**Department of Electronics & Communication Engineering**
**College of Technology and Engineering, MPUAT, Udaipur**

# POST GRADUATE PROGRAMME

Details of P.G. Programme Courses offered for the award of M.Tech. in Communication Systems

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| Course No. | Subject | Credits |
|---|---|---|
| | **I SEMESTER** | |
| EC511 | Signal Theory & Applications (Core Course) | 3+1 |
| EC512 | Advanced Optical Communication | 3+1 |
| EC513 | Advanced Digital Communication Systems (Core Course) | 2+1 |
| EC514 | Major Elective –I | 2+0 |
| EC515 | Major Elective –II | 2+0 |
| | **Total credits for semester** | 15 |
| | **II SEMESTER** | |
| EC 521 | Antenna Theory & Techniques | 3+1 |
| EC 522 | Satellite Communication (Core Course) | 2+1 |
| EC 523 | Telecommunication Switching & Networks | 3+1 |
| EC 524 | Major Elective –III | 2+0 |
| EC 525 | Major Elective –IV | 2+0 |
| | **Total credits for semester** | 15 |
| | **III SEMESTER** | |
| EC 531 | Mobile Communication (Core Course) | 3+0 |
| EC 532 | Minor Elective- I | 3+0 |
| EC 533 | Seminar | 0+1 |
| EC 534 | Comprehensive Examination | NC |
| EC 535 | Thesis | |
| | *Total credits for semester* | 7 |
| | **IV SEMESTER** | |
| | Thesis (Contd. From III Semester) | 20 |
| | **Total credits for the programme** | **57** |

**List of Major Electives**

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|---|---|
| EC 514 (A) | Microwave Circuits |
| EC 514 (B) | High Frequency Electronics |
| EC 514 (C) | Digital Communication Receivers |
| BS 514 (D) | Optimization Techniques |
| EC 515 (A) | Microwave Communication and Remote Sensing |
| EC 515 (B) | Smart Antennas |
| EC 515 (C) | WDM Optical Networks |
| EC 515 (D) | Digital Signal Processing Structures for VLSI |
| EC 524 (A) | MIMO Theory & Applications |
| EC 524 (B) | Advanced Techniques for Wireless Reception |
| EC 524 (C) | Adaptive Signal Processing |
| EC 524 (D) | Analysis & Design of Planar Transmission Lines |

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|---|---|
| EC 525 (A) | High Speed Communication Networks |
| EC 525 (B) | Ad hoc Networks |
| EC 525 (C) | RF Micro-Electro-Mechanical Systems |
| EC 525 (D) | Broadband Wireless Technologies |

**List of Minor Electives**

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|---|---|
| EC 532 (A) | Information Theory & Coding |
| EC 532 (B) | FPGA – based System Design |
| EC 532 (C) | Embedded System Programming |
| EC 532 (D) | Analog CMOS IC Design |

**SYLLABUS: M.Tech. (COMMUNICATION SYSTEMS)**

***SEMESTER – I***

## EC 511 Signal Theory & Applications (Core Course)
### Credits : 3+1

Representation of deterministic signals: Orthogonal representation of signals. Dimensionality of signal spaces. Construction of orthogonal basis functions.
Random Processes: Definition and classification, stochastic integrals, Fourier transforms of random processes, stationary and non-stationary processes, correlation functions. Ergodicity, power spectral density, transformations of random processes by linear systems.
Representation of random processes (via sampling, K-L expansion and narrow band representations), special random processes :white Gaussian noise, Wiener-Levy process, Poisson process, shot-noise process, Markov process.
Optimum Filtering: Matched filters for deterministic signals in white and colored Gaussian noise. Wiener filters for random signals in white and colored Gaussian noise.

**Reference Books:**
1. J.G.Proakis et al, Advanced Digital Signal Processing, McGraw –Hill
2. S.Haykin, Adaptive Filter Theory (3/e), Prentice- Hall

**EC 512 Advanced Optical Communication** **Credits : 3+1**

Optical fibers: review of fundamentals, Signal distortion and attenuation, Intermodal and intramodal dispersion, dispersion flattened and dispersion compensated fibers, Profile dispersion, study of PMD.
Laser diode and photodiode, Photodetector noise analysis, Analog and Digital communication link design. WDM, DWDM, optical couplers, Mach-Zehnder interferometer multiplexer, optical add/drop multiplexers, isolators, circulators, optical filters, tunable sources and tunable filters, arrayed waveguide grating, diffraction grating, optical amplifiers, optical integrated circuits .Characterization of optical fibers, OTDR
SONET: frame format, overhead channels, payload pointer, Virtual tributaries, multiplexing hierarchy.
SDH: Standards ,frame structure and features.
Optical switching, WDM networks,
Classification of optical sensors: Intensity modulated, phase modulated and spectrally modulated sensors.

