Department of Electronics and Communication Engineering
M.M.M. University of Technology, Gorakhpur (U.P.)

The Overall Credit Structure for PG Programme

Credit Courses			
Postgraduate Core (PC)		**Postgraduate Elective (PE)**	
Category	**credits**	**Category**	**credits**
Maths (M)	4	Program Electives (PE)	16
Program Core (PC)	22		
Minor Project (MP)	4		
Dissertation (D)	18		
Seminar	2		
Total	**50**	**Total**	**16**
Grand Total	**66 (minimum)**		
Audit Courses			
Audit Course (Other Departments) (AC)	6		
Total	**6**		

Credit Structure for M. Tech. in Digital Systems & Communication Engg.

Category Semesters	**I**	**II**	**III**	**IV**	**Total**
Maths (M)	4	-	-	-	4
Programme Core (PC)	13	9	-	-	22
Program Electives (PE)	-	8	8	-	16
Minor Project (MP)	-	-	4	-	4
Dissertation (D)			4	14	18
Seminar (S)	-	-	-	2	2
Total	**17**	**17**	**16**	**16**	**66**

Department of Electronics and Communication Engineering
M.M.M. University of Technology, Gorakhpur (U.P.)
Curriculum for M.Tech (Communication Engg.)

Junior year, Semester-I

S. No.	Category	Paper Code	Course Name	L-T-P	Credits
1.	M	MAS-112	Advanced Engg. Mathematics	3-1-0	4
2.	PC	MEC-201	Advanced Digital Communication	3-1-2	5
3.	PC	MEC-202	Advanced Digital Signal Processing	3-1-0	4
4.	PC	MEC-203	Optical Communication System	3-1-2	5
			Audit		
				Total	**18**

Junior year, Semester-II

S. No.	Category	Paper Code	Course Name	L-T-P	Credits
1.	PC	MEC-204A	Optical Wireless Communication	3-1-0	4
2.	PC	MEC-205	Mobile Communication Systems	3-1-2	5
3.	PE1	MEC-2**		3-1-0	4
4.	PE2	MEC-2**		3-1-0	4
			Audit		
				Total	**17**

Senior year, Semester-III

S. No.	Category	Paper Code	Course Name	L-T-P	Credits
1.	PE3	MEC-***		3-1-0	4
2.	PE4	MEC-***		3-1-0	4
3.	MP	MEC-220	Minor Project	0-0-8	4
4.	D	MEC-230	Dissertation Part-I	0-0-8	4
				Total	**16**

- Minor Project should be completed during the summer vacation after second semester.

Senior year, Semester-IV

Sr. No.	Category	Paper Code	Course Name	L-T-P	Credits
1.	S	MEC-240	Seminar	0-0-4	2
2.	D	MEC-250	Dissertation Part-II	0-0-28	14
				Total	**16**

Audit Subjects

S. No.	Course Code	Name of the Course	Prerequisite Subject	L-T-P	Credits
1.	BCS-01	Introduction to Computer Programming	None	2-1-2	--
2.	MCS-206	Information Security and Cyber Laws	None	3-0-0	--
3.	MBA 109	Research Methodology	None	3-0-1	--

PE-1 and PE-2

S. No.	Course Code	Name the Course	Prerequisite Subject	L-T-P	Credits
1.	MEC-251	ISDN and Broadband Networks		3-1-0	4
2.	MEC-252	Microwave Devices & Ckts		3-1-0	4
3.	MEC-253	Opto-Electronics Integrated Circuits		3-1-0	4
4.	MEC-254	Digital Image Processing		3-1-0	4
5.	MEC-256	Advanced Coding Theory		3-1-0	4
6.	MEC-257	Embedded Systems		3-1-0	4
7.	MEC-258	Internet of Things (IOT)		3-1-2	5
8.	MEC-259	Linear Algebra and Stochastic Process		3-1-0	4
9.	MEC-159	RFIC		3-1-0	4

PE-3 and PE-4

S. No.	Course Code	Name the Course	Prerequisite Subject	L-T-P	Credits
1.	MEC-163	Neural Networks		3-1-0	4
2.	MEC-261	Antenna Design and MIMO Systems	Antenna and Wave Propagation	3-1-0	4
3.	MEC-262	Satellite Communication		3-1-0	4
4.	MEC-263	Inter & Intra-net		3-1-0	4
5.	MEC-264	Body Area Networks		3-1-0	4
6.	MEC-265	IC Design	VLSI Technology & Design	3-1-0	4
7.	MEC-168	High Speed Devices and Circuits		3-1-0	4

MEC-201 ADVANCED DIGITAL COMMUNICATION (3-1-2)

UNIT I **9**

Overview of Digital Communication: Digital communication system model. Sampling theorem, Communication channels, characteristics and Models, Signal space representations. Digitally modulated signals-Representations. Constellation diagram and design of transmitter and receiver for BPSK,QPSK,M-PSK,16-QAM, FSK, MSK and GMSK and their BER performance analysis in AWGN channel.

