MA65004: LINEAR ALGEBRA, PROBABILITY THEORY AND OPTIMIZATION

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Use matrix analysis concept to solve communication problem.
2. Understand the concept of vector space.
3. Use the probability and random process concept in network.
4. Implement the calculus concept in wireless communication.
5. Apply the optimization technique in network.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	1	0	4	0	70	30	0	0	100

UNIT-1: Matrix Analysis: Basic Concepts, type of matrices, scalar multiplication, matrix multiplication, properties, hadamard product, inverse, rank, system of linear equations, linear transformation, eigenvalues & eigenvectors, positive definite matrix, Principle component analysis, Singular value decomposition.

UNIT-2: Vector Space: Definition, scalars, addition, scalar multiplication, inner product(dot product), vector projection, cosine similarity, orthogonal vectors, normal and orthonormal vectors, vector norm, vector space, subspace, linear combination, linear span, linear independence, basis and dimension.

UNIT-3: Probability: Events, sample space, dependent and independent events, conditional probability, Random variables- continuous and discrete, expectation, variance, binomial, Bernoulli, Poisson, exponential, Gaussian distributions, random process, Markov Chain- definition, transition matrix, stationary.

UNIT-4: Calculus: Differentiation, chain rule, partial derivatives, total differentiation, implicit differentiation, Jacobian, gradient, directional derivative, Expansion of functions by Taylor's and Maclaurin's series of one and two variables.

UNIT-5: Optimization: Maxima and minima, saddle point, Lagrange's method of undetermined multipliers and their applications, non-linear optimization, Kuhn-Tucker condition, Fibonacci search, quadratic interpolation optimization, evolutionary algorithms

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. S. Lipschutz & M. Lipson, Schaum's outlines on Linear Algebra, McGraw Hill Education, 2005.
2. Scott Miller & Donald childers, Probability and Random Processes with Applications to Signal Processing and Communications, Elsevier Science, 2004.
3. James Stewart, Calculus, Brooks/Cole; International ed edition, 2003.

EC65005: WIRELESS AND MOBILE COMMUNICATION

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques.
2. Understand path loss and fading over wireless channel
3. Study Error performance of wireless system and their influences on system's performance.
4. Analyze fading mitigation techniques and their implementation.
5. Learn basics of emerging technologies recommended for Next Generation wireless systems.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Cellular Communication Fundamental s: Concept of spectral efficiency, Cellular system design, Frequency reuse, cell splitting, handover, Co channel and adjacent channel interference, Techniques and methods to improve cell coverage, Frequency management and channel assignment.GSM architecture and interfaces, GSM subsystems, GSM Channels and frame structure.

UNIT-2: Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection (Two-Ray) Model, Path Loss Models, Outdoor and Indoor Propagation Models, Shadowing, Small Scale Fading and Multipath Propagation, key channel parameters like Time Delay Spread; Doppler spread , lcr, AFD etc and classification of channel based on these parameters.

UNIT-3: BER performance of communication System: Performance in AWGN channel for different modulation techniques, BER performance of various wireless channel such as Rayleigh, MIMO system and Receiver, BER performance of Multi antenna system.

UNIT-4: Fading mitigation techniques -Diversity techniques, space, time, code, polarization, frequency diversity, Interleaving, Equalizers in a communications receiver, Algorithms for adaptive equalization.

UNIT-5: Introduction to CDMA, OFDM Technology, Speech coders, 5G and beyond technologies, Regulatory bodies for spectrum management.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1.Principles of Modern Wireless communication Systems, theory and practice, Aditya K. Jagannatham, McGraw Hill Education.

2.T.S.Rappaport, "Wireless Communications Principles and Practice", 2nd edition, PHI,2002.

3.Andreas F. Molisch, Wireless Communications, 2nd ed., 2001, Wiley Pub.

REFERENCE BOOKS RECOMMENDED:

1. Wilkis and Garg, Principles of GSM Technology, 2nd ed. 2004, PHI.

2. David Tse and Pramod Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005.

3. Ramji Prasad and Richard Van Nee, OFDM Wireless Multimedia Communication, 2nd ed.1998, Artech House.

EC65006: MODERN COMMUNICATION NETWORKS

COURSE OUTCOMES:
At the end of this course students will demonstrate the ability to:
1. Understand advanced concepts in Communication Networking.
2. Design and develop protocols for Communication Networks.
3. Understand the mechanisms in Quality of Service in networking.
4. Optimize the Network Design.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Overview of Internet-Concepts, challenges and history. Overview of - ATM. IPV4, IPV6, TCP/IP Congestion and Flow Control in Internet-Throughput analysis of TCP congestion control. TCP for high bandwidth delay networks. Fairness issues in TCP.

UNIT-2: Introduction to IP routing and services: Routing algorithms, various interior Gateway protocols like RIP, OSPF, and Routing among the ISPs using BGP. IP Services: Network Management with SNMP

UNIT-3: IP tunneling, IP switching and MPLS, Overview of IP over ATM and its evolution to IP switching. MPLS architecture and framework. MPLS Protocols. Traffic engineering issues in MPLS.