## Reference Books:

1. G. Keiser, " Optical Fiber Communication (3rd Edition) ", McGraw Hill International
2. C.S.Murthy & M.Gurusamy, WDM Optical Networks, PHI
3. G.P.Agrawal, Non linear Fiber Optics, (3/e), Elsevier

## EC 513 Advanced Digital Communication Systems (Core Course)
## Credits : 2+1

Characterization of communication signals, signal space representation, equalisation, matched filtering, binary PSK, QPSK, FSK, QAM & M-Ary modulation techniques and their representation. Coherent & non coherent detection, carrier & symbol synchronization, bits vs symbol error probability, bandwidth efficiency, Spread spectrum modulation: Pseudo noise sequences, DS & FH spread spectrum.

**Reference Books:**

1. S.Haykin, Communication Systems (4/e), Wiley
2. R.E.Zimer & R.L.Peterson : Introduction to Digital Communication, PHI
3. J.G.Proakis, Digital Communication (4/e), McGraw- Hill

## EC 514 Major Elective – I Credits : 2+0

## EC 514 (A) Microwave Circuits

Two-port network characterization. Scattering matrix representation of microwave components.
Planar transmission lines; characteristics, properties ; design parameters and applications. Design of mixers.
MIC filters. Kuroda transformation, K inverter, J inverter. Resonator filters.Realization using microstrip lines and strip lines.
Microwave amplifier design. Power gain equations. Maximum gain design. Low noise design. High power design. Stability considerations.
Microwave oscillator design. One port and two port negative resistance oscillators. Oscillator design using large – signal measurements.

**Reference Books:**

1. G.Gonzalez, Microwave Transistors and Amplifiers, Prentice- Hall, Englewoo Cliffs
2. S.Y.Liao, Microwave Amplifier and Oscillator Design, Pearson Education
3. Soohoo, Microwave Electronics, Addison Wesley.

## EC 514 (B) High Frequency Electronics

Analysis of planar transmission lines: Variational method. losses in microstrip lines, analysis & design of devices; passive circuits, impedance transformers, couplers, power dividers, filters,

oscillators, mixers, switches, amplifiers (narrow band /broad band) oscillators, active & passive phase shifters.
Microstrip lines on ferrite and garnet substrate; Isolators and circulators; lumped elements in MICs
Analysis of basic transmission lines for millimeter wave frequencies. Integrated finline, image guide and its variants, non-radiative guide, H-guide and groove guide. Millimetre wave devices for generation and detection. Transitions, bends and discontinuities.
Monolithic circuit components planar transmission lines, lumped and distributed passive elements.

## EC 514 (C) Digital Communication Receivers

Baseband PAM. Clock recovery circuits. Error tracking and spectral – line generating synchronizers. Squaring and Mueller and Muller synchronizers.Channel models. Receivers for PAM. Optimum ML receivers. Synchronized detection. Digital matched filter.
ML synchronization algorithms – DD and NDA. Timing parameter and carrier phase estimation – DD and NDA.
Performance analysis of carrier and symbol synchronizers. Feedback and feedforward synchronizers. Cycle slipping Acquisition of carrier phase and symbol timing.
Fading channels. Statistical characterization. Flat and frequency selective fading channels. Optimal receivers for data detection and synchronization parameter estimation. Realizable receiver structures for synchronized detection.

**Reference Books:**
1. N.Benuveruto & G.Cherubini, Algorithms for Communication Systems and their Applications, Wiley
2. H.Meyr & G.Ascheid, Synchronization in Digital Communications, John Wiley

## BS 514 (D) Optimization Techniques

Introduction: Historical development, application to engineering problems, statement of optimization, classification of optimization, examples of optimization problems.
Linear Programming: Graphical method, simplex method, revised simplex method, Big-M method, 2-phase method, alternate optimal solutions, unbounded LPs, degeneracy and convergence, duality in linear programming, sensitivity analysis, dual simplex method, Transportation, assignment and other applications.
Non-Linear Programming: Unconstrained optimization techniques, descent methods, constrained optimization, direct and indirect methods, optimization with calculm, kuhn-tucker conditions.
Dynamic Programming: Multistage decision process, principles of optimality, computational procedures in dynamic programming.

