University of Pune
Department of Electronic Science

Syllabus for M.Sc. Electronic Science (Part II)
(Credit System)
Revised 2012
To be implemented from 2013-14

Course structure :

Sem I, II and III students should complete 90 credits + Sem IV Project / Internship 10 credits with distribution as follows

Sem I	**Common Courses**	**Credits**
EL – 103	Semiconductor devices and circuit design	4
EL – 104	Mathematical Methods in Electronics and Network Analysis	4
EL – 105	Foundation of Nano Electronics	4
EL – 109	Problem solving	2
EL – 110	Seminar	2
EL - 101	Lab 1 (General Electronics)	4
EL - 102	Lab 2 (Computer Programming)	4
		24
	Elective Courses (minimum 6 Credits)	6
		30
Sem II	**Common Courses**	
EL – 203	Electromagnetics, Microwave and Antenna	4
EL – 204	Digital Electronics and Microprocessors	4
EL – 205	IC Technology and CAD VLSI Tools	4
EL – 209	Problem Solving	2
EL – 210	Seminar	2
EL – 201	Lab 3 (Electronics Systems)	4
EL – 202	Lab 4 (Software Tools)	4
		24
	Elective Courses (minimum 6 Credits)	6
		30

Sem III	**Common Courses**	
EL -303	Communication	4
EL – 304	Embedded system design	4
EL – 305	Foundation Course in IPR	2
	Special Electives (<u>Any two</u> courses + Corresponding Lab)	
EL – 301	Lab5 (Special Electives Lab1)	4
EL – 302	Lab6 (Special Electives Lab2)	4
	EL -301/2 Special Elective Lab 0ptions	
	A RTOS	
	B Wireless embedded	
	C Advanced VLSI Design	
	D IC Layout Design	
	E Mobile and Data Communication Systems	
	F MEMs Design	
EL – 311	RTOS	4
EL – 312	Wireless embedded	4
EL – 313	Advanced VLSI Design	4
EL – 314	Foundation Course in IC Layout Design	4
EL – 315	Mobile and Data Communication Systems	4
EL – 316	MEMs Design	4
		26
	Elective Courses (minimum 4 Credits)	4
		30
Sem IV	**Common Course**	
EL – 401	Internship/ Project	10
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	General Electives	Credits
EL – E01	Technical Communication	2
EL – E02	Electronic Instrument Design	2
EL – E03	C programming	2
EL – E04	Transducers and Measuring Instruments	2
EL – E05	Power supplies	2
EL – E06	Computational Methods in Electronics	2
EL – E07	Industrial applications of Opto electronics	2
EL – E08	Fundamentals of Image processing	2
EL – E09	VHDL/Verilog testing and verification	2
EL – E10	C++ Programming	2
EL – E11	Theory of Industrial process control	2
EL – E12	Power electronic devices and Systems	2
EL – E13	Processes in device fabrication	2
EL – E14	Physics of semiconductor Devices	2
EL – E15	Properties of Electronic Materials	2
EL – E16	Mechatronics	2
EL – E17	Semiconductor foundry techniques	2
EL – E18	Optical Fiber Communication	2
EL – E19	Analytical Instruments	2
EL – E20	Processor Architecture & Design	2
EL – E21	DSP Systems: Processors & Applications	2
EL – E22	Analog RF Circuit Design	2
EL – E23	Foundation Course in Design IPR Management	2
EL – E24	Microwave and Satellite Communication	2
EL- E25	Observational Space Instrumentation – Basics	2
EL- E26	Observational Space Instruments	2

Semester III

Common Courses

EL -303	Communication Electronics	4
EL – 304	Embedded system design	4
EL – 305	Foundation Course in IPR	2

Special Electives (<u>Any two</u> courses + Corresponding Lab)

EL – 301	Lab5 (Special Electives Lab1)	4
EL – 302	Lab6 (Special Electives Lab2)	4
EL – 311	Real Time Operating Systems	4
EL – 312	Wireless embedded	4
EL – 313	Advanced VLSI Design	4
EL – 314	Foundation Course in IC Layout Design	4
EL – 315	Mobile and Data Communication Systems	4
EL – 316	MEMs Design	4
		26
	Elective Courses (minimum 4 Credits)	4
		30

Electives

EL – E17	Semiconductor foundry techniques	2
EL – E18	Optical Fiber Communication	2
EL – E19	Analytical Instruments	2
EL – E20	Processor Architecture & Design	2
EL – E21	DSP Systems: Processors & Applications	2
EL – E22	Analog RF Circuit Design	2
EL – E23	Foundation Course in Design IPR Management	2
EL – E24	Microwave and Satellite Communication	2
EL- E25	Observational Space Instrumentation – Basics	2
EL- E26	Observational Space Instruments	2

EL – 303 Communication Electronics 4

Basic principles of amplitude, frequency and phase modulation, Demodulation, Intermediate frequency and principle of super-heterodyne receiver,

Spectral analysis and signal transmission through linear systems, Random signals and noise, Noise temperature and noise figure, radio wave propagation, guided and unguided waves. wire and wireless transmission.

