Department of Electronics & Communication Engineering
राष्ट्रीय प्रौद्योगिकी संस्थान,मणिपुर
NATIONAL INSTITUTE OF TECHNOLOGY MANIPUR
Langol, Imphal – 795 004, Ph. (0385)2445812, e-mail: hodece@nitmanipur.ac.in
(An Autonomous Institute under MHRD, Govt. of India)

PROPOSED SYLLABUS FOR M.TECH IN COMMUNICATION AND SIGNAL PROCESSING

Program Outcomes (POs) of the M.Tech Program in Communication and Signal Processing:

Engineering Masters will be able to:

- Interpret, analyse and process the communication signals, data using appropriate modern techniques and tools.
- Analyse and evaluate the modulation and detection techniques for a communication network and suggest enhancements.
- Ability to use software and hardware based approach in design, analysis and implementation of various signal processing algorithms and communication based systems for different applications.
- Applications in Signal Processing and its various algorithms for system optimization and design optimal coding schemes for efficient use of channel capacity using appropriate modern techniques and tools.
- Ability to plan, implement and operate state of the art communication and networking equipment and modern software tools.
- Ability to specify and architect a communication system suitable for given application as per international standards using necessary signal processing algorithm.
- Ability to design and operate Software Defined Radio systems and identify the components of a multimedia communication system.
- Ability to apply suitable tools to design, simulate and demonstrate the working of mobile cellular networks and routing of data as per the societal needs.
- Ability to specify and architect an optimal coding schemes for communication system suitable for given application as per international standardsand suggest enhancementsfor efficient use of channel capacity
- Work in a team and contribute collaboratively in multi-disciplinary research in the field of sensor networks to achieve the project objectives.
- Pursue life-long learning as a means of enhancing the knowledge and skills.

The Programme Educational Objectives (PEOs) are,

1. Specify the communication system for a given requirement.
2. Select coding technique for efficient transmission and reception and to provide required security. Model, simulate, design and implement the communication and computer network systems as per the specifications.
3. Apply the knowledge of communications and networking areas to innovatively solve the problems of changing world using modern engineering tools.
4. Pursue life-long learning as a means of enhancing the knowledge base and skills necessary to serve the engineering and scientific community.
5. Contribute as an individual or a member of a team in product oriented research and demonstrate leadership skills.

The Programme Specific Objectives (PSOs) are,

1. To design and develop electronic systems which optimize power and area requirements, free from faults and dependencies by modelling, simulation and testing.

2. To develop electronic systems by learning advanced algorithms, architectures and software-hardware co-design.
3. To communicate engineering concepts effectively by exhibiting high standards of technical presentations and scientific documentations.

PROPOSED SYLLABUS FOR M.TECH. IN COMMUNICATIONSYSTEMS AND SIGNAL PROCESSING

SEMESTER-I

Course Code	Course Title	L	T	P	C
EC 501	Advanced Antenna Design	3	0	0	6
EC 503	Information Theory and Coding	3	0	0	6
EC 505	Modern Wireless Communication	3	0	0	6
EC 507	Signal Processing Algorithms	3	0	0	6
EC 5xx	Elective-I	3	0	0	6
EC 51x	Elective-II	0	0	3	3
		Total:			33

SEMESTER-II

Course Code	Course Title	L	T	P	C
EC 502	Image Processing Techniques	3	0	0	6
EC 504	Advanced Digital Communication	3	0	0	6
EC 506	Advance Microwave Engineering	3	0	0	6
EC 5xx	Elective-III	3	0	0	6
EC 51x	Elective-IV	0	0	3	3
		Total:			27

SEMESTER-III

Course Code	Course Title	L	T	P	C
EC 621	Project-I	0	0	24	24
		Total:			24

SEMESTER-IV

Course Code	Course Title	L	T	P	C
EC 622	Project-II	0	0	24	24
		Total:			24

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M.Tech in Communication and Signal Processing

Elective-I

Course Code	Course Title	L	T	P	C
EC 551	Advance Digital Signal Processing	3	0	0	6
EC 553	Mobile Communication	3	0	0	6
EC 557	Fiber Optics Communication	3	0	0	6
EC 559	Software Defined Radio	3	0	0	6
EC 561	Advance Electromagnetic	3	0	0	6
EC 563	Antenna for Mobile Applications	3	0	0	6
EC 565	Electromagnetic Interference	3	0	0	6
EC 567	Principle of Microwave solid state devices	3	0	0	6

Elective-II

Course Code	Course Title	L	T	P	C
EC 515	Advanced Microwave and Antenna Lab	0	0	3	3
EC 517	Communication System Lab	0	0	3	3
EC 519	Signal Processing Lab	0	0	3	3

Elective-III

Course Code	Course Title	L	T	P	C
EC 552	Data Communication	3	0	0	6
EC 554	Satellite Communication	3	0	0	6
EC 556	Advance Radio Communication	3	0	0	6
EC 558	System on Chip (SoC)	3	0	0	6
EC 560	Microwave Devices and Circuits	3	0	0	6
EC 562	RF Components & Circuit Design	3	0	0	6
EC 564	Radar Engineering	3	0	0	6
EC 568	Advance EM Wave Propagation and Antenna	3	0	0	6
EC 570	Microwave Filter Design	3	0	0	6
EC 572	Research Methodology for Engineers	3	0	0	6

Elective-IV

Course Code	Course Title	L	T	P	C
EC 514	Advanced Communication Lab	0	0	3	3
EC 516	Image Processing Lab	0	0	3	3

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Detailed Syllabus and Course Outcomes