## EC 515 Major Elective – II Credits : 2+0

### *EC 515 (A) Microwave Communication & Remote Sensing*

Line of sight & troposcatter communications. Channel characterization, Propagation Studies, Performance requirement, Impairments and evolutions of digital and analog communications using Los & troposcatter systems. Design of Los communication Systems, Link calculation.
Characterization of sub systems of line of sight communication system. Theory and system design of troposcatter communication system.

Introduction to Microwave remote sensing. Theory and principle of microwave remote sensing.
Microwave Sensors both Passive and Active Microwave, Receivers, Radiometers, Real Aperture Radar, Synthetic Aperture Radar, Scatterometers, Altimeters, Antenna System for Microwave Sensors, Characterizationn of Microwave Sensors.
Data Processing of Microwave, Data Applications of Passive and Active Microwave sensors for ocean land and atmosphere from tower aircraft and space craft.

## EC 515 (B) Smart Antennas

Spatial processing for wireless systems. Adaptive antennas. Beam forming networks. Digital radio receiver techniques and software radios.
Coherent and non-coherent CDMA spatial processors. Dynamic re-sectoring. Range and capacity extension – multi-cell systems.
Spatio – temporal channel models. Environment and signal parameters. Geometrically based single bounce elliptical model.
Optimal spatial filtering – adaptive algorithms for CDMA. Multitarget decision – directed algorithm.
DOA estimation – conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using eigen decomposition. Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques.

**Reference Book:**
1. M.J. Bronzel, Smart Antennas, John Wiley

## *EC 515 (C) WDM Optical Networks*

First generation optical networks. SONET/SDH. Computer interconnects. Metropolitan area networks. Layered architecture.
WDM optical network evolution. Enabling technologies. WDM optical network architecture. Wavelength routed networks.
Wavelength routing networks. Optical layer. Node designs. Network design and operations. Routing and wavelength assignment.
Wavelength convertible networks, performance evaluation. Networks with sparse wavelength conversion. Converter placement and allocation problems.
Virtual topology design problem, light path routes, implementation in broadcast and select networks.

**Reference Books:**
1. K.M.Sivalingam & S.Subramanium, Optical WDM Networks- Principles & Practice,
2. B.Mukherjee, Optical Communication Networks, (1/e), McGraw Hill

### *EC 515 (D) Digital Signal Processing structures for VLSI*

VLSI Architectures for DSP algorithms – Data flow representations, pipelining and parallel processing, retiming, unfolding, register minimization techniques, systolic architectures, algorithms for fast implementation of convolution, FIR, IIR and adaptive filters, DCT, analysis of finite word length effects, Low power design strategies; Architecture, programming and

applications of general purpose digital signal processors (Emphasis on TI & AD processors); Application case studies: Speech coding, image and video compression, Viterbi decoding, wireless communication.

**Reference Books:**

1. K.K. Parhi, VLSI Digital signal processing systems: Design and implementation, John Wiley
2. Lars Wanhammar, DSP Integrated Circuits, Academic Press
3. S.M. Kuo, B.H.Lee, Real-Time Digital Signal Processing: Implementations, Applications, and Experiments
with the TMS320C55X, Wiley

SEMESTER – II

## EC 521 Antenna Theory and Techniques
### Credits : 3+1

Review of the theory of electromagnetic radiation. Introduction to various antenna types wire, loop and helical antennas, analysis using assumed current distribution.

Aperture antennas: slot, wave guide, horn, and reflector antennas. Analysis using field equivalence principle and Fourier transform methods. Linear arrays. Traveling wave & broadband antennas. Antenna measurements.

Printed antennas: Feeding methods, transmission line & cavity models, analysis and design of rectangular & circular microstrip antenna. Arrays: pattern synthesis, planar arrays, phased arrays. Active antennas and arrays.

Paraboloidal reflector antenna, different feed configurations, shaped beam antennas, lens antenna.

Antennas for biomedical applications, Smart antennas for mobile communications. Antenna for infrared detectors.

