Pre Ph.D./ M.Phil (Electronic Science) Syllabus

Course I : Research methodology : [5 Credits]

Course II : Electronic-Science Core [5 Credits]

Course III : Guide's course [5 Credits]

Course I : Research methodology [5 Credits]

Research methodology : As per the common syllabus defined by University of Pune for Science faculty.

Course II : Any combination of modules worth [5 credits]

Digital Systems: **[1 Credit]**

Combinatorial logic circuits, Sequential Ciruits, Finite state machines, Control Unit design, Digital Sytem design concepts, approaches, programmable logic devices PLAs ,PALs, CPLD, FPGA Architectures, PLD based System design applications.

VLSI Design: **[1 Credit]**

Hierarchical design of VLSIs, interception levels, behavioral description, RTL, Logic circuit, gate, circuits, device, process, The cost - volume trade-off, role of design center and foundry, custom and semicustom design styles. CAD VLSI tools, simulators for logic, timing, circuit, device and process optimization,

Layout design, assignment, partitioning, placement, global and channel routing, compaction and verification algorithms and tools. Design of NMOS and CMOS inverter, stick diagrams, colour and monochrome codes in stick diagrams and mask layout designs for NMOS/CMOS gates.

Hardware description languages - VHDL and Verilog, programming and subsystem design concepts, Fault Modeling and Simulation, Functional testing, Design for testability, Scan based designs, Boundary scan standards (JTAG), BIST, BILBO

Embedded System Design: **[2 Credits]**

Design of Embedded systems, Microcontroller architectures, microcontroller based system design, case studies. Interfacing Memory and I/O devices, synchronous and asynchronous transfer, interrupts, DMA, Serial data transfer, GPIB, RS-232C, I2C, CAN bus protocols. RFID, Smart cards, PDA's, Zip drives. Development and troubleshooting tools, single board microcomputer kits, simulators, In Circuit Emulators, IDE, Logic analyzer.

Introduction to Operating Systems, Process Management & Inter Process Communication, semaphores, conditional critical regions, event queues, deadlock, processor management, scheduling algorithms, queuing system model,Memory management, I/O subsystem, File System Organization, POSIX Thread ProgrammingReal-time,

Digital Communication Technology : **[2 Credits]**

Digital communication principles, FDM, TDM and WDM systems, PCM, delta modulation, transmission coding, code compression, Compading, CODECs, error detection and correction codes, cyclic codes, convolution codes, data security, encryption/decryption algorithms. MODEMs, Shift Keying Techniques, Spread Spectrum modulation, FDMA, TDMA and CDMA.

Telephone communication, switching networks, analog and digital exchanges, speech digitization and transmission, traffic engineering, numbering and charging plan, facsimile, WLL, radio paging and other telecommunication services, Mobile communication systems, cellular concepts, UMTS, frequency reuse, roaming, SMS, GSM, GPRS, CDMA and EDGE, GPS.

Industrial controllers: PLC and PID: [2 Credits]

Programmable logic controllers,, process event and space sequence description, ladder diagram, programming a plc, use of microcontrollers, fuzzy logic. Process control systems and automation, case studies of boiler, chiller, clean room, furnace, heat exchanger, pump, steam turbine, bottling plant and tea/coffee vending machine control.

Process Control loop characteristics, controller modes, ON-OFF control, proportional mode, integral and differential actions, P, PI, PID modes, Analog and digital PID controllers, open/ closed loop tuning of PID, Ziegler-Nicholas method. Auto-tunning PID controllers.

Sensors and Actuators : [1 credit]

Transducer classification, Mechanical, thermal, optical, electrical, magnetic, chemical sensors, displacement, strain, vibration, pressure, flow, force and torque, temperature transducers. Actuators, electromechanical, electrothermal, electrooptical and electrochemical actuators, working principles, specifications and application examples, relays, motors, heaters.

Circuit Analysis : [2 Credits]

Circuit Design and Analysis using PSPICE – Schematics, attributes and types of analysis in PSPICE, use of PROBE.

Design and analysis of current sources, current mirrors, and active loads.

Design and analysis of BJT/FET differential and multistage amplifiers, dc transfer characteristics, small signal circuit analysis, amplifier frequency response, equivalent circuits, system transfer functions, s-domain analysis, Bode plots.

Applications and design of integrated circuits – Bipolar OPAMP circuits, CMOS OPAMP circuits, Active filters, Oscillators, Schmitt trigger circuit, Nonsinusoidal oscillators and timing circuits

Design and analysis of Signal conditioning circuits, Instrumentation amplifier, switched capacitor filters, Current to voltage, voltage to current, voltage to frequency, frequency to voltage converters

Design and analysis of Phase Locked loop and its application circuits.

Semiconductor Devices: [2 Credits]

PN junction diodes, Metal semiconductor junctions, Schottky diode, Semiconductor heterojunctions, Bipolar junction transistors, Field Effect transistors, JFET, MOSFET, Microwave devices: construction, principles of operation and applications of microwave transistors. Negative conductance devices – IMPATT, TRAPATT, Gunn diode, masers

OPAMPS-internal circuit design, application circuits, power considerations and feedback, multi pole circuits, transient and slew rate considerations of OPAMP. Phase locked loops, Phase detectors, Voltage Controlled Oscillators, PLL applications.