EC 501	Advanced Antenna Design	3	0	0	6
Course Outcome	EC501.1: Identify basic antenna parameters and list the different types of antenna. EC501.2: Solve the radiation mechanism of linear antennas EC501.3: Compare the different types of antennas and classify their uses. EC501.4: Design a microstrip antenna and analyse the results.				
	Basic of the Antenna, Different radiation zones, Mechanism of radiation, Scattering parameters, dipole antennas and arrays, horn antenna, slot antenna, SIW antenna, dielectric resonator antenna, Helical antenna, Log periodic antenna, Microstrip antenna design: structure, feeding techniques, field distribution, surface wave propagation, radiation mechanism, microstrip array antenna. **Text/References:** 1. C. A. Balanis, "Antenna Theory: Analysis and Design," John Wiley & Sons, 2009. 2. R. J. Marhefka, A. S. Khan and J. D. Kraus, "Antennas and Wave Propagation", Tata McGraw - Hill Education 2010. 3. M. Sachidananda and A. R. Harish "Antennas and Wave Propagation" Oxford University Press, USA 2007.				
EC 502	Image Processing Techniques	3	0	0	6
Course Outcome	EC502.1: Illustrate various transform methods in image processing EC502.2: Apply various filtering techniques for image enhancement and image restoration EC502.3: Analyze various image segmentation algorithms EC502.4: Evaluate transforms (DCT,FFT etc) and encoding techniques in application of image compression				
	Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD. Image Enhancement - Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contraharmonic mean filters, Homomorphic filtering, Color image enhancement. Image restoration - Degradation model, Unconstrained restoration - Lagrange multiplier and Constrained restoration, Inverse filtering-removal of blur caused by uniform linear motion, Wiener filtering, Geometric transformations-spatial transformations. Image segmentation - Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and Merging – Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm-Segmentation by K-Means Algorithm. Digit Recognition using Convolutional Neural network. Compression - Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG. Image. Morphology - Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms. **Texts/ References:** 1. Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, Second Edition, Pearson Education/PHI, 2000. 2. W.K.Pratt, Digital Image Processing , 3/e Edn., John Wiley & sons, Inc. 2006.				

	3. K. R. Castleman, Digital Image Processing, Pearson, 2006. 4. Anil K. Jain, Fundamental of image processing, Pearson, 2002. 5. Image Processing, Analysis, and Machine Vision, Milan Sonka, Vaclav Hlavac and Roger Boyle, Second Edition, Thomson Learning, 2008. 6. Introduction to Digital Image Processing with Matlab, Alasdair McAndrew, Thomson Course Technology,2001. 7. Computer Vision and Image Processing, Adrian Low, Second Edition, B.S. Publications, 2005. 8. Digital Image Processing using Matlab, Rafael C.Gonzalez, Richard E.Woods, Steven L. Eddins, Pearson Education, 2007.				
EC 503	Information Theory and Coding	3	1	0	6
Course Outcome	EC503.1: Summarize various theorems related to information channels EC503.2: Illustrate various encoding techniques related to information channels EC503.3: Analyze information using various encoding techniques EC503.4: Monitor performance of encoding techniques in the application of data transmission.				
	Definitions, Uniquely Decodable Codes, Instantaneous Codes, Krafts Inequality, McMillan's Inequality, Optimal Codes, Binary Huffman Codes, r-ary Huffman codes, Information and Entropy, Properties of Entropy Function, Entropy and Average Word-Length, Shannon-Fano Coding, Shannon's First Theorem, Information Channels, Binary Symmetric Channel, System Entropies, System Entropies for Binary Symmetric Channel, Extension of Shannon's First Theorem to Information Channels, Mutual Information, Mutual Information for the Binary Symmetric Channel, Hamming Distance, Shannon's Second (Fundamental) Theorem, Converse of Shannon's Theorems. Review: Algebra, Krawtchouk Polynomials, Combinatorial Theory, Probability Theory. Linear Codes: Block Codes, Linear Codes, Hamming Codes, Majority Logic Coding, Weight Enumerators, The Lee Metric, Hadamard Codes, Golay Codes (Binary and Ternary), Reed Muller Codes, And Kerdock Codes.Bounds on Codes: Gilbert Bound, Upper Bound, Linear Programming Bounds, Hamming's Sphere –Packing Bound, Gilbert Varshamov Bound, Hadamard Matrices and Codes. Cyclic Codes: Generator Matrix, Check polynomial, Zeros of Cyclic Codes, BCH Codes, Reed-Solomon Codes, Quadratic Residue Codes, Generalized Reed-Muller Codes. Perfect Codes and Uniformly Packed Codes: Lloyd's Theorem, Characteristic Polynomial of a Code, Uniformly Packed Codes, Nonexistence Theorems. Quaternary Codes, Binary Codes Derived from codes over Z4, Galois Rings over Z4, Cyclic Codes over Z4. Goppa Codes. Algebraic Curves, Divisors, Differentials on a Curve, Riemann – Roch Theorem, Codes from Algebraic Curves. Arithmetic Codes: AN Codes, Mandelbaum – Barrows Codes, Convolutional Codes. **Text/References:** 1. G. A. Jones and J. M. Jones, "Information and Coding Theory", Springer, 2000. 2. J. H. van Lint, "Introduction to Coding Theory", Springer, 1999. 3. Cover Thomas, "Elements of Information Theory", and Wiley 2006. 4. R. W. Hamming, "Coding and Information Theory", Prentice Hall, 1986. 5. T. M. Cover and J. A. Thomas, "Elements of Information Theory", Wiley, 1991. 6. R. E. Blahut, "Principles and Practice of Information Theory," AWL, 1987.				
EC 504	Advanced Digital Communication	3	0	0	6
Course Outcome	EC504.1: Understanding Concepts of Data Conversions EC504.2: Learning Digital Modulations and data transmissions EC504.3: Analyze concepts of Information content.				