UNIT II 9

Communication Through Band-Limited Linear Filter Channels: Optimum receiver for channels with ISI and AWGN. Linear equalization, Decision feedback equalization, Turbo equalization, Self recovering equalization,

UNIT III 9

Multichannel, Multicarrier Systems and Spread Spectrum Signals: Model of Spread spectrum system. Direct sequence spread spectrum signals. Frequency -Hopped spread spectrum signals. Performance of spread spectrum system in jamming environment, Synchronization of spread spectrum signals.

UNIT IV 9

Digital Communications through Fading Multipath Channels: Characterization and model. Frequency-Non selective, slowly fading channel, performance analysis of MRC, EGC, SC Diversity techniques over flat fading channel, Digital signaling over a frequency-selective, slowly fading channel, Coded waveforms for fading channel, Multiple access techniques, Capacity of multiple access methods, CDMA, Random access methods.

EXPERIEMNTS

1. Experiment on QPSK digital Modulation.
2. Experiment on M-ary QAM for different fading channels.
3. Analysis of Bit Error Rate (BER) for BPSK digital Modulation.
4. Analysis of Bit Error Rate (BER) for BFSK digital modulation
5. Analysis of BER for ASK digital modulation.
6. Study of ASK, PSK and FSK digital modulation using MATLAB.

Books & References:

1. John G. Proakis, Digital Communications, 4/e, McGraw-Hill
2. Simon Haykins, Communication System, John Wiley Sons, 4th Edition.
3. Viterbi, A. J., and J. K. Omura, Principles of Digital Communication and Coding. NY: McGraw-Hill, 1979. ISBN: 0070675163.
4. Marvin K Simon, Sami M Hinedi, William C Lindsey - Digital Communication Techniques – Signal Design & Detection, PHI.
5. MIT OpenCourseWare, Electrical Engineering and Computer Science, Principles of Digital communication II, Spring 2006

6. Aazhang B. Digital Communication Systems (Connexions Web site). January 22, 2004. available at: http://cnx.rice.edu/content/col10134/1.3/

MEC-202: Advanced Digital Signal Processing (3-1-0)

Unit-I **(9L)**

Basics of Multirate systems and its application, up sampling and Down - Sampling, Fractional Sampling rate converter. Polyphase decomposition. Efficient realisation of Multirate systems.Uniform filter banks and it's implementation using polyphase decomposition.

Unit-II **(9L)**

Two channel Quadrature Mirror Filter Banks, Perfect Reconstruction, M-channel PR QMFB.Time Frequency Analysis, Heisenberg's uncertinity principle. Short time fourier transform - Gabor transform. Continous Wavelet Tranform and it's properties. Multi Resolution Analysis, Discrete Wavelet Transform, Orthonormal Wavelet Analysis - Filterbank interpertation. Haar and Daubechise wavelets, Bi-orthogonal wavelets and Filter bank interpretation.

Unit-III **(9L)**

B-Spline wavelets, Wavelet packets.2D wavelt transforms. Application of wavelet tranform for data compression, noise reduction. Linear Prediction -Forward and Backward Prediction - Levinson-Durbin Algorithm, Schur Algorithm.

Unit-IV **(9L)**

Power spectrum estimation of signals: Wide Sense Stationary Random Processes. Power spectral density. Non parametric methods: periodogram,Backman-Tuckey method. Parametric method: ARMA, AR processes, Yule-Walker method.

Books & References:

1) P. P. Vaidyanathan, Multirate Systems and Filterbanks, Prentice Hall
2) Wavelet Transforms - Bopadikar and Rao, Pearson Education
3) Insight into wavelets, K. P. Soman, Prentice Hall India
4) Digital signal Processing, By John G. Proakis, Dimitris G. Manolakis
Pearson Education

MEC-203: Optical Communication Systems (3-1-2)

Unit-I **(9L)**

Lightwave system components-Optical Transmitters and receivers–concepts, components and design. Control of Longitudinal Modes – Design of Optical transmitters.

Unit-II **(9L)**

Receiver Noise and sensitivity. Sensitivity degradation- Receiver Design.Architecture and Design of Light wave systems- Loss limited and Dispersion limited lightwave systems.

Unit-III **(9L)**

Optical amplifiers-Various types-Design of EDFAs- Various Techniques for Dispersive management: WDM systems –Components and performance issues.

Unit-IV (9L)

Soliton based systems- Impact of amplifier noise-Timing Jitter, Gordon – Hauss Effect, Bit Error Rate Performance.Coherent light wave systems-Concepts, Modulation Formats and Bit Error Rate Performance.