Basic concepts of information theory, Digital modulation and Demodulation, PM, PCM, ASK, FSK, PSK, Time-division Multiplexing, Frequency-Division Multiplexing

Data Communications - fundamentals, Circuits, Codes and Modems; Basic concepts of signal processing and digital filters, analog and digital transmission fundamentals.

Text/Reference Books:

1. Electronics Communication systems : William Schweber
2. Electronic Communication systems: G.Kennedy and B.Davies
3. Modern Digital and Analog Communication systems: B.P.Lathi
4. Digital Communications: Bernard Sklar
5. Advanced Electronic Communications systems: W.Tomasi
6. Digital Signal Transmission, Chris Bissell, David Chapman

EL – 304 Embedded system design 4

Introduction to Embedded Systems; Characteristics , concept of Real Time, Design Metrics, Design strategies, Challenges, Design Process, HW-SW Co Design, System Integration, Embedded Processors / Microcontroller Architecture, Harvard, CISC and RISC architectures, Memory, I/O ports, Timer / counters, Serial interfaces, Interrupt structure**,** Interrupt servicing, priorities and interrupt latency. CPU Power Consumption and DPM, Pipelining, Super-scalar Execution, Introduction to ARM Architecture & Organization.

Memory hierarchy, Memory interfacing, decoding, Memory Management and Address Translation. I/O Interfacing, Polled and Interrupt driven I/0, DMA, Basic peripherals: Multifunction I/O ports, Timers and Counters, Watchdog Timers, Real time clocks, Serial ports: USART, SPI, I2C, USB, IRDA, Data acquisition system design, ADC/DAC and Codecs

Software design cycle, Modular programming concepts, Parameter passing, Recursion, Dynamic allocation, Operating system fundamentals, multi user multi tasking OS, RTOS basics, Tasks, Processes and Threads, Scheduling, communication and synchronization.

Development environment and debugging tools: Assemblers, Compilers, Linkers, Loaders, Debuggers, Profilers & Test Coverage Tools, IDE's, Emulators, Logic Analyzer.

Text / Reference Books:

1. Embedded system design, F. Vahid, T. Gargivis, John Wiley and Sons
2. Embedded Systems Design, Steve Heath, Elsevier
3. The Art of Designing Embedded Systems, Jack G. Ganssle, Academic Press.
4. The Art of Programming Embedded Systems, Jack G. Ganssle, Academic Press.
5. Embedded Systems- Architecture, Programming and Design, Raj Kamal, TMH
6. Computers as Components: Principles of Embedded Computer Systems Design, Wayne Wolf, Morgan Kaufmann

EL – 305 Foundation Course in IPR **2**

Knowledge, Innovation and Intellectual Property Rights: An Introduction, Knowledge – characteristics and role in economic growth, Tacit and codified knowledge, Knowledge as public good and 'market failure', Market for knowledge, Incentives for creation of new knowledge, Appropriation of knowledge: knowledge monopoly and its consequences, Pre-IPR system of protection: Secrecy/Trade guilds/Cartels

IPR: Consequentiality, right based justification and economic justification, Evolution of IP Statutes – Origin and Internationalization, International organizations and Treaties (pre- TRIPs era): Paris Convention, Berne Convention, Rome convention, IPIC Treaty, Budapest Treaty. CBD, UPOV convention. WIPO, GATT, FAO, UNCTAD,

Basic forms of IPRs: Patent, copyright, trademark, industrial design, Patents and Patent information Need for Patent, Patentable and Non-Patentable Invention, Types of Patent application in India, PCT System, Guidelines for Registration of Patent, Patent filing, Opposition and Grant

Text/Reference Books

1. Deborah E. Bouchoux, Intellectual Property for Paralegals Cengage Learning.
2. Prabuddha Ganguli, Intellectual Property Rights, Tata McGraw Hill
3. R. Radhakrishnan, S. Balasubramanian, Intellectual Property Rights :Text and Cases, Excel Books
4. Richard Stim Intellectual Property: Patents, Trademarks and Copyrights Cengage Learning

EL – 311 Real Time Operating Systems **4**

Introduction to Operating Systems, Multi tasking operating systems, Process Management & Inter Process Communication, semaphores, conditional critical regions, event queues, deadlock, processor management, scheduling algorithms, queuing system model, Memory management, File System Organization, file sharing and protection, I/O systems and I/O interfaces: polled I/O, interrupt-driven I/O, and direct memory access.

