is onlayered& cross layer communication along with Packet and circuit switching communication. Provides Link layer error and flowcontrol mechanisms, also know about queuing models of networks and its applications. Finally have idea about different internet protocols and packet scheduling algorithm.*

CourseObjectives:

1. *Knowdifferentdesignandperformanceissuesofcommunications networks.*
2. *Understandtheconceptsof layered& crosslayercommunication, along with circuit & packet switching technologies and their deployments in public networks*
3. *Understandtheroleof datalinklayerandvariousqueuingmodelsfor*

communication.

4. *Understand the functions of internetworking devices and importance ofdifferent internet protocols.*

CourseOutcomes:

1. *An ability to apply knowledge of networking. network topologies in designing of a network.*
2. *Anabilitytomodelsystemsusingconceptoflayered/crosslayeredand TCP/IP architecture.*
3. *Anabilityapplythelinklayerfunctionalitiesandqueuingmodelsduring communication.*
4. *Anabilitytousemodernengineeringtechniquesforanalysisanddesign ofanetworkwiththeknowledgeofinternetconceptsandprotocols.*

SyllabusContents:

Unit1

Network Design Issues, Network Performance Issues, Network Terminology, centralizedanddistributedapproachesfornetworksdesign,Issuesindesign of voice and data networks.

Unit2

Layered and Layer less Communication, Cross layer design of Networks, Voice Networks (wired and wireless) and Switching, Circuit Switching and Packet Switching, Statistical Multiplexing.

Unit3

Data Networks and their Design, Link layer design- Link adaptation, Link Layer Protocols, Retransmission. Mechanisms (ARQ), Hybrid ARQ (HARQ), Go Back N, Selective Repeat protocols and their analysis.

Unit4

Queuing Models of Networks,Traffic Models,Little's Theorem, Markov chains, M/M/1 and other Markov systems, Multiple Access Protocols , Aloha System , Carrier Sensing , Examples of Local area networks,

Unit5

Inter-networking, Bridging, Global Internet, IP protocol and addressing, Sub netting, Classless Inter domain Routing (CIDR) , IP address lookup,Routing in Internet. End to End Protocols, TCP and UDP. Congestion Control,Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery, Congestion avoidance, RED TCP Throughput Analysis, Quality of Service in Packet Networks, Network Calculus, Packet Scheduling Algorithms.

References:

1. *D.BertsekasandR.Gallager,"DataNetworks",2nd Edition,Prentice Hall, 1992.*
2. *L. Peterson andB. S. Davie, "Computer Networks: ASystems Approach",5th Edition,MorganKaufman,2011.*
3. *Kumar,D.ManjunathandJ.Kuri,"CommunicationNetworking:An analyticalapproach",1st Edition,MorganKaufman,2004.*
4. *Walrand,"CommunicationsNetwork:AFirstCourse",2nd Edition, McGraw Hill, 2002.*
5. *Leonard Kleinrock, "Queueing Systems,Volume I: Theory", 1st Edition, John Wiley and Sons, 1975.*
6. *AaronKershenbaum,TelecommunicationNetworkDesignAlgorithms, McGrawHill,1993.*
7. *VijayAhuja,"DesignandAnalysisofComputerCommunicationNetworks", McGraw Hill, 1987*

CM15C:ProgramElective-II
3. Secured Communication

Instruction Hours/week : 3(L) **Credits:3**
Sessional Marks : 40 **Semester-end Examination : 60**

Course Description*: The principles are tempered with their practical significance to cope up with the interest to both researchers and system designers.Learningisfacilitatedbystreamlinedderivationsandassignments.*

CourseObjectives:

1. *Tointroducethebasicconceptencryptiontechniques*
2. *To familiarize with the concept of private key and public key cryptosystems.*
3. *TointroducetheconceptofEllipticcurves*

CourseOutcomes:*Aftercompletingthiscourse,studentswillbeableto:*

1. *To Understand Cryptography attacks, Integer arithmetic, linear congruence*
2. *ToUnderstandencryptiontechniques*
3. *ToUnderstandPrivatekeyandpubliccryptosystem*
4. *ToUnderstandEllipticCurves*
5. *DiscretelogarithmproblemonEllipticCurves*

UNIT1

Introduction:*Security Goals, Cryptographic Attacks, Servicesand Mechanisms, Integer Arithmetic, Modular Arithmetic, Linear Congruence.*

UNIT2

BasicEncryptionTechniques:*Conceptofcryptanalysis,Symmetrickey ,Block ciphers, Cryptographic algorithms,Features of DES, Stream ciphers, Pseudo random sequence generators, linear complexity, Non-linear combination of LFSRs ,Boolean functions.*

UNIT3

Private Key and Public Key Cryptosystems:*Asymmetic Key, One way functions, Primality Testing, Factorization problem, Chinese Remainder Theorem,RSA encryption, Diffie Hellmann key exchange,Message authentication and hash functions, Digital signatures, Secret sharing,features of visual cryptography , other applications of cryptography.*

UNIT4

EllipticCurves:*Basictheory,Weirstrassequation,Grouplaw,Pointat Infinity, Elliptic curves over finite fields.*

UNIT5

Discrete logarithm problem on Elliptic curve:*Ellipticcurvecryptography, Diffie Hellmann key exchange over EC, Elgamal encryption over EC, ECDSA.*

TextBooks:

1. *DouglasR.Stinson,MauraB.Paterson"Cryptography,TheoryandPractice", 4th Edition, CRC Press, Taylor& Francis Group, 2019.*
2. *LawrenceC.Washington,"EllipticCurves",***2ndEdition***,Chapman& Hall/CRCPressPublishers,April2008,ISBN:9781420071474.*
3. *DavidS.Dummit,RichardM.Foote,"AbstractAlgebra",ThirdEdition John Wiley & Sons, Inc., 2004.*

CM15C:ProgramElective-II
4. ElectromagneticInterferenceAndCompatibility

Instruction Hours/Week:3L **Credits: 3**
SessionalMarks :40 **EndSemesterExaminationMarks:60**

Courseobjective:

1. *The course Electromagnetic interference and compatibility gives the in- depth expose of unintentional generation, propagation and reception of electromagneticenergywhichmaycauseunwantedeffectssuchas*

electromagneticinterferenceorevenphysicaldamagetotheoperational or impaired function of equipment.

2. *The goal of EMC is to inbuilt the withstanding capability of operation of differentequipmentinacommonelectromagneticenvironment.This coursewillequipthelearner'sin-depthunderstandingofSourcesand victim of EMI. The course gives the insight of the suppression techniqueslikeShielding,bondingGrounding,Earthing.*
3. *Learners should be able to explore and apply EMI/EMC measurement technique, evaluation methods and various EMI/EMC standards.*
4. *A Prerequisite knowledge of Antennas and Microwave Engineering is required for the course.*

SyllabusContents:

UNITI

BASIC THEORY(10):*Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards tohumans,VariousissuesofEMC,EMCTestingcategories,EMC Engineering Application. Importance of EMI emission in communications.*

UNITII

EMI from Apparatus and circuits (10):*Electromagnetic emissions, noisefromrelaysandswitches,non-linearitiesincircuits,passiveinter-modulation,cross-talkintransmissionlines,transientsinpowersupplylines,electromagneticinterference (EMI),OverviewonOpenareatestsites and measurements*

UNITIII

Radiated and Conducted Interference Measurements(10):*Anechoic chamber, TEM cell, GH TEM cell, characterization of conduction Currents/voltages, conducted EM noise on power lines, conducted EMI from Equipment, immunity to conducted EMI detectors and Measurements.*

UNITIV

STANDARDS AND REGULATION (10):*Need for Standards,Generic/General Standards for Residential and Industrial environment,Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, CISPR, CENELEC, Electro MagneticEmissionandsusceptibilitystandardsandspecifications, MIL461E Standards.*

UNITV

EMITESTMETHODSANDINSTRUMENTATION(10):*Fundamental*

considerations, Basic principles of RE, CE, RS and CS measurements, EMI Shielding effectiveness tests, TEM cell for immunity test, Shielded chamber, Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks,Feedthroughcapacitors,Antennas,Currentprobes,MIL-STD test methods, Civilian STD test methods.