UNIT-4: Real Time Communications over Internet. Adaptive applications. Latency and throughput issues. Integrated Services Model (intServ). Resource reservation in Internet. RSVP.; Admission control in Internet. Concept of Effective bandwidth. Measurement based admission control. Differentiated Services in Internet (DiffServ). DiffServ architecture and framework. Leaky bucket algorithm and its properties.

UNIT-5: Packet Scheduling Algorithms-requirements and choices. Scheduling guaranteed service connections. GPS, WFQ and Rate proportional algorithms. High speed scheduler design. Active Queue Management - RED, WRED and Virtual clock. Control theoretic analysis of active queue management.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. Comer, *Internetworking with TCP/IP Vol. 1,* PHI.

2. Stalling W., *Data and Computer Communication*, PHI. Forouzan B., *Data Communication and Networking*, TMH.

3. Forouzan B., *Data Communication and Networking*, TMH.

4. Jean Wairand and Pravin Varaiya, "High Performance Communications Networks", 2nd

edition, 2000.

5. Jean Le Boudec and Patrick Thiran, “Network Calculus A Theory of Deterministic Queueing Systems for the Internet”, Springer Veriag, 2001.

6. Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001.

ELECTIVE-I
EC65205: INFORMATION THEORY AND CODING

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Design efficient source code for discrete memory less source and source with memory.
2. Calculate the channel capacities of discrete and continuous channel and understand trade off using Shannon's theorem.
3. Construct Galois field and describe their properties.
4. Construct binary and non-binary codes for error detection and correction in transmitted data and investigate their performance.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: **Information theory and Source coding:** Uncertainty, information, entropy and its properties, entropy of binary memoryless source and its extension to discrete memoryless source, source coding theorem, data compression, prefix coding, Huffman, Shannon Fano, Arithmetic, Adaptive coding, RLE, Lempel-Ziv coding:LZ-78, LZ-77, LZW Data Compaction, Source with memory and its entropy.

UNIT-2: Discrete channels: Binary Symmetric Channel, mutual information & its properties, Channel capacity, channel coding theorem and its application to BSC, Shannon's theorem on channel capacity, capacity of a channel of infinite bandwidth, bandwidth - S/N trade off, Differential entropy and mutual information for continuous ensembles, practical communication systems in light of Shannon's theorem, Fading channel, channels with memory.

UNIT-3: Groups, Ring, fields and Linear block codes: Galois field and its construction in GF (2^m) and its basic properties, GF addition, multiplication rules, Primitive elements, minimal polynomials vector spaces and matrices in GF(2), Linear block codes, systematic codes and its encoding circuit, syndrome and error detection, minimum distance, error detecting and correcting capabilities of block code, decoding circuit, probability of undetected error for linear block code in BSC, Hamming code and their applications.

UNIT-4: Cyclic codes and Introduction to BCH codes: Basic properties of Cyclic codes, Generator and parity check matrix of cyclic codes, encoding and decoding circuits, syndrome computation and error detection, cyclic Hamming codes, Introduction to BCH codes, Generator polynomials in terms of minimal polynomials, some examples of BCH codes and decoder, Reed-Solomon codes and decoder, Implementation of Reed Solomon encoders and decoders.

UNIT-5: Convolutional codes: Introduction to Convolutional code, its construction and Viterbi algorithm for maximum likelihood decoding. Automatic repeat request strategies and their throughput efficiency considerations, MAP decoding of Convolutional codes, Turbo codes and decoding, LDPC codes.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam.

TEXT BOOKS RECOMMENDED:

1. Lathi B. P., Modern Analog and Digital Communication Systems, Oxford Univ. Press

2. Shu Lin and Costello, Error Control Coding : Theory and Application, PH.

3. Sklar, Digital Communication, Pearson Education Asia.

5. Zhang Wang, “Internet QoS”, Morgan Kaufman, 2001.

REFERENCE BOOKS RECOMMENDED:

1. Haykins Simon, Digital Communication, Wiley Publ.

2. Proakis, Digital Communication, McGraw Hill

3. Schaum’s Outline Series, Analog and Digital Communication.

EC65206: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Study the parametric and linear models for classification.
2. Design neural network and SVM for classification.
3. Develop machine independent and unsupervised learning techniques.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Introduction to Pattern Recognition: Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning-Maximum likelihood and Bayesian Decision Theory- Bayes rule discriminant functions, lossfunctions and Bayesian error analysis.

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UNIT-2: Linear models: Linear models for Regression, Linear regression, Logistic regression linear models for Classification

UNIT-3: 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.

UNIT-4: Linear discriminant functions: Decision surfaces, two-category, multi-category, minimum squared error procedures, the Ho-Kashyap procedures, linear programming algorithms, Support vector machine.

UNIT-5: Algorithm independent machine learning: lack of inherent superiority of any classifier, bias and variance, re-sampling for classifier design, combining classifiers.

UNIT-6: Unsupervised learning and clustering: k means clustering, fuzzy k-means clustering, hierarchal clustering.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. Richard O Duda, Peter E. Hart, David G. Stork, Pattern Classification,", 2nd Edition John Wiley and Sons, 2001.

