**University of Pune**
**Department of Electronic Science**

**Syllabus for M.Sc. Electronic Science**
**(Credit System)**

- **The course is divided into four semesters and students are to complete 100 credits in four semesters.**
- **Core courses worth 75 credits are compulsory**
- **Remaining 25 credits can be earned either by opting for equivalent credits from the Advanced courses or from credits offered by other departments of the University (subject to approval by departmental teaching committee)**
- **Each theory and practical course is equivalent to credits mentioned in front of them**
- **Project is equivalent to 15 credits.**

- **The grades for courses will be based on 40 : 60 ratio of continuous internal assessment (CIA) and semester end examination (SEE)**

# SYLLABUS FOR M.SC. ELECTRONIC-SCIENCE

| Sr. No | Course Number | Course Title | Number of Credits | Sr. No. | Course Number | Course Title | Number of Credits |
|---|---|---|---|---|---|---|---|
| **Semester I** | | | | | | | |
| **Core Courses** | | | | **Advanced Courses** | | | |
| 1) | EL – 101 | Practical I<br>Experimental Techniques | 5 | 1) | EL – 113 | Elements of Quantum Computing | 2 |
| 2) | EL – 102 | Practical II<br>5<br>Computational Techniques | 5 | 2) | EL – 114 | Characterization Techniques | 3 |
| 3) | EL – 103 | Quantum and Statistical Mechanics | 2 | 3) | EL – 115 | Advanced Test & Measurement Instruments | 2 |
| 4) | EL – 104 | Properties of Electronic Materials | 3 | 4) | EL – 116 | Computational Methods in Electronics | 3 |
| 5) | EL – 105 | Analog Circuits and Systems | 3 | 5) | EL – 117 | Electronic Instrumentation Design | 3 |
| 6) | EL – 106 | Mathematical Methods in Electronics | 2 | 6) | EL – 118 | Theory of Industrial Process Control | 2 |
| **Semester II** | | | | | | | |
| **Core Courses** | | | | **Advanced Courses** | | | |
| 1) | EL – 201 | Practical III<br>Circuits and Systems | 5 | 1) | EL – 213 | Antenna Systems & Radiation | 3 |
| 2) | EL – 202 | Practical IV<br>Digital Design and CAD lab | 5 | 2) | EL – 214 | DSP Algorithms and Applications | 2 |
| 3) | EL – 203 | Electromagnetic Fields and Waves | 2 | 3) | EL – 215 | Sensors and Actuators | 2 |
| 4) | EL – 204 | Digital System Design | 3 | 4) | EL – 216 | Optical Fiber Communication | 3 |
| 5) | EL – 205 | Physics of Semiconductor Devices | 3 | 5) | EL – 217 | Power Electronics Devices and Systems | 3 |
| 6) | EL – 206 | Industrial Applications of Optoelectronics | 2 | 6) | EL – 218 | Foundation of Quantum Computing | 2 |
| **Semester III** | | | | | | | |
| **Core Courses** | | | | **Advanced Courses** | | | |
| 1) | EL – 301 | Practical V Special Lab | 5 | 1) | EL – 314 | Electronic Communication Systems | 2 |
| 2) | EL – 302 | Practical VI Special lab | 5 | 2) | EL – 315 | Embedded System Applications | 2 |
| 3) | EL – 303 | Practical VII Special Lab | 5 | 3) | EL – 316 | Semiconductor Foundry Techniques | 2 |
| 4) | EL – 304 | Digital Communication Technology | 2 | 4) | EL – 317 | Telecommunication Systems | 2 |
| 5) | EL – 305 | Embedded System Design | 2 | 5) | EL – 318 | Real Time Operating System | 2 |
| 6) | EL – 306 | Processes in Device Fabrication | 2 | 6) | EL – 319 | Sensor Fabrication Techniques | 2 |
| 7) | EL- 307 | Project<br>Project Literature Review<br>Time Management & Resource Planning<br>Presentation & Appreciation | 5 | | | | |
| **Semester IV** | | | | | | | |
| **Core Courses** | | | | **Advanced Courses** | | | |
| 1) | EL – 401 | Project<br>Project Execution<br>Technical Writing &Project Documentation | 10 | 1) | EL – 413 | Processor Architecture & Design | 2 |
| 2) | EL – 403 | VLSI Design | 2 | 2) | EL – 414 | Mechatronics | 2 |
| 3) | EL – 404 | Industrial Controllers:PLC & PID | 2 | 3) | EL – 415 | Industrial Power Drives | 2 |
| | | | | 4) | EL – 416 | DSP System : Processors & Applications | 2 |
| | | | | 5) | EL – 417 | VLSI Subsystem Design, Testing and Verification | 2 |
| | | | | 6) | EL – 418 | Data Communication Systems | 2 |