TEXTBOOK

1. *Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Interscience, 2006.*
2. *V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, Newyork, 2001.*

REFERENCES

1. *Henry W. Ott, "Electromagnetic Compatibility Engineering",JohnWiley & Sons Inc, Newyork, 2009.*
2. *Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science& Technology Books, 2002.*
3. *W Scott Bennett, "Control and Measurement of Unintentional ElectromagneticRadiation",JohnWiley&SonsInc.,(WileyInterscience Series) 1997.*
4. *Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2005.*

COURSEOUTCOMES:

1. *IdentifythevarioustypesandmechanismsofElectromagnetic Interference*
2. *IdentifythevarioustypesandmechanismsofElectromagnetic Interference Analyze various sources of EMI and various possibilities to provide EMC.*
3. *AnalyzepossibleEMIpreventiontechniquessuchasgrounding, shielding, filtering and use of proper coupling mechanisms to improve compatibility of electronic circuits and systems in a given electromagnetic environment.*
4. *Tomeasureemissionimmunitylevelfromdifferentsystemstocouple with the prescribed EMC standards*
5. *Understand the different types of EMI/EMC measurement techniquesand measuring equipment*

CM16L: Advanced Digital Signal Processing Lab
(Common to signal Processing)

Instruction Hours/week : 3(P) **Credits : 1.5**
Sessional Marks :40 **Semester-endExamination:60**

Course Overview: *This practical course enables students to apply skills learnedinAdvancedDigitalSignalProcessingalgorithmsandwillhelp to teach implementation of them. MATLAB is used to apply theoretical concepts and to demonstrate signal processing techniques by means of hands-onapplicationexamples.Recognizeestimationproblemsand design, implement and analyze algorithms for solving them. Implement signalprocessingsystemswithDSPbaseddevelopmentplatforms.*

Pre-requisites: *Signals & Systems, Digital Signal Processing, Digital Signal Processing Lab, MATLAB, and Code Composer Studio.*

CourseLearningObjectives: *Thestudentafterstudyingthiscourseis able to:*

1. *Understandhowtoanalyzeandmanipulatedigitalsignalsandhave the programming knowledge to do so.*
2. *Understand the trade-offs in the practical design and implement of various structures of FIR and IIR digital filters, for example which can be reduces noise or realizes various applications.*
3. *Understandtheoryofpredictionandsolutionofnormalequations.*
4. *Acquaintknowledgeoftheconcepts,algorithmsandapplicationsof adaptive signal processing in digital communication systems.*
5. *Understandtheimplementationofadaptivefiltersusedinsignalprocessing applications.*
6. *Understanddifferentmethodsforestimationofpowerspectraandits analysis.*

CourseOutcomes: *Aftercompletionofthiscoursethestudentis:*

1. *Abletodesign,analyze,andimplementdigitalfiltersusingMATLAB.*
2. *Abletoimplementvariousstructuresofdigitalfilters.*
3. *Able to implement up-sampling and down-sampling of a givenSequences.*
4. *Apply the Lattice filter architecture and implement the Wiener filter, Least Squares, LMS and RLS algorithms, and apply to selected applications.*
5. *Deduce and apply correlation functions and power spectra for various signal classes, in particular for stochastic signals.*

CourseContents:

Note:(i)Minimumof10Experimentshavetobedoneinvariably.
(ii) AllExperimentsmaybeSimulatedusingMATLABandtobe

verifiedtheoretically.

ListofExperiments:

1. *Introduction to DSP with MATLAB Programming Environment andFamiliarizationtoCodeComposerStudio.*
2. *Basic Operations on Signals, Generation of Various Signals and finding its FFT.*
3. *SimpleDigitalFilters(LPF,HPF,BPF,BSFandCombFilters).*
4. *Realization of Structures (Cascade / Parallel/ Lattice Structure's) of a system transfer function.*
5. *Implement Program to verify Decimation and Interpolation of a given Sequences.*
6. *ImplementProgramtoConvertCDdataintoDVDdata(sampling rate converters).*
7. *Estimation of data series using Nth order Forward Predictor andcomparingtotheOriginalSignal.*
8. *Design of linear prediction coding (LPC) filter using Levinson-Durbin Algorithm.*
9. *Apply the Lattice filter architecture from the Levinson-Durbinalgorithm.*
10. *ComputationofReflectionCoefficientsusingSchurAlgorithm.*
11. *ToimplementtheWienerfilter,andLeastSquaresalgorithms,and apply to selected applications.*
12. *To implement the LMS and RLS algorithms, and apply to selected applications.*
13. *DesignandverificationofaMatchedfilter.*
14. *AdaptiveNoiseCancellation/LinearEqualizer.*
15. *ComputingPowerSpectrumofaSquareSignalandchirpsignal.*
16. *DesignandSimulationofNotchFiltertoremove50HzHum/any unwantedfrequencycomponentofgivenSignal(Speech/ECG).*
17. *PlotthePeriodogramofaNoisySignalandestimatePSDusing Periodogram and Modified Periodogram methods.*
18. *EstimationofPowerSpectrumusingBartlettandWelchmethods.*
19. *Parametric methods (Yule-Walker and Burg) of Power Spectrum Estimation.*

ForMotivatedLearnersExtraexperimentscanbedone:

Applications: Adaptive filter and experiments on communication such as generation of a N-tuple PN sequence, generation of a white noise sequence using the PN sequence, restoration of a sinusoidal signal embedded in white noise by Wiener Filtering; speech and multi-media applications.

Texts/References:

1. **JohnG.Proakis***and***DimitrisG.Manolakis,***DigitalSignalProcessing:*

*Principles,AlgorithmsandApplications, 5thEdition,***ISBN-13: 9780137348657, Published** *by Pearson, 2021.*
2. *Sanjit Kumar Mitra, Digital Signal Processing: A Computer Based Approach, 4th edition, McGraw Hill Education, 2011.*
3. *LjiljanaMilić, Multirate Filtering for Digital Signal Processing: MATLAB Applications, Published by Information Science Reference, Hershey PA 17033,NewYork,ISBN978-1-60566-178-0(Hardcover)-ISBN978-1-60566-179-7(eBook),2009.*
4. *R. Chassaing andD. Reay, DigitalSignalProcessingand Applications withTMS320C6713and TMS320C6416, Wiley, 2008.*

CM17L:WirelessandMobileCommunicationLab

Instruction Hours/week : 3(P) Credits : 1.5
Sessional Marks :40 Semester-endExamination:60

CourseObjectives:

1. *Toenablethestudentstounderstandandinvestigate Wirelesschannels, Fadingenvironmentandanalyzetheirbehaviour.*
2. *Tostudyvariousradiopropagationmodels.*
3. *Todescribedifferentalgorithmsofadaptivefiltering.*
4. *To facilitate students with hands on 4G LTE network to establish communication between user equipment.*

ListofExperiments

1. *Radiopropagationmodels:OkumuraandHatamodels.*
2. *Calculationoffrequencyreusefactorandclustersize.*
3. *Improvingchannelcapacityofwirelessnetworkusingcellsectoring.*
4. *Selectiondiversityforwirelesscommunication.*
5. *PowerspectraldensityofGMSK.*
6. *RLSandLMSalgorithmsforadaptivefiltering.*
7. *Configurationof processor and IPaddress for4GLTEoperation.*
8. *ConfigurationofeNodeBRadioparametersandBandwidth.*
9. *ConfigurationofEPCanduserdatabase.*
10. *Configuration of IMS and users, complete LTE run and UE application setup.*
11. *Virtual lab experiments on understanding of pathloss, beam patterns, calculation of boundary coverage probability and SINR.*
12. *Virtual lab experiments on handoff, frequency reuse, flat and frequency selective fading.*