2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, 'The Elements of Statistical Model Curriculum of Engineering & Technology PG Courses [Volume 11] [332] Learning", 2nd Edition, Springer, 2009.

3. C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

ELECTIVE-II
EC65306: VOICE AND DATA NETWORKS

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Understand theoretical limits and issues in design of communication systems and voice/data networks, Asynchronous and Synchronous transmission systems, DTE-DCE interface, polling systems.
2. Design issues in error detection and correction codes, Elements of Galois field, CRC code and its error detection properties,
3. Link layer design, sliding window protocols as ARQ and flow control, their performance analysis in noiseless and noisy channel
4. Switched networks and routing protocols, Multiple access techniques in broadcast networks, Design, analysis and performance evaluation.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Review of data communication: Information and its quantization (Hartley), channel impairments, capacity of noiseless and AWGN channel, wireless link design calculations, PCM Voice digitization and multiplexing standards (E1, E3), asynchronous and synchronous transmission, framing errors, character and bit oriented frames, Unicode characters and IPV4 frame as examples.

UNIT-2: Multipoint links and error detection: Cyclic polling systems and their performance, performance analysis of character oriented frame with single bit parity, vertical and longitudinal parity checks, CRC code, its generation and error detection capability, RS-232C, null modem, USART, X.21

UNIT-3: Link level flow control: Logical link control, stop and wait and sliding window protocols (Go back N and selective repeat), corrective actions for damaged frame, window size and its control, performance of ARQ techniques in systems without and with bit errors, HDLC protocol frames and basic characteristics, Cross layer issue like AMC techniques

UNIT-4: Switching techniques and routing: Circuit, message and packet switching, Virtual circuits and datagrams, Dijkstra's Least cost routing algorithm, Flooding and adaptive routing, QoS parametes and traffic class (CBR, ABR), Congestion control and dead locks, their avoidance

UNIT-5: Multiple access techniques: Controlled and random access, Aloha and slotted Aloha, their performance analysis, CSMA, CSMA/CD, introduction to WLAN

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. Stallings W., 'Data and computer communication', Prentice Hall of India.

2. Tanenbaum A., 'Computer networks', Pearson edu.

3. Keshav S., 'An engineering approach to computer networking', Addison Wesley

REFERENCE BOOKS RECOMMENDED:

1. Kurose and Ross, 'Computer networking : Top down approach', Pearson edu.

2. Shay W., 'Understanding data communication and networks', Thomson edu.

3. Anurag Kumar, Manjunath, Joy Kury, ' Communication networks : An introduction to analytical approach', Elsevier

4. Bellamy J., 'Digital telephony', Wiley publ.

ADDITIONAL READING :

1. Hartley R., 'Transmission of information', BSTJ, pp 535 – 563, 1928
2. Shannon C. E., 'Communication in presence of noise'. Proc. IRE, pp 10-21, 1949

EC65307: GAME THEORY IN WIRELESS COMMUNICATION

PRE-REQUISITES: - Mathematics, Probability theory, Communication engineering.

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. To Introduce basic concepts of game theory
2. To understand Different types of Games and their fundamentals.
3. To have necessary background of Game theory to design wireless systems.
4. To study various Games and to identify their suitability in wireless comm.
5. To apply Game theoretic approach for various functionalities in wireless network.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Introduction to game theory: Prisoner's dilemma, Nash Equilibrium, Mixed strategy Nash equilibrium, Co-operative and Non co-operative games, zero-sum & nonzero-sum games. Types of strategies, Saddle point (Equilibrium) point, rules of determining a saddle point. Optimal strategies.

UNIT-2: Non-cooperative Game Theory: Game in Normal form and extensive form , Analysing Games, Pareto optimality , Maxmin and Minmax strategies.

UNIT-3: Stochastic games, Bayesian games, Computing equilibria,concept of Shapely value.

UNIT-4: Coalition Game Theory and algorithmic game theory: Basic concepts and analysis, Transferable Utility, Analyzing Coalitional Games.

UNIT-5: Application in Wireless Networks: Game theoretic approach used in Resource Allocations, Routing and Power Control, Radio Spectrum management.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1.Zhu Han, Game Theory in Wireless and Communication Networks: Theory, Models, and Applications,1edition.

2. Y Narahari, Game Theory and Mechanism Design.

REFERENCE BOOKS RECOMMENDED:

1. Noam Nisan and Tim Rough garden , Algorithmic Game Theory, September 2007.

EC65308: ADVANCED DIGITAL SIGNAL PROCESSING

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. To understand theory of different filters and algorithms.
2. To understand theory of multi-rate DSP, solve numerical problems and write algorithm.
3. To understand theory of prediction and solution of normal equations
4. To know applications of DSP at block level.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Overview of DSP: Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

UNIT-2: Multi rate DSP and Wavelets: Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Application of Multi rate DSP, Applications in sub-band coding. Introduction to wavelets, application to image processing.

UNIT-3: Optimum linear filters and prediction: Review of random signals, random processes, Power spectral densities, some useful random process models, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener filters for filtering and prediction, Application of DSP in speech processing.