**EL – 101 Practical I: General Lab :**

**Experiments covering following aspects : Credits 4**
**Gen lab mini Project : Credit 1**

Basic semiconductor material characterization, Electronic Device characterization,Basic Circuit Design, Circuit Design with Linear ICs, Familiarization with Test and Measuring instruments, Experimental techniques & observationsDocumentation standards

**EL – 102 Practical II: Computer Lab:**

**Programs/experiments covering following aspects: Credits 4**
**Computer lab mini Project : Credit 1**

C language familiarization and basics of C++, Program logic development,Numerical algorithms,String handling and File handling,Computer Graphics,Familiarization of computer hardware and peripherals,Operating system and Utilities,Software testing and validation procedures,Documentation standards

**103 Quantum and Statistical Mechanics : Credits 2**

Uncertainty principle, Experiments on duality, Schrodinger's equation and its applications to square well potential, square potential barrier (1D). Theory of scattering, Born approximation using Green's function approach. Discussion on various quantum well structures and quantum dot semiconductors.

Binomial and related distributions, Phase space, Statistical ensembles, applications of classical statistical mechanics, Quantum statistics, Brownian motion. Chemical potentials, their thermodynamic derivation and relation to statistical mechanics.

**Reference Books:**


1. Quantum Mechanics Schiff
2. Quantum Mechanics Ghatak Loknathan
3. Quantum Mechanics Mathews and Venkateshan
4. Statistical Mechanics B.B. Laud
5. Statistical & Thermal Physics Reif.


**EL – 104 Properties of Electronic Materials: Credits 3**

Electrical properties: of metals: Conductivity, reflection and absorption, Fermi surfaces, superconductivity, thermoelectric phenomena. Conduction in metals oxides, amorphous materials.
Dielectric Properties of materials:Macroscopic electric field, local electric field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, phase transition, piezoelectricity, ferroelasticity, electrostriction.
Optical properties of materials: Optical constants and their physical significance, Kramers – Kronig Relations, Electronic internbond and intra bond transitions Relations between Optical properties and band structure – colour of material (Frenkel Excitons), Bond Structure determination from optical spectra reflection, refraction, diffraction, scattering, dispersion, photoluminescence, Electroluminiscence.
Magnetic Properties of Materials: Dimagnetism, paramagnetism, various contributions to para and dia magnetism, Adia- batic demagnetization, Paramagnetic susceptibility. Ferromagnetism, ferrimagnetism, ferrites, antiferromagnetism, curic point, temperature dependence of saturation magnetization, saturation magnetization at absolute zero, magnons and their thermal excitation, dispersion relation, Neutron Magnetic scattering, Ferrimagnetic and antiferrimagnetic order, domains and domain walls, magnetic resonance. coercive force, hysterisis, methods for parameters measurements.

Polymers: Structure of polymers, polymerization mechanism, characterization techniques, optical electrical, thermal and dielectric properties of polymers.
Defects in crystals and their effects on mechanical, electrical and optical properties. Diffusion in materials.

**Text Books:**

1. Electronic Properties of materials, R.E. Hummel
2. Electronic Properties of materials, David Jiles
3. Solid State Physics, Dekkar
4. Introduction to Solid State Physics, C.Kittle
5. Solid State Physics, Ashcroft, Mermin
6. Principles of Electronic materials & dev, S.O. Kasap

**EL – 105 Analog Circuits and Systems : Credits 3**

Basic Network Analysis and equivalent circuits, DC and biasing consideration, current mirror, small signal amplifiers, special modifications in differential amplifiers for designing OPAMPS, power considerations and feedback.
Switching characteristics of diodes, transistors and transistor circuits. Transient response and switching speed, step response of single and multistage amplifiers, multi pole circuits, transient and slew considerations of OPAMP.
Phase locked loops, Phase detectors, Voltage Controlled Oscillators, PLL applications

**Text Books:**

1. Microelectronics,Millman Grabel
2. Analog Circuit Design,Cedra and Smith
3. Microelectronic Circuits Analysis and Design,Rashid, PWS pub.