List of Experiments

1. MAT Lab based experiments.
2. Experiments on various losses.
3. Experiments are the pulse broadening of a fiber optic communication link.
4. Setting up a fiber optic digital link.
5. Fiber Optics on PC: An interactive simulation package to study various aspects of fiber optics.

Books & References:

1. Govind P. Agrawal: Fiber Optic Communication System, John Wiley and Sons, 2003
2. W 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.

MEC-204A OPTICAL WIRELESS COMMUNICATION

UNIT I 9

Introduction: Brief History, OWC/RF comparison, Link configuration, OWC challenges, safety and regulations, LEDs, Lasers, its characteristics, Photodetectors: PIN & APD.

UNIT II 9

Channel Modelling: Introduction to indoor OWC channel, Outdoor channel: losses & atmospheric turbulence model.

UNIT III 9

Modulation techniques: OOK, M-PPM, PIM,DHPIM,OPolSKsubcarrier modulation etc, Detection techniques - Photon counter, PMT, coherent techniques,

UNIT IV 9

System Performance: Bit error rate evaluation in presence of atmospheric turbulence, concept of adaptive threshold, FSO performance under the Effect of atmospheric turbulence, Diversity Techniques. Review of recent advancement in OW communication, discussion of challenges, potential applications, state of the art, and prospects.

Books & References:

1. Z. Ghassemlooy, W. Popoola, S.Rajbhandari “Optical Wireless Communications: System and Channel Modelling with MATLAB” CRC Press 1st edition

2. Murat Uysal, Carlo Capsoni, et. al, "Optical Wireless Communications: An Emerging Technology (Signals and Communication Technology)" Springer, 1st edition

MEC-205 MOBILE COMMUNICATION SYSTEMS (3-1-2)

UNIT I **9**

Radio propagation characteristics, models for path loss, shadowing & multipath fading delay spread, coherence bandwidth, coherence time, Doppler spread Jake's channel model, probability distribution function (PDF) and cumulative distribution function (CDF) of multipath fading and shadowing, distribution for composite fading channel. Monte Carlo simulation of multipath fading channel.

UNIT II **9**

Digital modulation for mobile radio, BER performance analysis under fading channel, MRC, EGC and SC diversity techniques and rake demodulator, introduction to spread spectrum communication, multiple access techniques used in mobile wireless communications: FDMA/TDMA/CDMA.

UNIT III **9**

Cellular concept, frequency reuse basic theory of hexagonal cell layout, spectrum efficiency, FDM/TDM, cellular system, channel allocation schemes, handover analysis, cellular CDMA, soft capacity, Erlang capacity comparison, a review of handover analysis in 4G and 5G network system.

UNIT IV **9**

Evolution of Wireless technologies; review of 1G,2G,3G,4G and 5G**,** Wireless standards-GSM, IS-95, UMTS-IMT-2000, signaling, call control, mobility management and location tracing, wireless internet, ad hoc wireless networks, broadband wireless and quality of service, location management, pervasive healthcare.

Books & References:

1. Theodore S. Rappaport, Wireless Communications Principles and Practice, PHI.
2. Vijay Garg, Wireless Communications and Networkings, Elsevier.
3. William C.Y. Lee, Mobile Cellular Telecommunication, Analog and Digital Systems, McGraw Hill.
4. Kamilo Feher, Wireless Digital Communications, Modernization & Spread Spectrum Applications, PHI.
5. Kaveh Pahlavan and Allen H. Levesque" Wireless Information Networks", Wiley.

PE1 &PE2

MEC– 251: ISDN and Broadband Networks (3-1-0)

Unit-I **(9L)**
ISDN Channels, Access interface, functional devices and reference, Overview of ISDN services, Protocol structure, D- Channel Layer 3 Protocols, Numbering and addressing, ISDN Products.

Unit-II **(9L)**
Broadband networks - need, Fast packet switching, Frame relay, Cell relay & ATM, FDDI, SMDS. Frame Relay – Basic Definition, Protocol Architecture, Permanent and switched VC, Frame relay standards, Multicast services.

Unit-III **(9L)**
ATM – ATM standards, Terms and Concepts, B-ISDN Protocol Architecture, Physical Layer, ATM Layer, AAL, ATM services.

Unit-IV **(9L)**
ATM switches. SMDS Overview, SMDS Interface & Services. ISDN, B-ISDN and Internet Protocols.

Books & References:
1. Kessler & Southeick: "ISDN" – McGraw Hill, 3e, 1996.
2. William Stallings: "ISDN" – Pearson Education

MEC-252 Microwave Device & Circuits (3-1-0)

Unit-I **(9L)**
Microwave Devices: Tunnel Diode, Microwave Bipolar Transistors, HBTs, JFETs, MESFET, HEMTs, Mos Transistors and memory devices, CCDs. Transferred electron devices

Unit-II **(9L)**
Principle of Operation and characteristics of Gunn diode, TRAPATT and IMPATT diodes, GaAs Diode, RWH Theory, LSA Diode. Avalanche Transit Time Devices: Read diode IMPATT Diode, TRAPATT Diode, BARITT Diode, Parametric Devices.