Power Electronics Devices and Systems: [2 Credits]

Phase Controlled Recitifiers firing circuits, triggering circuits., DC-DC, switch mode converters, step down (Buck) converter, step-up (Boost) converter, Buck-Boost converter, Cuk-dc-dc converter fill bridge dc to dc converter. Cycloconverters Dual converters, microprocessor based firing schemes for dual converter, Resonant converters. Inverters, Power conditioners and uninterruptible power supplies.

Processes in Device Fabrication: **[2 Credits]**

Crystal growth and wafer preparation, Cz and Bridgeman techniques, ingot shaping, wafering, lapping and polishing, chemical polishing. Properties of silicon wafers: Mechanical, Electrical,

structural, Epitaxial growth, VPE, LPE and MBE, mechanism, apparatus and methods of evaluation of EPI-layers. Oxidation- thermal, anodic and plasma oxidation. Diffusion, theory of diffusion, mechanism and physical phenomena, diffusion models for constant source and limited source cases. Ion implantation, ion implantation system and principles. Metallization: Deposition techniques, CVD and PVD. Lithography, phtolithography, EBMF and X-ray lithography Etching: Etch mechanisms, Plasma etching, Reactive plasma etching, Wet chemical etching. Bonders – thermal, thermosonic, ultrasonic. Assembly and packaging: Package types, package fabrication techniques:ceramic package glass sealing, plastic moulding, Hermetic sealing, metal can package, package design consideration

Characterization Techniques: **[1 Credit]**

UV-VIS spectroscopy, IR spectrometry, X-ray absorption, fluorescence and diffraction methods, Energy dispersive X-ray Analysis (EDAX), Electron Spectroscopy for Chemical Analysis (ESCA). Ellipsometry: optical parameter measurements (n and k), thickness measurements Microscopic Techniques: optical microscope, Scanning Electron Microscope (SEM), Transmission Electron microscope (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy

Advanced Test & Measurement Instruments: **[1 Credit]**

Digital Storage Oscilloscopes, mixed signal oscilloscopes, Arbitrary waveform generators, RF generators, RF power meter, DC electronic load, Electrometer, Current Source, EMI/EMC Tester, Spectrum analyzers, Impedance analyzer, Vector signal analyzer, Network analyzers, Lock-in-Amplifier, Automatic test equipment, Semiconductor parameter analyzer.

DSP : Algorithms and Applications : **[2 Credits]**

Methods and techniques for digital signal processing. Review of sampling theorems, A/D and D/A converters. Demodulation by quadrature sampling. Z-transform methods, system functions, linear shift-invariant systems, difference equations. Correlation and convolutiton. Signal flow graphs for digital networks, canonical forms.

Design of digital filters, practical considerations, IIR and FIR filters. Digital Fourier transforms and FFT techniques. Applications to spectrum analyzer, speech processing, audio CD Player, AM detector, echo cancellor.

Optical Fiber Communication : **[2 Credits]**

Optical fiber theory and applications, parameters and types of optical fibers, single and multimode fibers, dispersion – intermodal and intramodal, step and graded index fibers, construction of optical fiber cables, loss mechanisms - absorption and scattering, connector types and splices, misalignment and mismatch losses, power budget of optical fiber link.

Optical fiber manufacturing processes. Optical fiber testing and parameter (cut off wavelength, loss per unit length, numerical aperture, bending loss, connector/splice loss) measurement. Power meter, OTDR- principle and uses. Spectrum analyzer.

Optical Amplifiers, semiconductor optical amplifiers, EDFA, Raman Amplifier. WDM and DWDM systems

Fiber communication systems. System design considerations for point to point link. System architecture, optical transmitters and receivers, elctro optic modulators, Non-linear effects and system performance, Dispersion management, Soliton propagation. Analog and digital modulation, bit error rate, eye diagram. Optical add-drop multiplexers. Applications of Optical fiber communication systems.

Data Communication Systems : **[2 Credits]**

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.

Artificial Neural Networks : **[1 Credit]**

Basic neuron models: McCulloch-Pitts model, nearest neighbor model, radial basis function model, etc., Neural network models: multilayer perceptron, nearest neighbor based multilayer perceptron, associative memory, radial basis function based multilayer perceptron, etc**.** Learning algorithms: the back propagation algorithm, self-organization learning, winner-take-all competitive learning, evolutionary learning, etc. Applications: character recognition, signal restoration, etc.

Image Processing : **[1 Credit]**

Image acquisition, Image representations, Image digitalization, Sampling, Quantization, Histograms, Image Quality, Noise in Images, Basic operations on images, Image Enhancement, Pixel intensity transformations, Histogram equalization and matching, noise removal, Edge sharpening, Spatial Filtering, Convolution, Image smoothing.

Image processing applications, Machine Vision, Biometrics…

Course III : Guide's course [5 Credits]

Review work related to latest developments in any related field excluding Ph.D. thesis topics.
The student should submit a detailed report of the review work and deliver a seminar before submission of the report and one final seminar.