	EC504.4: Have to concept of coding and its importance.				
	Analog-to-Digital Conversion: Sampling theorem, Pulse-Amplitude Modulation, Channel bandwidth for PAM signal, Natural sampling, Flat top sampling, Quantization of signals, Quantization error, Pulse- code modulation (PCM), Electrical representation of binary digits, The PCM system, Companding, Multiplexing PCM signals, Differential PCM, Delta modulation, Adaptive delta modulation, Vocoders, Channel Vocoder, Linear Predictive coder. Digital Modulation Techniques: Binary Phase-Shift Keying (BPSK), Differential Phase-Shift Keying, Differentially-Encoded PSK (DEPSK), Quadrature Phase-Shift Keying (QPSK), Quadrature Amplitude Shift Keying (QASK), Binary Frequency-Shift Keying (BFSK), Similarity of BPSK and BFSK, M-ary FSK, Minimum Shift Keying (MSK). Data Transmission: A base band signal receiver, Probability of error, The Optimum Filter, Matched Filter, Probability of error in Matched filter, Coherent reception, Coherent reception of PSK and FSK, Non-Coherent reception of FSK, PSK and QPSK, Calculation of error probability of BPSK and BFSK, Error probability for QPSK] Bit-by-bit encoding versus Symbol-by-Symbol encoding, Relationship between Bit error rate and Symbol Error rate and comparison of modulation systems. Information Theory and Coding: Discrete messages, The concept of amount of information, Entropy, Information rate, Coding to increase average information per bit, Shannon's theorem, Capacity of a Gaussian channel, Bandwidth-S/N tradeoff, use of orthogonal signals to attain Shannon's limit, Efficiency of orthogonal signal transmission, Coding: Parity check bit coding for error detection, Coding for error detection and error correction, Block codes (coding and decoding), Convolution codes (coding and decoding). **Text/References:** 1. Wayne Tomasi, "Electronic communications systems" 5th edition Pearson Educaion Asia, 2006 2. Taub and Schilling, "Principles of Communication Systems", TMH, 2nd Edition, 2006 3. S. Haykin, "Digital Communication", Wiley, 2006. 4. S. Haykin, "Analog and Digital Communication", Wiley.				
EC 505	Modern Wireless Communication	3	0	0	6
Course Outcome	EC505.1: Understanding the historical background of wireless communication and its evolution. EC505.2: Assimilating the concepts of increasing system capacity. EC505.3: Learning the effects of fading channels and various cellular interferences. EC505.4: Enquiry to latest cellular technologies.				
	Cellular concepts, frequency reuse, co channel interference, Cell splitting. Radio propagation characteristics; models for path loss, shadowing and multipath fading (delay spread, coherence bandwidth coherence time. Doppler spread). Jakes' channel model. Digital modulation for mobile radio; analysis under fading channels; diversity techniques and Rake demodulator. Introduction to spread spectrum communication. Multiple access techniques used in mobile wireless communications: FDMA/TDMA, CDMA. The cellular concept: Frequency reuse; the basic theory of hexagonal cell layout; spectrum efficiency. FDM/TDM Cellular systems; channel allocation schemes. Handover analysis. Cellular CDMA; soft capacity. Erring capacity comparison of FDM/TDM systems and cellular CDMA. Discussion of GSM standards; signaling and call control; mobility management; location tracing. Wireless data networking; packet error modeling on fading channels, performance analysis of link and transport layer protocols over wireless channels; mobile data networking (mobile IP); wireless data in GSM, IS-95, and GPRS. **Texts/References:** 1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education, 2003.				

	2. William Stallings, "Wireless Communications and Networks", Pearson Education, 2002. 3. Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", First Edition, Pearson Education, 2003. 4. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003. 5. C.K.Toh, "AdHoc Mobile Wireless Networks", First Edition, Pearson Education, 2002.				
EC 506	Advance Microwave Engineering	3	0	0	6
Course Outcome	EC506.1: Student should able to identify the basic microwave devices. EC506.2: Student should able to differentiate microwave devices for different frequency bands application under the microwave frequency range. EC506.3: Student should able to understand the working principle of the microwave devices. EC506.4: Student should able to implement the new microwave devices for practical applications.				
	Significance of Maxwell Equations, Theory of Transmission line, Principles of microwave circuits, Wave guides and boundary conditions, Cavity resonators, Directional couplers, Phase shifter, microstrip line, Various types of antennas and feed systems, Antenna measurement principles, MICs, antenna, stub matching, smith chart, Noise and None linear distortion: Noise in Microwave Circuits, Noise Figure, Nonlinear Distortion, Dynamic Range. **Text/References:** 1. B. Razavi, IEEE Press 1995. 2. D. M. Pozar, "Microwave Engineering," 4th Edition, Wiley, 2012. 3. Elements of Electromagnetics, 4th Edition – Matthew N O Sadiku Oxford University Press 4. Engineering Electromagnetics, 2ed Edition - Nathan Ida Springer India				
EC 507	Signal Processing Algorithms	3	0	0	6
Course Outcome	EC507.1: Summarize various Transforms like DFT, DCT, HAAR etc on 1-D and 2-D signals EC507.2: Apply such transforms to design Digital filters (FIR/IIR) EC507.3: Analyze the filter structures using realization techniques for computation and design efficiency EC507.4: Monitor the accuracy of Digital filters in Multi-rate signal processing				
	Orthogonal transforms: DFT, DCT and HAAR; Properties of DFT; Computation of DFT: FFT and structures, Decimation in time, Decimation in frequency; Linear convolution using DFT; Digital filter structures: Basic FIR/IIR filter structures, FIR/IIR Cascaded lattice structures, Parallel all pass realization of IIR transfer functions, Sine cosine generator; Computational complexity of filter structures; Multirate signal processing: Basic structures for sampling rate conversion, Decimators and Interpolators; Multistage design of interpolators and decimators; Polyphase decomposition and FIR structures; Computationally efficient sampling rate converters; Arbitrary sampling rate converters based on interpolation algorithms: Lagrange interpolation, Spline interpolation; Quadrature mirror filter banks; Conditions for perfect reconstruction; Applications in sub-band coding. **Texts:** 1. R. Chassaing and D. Reay, Digital signal processing and applications with TMS320C6713 and TMS320C6416, Wiley, 2008. 2. S. K. Mitra, Digital Signal Processing: A Computer Based Approach,3rd Edn., TMH, 2008. 3. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Pearson Prentice Hall, 2007.				