CourseOutcomes:

Uponcompletionofthecourse,studentswillbeableto

1. *UnderstandCellularconceptsandradiopropagationmodels.*
2. *Perform4GLTEwirelessnetworkthroughexperimentation*
3. *AnalyzeconfigurationparametersofSoftwareDefinedRadioinrealtime environment.*
4. *Demonstratevariousconceptsofwirelessandmobilecommunicationlike handoff, cell sectoring, frequency reuse, etc., using virtual labs.*

Resources:

1. *SoftwareTools:Matlab*
2. *Amitec4GLTENetworkSetup*
3. *Virtual Labs: Fading Channels and Mobile Communications, http://vlabs.iitkgp.ernet.in/fcmc*

CM18C:ResearchMethodologyandIPR

Instruction Hours/week : 3L **Credits:3**
Sessional Marks :40 **Semester-endExamination:60**

Description of the Course:*This subject gives how to proceedsystematically for research, present research findings. This course consistsof basics of research methods, paper writing, patenting methods and requirements.*

CourseEducationalObjectives(CEOs):

1. *Tounderstandtheimportanceofresearchobjectivesandprocedures.*
2. *Toknowtheproceduresofdatacollectionandreportwritingofresearch.*
3. *Tohavetheknowledgeoffilingandobtainingapatentonresearch findings.*

UNITI

Meaning, Objective and Motivation in Research: Types of Research,Research Approaches, Research Process, Validity and Reliability inResearch, Research Design: Features of Good Design, Types of Research Design, Basic Principles of Experimental Design

UNITII

Sampling Design: Steps in Sampling Design, Characteristics of a GoodSample Design, Random Samples and Random Sampling Design MeasurementandScalingTechniques:ErrorsinMeasurement,,Scaling andScaleConstructiontechniques,ForecastingTechniques,TimeSeries

Analysis,InterpolationandExtrapolation

UNITIII

Methods of Data Collection: Primary Data, Questionnaire and Interviews, Collection of Secondary Data, Cases and Schedules. Professional Attitudeand Goals, Concept of Excellence, Ethics in Science and Engineering, Correlation and Regression Analysis, Method of Least Squares, Regression Vs. Correlation, Correlation Vs. Determination.

UNITIV

Interpretation of Data and Report Writing, Layout of a Research Paper, Techniques o f Interpretation. Making Scientific Presentation at Conferencesand Popular Lectures to Semi Technical Audience, Participating in PubicDebates on Scientific Issues

UNITV

Nature of Intellectual property rights, Patents, designs, trademarks and copyrights, History of patenting,process of patenting, patent development, international cooperation on IPR, procedure of granting patent, patentrights, licensing and transferring technology, Geographical Indications ,IPR in biological and systems and software.

Text/ReferenceBooks:

1. *Research Methodology: Methods And Techniques - C. R. Kothari,2nd Edition, New Age Intemational Publishers.*
2. *Statistical Methods- S P.Gupta. S.chand&Sons,New Derhi.*
3. *Intellectual ProPerty-the law of trademarks, copyrights, Patents, and trade Secrets- Deborah E. Bouchoux, Esq.Georgetown University, Fourth edition*

CourseOutcomes(COs):

1. *1.Abletoknowresearchimportanceandrequirementsandprocedure*
2. *Abletoapplysamplingtechniquesforanalysisandforecasting.*
3. *Abletousemethodsfordatacollectionandanalyzethedatausing different mathematical techniques.*
4. *Abletowritereportonresearchdoneandpresenttheresearchfindings in systematic manner.*
5. *Abletohavetheknowledgetofileandobtainpatentonresearchfinding.*

SemesterII

CM21C:AntennasandRadiatingSystems

Instruction Hours/week : (L-T-P-C): 3-1-0-4 **Credits : 4**
Sessional Marks : 40 **Semester-end Examination :60**

Course Description*:To understand the fundamental principles of antenna theory and to apply them to analysis and design. Because there are so many methods of analysis and design and different antenna structures, applications are made to some of the most basic and practical configurations such as linear dipoles, loops, arrays, aperture antennas, horn antennas, microstrip antennas and reflector antennas.*

CourseObjectives:

1. *To fundamental antenna parameters and numerical methods to analyze and differentiate the antennas.*
2. *Toconceptofradiationmechanismofvariousantennas.*
3. *Tomechanismandmodelsforradio-wavepropagation.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Compute the far field distance, radiation pattern and gain of an antennafor given current distribution.*
2. *Estimatetheinputimpedance,efficiencyandeaseof match for antennas.*
3. *Compute the array factor for an array of identical antennas.*
4. *Designantennasandantennaarraysforvariousdesired radiation pattern characteristics.*

SyllabusContents:

Unit1

TypesofAntennas:Wireantennas,Apertureantennas,Microstrip antennas, Arrayantennas Reflector antennas, Lens antennas, Radiation Mechanism, Current distribution on thin wire antenna.

Fundamental Parameters of Antennas: Radiation Pattern, Radiation Power Density, Radiation Intensity, Directivity, Gain, Antenna efficiency, Beam efficiency, Bandwidth, Polarization, Input Impedance, radiation efficiency, Antenna Vector effective length, Friis Transmission equation, Antenna Temperature.

Unit2

Linear Wire Antennas: Infinitesimal dipole, Small dipole, Region separation, Finitelengthdipole,halfwavedipole,Groundeffects.

Loop Antennas: Small Circular loop, Circular Loop of constant current, Circular loop with non uniform current.

Unit3

LinearArrays: Two element array, N Element array: Uniform Amplitude and spacing,BroadsideandEndfirearray,Superdirectivity,Planararray, Design consideration.

Unit4

Aperture Antennas: Huygen's Field Equivalence principle, radiation equations,Rectangular Aperture, Circular Aperture.
HornAntennas:E-Plane,H-planeSectoralhorns,PyramidalandConicalhorns.

Unit5

MicrostripAntennas:BasicCharacteristics,Feedingmechanisms,Method of analysis, Rectangular Patch, Circular Patch, Reflector Antennas:Plane reflector, parabolic reflector, Cassegrain reflectors, Introductionto MIMO.

References:

1. *1.ConstantineA.Balanis,"AntennaTheoryAnalysisandDesign",John Wiley & Sons, 4thedition, 2016.*
2. *2.John D Kraus, RonaldJMarhefka, Ahmad S Khan, "Antennas for All Applications",TataMcGraw-Hill,2002.*
3. *3.R.C.JohnsonandH.Jasik,"AntennaEngineeringhandbook", Mc-Graw Hill, 1984.*
4. *4.I.J.BhalandP.Bhartia,"Micro-stripantennas",Artechhouse,1980.*

CM22C:Advanced CommunicationNetworks

Instruction Hours/week : (L-T-P-C): 3-1-0-4 Credits:4
Sessional Marks :40 Semester-endExamination:60

Description of the Course:*Basic techniques for modeling and analyzing communication networks. Fairness and utility functions, routing, congestion control, pricing, queuing models, loss networks, multi-class queuesand scheduling.*

CourseObjectives:

1. *Tofairnessandnetworkutilitymaximization*
2. *Tooptimizationbasedroutingandcongestioncontrol*
3. *To basic queuing models and their application to switching and scheduling in networks.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Understandadvancedconceptsin CommunicationNetworking.*
2. *DesignanddevelopprotocolsforCommunicationNetworks.*
3. *UnderstandthemechanismsinQualityofServiceinnetworking.*
4. *OptimisetheNetworkDesign*

SyllabusContents:

Unit1

Overview of Internet-Concepts, challenges and history. Overview of -ATM. TCP/IPCongestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

Unit2

Real Time Communications over Internet. Adaptive applications. Latency and throughputissues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.