UNIT-4: Adaptive Filters: Principles of adaptive filters, Method of steepest descent, LMS adaptive filters, Recursive Least Square adaptive filters, typical Applications of adaptive filters.

UNIT-5: Spectrum estimation: Estimation of mean, variance, covariance and ACRS/ACVS, Estimation of spectra from finite-duration observations of signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation..

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. J.G.Proakis and D.G.Manolakis, "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.

2. N.J.Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks – Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.

3. Bruce W. Suter, “Multirate and Wavelet Signal Processing”,1st Edition, Academic Press, 1997.

4. M.H.Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley & Sons Inc., 2002.

5. S.Haykin, “Adaptive Filter Theory”, 4th Edition, Prentice Hall, 2001.

6. D.G.Manolakis, V.K. Ingle and S.M.Kogon, “Statistical and Adaptive Signal Processing”, McGraw Hill, 2000

EC-65453 ADVANCE COMMUNICATION LAB

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Apply MATLAB for various mathematical operations, functions.
2. Analyze and plot different signals used in communication systems using MATLAB /SIMULINK
3. Analyze and design discrete-time LTI systems by applying various transforms using MATLAB /SIMULINK.
4. Analyze and design different communication systems using MATLAB /SIMULINK.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
0	0	4	0	2	-	-	40	60	100

Introduction to MATLAB: Variables, Vectors, Matrices and functions in MATLAB, Study of various MATLAB arithmetic operators and mathematical functions, Creation of m-files.

Analysis using MATLAB: Basic plotting of signals. Plotting of Continuous time and discrete time signals. Commands for creating two- and three-dimensional plots. Plotting elementary signals: Step Function, Impulse Function, Exponential Function, Ramp Function, Sine Function etc., transformations in Time and Amplitude of signals. Convolution of signals, Linear convolution of sequences. Autocorrelation and Cross-correlation.

Signal Transformation operation: Fourier Series and Gibbs Phenomenon. Calculation of Fourier Series coefficients associated with Square Wave, Calculation of different transform using MATLAB: Fourier Transform and Z-transform, Impulse response, Step response of a given system equation, Frequency response of a system, magnitude and phase response of a given system, DFT, FFT

Digital Signal Processing: Circular convolution, Design of FIR, IIR filters, Estimation of PSD, Sampling rate conversion, Spectrum estimation using AR process, Realization of digital system.

Introduction to SIMULINK: Checking Linearity/Non-Linearity of a system using SIMULINK, Build a system that amplifies a sine wave by a factor of two. Test the linearity of this system using SIMULINK.

Analysis of different Communication System: Realization of Matched Filter, Simulation of ASK, FSK, BPSK, DPSK, QPSK and QAM generation schemes. Simulation of signal constellations of BPSK, QPSK and QAM. Detection schemes of ASK, FSK and BPSK, OFDM. Simulation of Linear Block and Cyclic error control coding schemes. Simulation of Convolutional coding scheme. Communication link simulation.

ASSESMENT:- Internal viva, Continuous evaluation of experiments, Journal write-up, and Additional experiments conducted, Quiz, End semester exam.

LIST OF EXPERIMENTS

1. To define/create and use variables, functions, Vectors, Matrices, logical operators and m-files in MATLAB.
2. To study basic operations on Matrices, in MATLAB,
3. To apply various MATLAB commands for creating two- and three-dimensional plots.
4. Write MATLAB programs to plot the following Continuous time and discrete time signals a. Step Function b. Impulse Function c. Exponential Function d. Ramp Function e. Sine Function f. Periodic waveforms.
5. Write MATLAB programs to perform amplitude-scaling, time-scaling and time shifting on a given signal.
6. Write a MATLAB program to obtain linear convolution of the given sequences.
7. To calculate Fourier Series coefficients and plot their summations associated with Square Wave to study Gibbs phenomenon.
8. Write MATLAB programs for computation of DFT, FFT (Decimation in time, Decimation in frequency).
9. Write MATLAB programs for computing Spectrum of signals using FFT.
10. Calculating various transforms of signals using MATLAB.
11. Write a MATLAB program to find the impulse response and step response of a system from its difference equation and compute, plot the response of a given system to a given input.
12. Write a MATLAB program to find and plot pole-zero diagram, bode diagram, magnitude and phase response of a given system from the given system function.
13. Write MATLAB programs for design of FIR filters (Low Pass, High Pass) using various windowing techniques.
14. Write MATLAB programs for design of Butterworth Digital IIR filters.
15. Write MATLAB programs for transforming an Analog into Digital filter using Impulse invariant technique and Bilinear transformation technique.
16. Write a MATLAB program for estimation of Power Spectral Density(PSD) of sum of two sinusoids.
17. Write MATLAB programs for Sampling, Quantization, PCM, DM.
18. Analysis of ASK, FSK, BPSK, QPSK and QAM modulation schemes using SIMULINK.
19. Write a MATLAB program for Linear Block Code decoding technique.
20. Write a MATLAB code for OFDM transmission of QAM signals.