**EL – 106 Mathematical Methods in Electronics : Credits 2**

Differential equations and their solutions, Bessel functions of first and second kind, utility in antenna design.
Laplace, Fourier, and Z-transforms, their properties and applications in electronics. Signal and system modeling , impulse response, energy and power spectral density, convolution and correlation, Digital filtering

**Text Books:**

1. Mathematical methods for Physics, Arfken, A.G. Academic Press.
2. Engineering Mathematics, R.M. Baphana, Technova Publication
3. Mathematical methods for physicists and Engineers, M.A. Boas

**EL – 113 Elements of Quantum Computiation : Credits 2**

Quantum bits, single and multiple Q bit gates, quantum circuits, Q bit copying, Bell states, quantum teleportation, classical computation and quantum computers, quantum parallelism, Dentsch-Joscha algorithm.
Linear algebra, bases, operators, matrices, Pauli matrices, Tensor products, commutator and anti commutator, state space, quantum measurements, Distinguishing quantum states, projective measurements, POVM measurements, density operator, Schmitt decomposition EPR and the Bell inequality.
**Books:** 1. Quantum computation and quantum Information, M.A. Nielsen and I.L. Chuang (Cambridge University Press)

**EL – 114 Characterization Techniques : Credits 3**

Introduction to emission and absorption spectroscopy: Nature of electromagnetic radiation, electromagnetic spectrum, atomic, molecular, vibrational and X-ray energy levels, Nuclear and Electron spin behavior,

UV-VIS spectroscopy: Radiation sources, wavelength selection, Cells and sampling devices, Detectors, readout modules, data analysis.
IR spectrometry: Correlation of Infrared spectra with Molecular structure, Instrumentation, sample handling, Quantitative Analysis
X-ray methods: Production of X-rays and X-ray spectra, Instrumentation, Direct X-ray methods, X-ray absorption, fluorescence and diffraction methods, Energy dispersive X-ray Analysis (EDAX) Auger Emission Spectroscopy, Electron Spectroscopy for Chemical Analysis (ESCA), interpretation of spectra.
Mass Spectrometry: Sample flow in mass spectrometer, inlet sample system, ionization methods, mass analysers, ion collection systems, data handling, vacuum system, correlation of mass spectra with molecular structure, secondary ion mass spectrometry (SIMS),
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 (STM),
Other measuring techniques: Thickness measurement – gravimetric method, fitzeau fringe method, tally step method etc, Adhesion – contact angle, tape, scratch, strain / stress methods.
Measurement of electrical parameters of semiconductor materials, resistivity, mobility, carrier concentration, carrier type,

**Books:**


1. Instrumental Methods of Analysis, H.H. Willard, L.L Merritt, J.A. Dean, F.A. Settle, CBS Publishers, New Delhi, 1996.
2. Scanning Electron Microscopy: Ootley,


**EL – 115 Advanced Test & Measurement Instruments : Credits 2**

Review of Test and Measurement instruments- multimeters, LCR meters, function generators, CRO, probes and power supplies.
Block diagram, working principle and procedure of operation of Digital Storage Oscilloscopes, mixed signal oscilloscopes, Arbitrary waveform generators, RF generators, RF power meter, DC electronic load, Electrometer, EMI/EMC Tester, Spectrum analyzers, Impedance analyzer, Vector signal analyzer, Network analyzers, Logic analyzer, Automatic test equipment - PCB test and Inspection system, Semiconductor parameter analyzer.

**Reference Books:**


1. T&M Instrument Catalogs and application notes, Agilent
2. T&M Instrument Catalogs and application notes, Techtronix
3. T&M Instrument Catalogs and application notes, Keithley
4. T&M Instrument Catalogs and application notes, L.G.Electronics


**EL – 116 Computational Methods in Electronics : Credits 3**

Numerical methods for solution of simultaneous equations, LU factorization, Pivotal condensation and Gauss -Jordan methods of matrix inversion, applications in network analysis.
Iterative algorithms, solving equations and finding roots, practical considerations of convergence rate and accuracy.
Curve fitting: Regression, Least square, Polynomial,Lagrangian interpolation, Newtons divided difference, Splines Quadratic, Cubic

Numerical methods for solution of differential, partial differential and integral equations, Euler's method, Runge-Kutta method, Numerical integration, differentiation, Simpson's 1/3 rule, Gauss quadrature formula, Euler Maclaurine formula,

Finite difference and finite element methods, applications in solution of Poisson's equation, drift-diffusion transport process, propagation of e.m. waves etc.