Unit-III **(9L)**
Microwave Network Representations: S-matrix representations, matrices of some typical, microwave components such as attenuator, matched load, power divider, directional coupler, magic tee etc.

Unit-IV **(9L)**
Lumped element in MICs, Material and Fabrication Technique, Technology of hybrid MICs, Design of MIC components- transitions,

Books & References:

1. S.Y. Liao, "Microwave devices & Circuits", Prentice Hall of India, 3rd Ed..1995.
2. G.P. Srivatava,Vijay Laxmi Gupta,"Microwave Devices and Circuit Design" PHI,2006
3. M L Sisodia, G S Raghuvanshi, Microwave Circuits and Passive Devices, New Age International (p) Ltd, 2001

MEC-253 Opto-Electronics Integrated Circuits **(3-1-0)**

Unit-I **(9L)**

Optoelectronic Properties of Semiconductor: effect of temperature and pressure on bandgap, Carrier scattering phenomena, conductance processes in semiconductor, bulk and surface recombination phenomena Optical Properties of Semiconductor, EHP formation and recombination, absorption in semiconductors, Effect of electric field on absorption, absorption in quantum wells, radiation in semiconductors, deep level transitions, Augur recombination's

Unit-II **(9L)**

Junction theory, Schottky barrier and ohmic contacts, semiconductor heterojunctions, LEDs, Photo detectors, Solar Cells, Lasers: Operating Principles, Various Structures and its types

Unit-III **(9L)**

Special Detection Schemes: Phototransistors, Modulated Barrier Photodiode, Schottky Photdiode, MSM photodiode

Unit-IV **(9L)**

Optoelectronic modulation and switching devices: Analog and Digital modulation, Franz-Keldysh and Stark effects modulators, Electro-optic modulators, Optolectronic Integrated Circuits(OEICs): Need for hybrid and monolithic integration, OEIC transmitters and receivers

Books & References:

1. Semiconductor Optoelectronic Devices By Pallab Bhattachrya, Prentice Hall Publications.
2. Physics of Semiconductor Devices, By S.M. Sze, Wiley Publications.
3. Optoelectronics and Photonics: Principles and Practices, by S. O. Kasap, Prentice Hall Publications.
4. Integrated Optoelectronics, by Ebeling, Springer-Verlag, Berlin, 1992

MEC-254: Digital Image Processing (3-1-0)

Unit-I **(9L)**

Introduction to Digital Image model and Transforms: Digital Image Representation, Image Processing Systems, Digital Image fundamentals, Image model, Sampling & Quantization, Introduction to Fourier Transform, Properties, DFT, FFT, Separable Image Transform, Hough Transform.

Unit- II **(9L)**

Image Enhancement: Spatial Frequency Domain methods, Histogram modification techniques, Direct histogram modification techniques, Direct histogram specifications, Image Smoothening, Image Sharpening.

Unit-III **(9L)**

Image Restoration & Encoding: Degradation model, Diagonalization of Circulant and Block Circulant matrices, Algebraic Approach, Inverse Filtering, Wiener Filtering.
Image Encoding:Fidelity criteria, The Encoding Process, Error – free encoding relative to fidelity criteria.

Unit-IV **(9L)**

Image Segmentation: Detection of discontinuities, Edge Linking & Boundary Linking, Thresholding, Region oriented Segmentation.

Books & References:

1. Rafael C. Gonzalez, Paul Wintz: "Digital Image Processing" – Prentice Hall
2. Anil K Jain: "Fundamentals of Digital Image Processing" – Prentice Hall
3.A Resenfeld, A.C. Kak: "Digital Image Processing" – Academic Press

MEC-256: Advanced Coding Theory (3-1-0)

Unit-I **(9L)**

Linear block codes, encoding and decoding, cyclic codes, Non-binary codes. Linear convolutional encoders – Structural properties of convolutional codes – State diagrams – Transparent convolutional codes – Receiver phase offset and Differential decoding – Trellis diagrams – Viterbi algorithm – Performance analysis – Design and Implementation of Viterbi decoder – Punctured convolutional codes.

Unit-II **(9L)**

Tree diagrams – The Fano algorithm – The Stack algorithm – Performance analysis for Sequential decoders – Burst error correcting codes – Decoding of single burst error correcting cyclic codes – Fire Interleaved codes – Phased burst error correcting codes – Concatenated codes

Unit-III **(9L)**

M-ary signaling – One and Two-dimensional TCM – Multiple TCM – Decoding and performance analysis – Implementational considerations.