REFERENCE BOOKS:

1. 'Getting started with MATLAB' by Rudra Pratap, Oxford University Press, Inc.
2. D.G. Manolakis and V.K. Ingle Applied Digital Signal Processing: Theory and Practice, Cambridge, University Press, 2011.
3. S.K. Mitra, Digital Signal Processing: A computer based approach.TMH.
4. S. Salivahanan, Digital Signal Processing 3rd edition, Mc Graw Hill Publications.
5. 'Contemporary Communication Systems', by M.F. Mesiya, Mc Graw Hill Publications.
6. 'Modern Digital and Analog Communication Systems' by Lathi & Ding, 4th edition Oxford University Press.
7. 'Problem-Based Learning in Communication Systems using MATLAB and Simulink, by Kwonhue Choi & Huaping Liu.

EC-65454 NETWORK DESIGN AND SIMULATION LAB

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Install and administer a LINUX based network.
2. Configure various network interfaces required for a network
3. Create an automation of tasks using shell scripting.
4. Analyze the performance of a network using network simulator.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
0	0	4	0	2	-	-	40	60	100

Syllabus Contents:

Linux installation : Distribution of Linux & its installation, Unix directory super structure, Creation and deletion of partitions, file systems, formatting, mounting, and booting, addition and removal of packages.

Introduction to Linux system administration: Linux file system standards, creation and deletion of user and group under supervisor mode, various log files in Unix. Basic Unix Commands. User account, file ownerships, various file permissions.

Networking interfaces and configuration: Various networking devices and their interfacing. UNIX network commands and configuring TCP, FTP. Text editor, Vi editor and advance editor.

Shell Scripting: Process and Environment Variables: Elements of shell programming, environmental variables and their settings, export of variables, regular expressions and its usage, brief study of awk, sed, at and writing small cron jobs.

Network Simulators; Features of network simulator package (e.g. NS2/NS3) for various types of traffic generation, queuing and aggregate performance. Report generation and its graphical presentation using report generation packages like latex.

ASSESMENT:- Internal viva, Continuous evaluation of experiments, Journal write-up, and Additional experiments conducted, Quiz, End semester exam.

PRACTICALS: LIST OF EXPERIMENTS

1. Linux installation, addition and Removal of Packages
2. Basic and advance LINUX commands.
3. Change of permission using UNIX commands.
4. Text edition using Vi editor and VIM
5. Programming using shell script & awk script.
6. Configuring the FTP services on a LINUX machine
7. Installation of network simulator 2 on a Linux environment.
8. Performance analysis of a network using NS2/NS3
9. Configuration and installation of LATEX on window environment.
10. Report generation using LATEX.

Text Books Recommended :

1. Das Sumitabh, UNIX Concepts and Applications, TMH.
2. Strobel and Elling, Linux: Unleashing the workstation in your PC, Springer.
3. Kanetkar, UNIX shells programming, BPB Publ.
4 Moris & Mcgilton, UNIX system V, MGH
5. Kochen and Wood, Exploring UNIX system V, PHI.
6. Buerger D. J., Latex for engineers and scientists, MGH.

Reference Books Recommended:

1. Card, Dumas and Mevel, The linux kernel book, John wiley.
2. Campbell Richard, Managing Andrew file system, PH.
3. Mann and Mitchell, Linux system security, PH.
4. Bach, Unix system V
5. Leslie Lamport, Latex, a document preparation system, Addison Wesley.
6. www.isi.edu/nsnam/ns, www-mash.cs.berkeley.edu/ns, Mobile network simulator - www.icsi.berkeley.edu/~widmer/mnav/ns-extensions

EC65504: SDR AND COGNITIVE RADIO

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. To understand the evolving software defined radio and cognitive radio techniques and their essential functionalities.
2. To study the basic architecture and standard for cognitive radio.
3. To understand the physical, MAC and Network layer design of cognitive radio.
4. To expose the student to evolving applications and advanced features of cognitive radio.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Introduction to Software Defined Radio: Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications, Introduction to Software Communication Architecture (SCA), Application of SCA,SCA and Non SCA Waveform Development.

UNIT-2: SDR Architecture: Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules. SDR Waveform development, SDR Hardware and software tools and programming.

UNIT-3: Introduction to Cognitive Radio: Cognitive Radio - functions, components and design rules of Cognitive Radio, Cognitive radio architecture ,Spectrum analysis and decision, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software Defined Radio Architecture. Potential applications of cognitive radio.

UNIT-4: Spectrum Sensing: Spectrum Sensing, Detection of Spectrum holes(TVWS),collaborative sensing, geo- location database, dynamic spectrum access (DSA), spectrum broker, cognitive radio architectures, distributed dynamic spectrum access, learning algorithms and protocols.

UNIT-5: Next Generation Wireless Networks: The XG Network architecture, Network layer and transport layer issues, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design for cognitive radio Networks.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, Cognitive Radio Communications and Networks, Academic Press, Elsevier, 2010.

