MAHATMA GANDHI UNIVERSITY

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

ADVANCED COMMUNICATION & INFORMATION SYSTEMS

(2013 ADMISSION ONWARDS)

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN

ADVANCED COMMUNICATION & INFORMATION SYSTEMS

SEMESTER – I

Sl. No.	Course No.	Subject	Hrs / Week			Evaluation Scheme (Marks)					Credits (C)
			L	T	P	Sessional			ESE	Total	
						TA	CT	Sub Total			
1	MECCI/EC 101*	Linear Algebra	3	1	0	25	25	50	100	150	4
2	MECCI/EC 102*	Probability and Random Processes	3	1	0	25	25	50	100	150	4
3	MECCI 103	Queuing Theory and Communication Networks	3	1	0	25	25	50	100	150	4
4	MECCI 104	Advanced Optical Communication Systems	3	1	0	25	25	50	100	150	4
5	MECCI 105	Elective I	3	0	0	25	25	50	100	150	3
6	MECCI 106	Elective II	3	0	0	25	25	50	100	150	3
7	MECCI 107	Communication Systems Lab	0	0	3	25	25	50	100	150	2
8	MECCI 108	Seminar I	0	0	2	50	0	50	0	50	1
Total			**18**	**4**	**5**	**225**	**175**	**400**	**700**	**1100**	**25**

Elective – I (MEC CI 105)		Elective – II (MEC CI 106)	
MECCI/EC 105 – 1	Estimation and Detection Theory	MECCI 106 – 1*	Signal Compression
MECCI/AE 105 – 2	RF MEMS	MECCI 106 - 2	Network Administration
MECCI/CE/AE 105 – 3	Image and Video processing	MECCI/EC 106 – 3	FPGA based System Design
MECCI 105 - 4	Coding Theory	MECCI /EC106 – 4	Pattern Recognition

L – Lecture, **T** – Tutorial, **P** – Practical

TA – Teacher's Assessment (Assignments, attendance, group discussion, quiz, tutorials, seminars, etc.)

CT – Class Test (Minimum of two tests to be conducted by the Institute)

ESE – End Semester Examination to be conducted by the University

Electives: New Electives may be added by the department according to the needs of emerging fields of technology. The name of the elective and its syllabus should be submitted to the University before the course is offered.

*** Common with MAESP**

MECCI/EC 101* **LINEAR ALGEBRA**

L	T	P	C
3	1	0	4

Module I

Matrices: Introduction to linear system, matrices, vectors, Gaussian elimination, matrix notation, partitioned matrices, multiplication of partitioned matrices, inverse of partitioned matrices, triangular factors and row exchanges (LU, LDU), row exchanges and permutation matrices, inverses (Gauss-Jordan method)

Module II

Vector spaces: Vector space, subspace, linear independence, span, basis, dimension, spanning set theorem, null space, column space, row space-(Matrix), basis and dimension of null space, column space, row space-(Matrix), rank nullity theorem, co-ordinate system, change of basis–(finite space)

Module III

Linear transformation: Linear transformation, Kernel and range of linear transformation, matrix representation of linear transform, inverse transform

Inner product spaces: Inner product space, norm, Cauchy-Schwarz inequality, Triangular inequality, self adjoint and normal operators, orthogonality, Hilbert spaces, orthogonal complements, projection theorem, orthogonal projections, orthonormal basis, Gram-Schmidt orthogonalization.

Module IV

Selected topics: Eigen values, eigen vectors, diagonalization, symmetric matrices, quadratic forms, classification of quadratic forms, least-square solution of inconsistent system, singular value decomposition.

References:

1. K. Hoffman, R. Kunz, "Linear Algebra", Prentice Hall India
2. D. C. Lay, "Linear algebra and its applications", Pearson
3. G. Strang, "Linear algebra and its applications", Thomson
4. Gareth Williams, "Linear algebra with applications", Narosa

5. Michael W. Frazier, “An Introduction to wavelets through linear algebra”, Springer

MECCI/EC 102* PROBABILITY ANF RANDOM PROCESSES

L	T	P	C
3	1	0	4

Module I

Introduction to Probability Theory: Sample space and events, conditional probabilities, independent events, the law of total probability and Bayes’ theorem.