Unit-IV **(9L)**

Turbo decoder, Interleaver, Turbo decoder MAP and log MAP deicers Iterative turbo decoding. Optimum decoding of turbo codes

Books & References:

1. S. Lin & D. J. Costello, Error Control Coding (2/e), Pearson, 2005.
2. B.Vucentic & J. Yuan, Turbo Codes, Kluwer, 2000
3. C.B. Schlegel & L.C. Perez, Trellis and Turbo Coding Wiley.

4. Stephen B. Wicker, “Error control systems for Digital communication and storage”, Prentice Hall
Upper Saddle River, NJ, 1994.
5. E. Biglieri, et al. “Introduction to Trellis coded modulation with Applications”, Macmillan Publishers,1991.
6. R. Johannesson and K.S. Zigangirov, “Fundamentals of Convolutional coding”, IEEE Series on Digital and Mobile Communication, Wiley-IEEE Press, 1999.

MEC – 257: Embedded Systems (3-1-0)

Unit-I **(9L)**

Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems, Applications.

Unit-II **(9L)**

Embedded Processor: Devices & Architecture of 8051/89C51 Motorola, PIC, AVR, etc. Review of memory Architecture, I/ O, Timer/ Counter & Interrupts.

Unit-III **(9L)**

RTOS Based Embedded & Task Communication: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

Unit-IV **(9L)**

Embedded Communication Protocols: Embedded Networking: Introduction – Serial/Parallel Communication – Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I^2C) – PC Parallel port programming -ISA/PCI Bus protocols

Books & References:

1. Burns, Alan and Wellings, Andy: “Real-Time Systems and Programming Languages", 2e, Addison-Wesley-Longman, 1997.
2. Raymond J.A. Bhur and Donald L.Bialey: " An Introduction to real time systems: Design to networking with C/C++" – Prentice Hall, 1999.
3. Grehan Moore, and Cyliax: "Real time Programming: A guide to 32 Bit Embedded Development” – Addison-Wesley-Longman, 1998.
4. Heath, Steve: "Embedded Systems Design" – Newnes, 1997.
5. Frank Vahid and Tony Givargis: Embedded System Design: A Unified Hardware /Software Introduction” – Wiley 2001

MEC – 258 Internet of Things (IoT) (3-1-2)

Unit-I **(9L)**

IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management

Unit-II **(9L)**

Reference Architecture: IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.

Unit-III **(9L)**

IoT Data Link Layer & Network Layer Protocols: PHY/MAC Layer(3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART,Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP

Unit-IV **(9L)**

Transport & Session Layer Protocols: Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT
Service Layer Protocols & Security Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, RPL, Application Layer

Experiments

IoT architecture outline, standards considerations

1. Understand SENSEnuts protocol stack code architecture
2. To develop a code for LED blink operation for SENSEnuts device.

M2M and IoT Technology Fundamentals- Devices and gateways

3. Get to know the type of devices in SENSEnuts platform.

M2M and IoT Analytics/Data representation and visualization

4. Get to know the working of SENSEnuts GUI.
5. To develop a code to read temperature and light sensor data from sensor module attached to radio module.
6. To develop a code to broadcast the temperature and light sensor data in the network, catch it at destination and display it in GUI.

Technical Design constraints

7. To develop a code to program the temperature and light sensor with threshold values, and catch the interrupt generated by them when threshold is passed.

8. To check the change in link quality as the distance between two nodes increase.
9. To check previous experiment at three different channel frequencies supported by 802.15.4.
10. To implement following 4 Coordinator selection mechanisms after active scan at mac layer for node association
    a) Node tries to associate with a coordinator giving best link quality.
    b) Node tries to get associated with Pan Coordinator first and if not found tries toassociate with any other coordinator.
    c) Node tries to associate with a specific coordinator with given ID every time.
    d) Node tries to associate only on specific channels.

IoT Data Link Layer & Network Layer Protocols

11. Get to know 802.15.4 and its operation.
12. To check the impact of dynamic channel selection by PAN coordinator on the network when Pan Coordinator is switched off and then on while the network is running in a non-acknowledged broadcast network.
13. To check the impact of reduced size task queues on the capability of device.
14. To check the impact of increase in payload size on the network.
15. To create a MBR (mac based routing) based multi-hop network.
16. To create a LBR (level based routing-multipath) based multi-hop network and check the impact of node failure on LBR's functionality. Also check the advantage of MBR support in LBR.
17. To create an AODV based multi-hop network.

Battery Saving and Link Quality Control

18. To modify the code of LBR to make it battery and link quality aware.
19. To modify the code of AODV to make it battery and link quality aware.
20. To implement sleep and wake mechanism in SENSEnuts nodes.
21. To implement an algorithm to control transmission power of the node dynamically based on link quality.