Characterization of Traffic by Linearly Bounded Arrival Processes (LBAP).Leaky bucketalgorithm and its properties.

Unit3

Packet Scheduling Algorithms-requirements and choices.Scheduling guaranteed serviceconnections. GPS, WFQ and Rate proportionalalgorithms. High speed scheduler design. Theory of Latency Rate serversand delay bounds in packet switched networks for LBAP traffic.

ActiveQueueManagement-RED,WREDandVirtualclock.Control theoretic analysis of active queue management.

Unit4

IP address lookup-challenges. Packet classification algorithms and Flow Identification-Grid of Tries, Cross producting and controlled prefix expansion algorithms.Admission control in Internet. Concept of Effective bandwidth.Measurementbasedadmissioncontrol.DifferentiatedServicesin Internet (DiffServ). DiffServ architecture and framework.

Unit5

IPV4, IPV6, IP tunnelling, IPswitching and MPLS, Overview of IP over ATM and itsevolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

References:

1. *JeanWairandandPravinVaraiya,"HighPerformanceCommunications Networks", 2nd edition, 2000.*
2. *JeanLeBoudecandPatrickThiran,"NetworkCalculusATheoryof DeterministicQueueingSystemsfortheInternet",SpringerVeriag,*

2001.
3. *ZhangWang,"InternetQoS",MorganKaufman,2001.*
4. *Anurag Kumar, D. Manjunath and Joy Kuri, "CommunicationNetworking: An Analytical Approach",Morgan Kaufman Publishers, 2004.*
5. *GeorgeKesidis,"ATMNetworkPerformance",KluwerAcademic,Research Papers, 2005.*

CM23C:ProgramElective-III
1. SatelliteCommunication

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks :40 **Semester-endExamination:60**

Description of the Course:*Antennas and propagation effects play a crucial role in RF systems. In practice, the design of a working system such as mobile phone networks, WiFi, RFID, Satellite communication and GPS requiresagoodunderstandingof thesecomponents. This courseteachesthe fundamentals of antenna and propagation and shows the application in practical examples. The course covers the theory of radiation, fundamental antenna parameters and concepts, wire antennas such as dipoles and loop antennas, antenna arrays, aperture antennas, microstrip antennas,numerical analysis, communication& radar systems and propagationeffects.*

CourseObjectives:

1. *Tofairnessandnetworkutilitymaximization*
2. *Tooptimizationbasedroutingandcongestioncontrol*
3. *To basic queuing models and their application to switching and scheduling in networks.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Visualize the architecture of satellite systems as a means of high speed, high range communication system.*
2. *State various aspects related to satellite systems such as orbital equations, sub-systems in a satellite, link budget, modulation andmultiple access schemes.*
3. *Solve numerical problems related to orbital motion and design of linkbudgetforthegivenparametersandconditions.*

SyllabusContents:

Unit1:

ArchitectureofSatelliteCommunicationSystem:Principlesandarchitecture

of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications, and frequency bands used for satellite communication and their advantages/drawbacks.

Unit2:

OrbitalAnalysis:Orbitalequations,Kepler'slawsofplanetarymotion,ApogeeandPerigeeforanellipticalorbit,evaluationofvelocity,orbital period,angularvelocityetcofasatellite,conceptsofSolardayandSidereal day.

Unit3:

Satellite sub-systems: Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems, antenna sub-system.

Unit4:

TypicalPhenomenainSatelliteCommunication:SolarEclipseonsatellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift.

Unit5:

Satellite link budget: Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions, Case study of Personal Communicationsystem (satellite telephony) using LEO. Modulation and Multiple Access Schemes used in satellite communication. Typical case studies of VSAT,DBS-TV satellites and few recent communication satellites launched by NASA/ ISRO. GPS.

References:

1. *TimothyPrattandOthers,"SatelliteCommunications",WileyIndia,2nd edition,2010.*
2. *S. K. Raman, "Fundamentals of Satellite Communication", PearsonEducation India, 2011.Tri T. Ha, "Digital Satellite Communications", Tata McGraw Hill, 2009.*
3. *DennisRoddy,"SatelliteCommunication",McGrawHill,4thEdition, 2008.*

CM23C:ProgramElective-III
2. IOT and Applications
(Common to Signal processing)

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks :40 **Semester-endExamination:60**

Description of the Course:*Internet of Things (IoT) cuts across different application domain verticals ranging from civilian to defense sectors. These domainsincludeagriculture,space,healthcare,manufacturing,construction,water,a ndmining,whicharepresentlytransitioningtheir legacyinfrastructuretosupportalot.Todayitispossibletoenvision pervasiveconnectivity,storage,andcomputation,which,inturn,givesriseto building different lot solutions. IoT-based applications such as innovative shoppingsystems,infrastructuremanagementinbothurbanandruralareas, remote health monitoring and emergency notification systems, and transportationsystems,aregraduallyrelyingonIoT-basedsystems. Therefore, it is very important to learn the fundamentals of this emerging technology.*

CourseObjectives:

1. *To apprise students with basic knowledge of IoT that paves a platform to understandphysicalandlogicaldesignofIOT*
2. *Toteachastudenthowtoanalyserequirementsofvarious communication models and protocols for cost-effective design of IoT applications on different IoT platforms.*
3. *TointroducethetechnologiesbehindInternetofThings(IoT).*
4. *To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.*

SyllabusContents:

UNITI

THEINTERNETOFTHINGSTODAY,TIMEFORCONVERGENCE

M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT,The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNITII

COMPONENTSININTERNETOFTHINGS

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wi-Fi, GPS, GSM Modules)

UNITIII

PROTOCOLSANDTECHNOLOGIESBEHINDIOT

IOTProtocols-IPv6,6LoWPAN,MQTT,CoAP-RFID,WirelessSensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

UNITIV

OPENPLATFORMSANDPROGRAMMING

IOT deployment for Raspberry Pi /Arduino platform-Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving SignalsUsingGPIOPins–ConnectingtotheCloud.

UNITV

IOTAPPLICATIONS

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

COURSEOUTCOMES:

Uponcompletionofthecourse,studentswillbeableto

1. *ExplaintheconceptofIoT.*
2. *UnderstandthecommunicationmodelsandvariousprotocolsforIoT.*
3. *DesignportableIoTusingArduino/RaspberryPi/openplatform.*
4. *Applydataanalyticsandusecloudofferingsrelatedto IoT.*
5. *AnalyzeapplicationsofIoTinrealtimescenario.*

TEXTBOOKS:

1. *Dr. Ovidiu Vermesan, Dr. Peter Friess,"Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publishers, Aalborg, 2013.*
2. *Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press,2017.*
3. *SamuelGreengard,TheInternetofThings,TheMITPress,2015.*

REFERENCES:

1. *Perry Lea,"Internetofthingsfor architects",Packt,2018*
2. *OlivierHersent,DavidBoswarthick,OmarElloumi,"TheInternetof Things – Key applications and Protocols", Wiley, 2012*
3. *IOT(InternetofThings)Programming:ASimpleandFastWayof*

Learning,IOTKindleEdition.
4. *Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "ArchitectingtheInternetofThings",Springer,2011.*
5. *ArshdeepBahga,VijayMadisetti,"InternetofThings–Ahands-onapproach", Universities Press, 2015.*
6. *https://www.arduino.cc/https://www.ibm.com/smarterplanet/us/en /?ca=v_smarterplanet.*

CM23C:ProgramElective-III
3. RFandMicrowaveCircuitDesign

Instruction Hours/week : 3(L) Credits : 3
Sessional Marks :40 Semester-endExamination:60

CourseObjectives:

1. *TounderstandthebehaviourofRFpassivecomponentsmodelactive components and Perform transmission line analysis.*
2. *ToknowtheuseofSmithChartforhighfrequencycircuitdesign.*
3. *ToJustifythechoice/selectionofcomponentsfromthedesignaspects and contribute in the areas of RF circuit design*

CourseOutcomes:*Attheendofthiscourse,studentswillbeableto*

1. *UnderstandthebehaviourofRFpassivecomponentsandmodelactive components.*
2. *Performtransmissionlineanalysis.*
3. *DemonstrateuseofSmithChartforhighfrequencycircuitdesign.*
4. *Justifythechoice/selectionof componentsfromthedesignaspects.*
5. *ContributeintheareasofRFcircuitdesign.*

SyllabusContents:

Unit1

Transmission Line Theory: Lumped element circuit model for transmission line, field analysis, Smith chart, quarter wave transformer, generator and load mismatch, impedance matching and tuning.
MicrowaveNetworkAnalysis:Impedanceandequivalentvoltageandcurrent, Impedance and admittance matrix, The scattering matrix, transmission matrix, Signal flow graph.