POSIX Thread Programming Hard/soft real time, Static scheduling, Dynamic scheduling, functional decomposition, Hardware-software trade-offs in embedded system, Distributed operating systems concepts, Resource sharing by multiple tasks and routines; Inter Process Communication, Mailboxes, Critical Regions, Semaphores, Deadlock, Priority inheritance and priority ceiling protocols, stack resource protocol, Performance Metrics of RTOS

Linux & RTLinux Internals, Programming in Linux & RTLinux, Shell programming, System Programming, Configuring & Compiling RTLinux,

Embedded Operating Systems basics, uC/OS-II, uCLinux, VxWorks, Porting RTOS & Embedded Operating Systems, Writing Time & Space Sensitive Program, Writing Device Drivers, host-target based development, cross compilers, cross libraries etc, remote debugging using serial/jtag (case study gdb), power-on to boot sequence, os with multiple apps and control switching cross-compiling a linux kernel and loading it onto a dev board (case study BeagleBoard)

Text/Reference Books:

1. Operating Systems: Design and Implementation, A. Tanenbaum & A. Woodhull, Prentice- Hall
2. The Art of Programming Embedded Systems, Jack G. Ganssle. Publisher: Academic Press.
3. Real-Time Systems, Jane W. S. Liu, Prentice-Hall,
4. Fundamental of Embedded Software, Daniel W. Lewis, Prentice Hall.
5. MicroC/OS-II, The Real-Time Kernel, Jean J. Labrosse, 2nd Ed., CMP Books
6. Real –Time Systems Design and Analysis, Phillip A. Laplante,3rd Edition, Wiley-IEEE Press

EL -312 Wireless Embedded Systems Design 4

Basics of Ubiquitous Computing, Introduction Networked Embedded Systems and their applications, Wireless embedded system design: Medium access Control protocols, Wireless Networking, Protocol Design and Validation, Introduction to Bluetooth, Zigbee, IrDA, Wi-Fi IEEE 802.11, Home RF, GSM and GPRS.

Wireless Sensor Networks and Sensor Network Motivating Applications, Embedded Processors and Sensor Network Platforms, Design considerations, Node Architecture , Operating Systems, Routing Protocols, Dynamic Power Management, Programming Environments, network self-configuration and adaptation; localization and time synchronization; collaborative processing, distributed feature extraction & programming sensor networks.

Communication Protocols for In-Vehicle Networks CAN (Controller Area Network), LIN (Local Interconnect Network), MOST (Media Oriented Systems Transport) and Flex Ray standards and protocols.

Text/Reference Books:

1. Wireless Communications and Networks, William Stallings, Prentice Hall
2. TCP/IP Illustrated Volume 1, The Protocols, W.Richard Stevens, Pearson
3. Principles of Embedded Networked System Design, G. Pottie and W.Kaiser, Cambridge University Press
4. Protocols and Architectures for Wireless Sensor Networks, H. Karl and A. Willig, John Wiley & Sons.
5. Wireless Sensor Networks, Raghavendra, S. Cauligi, Kluwer Academic Publishers.
6. Wireless Sensor Networks, Raghavendra, S. C., Siivalingam K.M. and T. Znati, Springer

EL – 313 Advanced VLSI Design 4

N Well, Metal layers, Bonding Pads, N+ and P+ layers, Poly layers: Patterning, Lay out, Design Rules, Associated parasitics, Resistance Calculation, Depletion Layer & Storage Capacitance, current carrying capacity, crosstalk and ground bounce, CMOS Passive Elements: R and C: design rules, parasitic, temperature and voltage dependence

Analog Circuit Modeling, Simple MOS Large Signal Model, Small-signal MOS Model, Analog Subcircuits, The MOS Switch, MOS and Bipolar Current Source/Sinks, Current Mirrors, Basic principles of analog IC design -Matching, Process and temperature variations, Introduction to feedback circuits, Loop gain, Reference circuits and voltage regulators, Current and Voltage References, Bandgap Voltage References, Operational Transconductance Amplifiers,

General Design Principles of Op Amps, Op-amp application circuits and op-amp characteristics, Transistor-level view of a two-stage op-amp, Output stages, Device high-frequency small-signal models & capacitances, Simplified BW and high-frequency analysis, BW limitations of basic gain stages: common-source and Cascode Amplifiers, Analog and mixed devices and circuits, Analog and mixed circuit design strategies and design optimizations, Circuit simulation tools like SPICE, Digital-Analog & Analog-Digital Converters, testing and verification Timing Analysis, Setup, Hold Times, Clock skew.