Security Aspects

22. To make one node in LBR as malicious node and drop packets sent through it.

Advance Experiments

23. To develop a MATLAB interface to receive all the data sent by wireless nodes in MATLAB rather than SENSEnuts GUI and develop graphs in matlab based on data received.
24. To simulate a resistance control mechanism in MATLAB based on data received from SENSEnuts device

Books & References:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1 st Edition, Academic Press, 2014.
2. Peter Waher, “Learning Internet of Things”, PACKT publishing, BIRMINGHAM – MUMBAI
3. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
4. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118- 47347-4, Willy Publications

5. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, 1 st Edition, VPT, 2014.
6. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

MEC-259 Linear Algebra and Random Process (3-1-0)

Unit I: **9**

Vector spaces. Four fundamental vector spaces of the matrix. Rank-Nullity theorem. Projection theorem.- Linear transformation matrix with different basis- Gram-Schmidt orthogonalization procedure. QR factorization. Eigen values and Eigen vectors. Diagonalization of the matrix. Schur’s lemma. Hermitian Matrices- Unitary Matrices - Normal Matrices. Singular Value Decomposition.

Unit II: 9

Probability spaces. Random variables and random vectors. Distributions and densities- Conditional distributions and densities. Independent random variables. Transformation of random variables Expectations. Indicator. Moment generating function. Characteristic function. Multiple random variable. Gaussian random vector. Co-variance matrix. Complex random variables. Sequence of random variable-Central limit theorem.

Unit III: 9

Strictly stationary random process. Wide sense stationary random process. Complex random process. Jointly strictly and wide sense stationary of two random processes. Correlation matrix obtained from random process. Ergodic process. Independent random process. Uncorrelated random process. Random process as the input and output of the system. Power spectral density.

Unit IV: 9

White random process. Gaussian random process. Cyclo-stationary random process. Wide sense cyclo stationary random process. Sampling and reconstruction of random process. Band pass random process.

Books & References:

1.R.B.Ash & C.Doleans-Dade, “Probability and Measure Theory (2/e)”, Elsevier, 2005
2. A.Papoulis, S.U.Pillai, “Probability, Random variables and Stochastic processes” 4th edition Tata-Mc Hill (4/e) ,2001
3. G.Strang, “Linear Algebra”, Thomson Brooks/Cole Cengage Hill (4/e), 2006
4. Stakgold, I., Green‟s “Functions and Boundary value Problems (e)”, Wiley,1998
5. E.S.Gopi, “Mathematical summary for digital signal processing applications with Matlab”, Springer,2011.
6. E.Wong & B.Hajek, “Stochastic Processes in Engineering systems”, Springer, 1985.
7. R.B.Ash & W.A.Gardner, “Topics in stochastic processes”, Academic Press, 1975.
8. Recent literature in Linear Algebra and Stochastic Processes.

MEC-159 RFIC	
Unit	Topic
I	Introduction to RF And Wireless Technology: Complexity comparison, Design bottle necks, Applications, Issues in RF Design: Noise, Linearity and Signals
II	Basics of LNA technologies, LNA topologies, CS stage with inductive load, Resistive feedback, Alternative LNA technologies, layout of cascade devices
III	Mixers and Oscillators: General Considerations and Performance Parameter of Mixer circuit, Up & Down Conversion Mixers, Cascaded Stages, oscillators, Frequency synthesizers.
IV	Power Amplifiers: General considerations, Classification, High Frequency Power Amplifiers, large signal impedance matching, linearization techniques. On-chip Passive Devices and integrated passive devices used in RF transceiver design
Text Books: **1.** Behzad Razavi, RF Microelectronics Prentice Hall of India, 2001. **2.** Thomas H. Lee, The Design of CMOS Radio Integrated Circuits, Cambridge University Press.	
Reference Books/Materials: 1. John W. M. Rogers and Calvin Plett, " Radio Frequency Integrated Circuit Design" Second Edition, Artec House Publication	

PE-3 & PE-4

MEC-163 Neural Networks (3-1-0)

UNIT-I **(9L)**

Neural networks characteristics, History of development in neural networks principles, Artificial neural net terminology, Model of a neuron, Topology, Learning, types of learning, Supervised, Unsupervised and Reinforcement learning, Knowledge representation and acquisition.

UNIT-II **(9L)**

Basic Hop field model, Basic learning laws, Unsupervised learning, Competitive learning, K-means clustering algorithm, Kohonen`s feature maps.

UNIT-III **(9L)**

Radial basis function neural networks, Basic learning laws in RBF nets, Recurrent back propagation, Introduction to counter propagation networks, CMAC network, and ART networks.

UNIT-IV **(9L)**

Applications of neural nets such as pattern recognition, Optimization, associative memories, speech and decision making. VLSI implementation of neural networks.