Unit2

Microwave Components: Microwave resonators, Microwave filters,power dividersanddirectionalcouplers,Ferromagneticdevicesandcomponents.

Unit3

NonlinearityAndTimeVarianceInter-symbolinterference,randomprocess& noise, definition of sensitivity and dynamic range, conversion gain and distortion.

Unit4

Microwave Semiconductor Devices and Modeling: PIN diode, Tunnel diodes, Varactor diode, Schottky diode, IMPATT and TRAPATT devices, transferred electron devices, Microwave BJTs, GaAs FETs, low noise and power GaAs FETs, MESFET, MOSFET, HEMT.

Unit5

Amplifiers Design: Power gain equations, stability, impedance matching, constant gain and noise figure circles, small signal, low noise, high powerand broadband amplifier, oscillators, Mixers design.

References:

1. *Matthew M. Radmanesh, "Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design", AuthorHouse, 2009.*
2. *D.M.Pozar,"Microwaveengineering",Wiley,4thedition,2011.*
3. *R.Ludwig and P.Bretchko, "R. F. Circuit Design", Pearson Education Inc,2009.*
4. *G.D.Vendelin,A.M.Pavoi,U.L.Rohde,"MicrowaveCircuitDesign Using Linear And Non Linear Techniques", John Wiley 1990.*
5. *S.Y. Liao, "Microwave circuit Analysis and Amplifier Design", PrenticeHall 1987. Radmanesh, "RF and Microwave Electronics Illustrated", Pearson Education, 2004.W.H.Freeman & Co, 1978*

CM23C:ProgramElective-III
4. MIMOSystems

InstructionHours/week:3(L) Credits:3
Sessional Marks : 40 Semester-endExamination:60

Course Objectives:

1. *Tounderstandchannelmodellingandpropagation,MIMOCapacity, space-timecodingMIMOreceivers,MIMOformulti-carrier*
2. *systems (e.g. MIMO-OFDM), multi-user communications, multi-user MIMO.*
3. *Togainknowledgeunderstandcooperativeandcoordinatedmulti-cell MIMO,introductiontoMIMOin4G(LTE,LTE-Advanced,WiMAX).*
4. *ToperformMathematicalmodellingandanalysisofMIMOsystems.To build a small low-cost embedded system using Arduino / Raspberry Pi or*

equivalentboards.

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Understandchannelmodellingandpropagation,MIMOCapacity,space- time coding.*
2. *MIMOreceivers,MIMOformulti-carriersystems(e.g.MIMO-OFDM), multi-user communications, multi-user MIMO.*
3. *Understand cooperative and coordinated multi-cell MIMO, introduction toMIMOin4G(LTE,LTE-Advanced,WiMAX).*
4. *PerformMathematicalmodellingandanalysisofMIMOsystems.*

SyllabusContents:

Unit1:

Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems,MIMO vs. multi-antenna systems.Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, TheAlamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receivediversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation

Unit2:

The generic MIMO problem, Singular Value Decomposition, Eigenvalues andeigenvectors,EqualisingMIMOsystems,Disadvantagesofequalising MIMO systems, Pre-distortion in MIMO systems, Disadvantages of pre- distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of pre-coding and combining,Channelstateinformation.

Unit3

Codebooks for MIMO, Beamforming, Beamforming principles, Increased spectrumefficiency,Interferencecancellation,Switchedbeamformer,Adaptive beamformer, Narrowband beamformer, Wideband beamformer

Unit4:

Case study: MIMO in LTE, Codewords to layers mapping, Pre-coding for spatialmultiplexing, Pre-coding for transmit diversity, Beamforming in LTE, Cyclic delay diversity based pre-coding, Pre-coding codebooks, Propagation Channels, Time& frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values and time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models

Unit5:

Channel Estimation, Channel estimation techniques, Estimation andtracking, Trainingbased channel estimation, Blind channel estimation, Channel estimation architectures, Iterative channel estimation, MMSE channel estimation, Correlative channel sounding, Channel estimation in single carrier systems, Channel estimation for CDMA,Channel estimationfor OFDM.

References:

1. *ClaudeOestges,BrunoClerckx,"MIMOWirelessCommunications: From Real-world Propagation to Space-time Code Design",Academic Press, 1st edition, 2010.*
2. *Mohinder Janakiraman, "Space - Time Codes and MIMO Systems",Artech HousePublishers, 2004.*

CM24C:ProgramElective-IV
1. Random Processes and Queuing Models (Common to Signal Processing)

InstructionHours/week:3(L) **Credits:3**

SessionalMarks :40 **Semester-endExamination:60**

Prerequisites:*ProbabilityTheoryandStochasticProcesses*

Preamble:*This course is designed to provide necessary basic concepts in random processes which are widely applied in random signals, linear systems in communication engineering and IT fields. The objective of this course is to familiarize the understanding of stochastic processes and queuing models. The syllabus also covers the concepts of Markovian and advanced queueing models which are essential to design and analyze communication networks.*

CourseLearningObjectives:*Theobjectivesofthiscourseistoenablethe student to*

1. *Characterizestochasticprocesseswithanemphasisonstationary random processes.*
2. *UsethepropertiesofrandomprocesseswithLTIsystemsinrealworld situations.*
3. *UnderstandMarkovchainsandtheirtransientbehavior.*
4. *Differentiatebetweendifferentmodelsofqueuingtheoryandtheirperformance measures.*
5. *Understand network of queues with Poisson external arrivals, exponentialservicerequirementsandindependentrouting.*

CourseOutcomes:

Attheendofthecourse,thestudentswillbeableto

1. *AnalyzethevariousclassificationsofRandomProcessesandcharacterize phenomena which evolve with respect to time in a probabilistic manner.*
2. *Apply the ideas of Random Processes to the LTI Systems forSpectral analysis.*
3. *Understand Markov Chains and regenerative processes used in modeling a wide variety of systems.*
4. *Understand the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.*
5. *Analyzetheperformanceofthequeuingnetworks.*

UNITI

REVIEW OF RANDOM PROCESSES:*Classification of General Random Processes, Binomial Processes, Poisson Processes, Ergodic Process,GaussianRandomProcesses,StationaryandWideSenseStationary Random Processes, Random walks and gambler's ruin, Processes with independent increments and martingales, Brownian motion, Counting processes and the Poisson process, Stationarity, Joint properties of random processes.*

UNITII

RANDOMPROCESSESINLINEARSYSTEMSANDSPECTRALANALYSIS*:*

Basic definitions, Spectral Density Function, transfer functions and power spectral densities, Discrete-time processes in linear systems, Low Pass and Band Pass Processes, Baseband random processes, Narrowband random processes.