Random variables : Discrete and continuous random variables, distributions, expectation of a random variable, moment generating function, joint probability distributions, marginal probability distributions and random vectors.

Module II

Limit theorems: Markov and Chebyshev inequalities, weak and strong law of large numbers, convergence concepts and central limit theorem.

Stochastic process (definition), conditional probability distributions (continuous and discrete cases), computing mean and variances by conditioning.

Module III

Random Process: classification of random process, special classes of random process, SSS and WSS, auto and cross–correlation, ergodicity, Mean ergodic process, power spectral density, unit impulse response system, response of a LTI system to WSS input, noise in communication system-white Gaussian noise, filters

Module IV

Selected Topics: Poisson process-Properties, Markov process and Markov chain, Chapman-Kolmogorov theorem, classification of states of a Markov chain, Birth-death process, Wiener process.

References:

1. T. Veerarajan, “Probability, Statistics and random processes”, McGraw-Hill
2. S. M. Ross, “Stochastic Process”, John Wiley and sons
3. V. Sundarapandian, “Probability, statistics and Queueing theory”, Prentice Hall of India

4. Athanasios Papoulis, S. Unnikrishnan Pillai, “Probability, Random Variables and Stochastic Processes”, Tata Mc GrawHill
5. Henry Stark, John W. Woods, “Probability and random processes with application to signal processing”, Pearson Education

MECCI 103	QUEUEING THEORY &COMMUNICATION NETWORKS	L	T	P	C
		3	1	0	4

Module I

Applications and Layered architecture: OSI model and TCP/IP architecture. Application protocols, Transmission system and telephone networks. Multiplexing, SONET, WDM. Telephone network signaling. Traffic overload control in Telephone network.

Module II

Local Area Networks and Medium Access Control Protocols: LAN, Random Access. Scheduling approach to MAC, LAN standards, LAN bridges.

Packet Switching: Routing, shortest path algorithms, ATM, Traffic management, QoS, Congestion Control.

Module III

TCP/IP: TCP/IP architecture, IP, IPV4/IPV6, UDP, DHCP and Mobile IP, Internet routing protocol, Multicast routing.

Advanced Network Architecture: IP forwarding architecture, MPLS, Integrated service in Internet, RSVP, Differentiated services, Name Services (DNS), Electronic mail, SNMP, Multimedia application, overlay network.

Module IV

Delay models in data networks: Queuing models: Little's Theorem, M/M/1 queuing system, M/M/m, M/M/∞, M/M/m/m and other Markov systems, M/G/1 system, Network of transmission lines, Network of Queues.

References

1. Alberto Leon-Garcia, Indra Widjaja "Communication Networks, Fundamental Concepts and Key applications", 2/e, Tata McGraw-Hill, 2003
2. L. L. Peterson, B. S. Davie, "Computer Networks: A System Approach", 4/e, Elsevier, 2007
3. Jean Walrand, PravinVaraiya, "High Performance Communication Networks", 2/e, Morgan Kaufman Publishers, 2000.

4. A. Behrouz Forouzan, “Data Communications & Networking”, Tata McGraw-Hill, 2006
5. Dimitri P. Bertsekas, Robert G. Gallager, “Data Networks," 2/e, Prentice Hall.

MECCI 104 **ADVANCED OPTICAL COMMUNICATION SYSTEM**

L	T	P	C
3	1	0	4

Module I

Light wave system components: Optical fibers, wave propagation, single mode and multi mode fibers, dispersion in fibers.

Optical transmitters: LED and semiconductor LASER, characteristics, transmitter design.

Optical receivers: Common photo detectors. receiver design, receiver noise and sensitivity.

Module II

Light wave system architecture: Design, loss limited and dispersion limited, power budget and rise time budget, long haul systems, performance limiting factors, terrestrial light wave system, under sea light wave systems.