Books & References:

1. J.M. Zurada: "Introduction to artificial neural systems"- Jaico Pub,2009
2. Simon Haykin : "Neural Networks"- PH, 1999

MEC-261 Antenna Design & MIMO System (3-1-0)

UNIT I **(9L)**

FUNDAMENTAL CONCEPTS AND RADIATION FROM WIRE ANTENNAS: Physical concept of radiation, Radiation pattern,near and far field regions, antenna theorem formulation of fundamental antenna properties, Friis transmission equation,radiation integrals and auxiliary potential functions,Infinitesimal dipole,finite length dipole,linear elements near conductors,dipoles for mobile communication,small circular loop.

UNIT II **(9L)**

ANTENNA ARRAYS AND SYNTHESIS: Linear arrays Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, binomial array, phased array, synthesis of antenna arrays, Schelkunoff polynomial method, Woodward-Lawson method, Fourier transform method, Taylor method, Integral equations moment method, impedances.

APERTURE AND REFLECTOR ANTENNAS: Huygens 'Principle, radiation from rectangular and circular apertures design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns-design concepts prime-focus parabolic reflector and cassegrain antennas.

UNIT III **(9L)**

BROADBAND AND MICROSTRIP ANTENNAS:Log-periodic and Yagi antennas- frequency independent antennas- helical antennas -Basic characteristics of microstrip antennas -feeding methods- methods of analysis -design of rectangular and circular patch antennas-microstrip arrays.

UNIT IV **(9L)**

Capacity and Information rates of noisy, AWGN and fading channels, Capacity of MIMO channels, Capacity of non-coherent MIMO channels,Constrained signaling for MIMO communications. Transmit diversity with two antennas: The Alamouti scheme Orthogonal and Quasi-orthogonal space-time block codes,Linear dispersion codes,Generic space-time trellis codes,Basic spacetime code design principles, Representation of space-time trellis codes for PSK constellation,Performance analysis for space time trellis codes,Comparison of space-time block and trellis codes.

Books & References:

1. C. A. Balanis, "Antenna Theory Analysis and Design", 3rd Ed., John Wiley & Sons, 2008.
2. W. L. Stutzman, and G. A. Thiele, "Antenna Theory and Design", 2nd Ed., John Wiley & Sons, 2010.
3. R. S. Elliot, "Antenna Theory and Design", Revised edition, Wiley-IEEE Press, 2005.
4. R. E. Collin, "Antennas and Radio Wave Propagation", McGraw-Hill., 1985.

MEC-262 Satellite Communication (3-1-0)

UNIT-I **(9L)**

Evolution of satellite communication, Kepler laws, Orbital elements, Orbital perturbations, Apogee perigee heights, Inclines orbits, Sun synchronous orbits, Geo stationary orbits, Limits of visibility, Sun transit outage, polar Mount antenna, Antenna Look angles, Launching orbits, Low earth orbits, Medium orbits, Constellation.

UNIT-II **(9L)**

EIRP, transmission losses, Link-power budget equation, System Noise, carrier to Noise ratio, Uplink and downlink equations, Input and Output back Off, TWTA, Inter modulation Noise.

UNIT-III **(9L)**

Space segment: power supply, attitude control, station keeping, thermal control, TT & C Subsystem, Transponders, Antenna subsystem, Earth segment: Receive-Only Home TV Systems, Master Antenna TV System, Transmit-Receive Earth Stations.

UNIT-IV **(9L)**

Indian Regional Navigation Satellite System (IRNSS) system: IRNSS system overview, IRNSS signal characterisitcs, IRNSS PRN codes. GPS Aided Geo Augmented Navigation (GAGAN) system.

Books & References:

1. Dennis Roddy: "Satellite Communications"- McGraw Hill, 2009.
2. Tri, T.Ha: "Digital Satellite Communications"- Tata McGraw-Hill Education, 2009.
3. Trimothy Pratt, Charles W. Bostian, Jeremy E. Allnutt "Satellite Communications", JohnWiley& Sons, 2002.
4. Indian Regional Navigation Satellite System: Signal in space ICD for Standard Positioning Service, VERSION 1.1, ISRO satellite centre indian space research organization Bangalore.

MEC-263 Internet and Intranet (3-1-0)

UNIT I **(9L)**

Common characteristics of Client/Server systems and protocols, Client/Server Architecture, Strategies for concurrency, Asynchronous I/O, Processes vs. Threads Protocol Definition and Specification, Networking review: The layered networking model, Packet switched networking IP.

UNIT II **(9L)**

Client/Server Architecture and Network Programming: Socket programming, Endpoint addressing, JAVA Sockets, Sockets in C.

UNIT III **(9L)**

The Transport Layer in the Internet: The transport layer: UDP & TCP, General Characteristics of Internet Protocols; the Email Protocol, Internet protocols: Request/Response format, Document types, Simplicity, Email, Sending: SMTP, Receiving: POP3, perhaps IMAP.