**Text Books:**

1.Applied Numerical Methods in Physical Science. Ed., 2nd Ed, Boas M.L, Willey Int.

2.Numerical Analysis, Malvin Marion

3.Data Reduction & Error Analysis for the Physics Sciences, Bevington P.R. McGraw-Hill

**Reference Books:**

1. Applied Numerical Methods for the Micro-computer., Shoup T.E. Rent.Hall

2. Numerical Methods for Scientists and Engineers, K Sankara Rao, DHI, Publication.

3. Numerical Methods for engineers with programming and software applications, S.C.Chapra and R.P.Canale,TMH

**EL – 117 Electronic Instrument Design : Credits 3**

Development cycle of an Electronic Instrument – System engineering, architecting, concept development, documentation, teamwork, design development, validation, verification and integration, Rapid prototyping, Field testing, failure, iteration and judgment.

Documentation types, methods, layouts, audience oriented preparation, presentation and preservation.

Instrument-human interface, user centered design, ergonomics, utility, principles of appropriate operation, Case studies

Packaging and enclosures-design for manufacturing, assembly and disassembly, Wiring, temperature, vibration and shock, rugged systems. Grounding and shielding design, safety and noise.

Circuit design, Circuit lay-out, power supplies, power distribution, Cooling – heat transfer, thermal management, cooling choices-heat sinks, heat pipes and thermal pillows, fans and forced air cooling, liquid cooling, evaporation and refrigeration, Tradeoffs in design.

Integration, production and logistics.

**Text Books:**

1.Electronic Instrument Design, H.R. Fowler, Oxford

**Reference Books:**

1. Principles of Instruments and systems, R.G. Gupta, TMH

2. Industrial Electronics, T.E. Kissell, PHI

3. Instrument Engineer's Handbook– Process Control, B.G. Liptak

**EL – 118 Theory of Industrial Process Control : Credits 2**

Introduction to functional elements of control system, control strategies, continuous and discrete state controller, Open loop control systems, Closed loop control systems - feedback, feed forward and adaptive control strategies. Data logger, supervisory and direct digital control systems.

Mathematical models of systems, state variable models, Transfer function, Block diagrams and signal flow-graphs, analysis of state variable models of open and closed loop systems, Mathematical modeling of Physical systems, equations of electric networks, modeling mechanical system elements.

Stability of linear control systems. Methods of determining stability- Routh-Hurwitz stability criterion, root locus and frequency response methods of control system analysis, Bode and Nyquist plots.

**Text Books:**

1.Automatic Control Systems, B.C. Kuo PHI.

**Reference Books:**

1. Modern Control Systems, R.C. Dorf and R.H. Bishop, Addison Wesley

2. Fundamentals of Modeling and Analyzing Engineering Systems, P.D. Cha, J.J. Rosenberg and C.L. Dym, Cambridge Univ. Press

3. Control Engineering Theory and Practice, M.N. Bandopadhyay, PHI

**EL – 201 Practical III: Circuits & Systems Lab**

**Experiments covering following aspects : Credits 4**
**Systems lab project : Credits 1**

Sensing Principles and signal conditioning, Power Electronics,Optoelectronics,Digital Electronics, Circuits and systems design, Product development, Manufacturability, reliability and cost effectiveness

**EL – 202 Practical IV: Digital Design and CAD Lab**

**Experiments covering following aspects : Credits 4**
**Digital Systems lab project : Credits 1**

(i) Sequential circuits and Finite State Machines
(ii) Circuit simulation using Pspice
(iii) Digital circuit Simulations using Xilinx tools
(iv) Development of ECAD tools
(v) Software system analysis and design
(vi) User interface and graphics
(vii) Familiarization with contemporary tools

**EL – 203 Electromagnetic Fields and Waves : Credits 2**

Revision of Electrostatics and Magnetostatics
Maxwell's equations, correspondence of field and circuit equations, wave equation, Poynting vector theorem, propagation, reflection and refraction of plane waves in free space, through media, lossless and lossy Transmission lines, standing wave and standing wave ratio, line impedance and admittance, impedance matching, Smith chart, application to high frequency devices, transients, plane normal incident wave on dielectric boundary.
Waveguides, standing wave and standing wave ratio, characteristic impedance and admittance, impedance matching, propagation modes in conducting rectangular and cylindrical boundaries, dielectric waveguides and optical fibers.
Directional couplers and microwave cavities, waveguide measurements.