EC 551	Advance Digital Signal Processing	3	0	0	6
Course Outcome	EC551.1: Summarize various estimation methods in signal and image processing. EC551.2: Apply adaptive signal processing algorithms in various signal processing applications. EC551.3: Integrate FIR structures in multi-rate signal processing. EC551.4: Monitor various signals and systems in frequency domain using transforms.				
	Parametric methods for power spectrum estimation: Relationship between the auto correlation and the model parameters – The Yule – Walker method for the AR Model Parameters – The Burg Method for the AR Model parameters – unconstrained least-squares method for the AR Model parameters – sequential estimation methods for the AR Model parameters – selection of AR Model order Adaptive signal processing :FIR adaptive filters – steepest descent adaptive filter – LMS algorithm – convergence of LMS algorithms – Application: noise cancellation – channel equalization – adaptive recursive filters – recursive least squares. Multirate signal processing: Decimation by a factor D – Interpolation by a factor I – Filter Design and implementation for sampling rate conversion: Direct form FIR filter structures – Polyphase filter structure. Linear prediction and optimum linear filters: Innovations Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of the Normal Equations, Levinson-Durbin Algorithm, Schiir Algorithm, Properties of the Linear Prediction-Error Filters, Wiener Filters for Filtering and Prediction Wavelet transforms :Fourier Transform : Its power and Limitations – Short Time Fourier Transform – The Gabor Transform - Discrete Time Fourier Transform and filter banks – Continuous Wavelet Transform – Wavelet Transform Ideal Case – Perfect Reconstruction Filter Banks and wavelets – Recursive multi-resolution decomposition – Haar Wavelet – Daubechies Wavelet. **Text/References:** 1. John G.Proakis, Dimitris G.Manobakis, Digital Signal Processing, Principles, Algorithms and Applications, Third edition, (2000) PHI. 2. Monson H.Hayes – Statistical Digital Signal Processing and Modeling, Wiley, 2002. 3. L.R.Rabiner and R.W.Schaber, Digital Processing of Speech Signals, Pearson Education(1979). 4. Roberto Crist, Modern Digital Signal Processing, Thomson Brooks/Cole (2004) 5. Raghuveer. M. Rao, Ajit S.Bopardikar, Wavelet Transforms, Introduction to Theory and applications, Pearson Education, Asia, 2000				
EC 552	Data Communication	3	0	0	6
Course Outcome	EC552.1: Understand and explain Data Communications System and its components. EC552.2: Be familiar with the architecture of a number of different networks. EC552.3: Understand the principles of protocol layering. EC552.4: Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.				

	Concept of CCN/DCN, characteristics of data – Users' sub-network, topological design etc. Accessing techniques, Data Modeling – M/M/1 analysis, Circuit switching, message switching, Packet switching, and ATM cell switching, Protocols, ISO, OSI. Networking objectives, classification of networks – LAN, MAN, WAN, ISDN. Techniques and theories of CSMA/CD Bus, Token Ring, Token passing bus- throughput analysis, Modeling (Stalling Models, IEEE Model etc.). Introduction to wireless networks, GSM, TDMA & CDMA-design and analysis, PCS concepts, Network operation and maintenance, NetworkDelay analysis, Routing, Flow Control, Congestion Control. **Text/Reference:** 1. Behrouz A. Forouzan, "TCP/IP Protocol Suit", TMH, 2000 2. Wayne Tomasi, "Introduction to Data communications and Networking", Pearson Ed. 2007 3. Tananbaum A. S., "Computer Networks", 3rd Ed., PHI, 1999 4. Black U, "Computer Networks-Protocols, Standards and Interfaces", PHI, 1996 5. Stallings W., "Data and Computer Communications", 6th Ed., PHI, 2002.					
EC 553	Mobile Communication	3	0	0	6	
Course Outcome	EC553.1: Familiarization with various cellular mobile systems technologies. EC553.2: Concepts of cell coverage and antenna associated cellular communication. EC553.3: Application of frequency reuse and channel assignments. EC553.4: Learning various multiple assess techniques and uncoming techniques.					
	Introduction to Cellular Mobile Systems: A basic cellular system, performance criteria, uniqueness of mobile radio environment, operation of cellular systems, planning a cellular system, overview of generations of cellular systems. Elements of Cellular Radio Systems Design and interference: General description of the problem, concept of frequency reuse channels, co-channel interference reduction factor, desired C/I from a normal case in an omni directional antenna system, cell splitting, consideration of the components of cellular systems. Introduction to co-channel interference, co-channel measurement design of antenna system, antenna parameter and their effects. Cell Coverage for Signal & antenna structures: General introduction, obtaining the mobile point to point mode, propagation over water or flat open area, foliage loss, propagation near in distance, long distance propagation, point to point prediction model- characteristics, cell site, antenna heights and signal coverage cells, mobile to mobile propagation. Characteristics of basic antenna structures, antenna at cell site, mobile antennas. Frequency Management & Channel Assignment, Hand Off & Dropped Calls: Frequency management, fixed channel assignment, non- fixed channel assignment, traffic & channel assignment. Why hand off, types of handoff and their characteristics, dropped call rates & their evaluation. Modulation methods and coding for error detection and correction: Introduction to Digital modulation techniques, modulation methods in cellular wireless systems, OFDM. Block coding, convolution coding and Turbo coding. Multiple access techniques: FDMA, TDMA, CDMA; Time-division multiple access (TDMA), code division multiple access (CDMA), CDMA capacity, probability of bit error considerations, CDMA compared with TDMA Second generation, digital, wireless systems, GSM, IS_136 (D-AMPS), IS-95, mobile management, voice signal processing and coding.					