Module III

Optical amplifiers: Gain spectrum, amplifier noise, amplifier specifications, semiconductor optical amplifiers, amplifier design characteristics, pulse amplifier, system application, Raman amplifiers, EDFA, gain spectrum, amplifier noise, multichannel amplification, distributed gain amplifier, dispersion management, pre-compensation schemes, post compensation technique, dispersion compensation fibers.

Module IV

Soliton Systems: Fiber solitons, nonlinear Schrodinger equation, bright soliton, dark solitons, soliton based communications, information transmission with solitons, soliton interaction, loss managed soliton, dispersion managed solitons, impact of amplifier noise, high speed soliton system.

Reference:

1. Govind P. Agrawal, “Fiber Optic Communication System”, John Wiley and Sons, 2003

2. J Diggonet, “Rare Earth Doped Fiber Lasres and Amplifiers”

3. Hasegawa, “Solitons in Optical Communications”

4. Govind P. Agrawal, “Nonlinear Optics”, Academic press 2nd Ed.

MECCI/EC 105-1 ESTIMATION AND DETECTION THEORY

L	T	P	C
3	0	0	3

Module I

Introduction to Estimation Theory: Parameter Estimation, mathematical formulation, Unbiased estimates, Minimum Variance Unbiased Estimates (MVUE), methods of finding MVUE, General MVUE, sufficient statistics, Best Linear Unbiased Estimation (BLUE), application examples.

Module II

Bounds and estimators: Cramer-Rao Lower Bound (CRLB), CRLB for signals in White Gaussian Noise, Extension to vector parameter, Maximum likelihood estimators, Least Squares, Method of Moments, Bayesian estimators, Kalman filters, application examples.

Module III

Introduction to Detection Theory: Mathematical formulation, Hypothesis Testing, Neyman Pearson criterion, Bayes criterion and minimum probability of error criterion, likelihood ratio test, application examples.

Module IV

Detection: Detection with unknown signal parameters (GLRT, Bayes factor), MAP rule, multiple decision problem, detection of deterministic and random signals in noise, application examples.

References:

1. H. L. Van Trees, "Detection, Estimation, and Modulation Theory", Vol. I, John Wiley & Sons, 1968
2. Steven Kay, "Fundamentals of Statistical Signal Processing" Vol I: Estimation Theory, Prentice Hall.
3. Steven Kay, "Fundamentals of Statistical Signal Processing" Vol II: Detection Theory, Prentice Hall.

MECCI/AE 105-2 **RF MEMS**

L	T	P	C
3	0	0	3

Module I

RF MEMS relays and switches: switch parameters, actuation mechanisms, bistable relays and micro actuators, dynamics of switching operation.

Module II

MEMS inductors and capacitors: Micromachined inductor, effect of inductor layout, modeling and design issues of planar inductor, gap tuning and area tuning capacitors, dielectric tunable capacitors.

Module III

Micromachined RF filters: Modeling of mechanical filters, electrostatic comb drive, micromechanical filters using comb drives, electrostatic coupled beam structures, MEMS phase shifters, types, limitations, switched delay lines, micromachined transmission lines, coplanar lines, micromachined directional coupler and mixer.

Module IV

Micromachined antennas: microstrip antennas – design parameters, micromachining to improve performance, reconfigurable antennas.

References:

1. Vijay K. Vardan, K.J Vinoy,S.Gopalakrishnan, “RF MEMS and their Applications”, Wiley, 2003
2. H. J. D. Santos, “RF MEMS Circuit Design for Wireless Communications”, Artech House, 2002.
3. G. M. Rebeiz, “RF MEMS Theory , Design and Technology”, Wiley, 2003.
4. Vijay K. Vardan, K.J Vinoy, S.Gopalakrishnan , “ Smart Material Systems and MEMS”, Wiely India ,2011

MECCI/EC/AE 105-3 IMAGE AND VIDEO PROCESSING

L	T	P	C
3	0	0	3

Module I

Introduction to Digital Image Processing & Applications: elements of visual perception, Mach band effect, sampling, quantization, basic relationship between pixels, color image fundamentals-RGB-HSI models, image transforms - two dimensional orthogonal and unitary transforms, separable unitary transforms, basis images, DFT, WHT, KLT, DCT and SVD.