**Text Books:**
1. Electromagnetics, J.D. Kraus, TMH, Co. Ltd.
2. Foundation of Electromagnetic theory, Reitz & Milford, Addison Wesley, Publishing Co
3. Elements of Electromagnetics, M.N.O. Sadiku, Oxford Univ. press.

**EL – 204 Digital System Design : 3**

Digital Sytem design concepts, approaches, programmable logic devices PLAs ,PALs, CPLD, FPGA Architectures
Combinatorial logic circuits, encoders/decoders, multiplexer/ demultiplexers, code convertors, Arithmetic and Logic circuits, Comparison circuits, parity checking and generation, adder, subtraction, look ahead carry, binary multiplication and division, floating and fixed point arithmetic, ALU design
Sequential Ciruits, Flip-flops, counters, shift registers, ring counter and sequencer circuits, Finite state machines, Control Unit design
PLD based System design applications like Washing machine, Wending machine, traffic lights etc

**Text Books:**
1. Logic and Computer design fundamentals, Morris Mano, Charles Kime, pearson edition
2. Digital System design, Gajeski

**Reference Books:**
1. Digital systems: Principles and applications, Tocci , Pearson
2. Digital system design and Principles, Wakerly,PHI
3. Digital system Design, Morris Mano

**EL – 205 Physics of Semiconductor Devices : Credits 3**

PN junction diodes, drift-diffusion currents, I-V and switching characteristics,
Metal semiconductor junctions, Schottky diode, metal silicides fabrication and applications, Semiconductor heterojunctions
Construction, principle of operation, and applications of Tunnel diode, PIN diode, Varactor diode and Zenner diode.

Bipolar junction transistors, Ebers-Moll expressions, I-V and switching characteristics, transient and ac conditions, secondary effects, frequency limitations
Field Effect transistors, JFET, MOSFET, ideal MOS capacitor, control of threshold voltage, surface field effect transistors, Id-Vds characteristics, practical device effects.
Microwave devices: construction, principles of operation and applications of microwave transistors. Negative conductance devices – IMPATT, TRAPATT, Gunn diode, masers

**Text Books:**
1. Solid State Electronics Devices, Ben G. Streetman
2. Physics of Microwave Semi- conductors Devices of their Applications., H.A. Watson
3. Physics of Semiconductor Devices, S.M. Sze

**EL–206 Industrial Applications of Optoelectronics : Credits 2**

Revision of basics of reflection, refraction, transmission and absorption of light radiation, Ray-tracing through lenses, convex, concave and plane mirrors, prisms etc. Refractive index, total internal reflection.
Lamps and illumination systems, LEDs – working principle and appplications, LED lighting, Display devices, indicators, numeric, alphanumeric and special function displays, Liquid Crystal Display elements, Plasma Displays, Multimedia projectors.
Gas and solid state LASERs, pulsed lasers, industrial applications of low power lasers. Alignment, Pointing, tracking and particle Size detectrion Instruments. Laser Level. Wire Diameter Sensor. Laser Doppler Velocimetry-Principle of Operation. Performance Parameters. Electronic Processing of the Doppler Signal.
Photodetectors types and applications, Optocouplers, Optointerruptors, LASCR. used in safety interlocks, power isolators, rotary and linear encoders and remote control. Intrinsic and Extrinsic Fiber optic sensors. Digital camera and automatic inspection systems.
Introduction to Optical computing and holography.

**Text Books:**
1. Optical Engineering Fundamentals, B.H. Walker, PHI
2. Industrial Electronics, T.E. Kissell, PHI
3. Electro-Optical Instrumentation Sensing and Measuring with Lasers**,** Silvano Donati, Pearson
4. Fiber optics and Optoelectronics, R.P. Khare, Oxford Press

**EL – 213 Antenna Systems and Radiation : Credits 3**

Theory and design of Antennas, Antenna parameters, Radar equation
Short dipole antennas, antenna arrays, horn and helical antenna, field pattern and radiation resistance in various cases. Antenna types and parameters for isotropic, dipole, broadside and end fire arrays, Yagi-Uda, log periodic and rhombic antenna, microwave antennas, horn, microstripline, slot antennas, parabolic reflector, Antenna design programs for microstrip.
Applications

**Text Books:**
1. Antennas, J.D. Kraus, TMH, Co. Ltd.
2. Antenna theory, C. A. Balanis, John Wiley & sons

**EL – 214 DSP Algorithms and Applications : Credits 2**

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.