**Reference Books**:

1. C. A. Balanis, Antenna Theory and Design, John Wiley & Sons
2. J.D. Kraus, Antennas, McGraw-Hill

## *EC 522 Satellite Communication (Core Course)* *Credits : 2+1*

Evolution of Satellite Technology, Communication Satellites, Satellite frequency Bands.
Satellite Channel analysis, cross-links, Carrier to Noise ratios, Frequency reuse with spot beams. Multiple beams.
Satellite front end, Front-end noise. Noise temperature, Front end filters.
Satellite multiple access methods. FDMA, TDMA, CDMA Systems, DS-CDMA and frequency hopped CDMA, Satellite jamming, Code acquisition and tracking.
Satellite applications. Data Communication and VSAT network. Mobile satellite services (GEO and NON GEO).

**Reference Books:**
1. The Satellite Communication applications handbook. By Brauce. R. Elbert Artech House, Inc.
2. Satellite Communication by Robert M. Gagliardi, CBS Publisher
3. Digital Satellite Comm By Tri T. Ha, Mc Graw Hill

**EC 523 Telecommunication Switching & Networks** **Credits : 3+1**

Principles of circuit switching & signaling schemes, space time & space time division switching, single stage & multi stage switching network. Traffic engineering and teletraffic theory.
Markov processes representing traffic, calculation of blocking probability.
Modeling and analysis of important media access control protocols: ALOHA, slotted ALOHA, CSMA, CSMA/CD.
LAN: Ethernet, token ring, FDDI.
B-ISDN architecture, B-ISDN protocols, ATM traffic & congestion control, signaling, routing and addressing, Internetworking: switches, bridges, routers, gateways. ATM switching.

*EC 524 Major Elective – III* *Credits : 2+0*

**EC 524 (A) MIMO Theory & Applications**

Overview of fundamentals of Digital Communications, The Wireless Channel, Detection, Diversity and Channel Uncertainty, Capacity of Wireless channels, Spatial Multiplexing and Channel modeling, Capacity and Multiplexing architectures, Diversity-Multiplexing tradeoff and Universal Space Time Codes, Multi-user Communication.

**Reference Books:**
1. David Tse, Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge University Press
2. E. Biglieri, Coding for Wireless Channels, Springer
3. E. Biglieri et al., MIMO Wireless Communications, Cambridge University Press

**EC 524(B) Advanced Techniques for Wireless Reception**

Wireless signaling environment. Basic signal processing for wireless reception. Linear receivers for synchronous CDMA. Blind and group-blind multiuser detection methods. Performance issues.
Robust multiuser detection for non Gaussian channels; asymptotic performance , implementation aspects.

Adaptive array processing in TDMA systems. Optimum space-time multiuser detection. Turbo multiuser detection for synchronous and turbo coded CDMA.
Narrowband interface suppression. Linear and nonlinear predictive techniques. Code-aided techniques. Performance comparison.
Signal Processing for wireless reception: Bayesian and sequential Montecarlo signal processing. Blind adaptive equalization of MIMO channels .Signal processing for fading channels. Coherent detection based on the EM algorithm. Decision-feedback differential detection. Signal processing for coded OFDM systems.

**Reference Books:**
1. Mohamed Ibnkahla, Signal Processing for Mobile Communications, CRC Press
2. A.V.H. Sheikh, Wireless Communications Theory & Techniques, Kluwer Academic Publications
3. A.Paulraj etal, Introduction to Space-time Wireless Communications, CambridgeUniversity Press

## EC 524 (C) Adaptive Signal Processing

Adaptive filtering: Wiener filters, linear prediction, methods of steepest descent and least-squares, least mean square adaptive filters, recursive least-squares adaptive filters, frequency domain & sub-band adaptive filters, kalman filters, square root adaptive filters, order recursive adaptive filters, finite precision effects, IIR adaptive filters. Adaptive algorithms: adaptive equalization and echo cancellation. Applications of adaptive filters.

**Reference Book :**

*1. Bernard Widrow, Adaptive Signal Processing, Pearson Education*

### EC 524 (D) Analysis & Design of Planar Transmission Lines

Parameters of planar transmission line variants. Static and dynamic analysis methods for microstrip line, coplanar waveguide, coplanar strips, striplines and slot line.
Spectral domain methods. Formulation of quasistatic and dynamic spectral domain analysis.Galekin's method.
Hybrid mode analysis. Formulation. Application in planar transmission lines. Characteristic equation. Evaluation of parameters.
Coplanar lines , quasi-static and full wave analysis. Design equations. Comparison with microstrip and slot lines.
General analysis of coupled lines. Design considerations for microstrip lines and coplanar waveguides.