	Text/References: 1. Mobile Cellular Telecommunications; 2nd ed.; William, C Y Lee McGraw Hill 2. Mobile wireless communications; Mischa Schwartz, Cambridge University press, UK, 2005 3. Mobile Communication Hand Book; 2nd Ed.; IEEE Press 4. Wireless communication principles and practice, 2nd Ed, Theodore S Rappaport, Pearson Education. 5. 3G wireless Demystified; Lawrence Harte, Mc. Graw Hill pub 6. Stallings W., "SNMP, SNMPv2, SNMPv3, RMON 1 & 2", 3rd Ed., Addison Wesley, 1999 7. Laurra Chappell (Ed), "Introduction to Cisco Router Configuration", Techmedia				
EC 554	Satellite Communication	3	0	0	6
Course Outcome	EC554.1: Understand the concept of orbital mechanics and launch methodologies. EC554.2: Understand how analog and digital technologies are used for satellite communication networks. EC554.3: Design link power budget for satellites. EC554.4: Understand the design of Earth station and tracking of the satellites.				
	Introduction: Origin and brief history of satellite communications, an overview of satellite system engineering, satellite frequency bands for communication. Orbital theory:Orbital mechanics, locating the satellite in the orbit w.r.t. earth look angle determination. Azimuth & elevation calculations. Spacecraft systems: Attitude and orbit control system, telemetry, tracking and command (TT&C), communications subsystems, transponders, spacecraft antennas. Satellite link design: Basic transmission theory, noise figure and noise temperature, C/N ratio, satellite down link design, satellite uplink design Modulation, Multiplexing, Multiple access Techniques: Analog telephone transmission, Fm theory, FM Detector theory, analog TV transmission, S/N ratio Calculation for satellite TV linking, Digital transmission, base band and band pass transmission of digital data, BPSK, QPSK , FDM, TDM, Access techniques: FDMA, TDMA, CDMA Encoding & FEC for Digital satellite links: Channel capacity, error detection coding, linear block, binary cyclic codes, and convolution codes. Satellite Systems: Satellite Earth station Technology, satellite mobile communication, VSAT technology, Direct Broadcast by satellite (DBS) **Text/Reference:** 1. Timothy Pratt, Charles W. Bostian, "Satellite communication", John Wiley & sons, Publication, 2003 2. J.J. Spilker, "Digital Communication by satellite, PHI Publication, 1997 3. J. Martin, "Communication satellite systems", PHI publication, 2001				
EC 556	Advance Radio Communication	3	0	0	6
	EC556.1: To understand Modulators and Demodulators EC556.2: To analyze TV and its mechanism EC556.3: To understand Cameras. EC556.4: To study Digital and satellite TV.				
	Elements of a Communication Systems, FM Modulators, FET Phase Modulator, Foster-Seeley FM Discriminator, Ratio Detector, AM Transmitter, FM Transmitter, SSB Transmitter, TRF Radio Receiver, Super heterodyne Receiver, Image Frequency, AGC, SSB Transceiver, Special Features in Communication Receiver, Digital Radio, Television Broadcasting, TV Channels, TV Scanning, Indian TV Standards, composite video Signal, Functional blocks and operational aspects of each block of TV transmitter and receiver, CCD cameras, color TV display systems, Digital TV technology, HDTV systems.				

	Texts: 1. Louis E Frenzil, Communication Electronics: Principles and Applications, 3rd Edition, MGH, 2001. 2. George Kennedy and Bernard Davis, Electronic Communication Systems, TMH, 4th Edition, 2000. 3. BernardGrob, Basic Television and Video Systems, 6th Edition, MGH, Singapore, 2000.				
EC 557	Fiber Optics Communication	3	0	0	6
Course Outcome	EC557.1: Learning various Optical communication techniques. EC557.2: Study of various types of Optical sources. EC557.3: Study of various types of Photo detectors. EC557.4: Learning techniques of optical amplification and optical couplers.				
	Overview of Optical Communications, Optical Fibers, Signal Degradation, International standards, Review of Optical Sources, Review of Photo detectors, structures for InGaAs APDs, Temperature effect on avalanche gain, Optical receiver, Introduction to optical amplifiers (EDFA), Overview of WDM, Passive optical couplers, Isolators and Circulators. **Texts:** 1. G.Keiser, Optical Fiber Communications, TMH, 4th Edition, 2008. 2. J. Gowar, Optical Communication Systems, PHI, 2nd Edition, 1993.				
EC 558	System-on-Chip (SoC)	3	0	0	6
Course Outcome	EC558.1: Design, optimize, and program a modern System-on-a-Chip. EC558.2: Implement both hardware and software solutions, formulate hardware/software tradeoffs, and perform hardware/software codesign. EC558.3: Analyze hardware/software tradeoffs, algorithms, and architectures to optimize the system based on requirements and implementation constraints. EC558.4: Appreciate issues in system-on-a-chip design associated with co-design, such as intellectual property, reuse, and verification.				
	IC Technology, Economics, CMOS Technology overview, Power consumption, Hierarchical design, Design Abstraction, EDA tools. MOSFET model, parasitics, latch up, advanced transistor structures; Wire parasitics; Design rules, Scalable design rules, process parameters; stick diagrams, Layout design tools; Layout synthesis, layout analysis. CMOS gate delays, transmission time, speed power product, low power gates; Delay by RC trees, cross talk, RLC delay, cell based layout, Logic & interconnect design, delay modeling, wire sizing; Power optimization, Switch logic networks. Pipelining, Data paths, Adders, ALUs, Multipliers, High density memories; Metastability, Multiphase clocking; Power optimization, Design validation, Sequential testing; Architecture for low power. Floor planning methods, global routing, switch box routing, clock distribution; off chip connections, packages, I/O architectures, pad design. Complete chip design including architecture, logic and layout for Kitchen timer chip OR Microwave oven chip. **Texts:** 1. Wayne Wolf, "Modern VLSI Design", Pearson Education, 1998. 2. Kamaran Eshraghian, "Principles of CMOS VLSI Design", Pearson Education, 2007 3. Rabey, Chandrakasan, "Digital IC Design", Preason Publication, 2009.				
EC 559	Software Defined Radio	3	0	0	6
	EC559.1: Understanding History of SDR. EC559.2: To study the effective use of available frequency spectrum. EC559.3: To enquire about the architectures of SDR. EC559.4: To assimilate the future prospects of SDR.				
	SDR concepts & history, Benefits of SDR, SDR Forum, Ideal SDR architecture, SDR Based End-to-End Communication, Worldwide frequency band plans, Aim and requirements of the SCA, Architecture Overview, Functional View, Networking Overview,				