ASIC Design Flow, IC design methodology and terminology, Physics of Power Dissipation in a nanometer CMOS, Design of Low Voltage CMOS Circuits, Low Power SRAM Architectures, Power Estimation/Analysis Techniques, Power Optimization Techniques Adaptive Power Supply Systems, Power Analysis, Area and Power Dissipation Estimation, Simultaneously switching outputs, VDD/VSS pairs, Ground Bounce, Latch up, Metastability, Design Tradeoffs: Designing for speed, power, reliability, testability, Fault Tolerance, Emerging Technologies,

Text/Reference Books

1. Analysis & Design of Analog Integrated Circuits, P. Gray, P. Hurst, S. Lewis, R. Meyer, Wiley
2. Analog Integrated Circuit Design, D. Johns, K. Martin, Wiley
3. Design of Analog CMOS Integrated Circuits, B. Razavi, McGraw Hill
4. CMOS Mixed-Signal Circuit Design, R. Jacob Baker, Wiley
5. MOSFET Modeling with SPICE, Daniel Foty, Prentice Hall
6. Operation and Modeling of the MOS Transistor, Yannis P. Tsividis,McGraw-Hill
7. SPICE, Gordon W. Roberts and Adel S. Sedra, Oxford University
8. Digital Integrated Circuits- A Design Perspective, Rabaey, Chandrakasan, and Nikolic,
9. CMOS VLSI Design, Weste and Harris

EL – 314 Foundation Course in IC Layout Design 4

Layout techniques on devices: CMOS transistors, bipolar transistors, resistors, capacitors, and diodes, Transistors in series and parallel. Finger & Bend gates, Stick diagrams, Transistor, Schematic, logic & Complex logic fundamentals, Analog circuit and device matching theories, Simple Static CMOS Gates, Inverting And Non-Inverting Gates, CMOS Inverter, Complex Static CMOS Gates, Special CMOS Gates, Pull Up To Pull Down Ratio, Correspondence Of Design Parameters With Specifications, Switching Characteristics, Transistor Sizing, Power Dissipation, Design Margining, Scaling Of Device Dimensions, CMOS Logic Gate Design, Mask Layout Designs For NMOS/CMOS, NAND, NOR Gates, 2 Input Multiplexer, Layout Optimization For Performance, Clocking Strategies, Clock circuit & Clock Skew issues, Lambda based rules

Concepts of analog layout-Sharing, Fingering, Matching, Shielding & crosstalk, Second order & Short channel effects, Issues to take care in analog layout- Latch up, Antenna effect, Electro migration, Electrostatic discharge, Antenna issue, Latch up theory & prevention, High Voltage circuit theory, I/O circuit, Noise and ground bounce theories, Strapping and Guard-ring techniques Advanced Digital and Analog mixed-signal layout techniques, High speed layout techniques, High Voltage layout techniques, Reverse Engineering techniques, ESD and Peripheral output driver and I/O cell layout techniques. Placement and routing techniques,

Chip floor planning techniques, Bonding pad, Seal-ring, Scribe-line layout techniques, Power bus routing, bus slotting, and Clock net routing techniques. Extracting Circuits From Layout, Split Gates, Cell Layout, Schematic And Layout Transistor Densities. Mixed Signal Circuits and Layouts: Nonlinear Analog Circuits, Dynamic Analog Circuits, Data Converter Fundamentals, DAC and ADC.

Introduction to Cadence virtuoso-Basic commands, Bind keys, Layout related functions, Layout vs layout, Layout design & verification-Floor planning- hierarchical design, Power planning, Pin placement, Understanding Design rules, DRC / LVS with ASSURA, Assignments- P - cells creation, Simple inverter, D – flip flop, Custom digital layout, Current mirrors/ buffers/ differential pair, Two stage differential amplifier, High current switches, Resistor/Capacitor dividers, Layout design & verification of LDO.

Text/Reference Books:

1. The Art of Analog Layout, A. Hastings, Prentice Hall
2. IC Mask Design, C. Saint, McGraw Hill
3. CMOS Circuit Design, Layout and Simulation, Baker, Li Boyce,
4. Application Specific Integrated Circuits, M.J.S.Smith, Addison-Wesley
5. CMOS Digital Integrated Circuits Analysis and Design, S. Kang and Y. Leblebici, McGraw-Hill
7. Principles of CMOS VLSI Design, H. E. Weste and David Harris, Addison Wesley
8. CMOS IC Layout, Dan Clein, Newnes

EL-315: Mobile & Data Communication Systems **4**

Mobile communication systems, cellular concepts, role of base station and mobile switching centers, Hands-off considerations, frequency reuse, roaming, SMS, GSM, GPRS, CDMA and EDGE, Speech coding techniques, Vocoders. ATM, SDH, SONET, Physical Layers, Interfaces, Signaling, IP routing, MPLS, VPN, Metropolitan Ethernet Services, Control plane and forwarding plane, architecture.