**Text Books:**
1.Digital Signal Processing: Principles, algorithms and applications, J.G. Proakias & D.G.Manolakis, PHI
2.Digital Signal processing: Hands on approach, C. Schuler and M. Chugani, TMH

**Reference Books:**
1. Discrete Time Signal Processing, A.V. Oppenheim and R.W. Schaffer, PHI
2. Theory and applications of Digital Signal Processing, L.R. Rabiner and B. Gold, Prentice Hall

**EL 215 Sensors and Actuators : Credits 3**

Transducer classification, requirements, basic physics, design considerations,
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.
Electronic components, specifications of commercially available components, modern package like SMDs, application circuits of sensors with electronic components, Signal conditioning circuits.

**Text Books:**
1. Sensors & Transducers, Patranabis
2. Measurement Systems (Application & Design), E.D.Doebelin
3. Transducers & Instrumentation, Rangan Mani Sharma
4. Silicon Sensors, Middlehock

**EL – 216 Optical Fiber Communication : Credits 3**

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.
Optical fiber networks, SONET, SDH.

**Text Books:**
1. Fiber optics and Optoelectronics, R.P. Khare, Oxford Press
2. Optical Fiber Communication Principles and Systems, A. Selvarajan, S.Kar and T.Srinivas, TMH
3. Optical Fiber Communications, Keiser, G. McGraw Hill, Int. Student Ed.

**Reference Books**

1. Fiber Optic Communication systems, G.P.Aggarwal,Wiley Eastern
2. Introduction to Fiber Optics , A.Ghatak and K.Thyagrajan, Cambridge Univ. Press
3. Introduction to Optical Electronics, K.A. Jones, Harper & Row
4. Principles and Applications of Optical communications, M.K.Liu, McGraw Hill

**EL – 217 Power Electronics Devices and Systems : Credits 3**

Introduction: Linear electronics Verses power electronics, applications of power electronics

Power devices : Construction, operating principles, ratings and operating parameters of following devices – SCR, Thyristors types :- phase control, inverter grade, asymmetrical (ASCR) reverse conducting, (RCT), Gate assistated Turn off (GATT), Bidirectional diode (DIAC), TRIAC, SUS, SBC, SCS, LASCR, power transistors, power MOSFETS, IGBT's, SITS, GTO, FCT, SITH, MCT, PIC's.
ate triggering circuits, series and parallel operations of
Phase Controlled Recitifiers : phase angle control, single phase – half wave control, full wave control, Half controlled bridge, voltage doubler, Three phase fully controlled, bridge, three phase half control bridge, selection of converter circuits, firing circuits, triggering circuits.
DC-DC, switch mode converters: Control of dc to dc converter, 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: Classification, basic concepts, load resonant converter, zero voltage and /or zero current switching.
Inverters : Basic concepts, classification, series inverter, self commutated inverters, parallel inverters, single-phase bridge voltage source invecter, three phase bridge, voltage control of single phase and three phase inverters, current source inverters, PWM inverters.
AC Regulators: Single phase, three phase.
Power Supply applications: Switching dc power supplies – linear power supplies, switching power supplies, dc-dc converter with electrical isolation, control of switch mode P/S, P/S protection, designing concepts.
Power Line Disturbances, Power conditioners and uninterruptible power supplies.

**Books:**

1.Power Electronics ',' N.Mohan, J.M. Undeland, and W.P. Robbins, John Wilay and Sons, 2003-2004.
2.Power Electronics, M.D. Singh,K.B.Khanchandani, Tata McGrawHill Publishing Co., New Delhi, 1998.
3.Industrial Electronics, Thomas E.Kissell, Prentice Hall of India, 2003.

**EL – 218 Foundation of Quantum Computing : Credits 2**

Single Q bit operations, universal quantum gate, two level, single qubit and CNOT are universal. The Quantum simulation algorithm.
Conditions for quantum computation, preparation of initial states and measurement results, Harmonic oscillator quantum computer, optical photon quantum computer, optical cavity electrodynamics, Ion traps, nuclear magnetic resonance. (2 Credits)

**Books:**

1. Quantum computation & quantum Information,M.A.Nielsen & I.L.Chuang (Cambridge Univ. Press)

**EL – 301 Practical V : Special Lab(Communication Electronics) : Credits 5**

**Experiments covering following aspects**

i. Transmission and reception systems
ii. Audio/ Video applications
iii. Signal digitization and PCM
iv. MODEM principles, Error Detection and correction
v. Digital communication system
vi. Telecom and Computer Networking applications