**Reference Books:**
1. C. Nquyen, Analysis Methods for RF, Microwave, and Millimeter-Wave Planar Transmission Line Structures, Wiley Interscience
2. T.Itoh, Numerical Techniques for Microwave and Millimeter Wave Passive Structures, John Wiley & Sons

***EC 525 Major Elective – IV*** ***Credits : 2+0***

## EC 525 (A) High Speed Communication Networks

Broadband ISDN. Protocol reference model. SDH- basic features. ATM standard. Multistage networks. Traffic models; delay and loss performance. Cell switching. Cell scale and burst scale queuing.
Protocol layers, their service and models.Internet protocol stack, link layer and local area networks. Network layer and routing.
Transport layer. Congestion control. Application layer protocols. Web and HTTP.FTP and email.
Mobile adhoc networking. Routing approaches.
Mobile ad hoc networking. Protocol performance and open issues. Clustering and hierarchial routing. Ad hoc network security.

**Reference Books:**
1. S.Basagni, Mobile Ad Hoc Networking, Wiley
2. J.M.Pitts & J.A.Schormans, Introduction to IP and ATM Design and Performance (2/e), Wiley
3. C.Siva Ram Murthy & B.S.Manoj, Adhoc Wireless Networks (2/e), Pearson Education

## EC 525 (B) Ad Hoc Networks

Mobile ad hoc networking; imperatives, challenges and characteristics. Bluetooth networks.
Routing approaches. Proactive and reactive protocols. Clustering and hierarchial routing. Multipath routing. Security aware routing.
Energy efficient communication in ad hoc networks. Measuring energy consumption. Power save protocols. Maximum life time routing.
Secure routing protocols. Intrusion detection. Security considerations in ad hoc sensor networks. Key management.
Characterization of IP traffic. QOS classification. Self similar processes. Statistical analysis of non – real time traffic and real – time services.

**Reference Books:**
1. C.S. Murthy & B.S. Manoj, AdHoc Wireless Networks, Pearson
2. T.Janevski, Traffic Analysis and Design of Wireless IP Networks, Artech House
3. Ozan K. Tonguz & Gianluigi, Adhoc Wireless Networks, Wiley

## EC 525 (C) RF Micro-Electro-Mechanical Systems

RF MEMS relays and switches. Switch parameters. Actuation mechanisms. Bistable relays and micro actuators. Dynamics of switching operation.
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. 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.
Micromachined antennas. Microstrip antennas – design parameters. Micromachining to improve performance. Reconfigurable antennas.

**Reference Book:**
1. V.K.Varadan etal, RF MEMS and their Applications, Wiley

### *EC 525 (D) Broadband Wireless Technologies*

The Cellular concept, System design, Capacity improvement in cellular systems, Co channel interference reduction. Intelligent cell concept and applications
Mobile radio propagation, fading, diversity techniques, design parameters at the base station, smart antenna systems, Practical link budget design using path loss models
CDMA- Principle, Network design, Link capacity, Power control, RAKE receiver, Channel modeling. WCDMA-Network planning
MC-CDMA, Orthogonal frequency division multiplexing, OFDM with code division multiplexing, Cellular mobile communication beyond 3G
GSM, IS-95, GPRS, UMTS, WLAN, Bluetooth, beyond 4G

**Reference Books:**
1. K.Fazel & S. Kaiser, Multi-carrier and Spread Spectrum Systems, Wiley
2. S.G. Glisic, Advanced Wireless Communications, 4G Technologies, Wiley
3. W.C.Y.Lee, Mobile Communication Engineering. (2/e), McGraw- Hill

*SEMESTER – III*

**EC 531 Mobile Communication (Core Course)** **Credits : 3+0**

Cellular concept. Mobile radio propagation. Co-channel interference. Diversity. Multiple access. Cellular coverage planning. Wireless networking. Wireless systems and standards. Fading channels, spreading codes, power control. WAP and other protocols for internet access. Data transmission in GSM and UMTS, TCP in wireless environment, multi-user detection and its performance analysis. Blue-tooth and other wireless networks, system comparison.
Spread spectrum concept. Basics of CDMA. Properties and generation of PN sequences. Applications of CDMA to cellular communication systems. Second and third generation CDMA systems/standards. Multicarrier CDMA. Synchronization and demodulation .Diversity techniques and rake receiver.