2. Huseyin Arslan (Ed.), Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.

EC65505: ADVANCED ANTENNA THEORY AND DESIGN

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Learn approach for mathematical modelling of electromagnetic antenna problems.
2. Basic concepts of design of antennas.
3. Concepts of Design of microwave components etc.
4. Application of numerical techniques in Antenna Design.
5. Learn Practical design of various antennas through simulator.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Introduction to Green's Function Technique: Solution of partial differential equation classification, symmetry property, conventional and scattering superposition methods, analysis of various antennas. Scalar and dyadic Green's function: Determination of various green's function for various open and closed boundary problems like rectangular wave guide antenna, cavity antenna, and patch antennas.

UNIT-2: Finite Difference Time Domain (FDTD): Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules. SDR Waveform development, SDR Hardware and software tools and programming.

UNIT-3: Perturbation and Variational Techniques: Stationary formula for waveguide, the antenna cavity problems, and other electrostatic problems. Classification of variational methods; direct method like Rayleigh Ritz and indirect method like weighted residuals, point matching, sub domain, Gelerkin and least square methods.

UNIT-4: Method of Moment (MOM): General method of moments for the solution of operator equation, Application of MOM in electrostatic problems like strip transmission lines etc. Application of MOM in scattering problems (conducting cylinder and parallel wire), Application to MOM Radiation problems i.e. wire antenna, cylinder antennas, patch antenna and Design using MOM like MIMO, Terahertz Antennas. Application to MOM in EM absorption in the human body.

UNIT-5: Finite Element Method (FEM): Solution of Laplace's Equation, Poisson's equation, Wave Equations. Automatic mesh Generation; Rectangular domain and arbitrary domain. FEM with higher order elements and three dimensional elements FEM for exterior Problems; Infinite element method, boundary element methods, and absorbing boundary conditions. Finite Element Methods and its application to various electromagnetic Design problems like wire antenna, patch antenna, antenna array, MIMO, Terahertz Antennas etc.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. Antenna Theory and Design : Warren L. Stutsman Gary A. Thiele , Wiley Publication.

2. Mathew N.O. Sadiku, Numerical Techniques in Electromagnetic, II edition, CRC press.

3. Ramesh Garg, Computational methods in Electromagnetic, CRC press.

4. Roger F. Harrington, Field computation by Moment Methods, Oxford university press.

REFERENCE BOOKS RECOMMENDED:

1. Collin R.E., Antennas & Wave Propagation, 3rd ed., 2001, McGraw Hill.

2. Roger F. Harrington, Introduction to Electromagnetic Engineering. Dover Publication.

3. Dean G. Duffy, Green's functions with Applications, CRC press.

4. Chen to Tai, Dyadic greens function in Electromagnetic Theory, Intent Education publication.

EC65506: INTERNET OF THINGS

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Understand the architecture and various communication protocols to be used for wireless sensor network based systems and applications.
2. Handle special issues related to WSN like data dissemination, energy conservation and security challenges.
3. Understand IoT architecture and Networking Protocols
4. Able to design End-to-End Solution, research scope and familiarize with current developments.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: WSN: Architecture, applications. Sensor node architecture, connectivity and topology. Hardware and software descriptions of real time sensor node. WSN protocols on Physical, MAC and routing/Network layers, multi-hop and cluster based protocols.

UNIT-2: WSN : Data dissemination and processing, data storage & query processing. Energy preservation and efficiency issues in WSN, security challenges in WSN and their remedial protocols, Wireless HART, Fundamentals of 802.15.4.

UNIT-3: IoT **:** Basic Framework, Architectural view, Physical & Logical design, Applications. Machine-to-machine (M2M), Software Defined Networking (SDN) and Network FunctionVirtualization (NFV), data storage, Cloud Based Services.

UNIT-4: IoT **:** Web Connectivity: Protocols, Message Communication mechanism, Sensors / Actuators and related communication protocols, Industrial & Automotive IoT. RFID Technology.

UNIT-5: IoT : Design methodology, Specification - Requirement, process, model, service, functional & Operational view. Privacy and security solutions, Raspberry Pi & arduino devices. Case studies: smart city streetlights control & monitoring.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. V. Madisetti and A. Bahga, “Internet of things (A-Hand-on-Approach)”, Universal Press.
2. Rajkamal, “Internet of Things”, Tata McGraw Hill publication.
3. A. Pajankar and A. Kakkar, “Raspberry Pi by Example”, Packt Publishing Ltd, Birmingham, UK.

4. Kazem Sohraby, Daniel Minoli and Taieb Znati, " Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley & Sons.

5. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley & Sons, Ltd.

6. Jun Zheng and Abbas Jamalipour (Eds.),"Wireless Sensor Networks: A Networking Perspective," Institute of Electrical and Electronics Engineers 2009.

REFERENCE BOOKS RECOMMENDED:

1. C. S. Raghavendra, K. M. Sivalingam, and T. Znati, Editors, "Wireless Sensor Networks", Springer Verlag, 1st Indian reprint, 2010.

2. F. Zhao and L. Guibas, "Wireless Sensor Networks: An Information Processing Approach", Morgan Kaufmann, 1st Indian reprint, 2013.