	Core Framework, Real Time Operating Systems, Common Object Request Broker Architecture (CORBA), SCA and JTRS compliance, Radio Frequency design, Baseband Signal Processing, Radios with intelligence, Smart antennas, Adaptive techniques, Phased array antennas, Applying SDR principles to antenna systems, Smart antenna architectures, Low Cost SDR Platform, Requirements and system architecture, Convergence between military and commercial systems, The Future For Software Defined Radio **Texts/References:** 1. Dillinger, Madani, Alonistioti (Eds.): Software Defined Radio, Architectures, Systems and Functions, Wiley 2003 2. Reed: Software Radio, Pearson, 1997. 3. Software Defined Radio for 3G, 2002, by Paul Burns. 4.Tafazolli (Ed.): Technologies for the Wireless Future, Wiley 2005. 5. Bard, Kovarik: Software Defined Radio, The Software Communications Architecture, Wiley, 2007.				
EC 560	Microwave Devices and Circuits	3	0	0	6
	EC560.1: Gain knowledge and understanding of microwave analysis methods EC560.2: Be able to apply analysis methods to determine circuit properties of passive/active microwave devices EC560.3: Know how to model and determine the performance characteristics of a microwave circuit or system with or without using smith chart. EC560.4: Have knowledge of basic communication link design, impedance matching and filter circuits.				
	Microwave frequencies, Interactions between electrons and fields, Electromagnetic plane waves, Electric and magnetic wave equations, Poynting theorem, Uniform plane waves and reflection, Plane wave propagation in free space and lossless dielectric, Plane wave propagation in lossy media, Plane wave propagation in metallic film coating on plastic substrate,Transmission line equations and solutions, Reflection coefficient and transmission coefficient, Standing wave and standing wave ratio, Line impedance and admittance, Smith chart, Microwave waveguides and components, Rectangular waveguides, Microwave cavities, Directional couplers, Circulators and isolators, Microwave transistors and tunnel diodes, Microwave bipolar transistors, Heterojunction transistors, Microwave tunnel diodes, Microwave field effect transistors, Junctionfield effect transistors, Metal semiconductor field effect transistors **Text/References:** 1. Samuel Y.Liao, " Microwave Devices and Circuits" Third edition,PHI 2. SK Roy, M Mitra, "Microwave semiconductor devices", PHI 2003 3. David M. Pozar, "Microwave Engineering" Wiley				
EC 561	Advance Electromagnetic	3	0	0	6
Course Outcome	EC561.1: Understand the basic mathematical concepts related to electromagnetic vector fields. EC561.2: Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density. EC561.3: Apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density. EC561.4: Understand the concepts Maxwell's equations to solutions of problems relating to transmission lines and uniform plane wave propagation.				
	Wave Equation, Waves in perfect dielectrics, Intrinsic wave constants, waves in lossy matter, reflection of waves, transmission line concepts, waveguide concepts, resonator concepts, radiation, and antenna concepts. Transmission line theory, Wave functions, Plane waves, rectangular waveguides, alternative mode sets, Rectangular cavity, partially filled wave guide, dielectric- slab guide, surface guided waves, modal Expansions of fields,				

	currents in waveguides, Apertures in ground planes. **Text/References:** 1. R. F Harrington., "Time Harmonic Electromagnetics", McGraw Hill, 1961. 2. RF Harrington, "Field Computation by Moment Methods", New York: MacMillan, 1968. 3. E.C Jordan & K.G. Balmain, "Electromagnetic Waves and Radiating Systems", 2nd Edition, Prentice Hall India, Pvt. Ltd., New Delhi.				
EC 562	RF Component & Circuit Design	3	0	0	6
Course Outcome	EC562.1: Student should able to identify the basic RF devices. EC562.2: Student should able to understand the principle of the RF devices and systems. EC562.3: Student should able to realize the problems of RF system to solve it. EC562.4: Finally student should able to design the RF system for practical applications				
	Transmission lines , Broadband Mactching, Scattering Parameters, microwave transistorsPassive Components: Inductors, Inductor Model, Analytical model, Printed Inductors, Inductors on Si substrate and GaAs substrate. Thick film inductors,Thin film inductors, LTCC inductors. Wire Inductors.Capacitors, Monolithic capacitors, interdigital capacitors. Resistors, chip resistor ,MCM resistor, Monolithic resistors, Microwave Resonators and Narrowband Filters, Broadband Filters Microwave Amplifier Design: Two-Port Power Gains, Amplifier Stability Low Noise Amplifier Design, Broadband Amplifier Design Microwave Amplifier Design: Two-Port Power Gains, Amplifier Stability Low Noise Amplifier Design,Broadband Amplifier Design Microwave Oscillators: One Port negative resistance oscillators, Two Port negative resistance oscillators, Oscillator configurations **Text/References:** 1. Lumped Elements for RF and Microwave Circuits " I. J. Bahl ,Artech House 2. Microwave Transistor Amplifier: Analysis and Design, Gonzalez G. Prentice Hall 1984. 3. Microwave Semiconductor Circuit Design, Davis W. Alan, Van NostrandReinhold, 1984. 4. Microwave Circuit Analysis and Amplifier Design, Samuel Y. Liao, Prentice Hall 1987. 5. High Frequency Amplifier, Ralph S. Carson, Wiley Interscience, 1982				
EC 563	Antenna for Mobile Applications	3	0	0	6
Course Outcome	EC563.1: To impart knowledge about the fundamental concepts of antenna engineering. EC563.2: To introduce the basic principle relevant to wired antennas and planar antennas. EC563.3: To enable the students to understand the factors related to frequency, radiation pattern and interference. EC563.4: Understanding the Practical antennas for various mobile application.				
	Radiation fields of wire antennas: Concept of vector potential. Modification for time varying retarded case. Fields associated with Hertzian dipole. Radiation resistance of elementary dipole with linear current distribution. Radiation from half-wave dipole and quarter – wave monopole. Use of capacity hat and loading coil for short antennas. Antenna Fundamentals and Antenna Arrays: Definitions: Radiation intensity, Directives gain, Directivity, Power gain, Beam Width, Band Width, Gain and radiation resistance of current element. Half-wave dipole and folded dipole. Reciprocity principle, Effective length and Effective area. Relation between gain effective length and radiation resistance. Loop Antennas: Radiation from small loop and its radiation resistance. Antenna Arrays: Expression for electric field from two and three element arrays. Uniform linear array. Method of pattern multiplication. Binomial array. Use of method of images for antennasabove ground. Traveling wave (wideband) antennas: Radiation from a traveling wave on a wire. Analysis and design of Rhombic antenna. Coupled Antennas: Self and mutual impedance of				