UNITIII

MARKOVPROCESSES:*MarkovChains,ProbabilityDistributionofaMarkov Chain, Transition Probability Matrices of a Markov Chain, Classification of States and Chains, Chapman-Kolmogorov Theorem,Stationary Distribution for a Markov Chains, Classification of States of a Markov Chain, Birth and Death Processes, Renewal Process, The Transition Probability Function, Limiting Probabilities, Exponential Distribution & Poison Process.*

UNITIV

QUEUING THEORY:*Basic Characteristics of Queueing Models, Introduction to Markovian queueing models, Steady state distribution, Little's Theorem, Cost equations, steady state probabilities, Queuing Models:* **(M/M/1) : (∞/FIFO)***Singleserverwithinfinitesystemcapacity,* **(M/M/1):(k/FIFO)**

*SingleServerwithFiniteCapacity,***(M/M/s):(∞/FIFO)***MultipleServerwith Infinite Capacity,***(M/M/s) : (k/FIFO)***Multiple Server with Finite Capacity, models balance equations, Erlang's B and C formulae,M/G/1 Queuing system characteristics,Queues with finite waiting rooms – Queues with impatient customers: Balking and reneging.*

UnitV

QUEUEINGNETWORKS:*Networkofqueuesbasicconcepts,Tandem Queues,ChannelsinSeriesorJacksonNetworks,Queuesinserieswith multiple channels at each phase, Closed Jackson Networks, Approximating Closed Networks, Open Networks with General Customer Routes, Symmetric Queues.*

TextBooks:

1. *Sheldon M. Ross, Introduction to Probability Models, 10th Edition, Elsevier, 2010.*
2. *T Veera Rajan,Probability, Statistics and Random Process, 3rd Edition, Tata Mc Graw Hill, 2008.*
3. *R.D.YatesandD. J.Goodman,"ProbabilityandStochasticProcesses: A Friendly Introduction for Electrical and Computer Engineers", 3rd Edition International Student Version, Wiley, 2014.*

ReferenceBooks:

1. *J.F.Shortle,J.M.Thompson,D.GrossandC.M.Harris,Fundamentals ofQueueingTheory,5th Edition,Wiley,2018.*
2. *J.Medhi,StochasticModelsinQueueingTheory,2nd Edition,Academic Press, 2003.*
3. *U.N.Bhat,AnIntroductiontoQueueingTheory,Springer,2015.*

CM24C:ProgramElective-IV

2. Pattern Recognition and Machine Learning (Common to Signal Processing)

Instruction Hours/week : 3(L) **Credits : 3**
SessionalMarks:40 **Semester-endExamination:60**

CourseObjectives:

1. *Tostudytheparametricandlinearmodelsforclassificationanddesign neural network and SVM for classification*
2. *Todevelopmachineindependentandunsupervisedlearningtechniques.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Study the parametric and linear models for classification*
2. *Design neuralnetwork andSVMfor classification*

3. *Developmachineindependentandunsupervisedlearning techniques.*

SyllabusContents:

Unit1

Introduction to Pattern Recognition*: Problems, applications, design cycle, learning andadaptation, examples, Probability Distributions,Parametric Learning - Maximum likelihood and Bayesian Decision Theory- Bayes rule, discriminant functions, loss functions and Bayesian error analysis*

Unit2

Linear models:*Linear Models for Regression, linear regression,logistic regression LinearModels for Classification*

Unit3

Neural Network*: perceptron, multi-layer perceptron, back propagation algorithm, error surfaces,practical techniques for improving back propagation, additional networks and training methods, Adaboost, Deep Learning*

Unit4

Linear discriminant functions -*decision surfaces, two-category, multi-category, minimum-squared error procedures, the Ho-Kashyap procedures, linearprogrammingalgorithms,Supportvectormachine*

Unit5

Algorithm independent machine learning– *lack of inherent superiority of anyclassifier,biasandvariance,re-samplingforclassifierdesign, combining classifiers*

Unsupervised learning and clustering-*k-means clustering, fuzzy k- means clustering,hierarchical clustering*

References:

1. *1.Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", 2nd Edition John*
2. *Wiley&Sons,2001.*
3. *2.Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical*
4. *Learning",2ndEdition,Springer,2009.*
5. *3.C.Bishop,"PatternRecognitionandMachineLearning",Springer,2006.*

CM24C:ProgramElective-IV
3. ProgrammableNetworks-SDN,NFV

Instruction Hours/week : 3(L) **Credits : 3**
Sessional Marks :40 **Semester-endExamination:60**

CourseObjectives:

1. *TounderstandadvancedconceptsinProgrammableNetworks,Software DefinedNetworking,anemergingInternetarchitecturalframework.*
2. *Toknowthemainconcepts,architectures,algorithms,protocolsandapplications in SDN and NFV.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *UnderstandadvancedconceptsinProgrammableNetworks.*
2. *Understand Software Defined Networking, an emerging Internet architectural framework.*
3. *Implementthemainconcepts,architectures,algorithms,protocolsand applications in SDN and NFV.*

SyllabusContents:

Unit1

Introduction to Programmable Networks, History and Evolution of Software Defined Networking (SDN), Fundamental Characteristics of SDN, Separation of Control Plane and Data Plane, Active Networking.

Unit2

Control and Data Plane Separation: Concepts, Advantages and Disadvantages, the basics of Open Flow protocol.
Network Virtualization: Concepts, Applications, Existing Network Virtualization Framework, Mininet A simulation environment for SDN.

Unit3

Control Plane: Overview, Existing SDN Controllers including Floodlight and Open Day light projects. Customization of Control Plane: Switching and Firewall Implementation using SDN Concepts. Data Plane: Software-based and Hadrware-based; Programmable Network Hardware.

Unit4

Programming SDNs: Northbound Application Programming Interface, Current Languages and Tools, Composition of SDNs. Network Functions Virtualization (NFV) and Software Defined Networks: Concepts, Implementation and Applications.

Unit5

Data Center Networks: Packet, Optical and Wireless Architectures, Network Topologies. Use Cases of SDNs: Data Centers, Internet Exchange Points, Backbone Networks, Home Networks, Traffic Engineering.

References:

1. *Thomas D. Nadeau, Ken Gray, "SDN: Software Defined Networks, An Authoritative Review of Network Programmability Technologies", O'Reilly Media, August 2013.*
2. *Paul Goransson, Chuck Black, Timothy Culver. "Software Defined Networks: A Comprehensive Approach", Morgan Kaufmann Publishers, 2016.*
3. *FeiHu,"NetworkInnovationthroughOpenFlowandSDN:PrinciplesandDesign",CRCPress,2014.*
4. *Vivek Tiwari, "SDN and OpenFlow for Beginners", Amazon Digital Services, Inc., ASIN: ,2013.*
5. *NickFeamster,JenniferRexfordandEllenZegura,"TheRoadtoSDN:AnIntellectualHistoryofProgrammableNetworks"ACMCCRApril204.*
6. *Open Networking Foundation (ONF) Documents, https://www.opennetworking.org,2015.http://www.openflow.org,*

CM24C:ProgramElective-IV
4. Remote Sensing
(Common to Signal Processing)

Instruction Hours/week : 3(L) **Credits : 3**
SessionalMarks:40 **Semester-endExamination:60**

CourseObjectives:

1. *To understand basic concepts, principles and applications of remote sensing, particularly the geometric and radiometric principles*
2. *To know the applications of principles to a variety of topics in remote sensing, particularly related to data collection, radiation, resolution, and sampling.*

CourseOutcomes:

Attheendofthiscourse,studentsshallbeableto

1. *Understand basic concepts, principles and applications of remotesensing, particularly the geometric and radiometric principles*
2. *Provide examples of applications of principles to a variety of topics in remote sensing, particularly related to data collection, radiation, resolution, and sampling.*

SyllabusContents:

Unit1

Physics Of Remote Sensing: Electro Magnetic Spectrum, Physics of Remote Sensing-Effects of Atmosphere-Scattering–Different types–Absorption-Atmospheric window-Energy interaction with surface features –Spectral reflectance of vegetation, soil and water atmospheric influence on spectral responsepatterns-multiconceptinRemotesensing.