3. Philip Levis, " TinyOS Programming"

4. Anna Ha´c, "Wireless Sensor Network Designs", John Wiley & Sons Ltd

5. F. Dacosta "Rethinking the Internet of things: A Scalable Approach to Connecting Everything", Apress publications.

6. 2. D. Norris, "The Internet of Things: Do-It-Yourself Projects with Arduino, Raspberry Pi, and Beagle Bone Black", McGraw-Hill Education, New Delhi.

ELECTIVE-III
EC 65707: EMBEDDED SYSTEMS

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Understand the basic RISC computer architecture using AVR Microcontroller.
2. Understand the interfacing of AT-mega 8 with Wireless Network.
3. Understand the Mixed signal controller and also able to interface the Networking module with it.
4. Understand the ARM Processor's Architecture and Basic Concept of RTOS.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: **AVR Microcontrollers**: Introduction to Embedded system, embedded system architecture, Introduction to AVR ATMEGA 8 bit Microcontroller, their Architecture and features, memory mapping, instruction set, addressing modes, assembly language programming.

UNIT-2: AVR Microcontroller's Interfacing & Basic I/O Programming: ATmega I/O ports, timers/counters, programming to generate delay and wave form generation, Interfacing of ATmega with LoRa Module, ZigBee Module and WiFi Module.

UNIT-3: **MSP 430 Microcontroller**: Introduction to MSP 430 microcontroller, Architecture MSP430 memory organization, I/O system organization, MSP 430 instruction Set and assembly language programming.

UNIT-4: **MSP 430 Microcontroller's Interfacing**: Basic Elements of Interfacing of MSP 430, System clock, fundamental Interrupts concept, times and event counter, GPIO ports, Iinterfacing with USART, Modem.

UNIT-5: **ARM Microprocessor & RTOS**: Introduction to ARM Microprocessor based systems, Architecture of Cortex M3, Instruction set, Registers, Processor Data Path, Memory Address Map, System Stack Architecture, Features of ARM. Introduction of Real Time operating systems, interrupt routines in RTOs, Inter-process communication.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. ARM Microprocessor systems, CORTEX M Architecture, programming & interface, CRC press, Muhammad tahir & kashif javed.

2. AVR, Microcontroller & Embedded system, Person Edu., Mazidi.

3. Introduction to Embedded systems Using microcontroller and the MSP430, Springer,

   Manuel, Rogelio, & isidoro.

REFERENCE BOOKS RECOMMENDED:

1.Microcontroller in Practice, Springer, L. Susnea, M. MitSecu.

2. Embedded Systems , TMH publications, Prof. Rajkamal.

3. MSP 430 Microcontroller Basics, Newnes, John Davies.

EC65708: OPTICAL NETWORKS

PRE-REQUISITES:- Computer networks, Optical Communication.

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Understand of second generation of Digital transport
2. Analyze the architecture of third generation of Digital transport.
3. Understand the operation of WDM.
4. Able to design End-to-End Solution, research scope and familiarize with current developments.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: SONET/SDH: Review of SONET/SDH, Frame structure, Functional Components, SONET Problem Detection.

UNIT-2: Optical Transport Network: Architecture**,** Current Digital Transport Hierarchy, New Optical transport and Digital Transport Hierarchy, The OTN Layered Model, Generic Framing Procedure (GFP).

UNIT-3: WDM networks: Operation, Dense Wave Division Multiplexing (DWDM), Elements of WDM networks, Amplifiers, WADM Input and Output Ports, WDM Cross-connects.

UNIT-4: Optical Routers: Switching in Optical Internets, Optical Switching Technologies, An Optical Router, Micro Electro Mechanical Systems (MEMS), Optical cross connects.

UNIT-5: Optical access networks: Architecture, Hybrid fiber coax (HFC), Enhanced HFC, Passive optical networks; Optical burst switching, Optical CDMA: Basic concept and applications.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. Ramaswami and Sivrajan, *Optical Networks: A Practical Perspective*, Pearson.

2. Uyless Black, *Optical Networks and 3rd Genration Transport Systems*, Pearson.

3. Senior J.M., *Optical Fibre Communications: Principles & Practice*, PHI.

REFERENCE BOOKS RECOMMENDED:

1. Biswanath Mukherjee **,** *Springer Handbook of Optical Networks***.**

ELECTIVE-IV
EC65758: CRYPTOGRAPHY AND E-SECURITY.

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Understand various possible security violations in electronic data transfer, possible solutions and networks security models.
2. Design and analysis of various symmetric key systems and modes of operations & cryptanalysis.
3. Understand structure of finite field and its applications in cryptography.
4. Design and analysis of public key crypto systems, digital signature, hash functions etc.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: The distributed information systems security problem: Basic definitions, risk analysis, physical security of systems, personnel security of documents and keys, Possible security violations, security attack, mechanism and services, X.800 security services and their categories, Network security models.

UNIT-2: Cryptographic Tools: Symmetric key systems, Caesar, mono-alphabetic, playfair, Hill cipher, Affine Transformation etc., Block cipher method, Simplified DES, DES, Feistel algorithm, avalanche effect, block cipher modes of operation (ECB, CBC, CFB, OFB, CTR), RC5 Stream chipper.