	antennas. Two and Three element Yagi antennas, Log periodic antenna. Aperture and Lens Antennas: Radiation from an elemental area of a plane wave (Huygen's Source). Radiation from the open end of a coaxial line. Radiation from a rectangular aperture treated as an array of Huygen's sources. Relation between dipole and slot impedances. Method of feeding slot antennas. **Text/References:** 1. E.C. Jordan and Balmain, "Electro Magnetic Waves and Radiating Systems", PHI, 1968, Reprint 2003 2. John D. Kraus and Ronalatory Markefka, "Antennas", Tata McGraw-Hill Book Company, 2002 3. R.E. Collins, "antennas and Radio Propagation", McGraw-Hill, 1987 4. Ballany, "Antenna Theory", John Wiley & Sons, Second Edition, 2003				
EC 564	Radar Engineering	3	0	0	6
Course Outcome	EC564.1: Student should able to identify different type of radar technology. EC564.2: Student should able to realize the difference between radar and any other communication systems. EC564.3: Student should able to understand how the radar is used in communication system. EC564.4: Student should able to design the radar system.				
	Radar and Radar Equation, Doppler Effect, CW Radar, FM - CW radar, altimeter, Multiple Frequency Radar, Pulse Radar, Pulse Doppler Radar, Tracking Radar, RADAR System Design, Matched Filter, Detector Characteristics, Phased Arrays, Advantages and Limitations Navigational Aids. **Text/References:** 1. M.I. Skolnik, Introduction Radar Systems, McGraw Hill Book Co., Fourth Edition, 2001. 2. G.S.N. Raju, Radar Engineering and Fundamentals and Navigational Aids, I.K. International, 2008. 3. Simon Kingsley and Shaun Quegan, Understanding Radar Systems, SciTech Publishing, 1999. 4. Introduction to Radar Systems – Merrill I. Skolnik, TMH Special Indian Edition, 2nd Edition, 2007.				
EC 565	Electromagnetic Interference	3	0	0	6
Course Outcome	EC565.1: To familiarize with the fundamentals that are essential for electronics industry in the field of EMI / EMC. EC565.2: To understand EMI sources and its measurements. EC565.3: Concept of signal integrity in ICs, conducted emissions and electromagnetic radiation susceptibility, and crosstalk and shielding EC565.4: To understand the various techniques for electromagnetic compatibility.				
	Introduction to Electromagnetic Compatibility (EMC), EMC Requirements for Electronic Systems, Radiated Emissions, Conducted Emissions ,Spectra of Digital Waveforms, The Spectrum of Trapezoidal (Clock) Waveforms, spectral Bounds for Trapezoidal Waveforms, Effect of Rise/Fall-time on Spectral Content, Bandwidth of Digital Waveforms, Effect of Repetition Rate and Duty Cycle, Effect of Ringing (Undershoot/Overshoot) Transmission Lines and Signal Integrity: The Transmission-Line Equations, Printed Circuit Board (PCB) Structures, High-Speed Digital Interconnects and Signal Integrity Sinusoidal Excitation of the Line and the Phasor Solution. Conducted Emissions and Susceptibility: Measurement of Conducted Emissions,1 The Line Impedance Stabilization Network (LISN),Common- and Differential-Mode Currents				

	Again, Power Supply Filters, Basic Properties of Filters, A Generic Power Supply Filter Topology, Effect of Filter Elements on Common. Differential-Mode Currents, Separation of Conducted Emissions into Common and Differential-Mode Components for Diagnostic Purposes, Power Supplies, Linear Power Supplies, Switched-Mode Power Supplies (SMPS), Effect of Power Supply Components on Conducted Emissions, Power Supply and Filter Placement, Conducted Susceptibility **Text/References:** 1. Clayton R Paul: Introduction to Electromagnetic Compatibility Wiley 2nd Edition 2. V.P. Kodali, "Engineering Electromagnetic Compatibility",S. Chand & Co. Ltd., New Delhi, 2000. 3. "Electromagnetic Interference and Compatibility", IMPACT series, IIT-Delhi, Modules1-9. 4. Keiser, "Principles of Electromagnetic Compatibility", 3rd ed., , Artech House 5. Henry W.Ott.,"Noise Reduction Techniques in Electronic Systems", A Wiley Inter Science Publications, John Wiley and Sons, Newyork, 1988				
EC 567	Principle of Microwave solid state devices	3	0	0	6
	EC567.1: Explain different types of microwave devices. EC567.2: Describe and explain working of microwave tubes and solid state devices. EC567.3: Study of different microwave diode based devices. EC567.4: Traveling wave tube and Reflex klystron working and its application.				
	Microwave devices and applications, Transferred electron devices, Gunn – effect diodes – GaAs diode, Ridley- watkins-Hilsum (RWH) theory, Modes of operation, LSA diodes, InP diodes, Avalanche transit time devices, Read diode, IMPATT diode, TRAPATT diodes, BARITT diodes, Microwave linear beam tubes (O Type), Conventional vacuum triodes, Tetrodes and pentodes, klystrons, Multicavity klystron amplifiers, Reflex klystrons, Helix traveling wave tubes (TWT), Coupled cavity traveling wave tubes, Microwave crossed filed tubes (M Type), Magnetron oscillators, Forward wave crossed field amplifier (FWCFA OR CFA), Strip lines, Microstrip lines, Parallel strip lines, Coplanar strip lines, Shielded strip lines, Monolithic microwave integrated circuits, Materials, Monolithic microwave integrated circuit growth, MOSFET fabrication. **Text/References:** 1. Samuel Y.Liao, " Microwave Devices and Circuits" Third edition,PHI 2. SK Roy, M Mitra, "Microwave semiconductor devices", PHI 2003 3. David M. Pozar, "Microwave Engineering" Wiley				
EC 568	Advance EM Wave Propagation and Antenna	3	0	0	6
Course Outcome	EC568.1: Identify basic wireless propagation system using various antennas. EC568.2: Student should able to solve the problem of radiation interferences. EC568.3: Student should able to characterize the EM wave. EC568.4: Design a microstrip antenna for given frequency band and analyse the results.				
	Review of Maxwell's Equation and boundary conditions; time harmonic electromagnetic fields; vector potentials; electromagnetic theorems and concepts, Impedance matching and tuning, dipole antennas and arrays, horn antennas, parabolic antennas, slot antennas and arrays, microstrip antennas, Ground wave propagation, sky wave propagation, space wave propagation. **Texts / References:** 1. C. A. Balanis, "Advanced Engineering Electromagnetics," John Wiley & Sons, 2009. 2. R. F. Harrington, "Time Harmonic Electromagnetic Fields," McGraw Hill, 2001. 3. C. A. Balanis, "Advanced Engineering Electromagnetics," John Wiley & Sons, 1989. 4. R. E. Collin, "Antenna and radio wave propagation," McGraw Hills, 1985. 5. C. A. Balanis, "Antenna Theory: Analysis and Design," John Wiley & Sons, 2009.				