Data Acquisition: Types of Platforms–different types of aircrafts-Manned and Unmanned space crafts–sun synchronous and geo synchronous satellites – Typesandcharacteristicsofdifferentplatforms– LANDSAT,SPOT,IRS,INSAT,IKONOS,QUICKBIRDetc.

Unit2

Photographic products, B/W,color, color IR film and their characteristics– resolving power of lens and film - Optomechanical electro optical sensors – across track and along track scanners-multispectral scanners and thermal scanners– geometriccharacteristicsofscannerimagery-calibrationof thermal scanners.

Unit3

Scattering System: Microwave scatterometry, types of RADAR –SLAR – resolution –range and azimuth –real aperture and synthetic aperture RADAR. Characteristics of Microwave images topographic effect-different types of Remote Sensing platforms –airborne and space borne sensors -ERS, JERS, RADARSAT, RISAT -Scatterometer, Altimeter-LiDAR remote sensing, principles, applications.

Unit4

ThermalAndHyperSpectralRemoteSensing:Sensorscharacteristics- principle of spectroscopy-imaging spectroscopy–field conditions, compound spectral curve, Spectral library, radiative models, processingprocedures, derivativespectrometry,thermalremotesensing– thermalsensors,principles,thermaldataprocessing,applications.

Unit5

Data Analysis: Resolution–Spatial, Spectral, Radiometric and temporal resolution-signal to noise ratio-data products and their characteristics- visual and digital interpretation–Basic principles of data processing – Radiometriccorrection–Imageenhancement–Imageclassification–Principles of LiDAR, Aerial Laser Terrain Mapping.

References:

1. *1.Lillesand.T.M. and Kiefer.R.W,"Remote Sensing and Image interpretation", 6th Edition, John Wiley & Sons, 2000.*
2. *2.JohnR.Jensen,"IntroductoryDigitalImageProcessing:ARemoteSensing Perspective", 2nd Edition, Prentice Hall,1995.*
3. *3.Richards,JohnA.,Jia,Xiuping,"RemoteSensingDigitalImage Analysis", 5th Edition, Springer-Verlag Berlin Heidelberg, 2013.*
4. *4.Paul Curran P.J.Principles of RemoteSensing, 1st Edition, Longman Publishing Group, 1984.*
5. *5.CharlesElachi,JakobJ.vanZyl,"IntroductiontoThePhysicsand TechniquesofRemoteSensing",2nd Edition,WileySerie,2006.*
6. *6.Sabins, F.F.Jr, "Remote Sensing Principles and Image Interpretation",3rd Edition, W.H.Freeman& Co, 1978*

CM25L:AntennasandRadiatingSystemsLab

Instruction Hours/week : 3(P) **Credits : 1.5**
Sessional Marks :40 **Semester-endExamination:60**

CourseObjectives:

1. *To determine specifications,design,construct and testantenna.*
2. *To explore and use tools for designing, analyzing and testing antennas. These tools include Antenna design and analysis software, network analyzers, spectrum analyzers, and antenna pattern measurement techniques.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Determinespecifications,design,constructandtestantenna.*
2. *Explore and use tools for designing, analyzing and testing antennas.These tools include Antenna design and analysis software, network analyzers, spectrum analyzers, and antenna pattern measurement techniques.*

ListofAssignments:

1. *Simulationofhalfwavedipoleantenna.*
2. *Simulationofchangeoftheradiusandlengthofdipolewireonfrequency of resonance of antenna.*
3. *Simulationofquarterwave,fullwaveantennaandcomparisonoftheir parameters.*
4. *Simulationofmonopoleantennawithandwithoutgroundplane.*
5. *Study the effect of the height of the monopole antenna on the radiation characteristics of the antenna.*

6. *Simulationof ahalfwavedipoleantenna array.*
7. *Studytheeffectofchangeindistancebetweenelementsofarrayon radiation pattern of dipole array.*
8. *Studytheeffectofthevariationofphasedifference'beta'betweenthe elementsofthearrayontheradiationpatternofthedipolearray.*
9. *Casestudy.*

CM26L:AdvancedCommunicationNetworksLab

Instruction Hours/week : 3(P) Credits : 1.5
Sessional Marks :40 Semester-endExamination:60

CourseObjectives:

1. *Toidentifythedifferenttypesofnetworkdevicesandtheirfunctions within a network.*
2. *To understand the skills of sub-netting and routing mechanisms, basic protocols of computer networks, and how they can be used to assist in network design and implementation.*

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Identifythedifferenttypesofnetworkdevicesandtheirfunctions within a network.*
2. *Understand and build the skills of sub-netting and routing mechanisms.*
3. *Understandbasicprotocolsofcomputernetworks,andhowthey can be used to assist in network design and implementation.*

ListofAssignments:

1. *StudyofNetworkingCommands(Ping,Tracert,TELNET,nslookup, netstat, ARP, RARP) and Network Configuration Files.*
2. *LinuxNetworkConfiguration.*
   a. *ConfiguringNIC'sIPAddress.*
   b. *Determining IP Address and MAC Address using if-config command.*
   c. *ChangingIPAddressusingif-config.*
   d. *StaticIPAddressandConfigurationbyEditing.*
   e. *DeterminingIPAddressusingDHCP.*
   f. *ConfiguringHostnamein/etc/hostsfile.*
3. *DesignTCPiterativeClientandServerapplicationtoreversethegiven input sentence.*
4. *DesignaTCPconcurrentServertoconvertagiventextintoupper case using multiplexing system call "select".*
5. *DesignUDPClientServertotransferafile.*
6. *ConfigureaDHCPServertoservecontiguousIPaddressestoapoolof*

four IP devices with a default gateway and a default DNS address. Integrate the DHCP server with a BOOTP demon to automaticallyserve Windows and Linux OS Binaries based on client MAC address.

a. *Configure DNS: Make a caching DNS client, and a DNS Proxy; implement reverse DNS and forward DNS, using TCP dump/Wireshark characterise traffic when the DNS server is up and when it is down.*

7. *Configure a mail server for IMAP/POP protocols and write a simpleSMTPclientinC/C++/Javaclienttosendandreceivemails.*
8. *Configure FTP Server on a Linux/Windows machine using a FTP client/SFTPclientcharacterisefiletransferrateforaclusterofsmall files 100k each and a video file of 700mb.Use a TFTP client and repeatthe experiment.*
9. *SignalingandQoSoflabeledpathsusingRSVPinMPLS.*
10. *FindshortestpathsthroughprovidernetworkforRSVPandBGP.*
11. *Understandconfiguration,forwardingtables,anddebuggingofMPLS.*

CM27C:CyberSecurity

Course Type:	**Value Added**	**Semester:**	**IISem**	**Credits:**	**3**
Course Code:	**CM27C**	**Theory:**	**2Hrs/ Week**	**Practical:**	**2Hrs/ Week**
		Assessment:	**Lab reports and written exams**	**Internal Continuous Assessment:**	**100M**

CourseOverview/Description:*Cybersecurityisperhapsthemost importanttopicintodayenvironment.Demandforcybersecurity professionalshasexploded,intheprivateandpublicsectorsalike.Student can learn how to defend information systems from cyber attacks, how torecovercompromisedsystems,howtoarchitectsecuresystemsandsomuch more. This course is focuses on the models, tools, and techniques for enforcement of security with some emphasis on the use of cryptography. Studentswilllearnsecurityfrommultipleperspectives.*

CourseLearningObjectives:

1. *To prepare students with the technical knowledge and skills needed to protect and defend computer systems and networks from cyber security attacks.*
2. *Todevelopgraduatesthatcanplan,implement,andmonitorcyber securitymechanismstohelpensuretheprotectionofinformation*

technologyassets.