Module II

Image Enhancement: filters in spatial and frequency domains, histogram-based processing, homomorphic filtering, image restoration: degradation models, PSF, circulant and block-circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy based methods, image segmentation: pixel classification, bi-level thresholding, multilevel thresholding, adaptive thresholding, spectral & spatial classification, edge detection, Hough transform, region growing.

Module III

Boundary Representation: chain codes, polygonal approximation, boundary segments, boundary descriptors, regional descriptors, relational descriptors, object recognition, pattern and pattern classes, recognition based on decision theoretic methods, matching, optimum statistical classifiers, structural methods, matching shape numbers, string methods, morphological image processing, erosion and dilation, opening or closing, HIT or MISS transformation, basic morphological algorithms, grey scale morphology.

Module IV

Video Processing: display enhancement, video mixing, video scaling, scan rate conversion, representation of digital video, spatio-temporal sampling, video compression-motion estimation, intra and interframe prediction, perceptual coding, standards - MPEG, H.264.

References

1. K. Jain, “Fundamentals Of Digital Image Processing”, Prentice Hall Of India, 1989.
2. R. C. Gonzalez, R. E. Woods, “Digital Image Processing”, Pearson Education.
3. Iain E Richardson, “H.264 and MPEG-4 Video Compression”, John Wiley & Sons, September 2003
4. M. Tekalp, “Digital Video Processing”, Prentice-Hall
5. Bovik, “Handbook of Image & Video Processing”, Academic Press, 2000
6. W. K. Pratt, “Digital Image Processing”, Prentice Hall
7. Rosenfeld, A. C. Kak, “Digital Image Processing”, vols. 1 and 2, Prentice Hall.
8. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “Multimedia Communication Systems: Techniques, Standards and Networks”, Prentice Hall

MECCI 105-4$ **CODING THEORY**

L	T	P	C
3	0	0	3

Module I

Introduction to Communication systems and Information theory: information sources and channels, detection and correction of errors, Shannon limit.

Source Coding:- instantaneous codes, Kraft inequality and McMillian's Theorem, average length and compact codes, perfect codes, Huffman codes, arithmetic code, data compression

Module II:

Algebraic Coding: error detection, correction and decoding, linear block codes, Hamming and Golay codes, Reed Muller codes, cyclic codes, BCH (Bose Chaudhuri Hocquenghem) codes, Reed Solomon and Justesen codes, classical Goppa codes, quadratic residue codes, alternating codes, Berlekamp-Massey-Sugiyama and Peterson-Gorenstein-Zierler decoders for alternating codes, the Meggitt decoder for cyclic codes.

Module III

Convolutional Codes: encoding of convolutional codes, decoding: trellis diagram and Viterbi algorithm, convolutional codes in mobile communications.

Module IV

Turbo Coding: LDPC codes, code concatenation & concatenated convolution codes, interleavers.

References:

1. S. Lin, D. J. Costello Jr,. "Error Control Coding: Fundamentals and Applications," Prentice-Hall, 2004
2. Neubauer, J. Freudenberger, V. Kuhn. "Coding Theory: Algorithms, Architectures and Applications," John Wiley & Sons, 2007
3. S. Ling, C. Xing. "Coding Theory: A First Course," Cambridge University Press, 2004
4. R. Togneri, C. J. S. deSilva. "Fundamentals of Information Theory and Coding Design" CRC Press, 2006

5. Justesen, J. Hoeholdt, T., “A course in error-correcting codes”, European Math. Soc., 2004.
6. Proakis J. G., Salehi M., “Communication Systems Engineering”, Prentice-Hall, 2002.
7. Lint Van J. H., “Introduction to Coding Theory”, Springer Verlag, 1999.

MECCI 106-1$ **SIGNAL COMPRESSION**

L	T	P	C
3	0	0	3

Module I

Lossless Compression: self information, average information, models, uniquely decodable codes, prefix codes, Kraft-McMillan inequality, Huffman coding, extended Huffman coding, nonbinary Huffman coding; arithmetic coding – coding a sequence, generating a binary code; dictionary techniques –LZ77, LZ78, LZW; context-based compression – ppm, Burrows- Wheeler transform.