Telecommunication Network management overview, Wireless Network fundamentals, OSI model layers, architecture, broadband systems. Introduction to Emerging technologies IP multimedia systems, GSM/CDMA, Wi-Fi, Wi-Max, Blue Tooth, 3G/4G & Next Gen. Networks (NGN), IP/ mobile TV, Long Haul systems.

Data communication networks and services, application and layered architecture, OSI model, IEEE 802.3 and IEEE 802.11, Network topologies, LAN and MAC, Data link control, Bridging, switching, addressing, Transmission systems, circuit switching networks, routing, signaling and traffic management

Packet switching networks, Internetworking – Repeaters, bridges, routers and gateways. Introduction to Routing protocols TCP/IP and Internetworking, TCP/IP protocol suite TCP/IP Sockets Client-Server, computing, Name Service, Application protocols over TCP/IP, IPV6, network architectures and protocols, Web server, SMIP server, DNS server, network security, ATM Networks, ISDN, BISDN, VoIP, VoDSL, VPN, MPLS-VPN, Metro-E network, VOIP. High speed LANs – Fast and Gigabit Ethernet, FDDI. Wireless LANs. Bluetooth, Wi-Fi WLAN, WAP and Mobile computing.

Text /Reference Books:

1. Telecommunication T.Vishwanathan, PHI
2. Mobile Cellular Telecommunications, W.C.Y. Lee, McGraw Hill
3. Future Developments in Telecommunication, J. Martin, PrenticeHall
4. Data Networks D. Bertsekas, R. Gallagher
5 Computer Networking Tanenbaum, PHI
6. Computer Networks U.Black, PHI

EL – 316 MEMs Design 4

Overview of MEMS and Microsystems,
Materials for MEMS and Microsystems: silicon, Silicon compounds, silicon piezoresistors, polymers, packaging materials, material characterization techniques - SEM, optical microscopy, XRD, IR, ESCA, SIMS,

MEMS Technology: Surface micromachining, Bulk micromachining, Deep Reactive Ion Etching

Engineering Mechanics for Microsystems design: Bending of thin plates, mechanical vibrations, thermomechanics, fracture mechanics, thin film mechanics,

Overview of finite element stress analysis, Scaling laws in miniaturization: scaling in geometry, scaling in electrostatic forces, scaling in electromagnetic forces, scaling in electricity
MEMS Design: Design considerations, Process design , Mechanical design, Mechanical design using finite element method, MEMS Design Analysis,

Computer Aided Design: What is CAD, CAD package for Microsystems, how to choose CAD package, Study of Coventorware /Intellisuite: 2D Process Visualizer, 3D Visualizer, Process modeling, device layout, cross-section viewing, photomask generation,

Design examples (any two in details): accelerometers, gyroscopes, infrared sensing array, RF MEMS, and Optical MEMS.
Reliability Overview, Design Rules and DRC

Text / Reference Books:

1. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf
2. The Micromachined Transducers Sourcebook, Gregory T.A. Kovacs, McGraw-Hill, Inc.
3. Microsystem Design, Stephen D. Senturia, , Kluwer Publishers
4. Fundamentals of Microfabrication Marc Madou
5. Micro and Smart Systems G. K. Ananthasuresh et al

ELECTIVE COURSES **[MINIMUM 4 CREDITS]**

EL - E17 Semiconductor foundry techniques 2

Clean room techniques: class of clean rooms, filters, air curtains, air showers, particle counters, Distilled water and De-ionized water plant, gas cylinders, gas links, purity of gases and materials, gas leakage detection systems, Quartzware, Lighting requirements, laboratory hazards and their prevention.

Fabrication Equipment : Wafer cleaning and etching baths, Ultrasonic cleaners, Spin coater, resist baking furnaces, Mask preparation techniques – coordinatograph, e-beam lithography mask making machine, step and repeat camera, Exposure system and Mask aligners, Furnaces - for Diffusion, Oxidation, Epitaxial growth Chemical Vapor Deposition, Gas flow meters and controllers – rotameters, mass flow meters, Physical Vapor deposition techniques – resistive evaporation, e-beam evaporation, sputtering (DC, RF, magnetron), Ion implanters, Plasma etching system, Wire Bonders – thermal, thermosonic, ultrasonic, Dicing machine- Principle of operation, Block diagram and description,