3. *To develop graduates that can identify, analyze, and remediate computer security breaches.*

CourseOutcomes:*Aftercompletingthiscoursestudentwillbe:*

1. *Be able to understand the basic terminologies related to cyber security and current cyber security threat landscape. They will also develop understanding about the Cyber warfare and necessity to strengthen the cyber security of end user machine, critical IT and national critical infrastructure.*
2. *Have complete understanding of the cyber attacks that target computers, mobiles and persons. They will also develop understanding about the type and nature of cyber crimes and as to how report these crimes through the prescribed legal and Government channels.*
3. *Be able to understand the legal framework that exist in India for cyber crimes and penalties and punishments for such crimes, It will also expose students to limitations of existing IT Act, 2000 legal framework that is followed in other countries and legal and ethical aspects related to new technologies.*
4. *Understand the aspects related to personal data privacy and security. They will also get insight into the Data Protection Bill, 2019 and data privacy and security issues related to Social media platforms.*
5. *Understandthemaincomponentsofcybersecurityplan.Theywillalso getinsightsintorisk-basedassessment,requirementofsecurity controlsandneedforcybersecurityauditandcompliance.*

Unit-IOverviewofCybersecurity

Cyber security increasing threat landscape, Cyber securityterminologies-Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protectionof end user machine, Critical IT and National Critical Infrastructure, Cyber warfare, Case Studies.

Unit-IICyberCrimes

Cyber crimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans,ransomware,databreach.,Onlinescamsandfrauds-emailscams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/credit card fraud, Online payment fraud, Cyber bullying, websitedefacement, Cyber squatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams& Frauds-impersonation, identity theft, job scams, misinformation, fake news cyber crime against persons - cyber grooming, childpornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies.

Unit-IIICyberLaw

Cyber crime and legal landscape around the world, IT Act, 2000 and its amendments,LimitationsofITAct,2000,Cybercrimeandpunishments, CyberLawsandLegalandethicalaspectsrelatedtonewtechnologies-

AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies.

Unit-IVDataPrivacyandDataSecurity

Defining data, meta-data, big data, non-personal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations(GDPR), 2016 Personal Information Protection and Electronic Documents Act (PIPEDA), Social media- data privacy and security issues.

Unit-VCybersecurityManagement,ComplianceandGovernance:

Cyber security Plan- cyber security policy, cyber crises managementplan, Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy.

PracticalWork

Thepracticallisthasbeensuggestedfortheapplicablemodules;however, the faculty may expand the list as per the syllabus content duly taking into considerationtheemergingnatureofcyberthreatsandincumbentprotectivemeasures toguardagainstsuchthreats.

PracticallistofExperiments:

1. *Platformsforreportingcybercrimes.*
2. *Checklistforreportingcybercrimesonline.*
3. *Settingprivacysettingsonsocialmediaplatforms.*
4. *Do'sandDon'tsforpostingcontentonSocialmediaplatforms.*
5. *Registeringcomplaints on a Social media platform.*
6. *Preparepasswordpolicyforcomputerandmobiledevice.*
7. *Listoutsecuritycontrolsforcomputerandimplementtechnicalsecurity controls in the personal computer.*
8. *Listoutsecuritycontrolsformobilephoneandimplementtechnicalsecuritycontrols inthepersonalmobilephone.*
9. *Logintocomputersystemasanadministratorandcheckthesecurity policies in the system.*

TextBooks/References:

1. *Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.*
2. *InformationWarfareandSecuritybyDorothyF.Denning,AddisonWesley.*
3. *Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space IndependentPublishing Platform.*
4. *Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.*

5. *InformationSecurityGovernance,GuidanceforInformationSecurity Managers by W. KragBrothy, 1st Edition, Wiley Publication.*
6. *AuditingITInfrastructuresforComplianceByMartinWeiss,MichaelG. Solomon, 2nd Edition, Jones Bartlett Learning.*

CM28M:MiniProjectWithSeminar

Instruction Hours/week : 4(P) Credits:2
Sessional Marks : 100 Semester-endExamination:-

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Understandofcontemporary/emergingtechnologyforvariousprocesses and systems.*
2. *Shareknowledgeeffectivelyinoralandwrittenformandformulate documents.*

SyllabusContents:

The students are required to search / gather the material / information on a specific a topic comprehend it and present / discuss in the class.

SemesterIII&IV
(Dissertation)DissertationPhase-I,Phase-IIandViva-Voce

Instruction Hours/week : 24+20(P) Credits:12+16
Sessional Marks :40+40 Semester-endExamination:60+60

CourseOutcomes:

Attheendofthiscourse,studentswillbeableto

1. *Abilitytosynthesizeknowledgeandskillspreviouslygainedandapplied toanin-depthstudyandexecutionofnewtechnicalproblem.*
2. *Capabletoselectfromdifferentmethodologies,methodsandformsof analysistoproduceasuitableresearchdesign,andjustifytheirdesign.*
3. *Abilitytopresentthefindingsoftheirtechnicalsolutionina written report.*
4. *PresentingtheworkinInternational/Nationalconferenceor reputed journals.*

SyllabusContents:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the worldofworkandtheworldofstudy.Thedissertationshouldhavethe

following

- *Relevancetosocialneedsofsociety*
- *Relevancetovalueadditiontoexistingfacilitiesintheinstitute*
- *Relevancetoindustryneed*
- *Problemsofnationalimportance*
- *Researchanddevelopmentinvariousdomain*

Thestudentshouldcompletethefollowing:

- *LiteraturesurveyProblemDefinition*
- *MotivationforstudyandObjectives*
- *Preliminarydesign/feasibility/modularapproaches*
- *ImplementationandVerification*
- *Reportandpresentation*

ThedissertationstageIIisbasedonareportpreparedbythestudentson dissertationallottedtothem.Itmaybebasedon:

- *Experimentalverification/Proofofconcept.*
- *Design,fabrication,testingofCommunicationSystem.*
- *Theviva-voceexaminationwillbebasedontheabovereportand work.*

GuidelinesforDissertationPhase-IandIIatM.Tech.(Electronics):

- *As per the AICTE directives, the dissertation is a yearlong activity, to be carriedoutandevaluatedintwophasesi.e.Phase–I:Julyto December and Phase – II: January to June.*
- *Thedissertationmaybecarriedoutpreferablyin-housei.e. department's laboratories and centers OR in industry allotted through department's T & P coordinator.*
- *After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertationobjectives.Thereferredliteratureshouldpreferablyinclude IEEE/IET/IETE/Springer/Science Direct/ACM journals in the areas of Computing and Processing (Hardware and Software), Circuits-Devices and Systems, Communication-Networking and Security, Robotics and Control Systems, Signal Processing and Analysis and any other related domain. In case ofIndustry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.*
- *Student is expected to detail out specifications, methodology, resources required,criticalissuesinvolvedindesignandimplementationand phase wise work distribution, and submit the proposal within a month from the date of registration.*
- *Phase–Ideliverables:Adocumentreportcomprisingofsummaryof*

literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.

- *Phase – I evaluation: A committee comprising of guides of respective specializationshallassesstheprogress/performanceofthestudent based on report, presentation and Q& A. In case of unsatisfactory performance,committeemayrecommendrepeatingthePhase-Iwork.*
- *During phase – II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.*
- *Phase – II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, a record of continuous progress.*
- *Phase – II evaluation: Guide along with appointed external examiner shall assess the*
- *progress/performanceofthestudentbasedonreport,presentationand Q&A.Incaseofunsatisfactoryperformance,committeemay recommend for extension or repeating the work.*

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