**EL – 302 Practical VII: Special Lab (Microprocessor Applications) : Credits 5**

**Experiments covering following aspects**

(i) Microprocessor/Microcontroller interfacing
(ii) Interfacing MIMIC panels
(iii) PC based instrumentation
(iv) JAVA applets design and Web page design
(v) VHDL coding and Logic/Timing simulations
(vi) Target board design
(vii) Virtual instrumentation

**EL – 303 Practical VI : Special Lab (Microelectronics) : Credits 5**
**Experiments covering following aspects**

(i) Electrical and spectroscopic characterization
(ii) Device characterization
(iii) Fabrication processes including vacuum deposition,
(iv) Oxidation, Lithography for MOS capacitor fabrication

**EL – 304 Digital Communication Technology : Credits 2**

Information theory, Shanon's definition of information, entropy, capacity of a channel, Shanon's theorem.
Digital communication principles, FDM, TDM and WDM systems. Sampling and digitization of analog signals, PCM, delta modulation, transmission coding, code compression, Compading, CODECs, error detection and correction codes, cyclic codes, convolution codes, data security, encryption/decryption algorithms.
Line coding, NRZ, RZ, AMI, Manchester, HDB3 coding, Block codes, clock extraction and synchronization.
Data communication, DTE, DCE, MODEMs, ASK FSK, PSK, DPSK, QPSK, MSK.GMSK, M-ary FSK, QAM, Spread Spectrum modulation DS-SS, FH-SS
FDMA, TDMA and CDMA techniques.

**Text Books:**
1.Communication Systems Analog and Digital, R.P. Singh, S.D. Sapre. TMH.
2. Analog and Digital Communication Systems, Martin S. Roden. Discovery Press
**Reference Books**
1. Fundamentals of Error Correcting Codes, W. Cary Huffman, V Pless. Cambridge University Press
2. Telemetry Principles , D.Patranabis. TMH
3. Wireless Communications Principles and Practice, T.S.Rappaport. Pearson Edu.Asia.

**EL – 305 Embedded System Design 2**

Design of Embedded systems, Microcontroller architectures, microcontroller based system design, application examples, temperature monitoring and control system, DC motor speed controller, ECG data acquisition and monitoring system, electrical characterization systems for semiconductor parameter analysis.
Development and troubleshooting tools, single board microcomputer kits, simulators, In Circuit Emulators , Logic analyzer. Operating system fundamentals, multi user multi tasking OS, DOS, Windows and Unix.

**Text Books:**
1. Embedded systems, Raj Kamal, TMH
2.The 8051 Microcontroller Architecture, Programming and Applications, K.J. Ayala, Penram Int. Pub.
3. Embedded system design, F. Vahid,T. Gargivis, John Wiley and Sons

**Reference Books:**

1. Computer Organization, C. Hamacher, Z, Vranesic, S. Zaki, TMH
2. Embedded system design:An Introduction to processes tools &Techni1ques, A.S.Berger,CMP books

**EL – 306 Processes in Device Fabrication : Credits 2**

Properties of silicon wafers: Mechanical, Electrical, structural

Epitaxial growth, VPE, LPE and MBE, mechanism, apparatus and methods of evaluation of EPI-layers.

Oxidation, Deal Grove model of thermal oxidation, dry, wet, rapid thermal, pyrogenic and steam oxidation, chlorine enhanced oxidation, dependence on process and substrate parameters, quality of oxide, oxidation induced staking faults, anodic and plasma oxidation.

Diffusion, theory of diffusion, mechanism and physical phenomena, diffusion models for constant source and limited source cases, effect of temperature, electric field, substrate material, orientation, defects and type of impurity species.

Ion implantation, ion implantation system and principles, implant model, penetration range, backscattering, staggling, channeling, Annealing and sintering.

Metallization: Deposition techniques, CVD and PVD, Laser ablation, Laser annealing and mixing.

Lithography, phtolithography, EBMF and X-ray lithography, Wet chemical etching, lift off process and plasma etching.

Etching: Etch mechanisms, Plasma etching, Reactive plasma etching, Wet chemical etching.

**Text Books**

1. VLSI Fabrication Principles, S.K. Gandhi, John Willey & Sons.
2. VLSI Technology, S.M. Sze, McGraw Hill,Int. Book Company.