Assembly and packaging: Package design considerations – electrical, thermal and mechanical, Die Bonding, Package types, fabrication techniques - ceramic package, metal can package, glass sealing, plastic moulding, Hermetic sealing Yield and Reliability issues

Text / Reference Books:

1. VLSI Fabrication Principles S.K. Gandhi, John Willey & Sons
2. VLSI Technology S.M.Sze, McGrawHill
3. Integrated Circuit Engineering A.B.Glasser, S.Sharpe
4. Semiconductor & Integrated Fabrication Techniques P.E. Gise, R. Blanchard Restonn Pub.Co.Inc
5. Large Scale Integration M.J. Hower, D.V.Morgan, JohnWiley
6. VLSI Technology C.Y. Chang, S.M. Sze, McGraw Hill

EL-E18 Optical fiber Communications: 2

Brief Historical Perspective, Optical Fiber Theory, Parameters of Optical Fibers, Types of Optical Fibers-Single Mode and Multi Mode Fibers, Step Index & Graded Index Fibers. Modal Properties-Waveguide Parameter (V Number), Cut-off wavelength, Dispersion-Intermodal and Intramodal (Chromatic) dispersion, Loss Mechanism in Optical Fibers-Adsorption and Scattering, Fresnel Reflection, Microbending & Macrobending, Connector types and Splices, Misalignment and Mismatch losses.

Light Sources-LEDs, -Semiconductor lasers, - Fabry-Perot lasers, Distributed Feedback, (DFB) lasers, Distributed Bragg Reflection (DBR) lasers, Vertical Cavity Surface Emitting Lasers (VCSEL), Photodetectors-PN and PIN Photodiodes, Avalanche Photodiodes (APD), Fiber-Optic Transmitters, Direct Modulators, External Modulators-Electro-Optic Modulators, Electro-Absorption Modulators, Fiber-Optic Receivers, Noise in detection process, Noise Equivalent Power (NEP), Signal to Noise Ratio,

Single Channel System Design, Power budgeting, Transmission Capacity Budgeting, Dispersion Compensation, Nonlinear effects in optical fibers-Stimulated Brillouin Scattering (SBS), Self-Phase Modulation (SPM), Cross-Phase Modulation (XPM), Four-Wave Mixing (FWM), Stimulated Raman Scattering (SRS) Soliton Propagation, Dispersion Management

Optical Amplifiers- Erbium-Doped Fiber Amplifier (EDFA), Raman Fiber Amplifier (RFA), Semiconductor Optical Amplifiers (SOA), WDM and DWDM Systems, Optical Add-Drop Multiplexers, Analog and Digital Modulation, Bit Error Rate, Eye Diagram, Fiber-Optic Measurements- Optical Power, Attenuation, Cut-Off Wavelength, Numerical Aperture & Acceptance Angle. Troubleshooting and Test Equipment : - OTDR, Priciples & uses, -Power Meters, -Light Sources,-Optical Loss Test Sets, - Visual Fault Locator, - Live Fiber Detectors,

Applications of Optical Fiber Communication Systems, Fiber-Optic Networks.

Text/Reference Books:

1. Fiber Optics and Optoelectronics R.P. Khare, Oxford
2. Optical Fiber Communication Principles and Systems A. Selvarajan, S.Kar and Srinivas, TMH
3. Optical Fiber Communications G. Keiser, MH
4. Introduction to Optical Electronics K.A. Jones, Harper & Row
5. Introduction to Fiber Optics A. Ghatak and K. Thyagarajan, Cambridge University Press.
6. Fiber Optic Communication Systems G.P. Aggarwal, Wiley Eastern
7. Principles and Applications of Optical Communications M.K. Liu, MH

EL – E19 Analytical Instruments 2

Spectroscopic: Radiation sources, wavelength selection, sample preparation, Detectors, analysers, readout modules, data analysis – quantitative, interpretation of spectra, commercially available equipments of the techniques Infrared (IR) and Fourier Transform Infrared (FTIR) spectroscopy, UV-Visible, Raman

Energy Dispersive X-ray Analysis (EDAX), Electron Spectroscopy for Chemical Analysis (ESCA), secondary ion mass spectrometry (SIMS), LEED

Diffraction: X-ray Diffraction (XRD), Operating principle, interpretation of the diffraction pattern – particle size, crystal structure

Microscopic Techniques : Otical microscope, Scanning Electron Microscope (SEM), Transmission Electron microscope (TEM) - Operating Principles, electron beam generation, Interactionof electron beam with matter, Components, Detectors, Vacuum System and Components, Control Console, Sample preparation, Performance Limitations, Interpretation of micrographs,

Other measuring techniques: Thickness measurement – gravimetric method, fitzeau fringe method, tally step method, quartz crystal thickness monitor, Adhesion – contact angle, tape, scratch, Refractive index measurement – Ellipsometer, Abeles method,

Measurement of electrical parameters of semiconductor materials: Resistivity- two probe and four probe methods, Dielectric constant - LCR meter, d33 meter, Mobility, Carrier concentration, Hall Coefficient- Carrier type, Vander Paw

Device characterization techniques: I-V characteristics, C-V characteristics, Diffusion profile.