UNIT IV **(9L)**

Internet Infrastructure: Domain Name Service and Routing, The Domain Name Service, Routing: routing algorithms and routing protocols,The Internet: Delay, Errors, Detection, Telnet and File Transfer Protocol: telnet (remote login and terminal emulation), FTP (File Transfer), The World Wide Web: History, Introduction and HTTP, Hypermedia, Uniform Resource Identifiers, WWW client/server model, HTTP, HTTP headers.

Books & References:

1. Daniel Minoli : "Internet & Intranet Engineering" -TMH Publication, 1997.
2. Subhashish Dasgupta: "Managing Internet and Intranet Technologies in Organizations Challenges and Opportunities" -Idea Group Publishing, 2000.

MEC-264 Body Area Network (3-1-0)

UNIT I **(9L)**

Introduction to BAN-Standard-Architecture-BAN layers-Drawback of BAN.

UNIT II **(9L)**

Wireless body sensors-Sensor nodes and hardware designs, Wireless systems and platforms, Wireless transceivers and microcontrollers, Existing sensor boards, Design of implanted sensor nodes for WBAN, WBAN Systems Software programs and monitoring.

UNIT III **(9L)**

Network topologies and configuration-Basics of MAC protocol, Traffic characteristics, Scheduled protocol, Random access protocol, Hybrid MAC protocol, Energy management in WBAN-Performance analysis of BAN

UNIT IV **(9L)**

Antenna Design and Propagation for BAN: Introduction-Antenna gain, Return loss, Efficiency, Reciprocity, Miniaturized, Antennas, Implanted Antennas, Volume Conduction Antennas.

Books & References:

1. Huan-Bang Li, KamyaYekehYazdandoost Bin-Zhen, "Wireless Body Area Networks",River Publishers, 2010.
2. Muhannad Quwaider SubirBiswas, "Wireless Body Area Networks"- VDM Verlag Dr. Muller, 2010.
3. Mehmet RastiYuce, JamilY.Khan, "Wireless Body Area Network:Technology, Implementation And Application" - CRC Press Taylor and Francis Group, 2012.

MEC-265 IC Design (3-1-0)

UNIT-I **9**

Analog and Digital ICs: Basic Components of Analog and Digital ICs, its Design challenges, IC chip size and circuit complexity, Fundamentals of Monolithic and Hybrid ICs, VLSI Design Flow, VLSI Design Hierarchy, Design quality, and Design Styles, Packaging Technology and CAD Technology applications.

UNIT II **9**

Introduction of IC Technology**:** Silicon Wafer Preparation, Epitaxy, Film Deposition, Lithography & Etching, Impurity Doping and Metallization process, Planar Process, Fabrication of a typical circuit

UNIT III **9**

Electrical behavior of MOS transistors and its design challenges: Short channel effects, Types of scaling and its impact, High-k Technology Inverters: nMOS and CMOS inverters, its design challenges, Switching characteristics, Introduction of Pass transistors and CMOS Transmission Gates, Design of circuits using pass transistor and CMOS TG.

UNIT IV **9**

Stick diagram and Layout representation of various ICs**:** Micron and λ based design rule for VLSI circuit design, Stick diagram and layout representation of a CMOS inverter, CMOS two-input NOR gate, CMOS two-input NAND gate and complex CMOS logic gates.

Books & References:

1. Kang and Leblebici: **"CMOS Digital Integrated Circuits"**- TMH Publication, 2003
2. S.M. Sze: **"Semiconductor Devices: Physics & Technology"** -Wiley India Publications, 2000.
3. Weste, Harris and Bannerjee: **"CMOS VLSI Design"** - Pearson Education Publication, 2011.
4. Douglas A Pucknell & Kamran Eshragian, **"Basic VLSI Design"** PHI 3rd Edition (original Edition – 1994)

MEC-168 HIGH SPEED DEVICES AND CIRCUITS (3-1-0)

Unit	Topic
I	Introduction to Basic Concepts, Requirements of High Speed Devices, Circuits & Materials, Classifications & Properties of Compound Semicondutors, Temary Compound Semiconductor and their Application, Crystal Structures in GaAs, Dopants and impurities in GaAs and InP
II	Brief Overview of GaAs Technology for High Speed, GaAs and InP Devices for Microelectronics, Ohmic Contacts on Semiconductors, Fermi Level Pinning & Schottky Barrier Diodes
III	Metal Semiconductor contacts for MESFET, MESFET Operation & I-V Characteristics
IV	Hetero Junctions & HEMT, HEMT 1-V Characteristics and Transconductance, SiGe Technology, SiGe HBT

Text Books:

1. S.M. Sze, “High Speed Semiconductor Devices”, Wiley
2. Michael Shur, “GaAs Devices and Circuits”, Plenum Press
3. C.Y. Chang and F. Kat, “Gallium Arsenide High Speed Devices: Physics Technology and Circuit Applications”, Wiley
4. H. Beneking, “High Speed Semiconductor Devices: Circuit Aspects and Fundamental Behavior”, Chapman and Hall, LONDON