**Reference Books :**

1. Wireless Digital Communication- Feher, PHI.
2. Principles & applications of GSM – Vijay K. Garg, and J.E. Wilkes – Prentice hall PTR.
3. Mobile Cellular Telecomm. Lee Mc Graw Hill Inc.

***EC 532 Minor Elective – I*** ***Credits : 3+0***

**EC 532 (A) Information Theory and Coding**

Shannon's fundamental coding theorems, Differential entropy & mutual information for discrete & continuous ensembles, source coding, Rate distortion theory.
Introduction to Algebra: Groups, fields, Binary field arithmatic, Basic properties of Galois field GF (2m) and vector spaces.
Channel coding & decoding: Run length limited codes, LBC, cyclic code, BCH code, convolutional code, Trellis coded modulation, Reed-Solomon code.

**Reference Books:**

1. Information theory : F.M Reza, McGraw Hill
2. Digital and Analog Communication Systems: K.Sam Shanmugam, John Wiley
3. Digital Communication: B. Sklar, Pearson Education Asia.

***EC 532 (B) FPGA – based System Design***

Digital system design options and trade offs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modeling and simulation, Hardware description languages, combinational and sequential design, state machine design, synthesis issues, test benches, Overview of FPGA architectures and technologies: FPGA Architectural options, granularity of function and wiring resources, coarse vs fine grained, vendor specific issues (emphasis on Xilinx and Altera), Logic block architecture: FPGA logic cells, timing models, power dissipation I/O block architecture: Input and Output cell characteristics, clock input, Timing, Power dissipation, Programmable interconnect - Partitioning and Placement, Routing resources, delays; Applications - Embedded system design using FPGAs, DSP using FPGAs, Dynamic architecture using FPGAs, reconfigurable systems, application case

studies. Simulation / implementation exercises of combinational, sequential and DSP kernels on Xilinx / Altera boards.

**Reference Books:**

1. M.J.S. Smith, Application Specific Integrated Circuits, Pearson
2. Peter Ashenden, Digital Design using VHDL, Elsevier
3. Peter Ashenden, Digital Design using Verilog, Elsevier
4. W.Wolf, FPGA based system design, Pearson

***EC 532 (C) Embedded System Programming***

Introduction: Overview of embedded systems, embedded system design challenges, common design metrics and optimizing. Survey of different embedded system design technologies & trade-offs. Embedded microcontroller cores, embedded memories, Examples of embedded systems. Architecture for embedded system, High performance processors – strong ARM processors, programming, interrupt structure, I/O architecture, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, Digital signal processing, Sub-system interfacing, interfacing with external systems. Software aspects of embedded systems: real time programming languages and operating systems for embedded systems – RTOS requirements, kernel types, scheduling, context switching, latency, inter-task communication and synchronization, Case studies

**Reference Books:**

1. Jack Ganssle, The Art of Designing Embedded Systems, Elsevier
2. J.W. Valvano, Embedded Microcomputer System: Real Time Interfacing, Brooks/Cole
3. David Simon, An Embedded Software Primer, Addison Wesley

**EC 532 (D) Analog CMOS IC Design**

Current mirrors – basic current mirror, Widlar, Wilson biasing, Cascoded current mirrors; Noise – Types, Representation of noise in circuits; Basic Single-stage amplifiers - CS, CD and CG amplifier; noise analysis; Differential amplifiers – current mirror load, current source load, CMR, CMRR, folded cascode amplifier, noise analysis, common-mode feedback circuits; Two-stage amplifiers – analysis, frequency response, stability, compensation; Band gap references; Constant–Gm biasing; Distortion in amplifiers; Introduction to switched capacitor circuits – MOSFET as a switch, charge injection and its cancellation, switched capacitor amplifiers.

**Reference Books:**

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill International Edition
2. David A. Johns and Ken Martin, Analog Integrated Circuit Design, John Wiley
3. Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, Oxford University Press

**EC 533 Seminar** **Credits : 0+1**

**EC 534 Comprehensive Examination** **Credits : NC**

**EC 535 Thesis**

## SEMESTER – IV

***Thesis (Contd. From III Semester)***
***Credits : 20***