Module II

Lossy Coding: distortion criteria, conditional entropy, average mutual information, differential entropy, rate distortion theory; rate distortion theorem, converse of the rate distortion theorem, models.

Scalar Quantization: uniform, adaptive, nonuniform, entropy-coded quantization

Module III

Vector Quantization: advantages over scalar quantization, LBG algorithm, tree structured and structured vector quantizers, trellis-coded quantization

Differential Encoding: basic algorithm, prediction in DPCM, adaptive DPCM, delta modulation, speech coding – G.726.

Module IV

Transform Coding: Introduction, Karhunen-Loeve transform, discrete cosine transform, discrete Walsh Hadamard transform, quantization and coding of transform coefficients, JPEG, MDCT

Subband coding: filters, basic subband coding algorithm.

Wavelet Based Compression: multiresolution analysis, image compression, EZW coder, SPIHT, JPEG 2000

Audio coding:-MPEG audio coding.

References:

1. Khalid Sayood, “Introduction to Data Compression”, 3/e, Elsevier.
2. David Salomon, “Data Compression: The Complete Reference”, Springer.

3. Thomas M. Cover, Joy A. Thomas, “Elements of Information Theory," Wiley India
4. Ali N. Akansu, Richard A. Haddad, “Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets”, Academic Press, 1992.

MECCI 106-2 **NETWORK ADMINISTARTION**

L	T	P	C
3	0	0	3

Module I

Advanced Socket & I/O functions: IPV4 and IPV6 interoperability, inetd superserver, advanced I/O functions, UNIX domain protocols, Nonblocking I/O, ioctl operations, routing sockets, data link socket address structure, Reading and writing, sysctd operations, get-ifi-info function, interface name & index functions, key management sockets: Reading and writing, dumping the security association database (SADB), creating a static security association (SA), dynamically maintaining SAs.

Module II

Broadcasting & Multicasting :-Broadcast addresses, Unicast verses Broadcast, dg-cli function using broadcasting, race function, multicasting: multicasting addresses, multicasting verses broadcasting on a LAN, multicasting on a WAN, source-specified multicast, multicast socket options, mcast_join and related functions, dg_cli function using multicasting, receiving IP multicast infrastructure session announcements, sending and receiving, simple network time protocol.

Module III

Advanced UDP sockets: receiving flags, destination IP addresses, interface index, datagram truncation, UDP verses TCP, adding reliability to UDP application, binding interface addresses, concurrent UDP services, IPV6 packet information, IPV6 path MTU control.

Module IV

Advanced SCTP sockets: auto closing, partial delivery, notification, unordered data, binding a subset of addresses, determining peer and local addresses, association of ID and IP addresses, peeling off and association, controlling timing SCTP verses TCP, Out_of_Banddata : TCP Out_of_Band data, socket:mark function.

Raw sockets: raw sockets creation, raw socket output, raw socket input, ping program, trace route program, ICMP message daemon.

References :

1. W. R. Stevens, B. Fenner, A. M. Rudoff, "UNIX Network Programming", vol. 1, 3/e, Pearson Education.
2. G. R. Wright, W. R. Stevens, "TCP/IP illustrated", vol. 2, Pearson Education.
3. D. E. Comer, D. L. Stevens, "Internetworking with TCP/IP", vol. 2, Pearson Education.

MECCI/EC 106-3 **FPGA BASED SYSTEM DESIGN**

L	T	P	C
3	0	0	3

Module I

Evolution of Programmable Devices: Introduction to AND-OR structured Programmable Logic Devices, PROM, PLA, PAL and MPGAs, combinational and sequential circuit realization using PROM based Programmable Logic Element (PLE), architecture of FPAD, FPLA, FPLS and FPID devices.

Module II

FPGA Technology: FPGA resources - Logic Blocks and Interconnection Resources, Economics and applications of FPGAs, Implementation Process for FPGAs Programming Technologies, Static RAM Programming, Anti Fuse Programming, EPROM and EEPROM Programming Technology, commercially available FPGAs - Xilinx FPGAs, Altera FPGAs, FPGA Design Flow Example - Initial Design Entry, Translation to XNF Format, Partitioning, Place and Route, Performance Calculation and Design Verification.