Text / Reference Books:

1. Instrumental Methods of Analysis H.H. Willard, L.L Merritt, J.A. Dean, F.A. Settle, CBS Publishers
2. Scanning Electron Microscopy, Ootley

EL – E20 Processor Architecture and Design 2

Subsystem design concepts, design of multiplexer, parity generator leaf cell, adder, subtractor, multiplier, ALU, datapaths and control unit design

Data path concepts, Design of Data Paths and control units, Processor architecture, Timing and Control unit designs, CISC and RISC architectures, ALU design, Pipelined processors, pipelined instruction execution, Scalable processors

Architectural concepts of Intel 8086 family including 80286, 386,486, Pentium, Memory and IO systems

Text / Reference Books:

1. Logic and Computer Design Fundamentals M. Mano, C.R. Kime, Pearson Edu
2. Modern Processor Design J. P. Shen, M.H. Lipasty, Tata McGraw-Hill
3. Computer organisation C. Hamacher, Z, Vranesic, S. Zaki, TMH
4. Computer Organisation and design D.A. Patterson, J.L. Henessye, Morgan Kaufmann
5. Computer Architecture and Organization Hayes, McGraw Hill

EL– E21 DSP system: Processors and Applications 2

DSP processor architecture, Multiplier and accumulator, ALU, Barrel shifter, Memory and Cache registers, Buses, Peripherals, Circular buffers and other specialized hardware, Study of architecture, assembly language and specific applications of TI, AD and Motorola DSP processors

Applications for filtering, modulation, demodulation, Image enhancement and compression, motion control and positioning, Radar, Sonar, Noise reduction and Echo cancellation, Speech recognition and interference rejection.

Text / Reference Books:

1. Digital Signal Processing: Principles,algorithms and applications, J.G. Proakias & D.G. Manolakis, PHI
2. VLSI Digital Signal Processing Systems: Design and Implementation K.K.Parhi, John Wiley
3. Digital Signal processing: Hands on approach, C. Schuler and M. Chugani, TMH
4. Theory and applications of Digital Signal Processing L.R. Rabiner and B. Gold, Prentice Hall
5. Discrete Time Signal Processing A.V. Oppenheim and R.W. Schaffer, PHI

EL- E22 Analog RF Circuit Design 2

Overview of basic principles in RF circuits including transmission lines, smith chart, multi-port networks, scattering parameters etc., RF Behavior of Passive Components: Resistors, capacitors and inductors at high frequencies, Components and Circuit Board considerations, Chip Resistors, Chip Capacitors, surface-Mounted Inductors, Active component modeling and design RF filter design, RF amplifier design. AWR microwave office simulation, RF oscillators and mixers, Feedback concepts, with mathematical derivation, stability considerations, Impedence matching, maximum power transfer theorem, reflection, transmission concepts, VSWR, Smith chart, case study of tuning an antenna, Baluns, $\lambda/4$ & $\lambda/2$ lines used for impedance conversion. Noise in passive and active devices, equivalent circuits of resistors, capacitors and inductors at low frequency and high frequency, low noise amplifiers, over all noise figure of a receiver system.

Low noise amplifier design using CAD with case study including DC biasing, matching, stability, noise figure and power / voltage gain Mixers using linear and non-linear concepts, single and double balanced mixers, mathematical analysis of mixers. Type of RF filters – butterworth, chebyshev, Bessel & elliptic, Design of filters using CAD with case studies. Crystal and its equivalent circuit, crystal filters Oscillators using IMPATT, GUNN diodes, MESFET, HEMT transistors.