	6. R. J. Marhefka, A. S. Khan and J. D. Kraus, "Antennas and Wave Propagation", Tata McGraw - Hill Education 2010. 7. M. Sachidananda and A. R. Harish "Antennas and Wave Propagation" Oxford University Press, USA 2007.				
EC 570	Microwave Filter Design	3	0	0	6
Course Outcome	EC570.1: Identify basic filter parameters and list the different types of techniques. EC570.2: Student should able to design low pass, high pass, band pass and band stop filter. EC570.3: Student should able to differentiate basic characteristics of the filters. EC570.4: Student should able to implement the FSS for varies application in communication system.				
	Introduction, General procedure for filter design, Active and passive filters, Periodic Structures, Filter Design by the Image Parameter Method, Filter Transformations, Insertion Loss Method, Type of Low Pass Filter, Maximally Flat, Butterworth, Binomial Filter, Equal Ripple or Chebyshev Filter, Elliptic Filter, Linear Phase Filter, Types of Scaling for Low Pass Prototype, Filters implementation in microwave circuits, Stepped Impedance Low Pass Filters, Filter Implementation, Stepped-Impedance Low-Pass Filters, Coupled Line Filters, Filters Using Coupled Resonators. **Text/References:** 1. Devid M. Pozer, " Microwave Engineering" 4th edition, Wiley. 2. Samuel Y.Liao, " Microwave Devices and Circuits" Third edition,PHI. 3. C. A. Balanis, "Advanced Engineering Electromagnetics," John Wiley & Sons, 2009.				
EC 572	Research Methodology for Engineers	3	0	0	6
Course Outcome	EC572.1: To understand research problems and planning. EC572.2: To familiarize with various research resources and academic writing. EC572.3:Understanding data collection, analysis and result presentation. EC572.4: To study mathematical modeling.				
	Research Preparation and Planning: Objectives of research – research and its goals. Critical thinking. Techniques for generating research topics. Topic selection and justification. Development of a research proposal – Theoretical and Experimental Processes. Research Resources: Sources of information. Literature search. World Wide Web, Online data bases – search tools. Citation indices - Principles underlying impact factor – literature review – Case studies, review articles and Meta-analysis – record of research review - Role of the librarian. Ethical and Moral Issues in Research, Plagiarism, tools to avoid plagiarism – Intellectual Property Rights – Copy right laws – Patent rights. Academic Writing and Presentation: Proposal submission for funding agencies, Elements of Style. Organization of proposals, Basic knowledge of funding agencies, Research report writing, Communication skills, Tailoring the presentation to the target audience – Oral presentations, Poster preparations, Submission of research articles for Publication to Reputed journals, Thesis writing, and Research report writing. Elements of excellent presentation: Preparation, Visual and Delivery. Oral Communication skills and Oral defense. Data Collection, Analysis and Inference: Basic Statistical Distributions and their applications - Binomial, Poisson, Normal, Exponential, Weibull and Geometric Distributions. Sample size determination & sampling Techniques-Random sampling, stratified sampling, systematic sampling and cluster sampling. Large Sample Tests and Small Sample Tests-Student–t-test, F-test and χ 2 test and their applications in research studies. Correlation and Regression Analysis-Time series Analysis-Forecasting methods. Factor analysis, Cluster Analysis and Discriminant Analysis. Principles of Experimentation, Basic Experimental Designs: Completely Randomized Design Randomized Block Design and Latin Square Design. Factorial Designs: 22 , 23 and 24 – Accuracy, Precision and error analysis. Mathematical Modelling: Basic concepts of modeling of Engineering systems – static and				

	dynamic model – Model for prediction and its limitations. System simulation -- validation. Use of optimization techniques – Genetic Algorithm, Simulated Annealing, Particle Swarm Optimization. **Texts/ References:** 1. Research Methodology for Engineers, Ganesan R, MJP Publishers, Chennai. 2.Probability & Statistics for Engineers and Scientists,Walpole R.A., Myers R.H., Myers S.L. and Ye, King: Pearson Prentice Hall, Pearson Education. 3. Thesis and assignment writing, Anderson B.H., Dursaton, and Poole M., Wiley Eastern. 4.How to write and illustrate scientific papers?, Bijorn Gustavii, Cambridge University Press. 5.Research Design and Methods, Bordens K.S. and Abbott, B.b.: Mc Graw Hill.