Module III

Technology Mapping for FPGAs: Logic Synthesis - Logic Optimization and Technology Mapping, Lookup Table Technology Mapping - Chortle-crf Technology Mapper, Chortle-d Technology Mapper, Lookup Table Technology Mapping in mis-pga, Lookup Table Technology Mapping in Asyl and Hydra Technology Mapper; Multiplexer Technology Mapping - Multiplexer Technology Mapping in mis-pga.

Module IV

Routing for FPGAs: Routing Terminology; Strategy for routing in FPGAs; Routing for Row- Logic Block Architecture: Logic Block Functionality versus Area-Efficiency - Logic Block Selection, Experimental Procedure, Logic Block Area and Routing Model and Results. Based FPGAs - Segmented channel routing, 1-channel routing algorithm, K – channel routing algorithm and results.

References

1. Wayne Wolf, “FPGA-Based System Design”, Verlag: Prentice Hall
2. Wayne Wolf, “Modern VLSI Design: System-on-Chip Design”, 3/e, Verlag

MECCI/EC 106-4 **PATTERN RECOGINITION**

L	T	P	C
3	0	0	3

Module I

Introduction: features, feature vectors and classifiers, Supervised versus unsupervised pattern recognition. Classifiers based on Bayes' Decision theory- introduction, discriminant functions and decision surfaces, Bayesian classification for normal distributions, Estimation of unknown probability density functions, the nearest neighbour rule. Linear classifiers, Linear discriminant functions and decision hyper planes, The perceptron algorithm.

Module II

Gaussian mixture models, expectation maximization, pattern classification problems – linear and nonlinear, multilayer feed forward neural networks, back propagation algorithm, Radial basis function networks.

Module III

Non-Linear classifiers: Support Vector machines-nonlinear case, decision trees, combining classifiers, feature selection, Receiver Operating Characteristics (ROC) curve, class separability measures, optimal feature generation, the Bayesian information criterion, dimension reduction technique: PCA, FDA.

Module IV

Clustering: cluster analysis, proximity measures, clustering algorithms - sequential algorithms, hierarchical algorithms - agglomerative algorithms, divisive algorithms, K-means algorithm.

References:

1. Richard O. Duda, Hart P. E., David G. Stork, "Pattern classification" , 2/e, John Wiley & Sons Inc., 2001
2. Sergios Theodoridis, Konstantinos Koutroumbas, "Pattern Recognition", Academic Press, 2006.
3. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", PHI Pvt. Ltd., NewDelhi-1, 1999.

4. Fu K. S., “Syntactic Pattern Recognition and Applications”, Prentice Hall, Eaglewood Cliffs, N.J,
5. Andrew R. Webb, “Statistical Pattern Recognition”, John Wiley & Sons, 2002.
6. Christopher M Bishop, “Pattern Recognition and Machine Learning”, Springer 2007.

MECCI 107 **COMMUNICATION SYSTEMS LAB**

L	T	P	C
0	3	0	2

(Experiments are to be conducted using DSP kit)

1. Generation of Sine wave
2. Amplitude Modulation and Demodulation
3. DSBSC Amplitude Modulation and Coherent Detection
4. SSB Amplitude Modulation and Coherent Detection
5. Frequency Modulation and Demodulation
6. Pseudo-Random Binary Sequence Generation(Scrambling and Descrambling)
7. Generation of PAM signal and Eye Diagram
8. QAM
9. Near-End Echo Canceller
10. Far-End Echo Canceller
11. BPSK Modulation and Demodulation
12. Convolution coding and decoding

Reference:

1. Steven A. Tretter, "Communication System Design Using DSP Algorithms with laboratory experiments for the TMS320C6713 DSK", Springer, 2008
2. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Wiley, 2005

MECCI 108 **SEMINAR I**

L	T	P	C
0	0	2	1

Each student shall present a seminar on any topic of interest related to the core/elective courses offered in the 1st semester of the M. Tech. Programme. He / She shall select the topic based on the references from international journals of repute, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator / Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.