Text/Reference Books:

1. Analog Communication Kennedy and Davies
2. Microwave devices, circuits & Subsystems for Communication Engineering, Glover, Pennock, Shepherd
3. RF circuit design, by Chris Bowick
4. RF circuit design by R. Ludwig and P.Bretchko
5. RF Circuit Design, Reinhold Ludwig, Pavel Bretchko, Pearson
6. Microwave Devices, Circuits and Subsystems for Communication Engineering, Edited By, I.A. Glover, S.R. Pennock and P.R. Shepherd,John Wiley & Sons, Ltd

EL-E23 Foundation Course in Design IPR Management 2

Concept of design, Design Act 2000, Need for protection of design, Concept, Purpose, Characteristics and functions of Trademark, Copyright and Geographical Indications, Concept of Copyright, Works Protected and Not Protected by Copyright, Copyright in Digital era, Concept of Geographical Indications,

IP Management, IPR Audit, Range and Classification of IP Services IPR Regime, Principles of IP Management, Sectoral IPR Debates on IPR and Development, IPRs and technology transfer, IPRs vis-à-vis access & affordability of medicines, Traditional knowledge, IPR and Benefit sharing, Indigenous knowledge and its appropriation

IPR in Semiconductor IC Layout Design, Concept of Integrated Circuit Layout design, Registration of Integrated Circuit Layout design, Semiconductor Chip Protection Copyrights, design registration, design protection, licensing, IP reuse.

Text/Reference Books:

1. Intellectual property rights for engineers, 2nd edition, by V. Irish, Published by The IEE,
2. Subbaram N.R. " Handbook of Indian Patent Law and Practice ", S. Viswanathan (Printers and Publishers) Pvt. Ltd
3. Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com]
4. Prabuddha Ganguli Intellectual Property Rights, Tata McGraw Hill

EL-E24 Basics of microwave and satellite communication 2

Principles of microwave communication; reflector antennas, wave guides horns and other prime focus offset feeds, Cassegrain feeds, Principles of radio wave propagation, Satellite communication: Low-earth, Medium-earth and Geo-sync. Satellites, Gain / Temp, link-loss, antenna standards, LNA HPA, system noise considerations down and up converters, microwave components, study of measuring instruments like Spectrum Analysers, VNAs.

Text/Reference Books :

1. Antennas : J.D.Kraus, TMH, Co.Ltd.
2. Antenna theory : C.A. Balanis, John Wiley & Sons.
3. Electronic Communication Systems: G.Kennedy & B.Davis,TMH Co.Ltd.
4. Satellite Communication : T.Pratt & C.W.Bostian Wiley&Co
5. Introduction to Satellite Communication : Skolnik

EL-E25 Observational Space instrumentation – Basics 2

Space basics: Science goals, variable(s) Engineering goals: spatial and temporal measurement frequencies, Radiation law, electromagnetic spectrum, absorption lines and windows, Noise (additive, multiplicative and speckle), signal to noise ratio (SNR), radiometric and spectral resolution, NEΔT, observation footprint, Concept instrument(s): constraints of the space environment and resultant characteristics of space instruments, Satellite basics

Basic components of space instruments: Lenses, mirrors (focusing and path folding), scanning mirrors, beam splitters, deformations. Gratings, interferometers, Fourier optics, material for optics, Sensors: CCD, cryogenic detectors, low noise receivers, Optical spectro-radiometer, radar

Text/Reference Books :

1. Principles of Modern Radar: Basic Principles **,** Mark A. Richards (Editor), James A. Scheer (Editor), William A. Holm (Editor), Scitech publishing Inc. 2010
2. Fundamentals of Optics**,** Francis Jenkins (Author), Harvey White (Author)
3. Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light, Max Born (Author), Emil Wolf (Author), et al. Cambridge University press, Repring 2002
4. Sattelite communication Dennis Roddy, McGraw Hill Telecom Engineering, 1989
5. Synthetic Aperture Radar Processing (Electronic Engineering Systems Series), Giorgio Franceschetti (Author), Riccardo Lanari (Author)
6. Satellite Technology: Principles and Applications [Hardcover], Anil K. Maini (Author), Varsha Agrawal (Author) wiely

EL-E26 Observational Space instruments 2

Remote and contact sensing instruments:

Passive instruments: Optical and microwave radiometers, sounders;

Active instruments: rain and cloud radar, altimeters, Synthetic Aperture Radar (SAR) Langmuire Probes (Electron density, heavier ions), TES (Ozone), magnetometers

Calibration: Pre-flight testing and calibration, In-line calibration: AVHRR, AMSU-B, Post-flight comparisons with standard data

Power supplies: Solar Cells, Batteries, their stability issues.

Text/Reference Books :

1. Principles of Modern Radar: Basic Principles **,** Mark A. Richards (Editor), James A. Scheer (Editor), William A. Holm (Editor), Scitech publishing Inc. 2010
2. Fundamentals of Optics**,** Francis Jenkins (Author), Harvey White (Author)
3. Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light, Max Born (Author), Emil Wolf (Author), et al. Cambridge University press, Repring 2002
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6. Satellite Technology: Principles and Applications [Hardcover], Anil K. Maini (Author), Varsha Agrawal (Author) wiely

Semester IV

EL – 401	Internship/ Project	10 Credits