UNIT-3: Message digest functions, key management, privacy issues (clipper / skipjack.), Confidentiality. Diffie-Hellman key exchange algorithm, Asymmetric key systems, RSA, hash function and algorithms. Authentication requirements, message authentication codes, authentication protocols, kerberos, X.509 certificates. Message Security: Digital signature (RSA, DSS, MD5)

UNIT-4: Elements of finite fields.GF(p), euclid's algorithm of GCD and multiplicative inverse, polynomial arithmetic, triple DES, AES.

UNIT-5: Electronics Mail implementations (PGP, PEM, S/MIME), World Wide Web Transactions. System Security : E-security issues, types of network attacks (e.g. denial of service), firewalls, Demilitarized Zones (DMZ), Intrusion Detection System (IDS). System Management - IP security, SNMP Version, Database Security.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1. Stallings W., *Cryptography and network security,* Pearson Edu.,
2. Schiller, *Applied Cryptography*, Wiley.
3. Kahate, *Cryptography and network security*, TMH.

REFERENCE BOOKS RECOMMENDED:

1. C. Kaufman, R. Perlman, S. Speciner, *Network Security,* PH.
2. D. Chapman, E. Zwickey, *Building Internet Firewalls,* O'Reilly and Associates.
3. Albrecht Beutelspacher, *Cryptology,* Cambridge Univ.

EC65759: MARKOV CHAINS AND QUEING SYSTEM.

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1.Develop conceptual understanding of different random variable and their statistical parameters.
2. Learn the stochastic process and its fundamentals.
3. Understand Markov Chains used in modeling a wide variety of systems.
4. Analyze continuous stochastic processes and regenerative processes and their phenomena.
5. Apply knowledge of stochastic process in developing queuing models.

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
3	0	0	3	0	70	30	0	0	100

UNIT-1: Introduction: Review of basic probability , Discrete and Continuous random variables, Probability Generating Function, Moment Generating Function, Markov and Chebyshev Inequality theorem.

UNIT-2: Stochastic processes and their classification, Bernoulli process, Poisson process and its properties, Renewal processes: Basic definitions, recurrence times, rewards and renewal reward theorem, point processes, Walds equation, Blackwell's theorem.

UNIT-3: Discrete time Markov chains: definitions and properties, matrix representation, computation of n-step transitions and steady state probabilities, irreducible finite chain with a periodic states, Perron Frobenius theory, Introduction to Game theory and stochastic game.

UNIT-4: Continuous time Markov chains: basic definitions, Q-matrix, birth-death processes, quasi birth death processes. Embedded Markov processes, semi Markov processes, reversible Markov chains, Random walks.

UNIT-5: Fundamental queuing results: Little's theorem, invariance of the mean delay, Conservation law. Markovian queues: Jackson and BCMP networks, numerical Algorithms. M/G/1 & G/M/1 queues and G/G/1 queues.

ASSESMENT: Mid-term test, Assignment, Tutorial, Quiz and End semester exam

TEXT BOOKS RECOMMENDED:

1.Cliffs, “Stochastic Modelling and the Theory Queues”, Prentice Hall, 1989
.
2.P.Bremaud, “Markov Chains”, Springer-Verlag, 1999.

3.E.Seneta, “Non Negative Matrices and Markov Chains”, Springer Series in Statistics, Springer,1981.

4.R.Gallager, “Discrete Stochastic Processes”, Kluwer Academic Press, 1996.

5.L.Kleinrock, “Queuing Systems”, vols I and II, John Wiley and Sons 1976.

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EC-65853 SENSOR NETWORKS AND IoT LAB

COURSE OUTCOMES:

At the end of this course students will demonstrate the ability to:

1. Familiarize with Arduino/Resberry pi's working.
2. Identity various sensors and implement IOT applications through scripting.
3. Implement the WSN topologies and protocol implementation on virtual simulation tools through scripting.
4. Understand the mobilility & various routing techniques used in WSN

Hours Per Week			Theory	Practical	Maximum Marks				
L	T	P	Credit	Credit	TH	CW	SW	Pr	Total
0	0	2	0	1	-	-	40	60	100

IOT: Familiarization with Arduino/Raspberry Pi and perform necessary software installation. Sensors & modules working: IR, OLED, LDR, DHT11, Temperature, humidity. Interfacing with Bluetooth, smartphone, stepper motor. Database management using thingspeak cloud & SQL. MQTT Protocol handling. Device/Home appliances control. Security aspects.

WSN: Introduction of WSN nodes/motes. TCL scripting (ns-2) for stationary /mobile nodes. TCP, UDP, AODV, TORA protocols implementation on motes and their performance comparison using various traffic strategies like CBR etc. Various topologies implementation & routing management. Simulation practices on Contiki-cooja.

ASSESMENT:- Internal viva, Continuous evaluation of experiments, Journal write-up, and Additional experiments conducted, Quiz, End semester exam.

Experiments list:

1. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
2. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
3. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
4. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
5. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
6. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
8. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thingspeak cloud.
9. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thingspeak cloud.
10. To install MySQL database on Raspberry Pi and perform basic SQL queries.
11. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.