**Reference Books:**

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

**EL – 314 Electronic Communication Systems : Credits 2**

Signals and systems. revision of transmission concepts from RF and microwave,antenna, propagation of em waves, ground, duct and sky wave propagation. Noise in communication systems, sources and types of noise.

Amplitude modulation- DSSBC, DSBTC, SSB, VSB, AM demodulators, Coherent and incoherent demodulation, IC modulators and demodulators. Frequency modulation and demodulation, Broadband FM and FM stereo, Phase modulation and demodulation, Narrowband and broadband PM.

Concepts of sound recording and reproduction, PA Systems, mixers, distribution amplifiers, filters, equalizers, mono and stereo systems, Superheterodyne radio receiver,

Video signal transmission, and reception, camera and picture tube, scanning, synchronization and composite video signal, television receiver, monochrome and colour, NTSC, PAL and SECAM systems, CCTV, HDTV, CATV and DTH, concepts of Home Theatre.

Principles of Telemetry

**Text Books:**

1. Television Engineering and Video systems, R.G.Gupta, TMH
2. Principles of Communication Sys., Taub & Schilling.

**Reference Books**

1. Electronic Communication Systems, G. Kened y and D. Davis, TMH
2. Electronic & Radio Engineering, Terman, F.E.
3. Basic Television, Grob.
4. Communication Electronics, Roddy Coolen.
5. Television and Video Engineering, Dhake
6. Television, Gulati
7. Audio and Video Systems, R.G.Gupta, TMH

**EL – 315 Embedded System Applications 2**

Interfacing Memory and I/O devices, Common peripherals and their interfacing, Data transfer schemes, programmed data transfer, synchronous and asynchronous transfer, interrupts, enabling, disabling, masking, prioritizing interrupts, Direct Memory Access (DMA) data transfer, Serial data transfer, GPIB, RS-232C, I2C, CAN bus protocols.

I/O devices for process control and instrumentation, transducers, signal conditioning circuits, instrumentation amplifier, programmable gain amplifier, S/H, analog multiplexers, data acquisition systems, timers and counters
RF ID, Smart cards, PDA's, Zip drives, Consumer applications, Automotive control

**Text Books:**
1.Embedded systems, Raj Kamal, TMH
2.Microprocessors & Interfacing Programming & Hardware, D. Hall, McGraw Hill Int. Edition.
**Reference Books**
1. Industiral Electronics, T.E. Kissel, PHI
2. Computer Organisation, C. Hamacher, Z, Vranesic, S. Zaki, TMH

**EL – 316 Semiconductor Foundry Techniques : Credits 2**

Crystal growth and wafer preparation, Cz and Bridgeman techniques, ingot shaping, wafering, lapping and polishing, chemical polishing.
Clean room techniques: Clean rooms, class of clean rooms, filter, air curtains, air showers, particle counters, De-ionized water, DI plant, purity of gases and materials, Quartzware, furnaces, gas bubblers and other apparatus in fab labs, components of fab systems including valves, flowmeters, gas links, vacuum links, sealing, gas leakage detection systems, laboratory hazards and their prevention.
Fabrication Equipment: Diffusion and oxidation furnaces, Mask aligners, Mask preparation techniques – co-ordinato graph, e-beam lithography machine, step and repeat camera, Ion implanters, Vacuum systems, sputtering techniques – DC, RF, magnetron, Gas handling equipment, Bonders – thermal, thermosonic, ultrasonic, Cleaning and etching baths
Assembly and packaging: Package types, package fabrication techniques:ceramic package glass sealing, plastic moulding, Hermetic sealing, metal can package, package design consideration
Reliability issues

1. VLSI Fabrication Principles, S.K. Gandhi, John Willey & Sons.
2. VLSI Technology, S.M. Sze, McGraw Hill,Int. Book Company.

**Reference Books:**
1. Integrated Circuit Engineering, A.B. Glasser, S.Sharpe
2. Semiconductor & Intgtd, P.E.Gise, R.Blanchard Fabrication Techniques Restonn Pub.Co.Inc. PHC.
3. Large Scale Integration, M.J. Hower, D.V.Morgan,John Wiley & Sons Ltd..
4. VLSI Technology, C.Y. Chang, S.M. Sze, McGraw Hill.

**EL – 317 Telecommunication Systems 2**

Telephone communication, manual and automatic switching networks, Strowger, Crossbar and Stored program switching, 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, role of base station and mobile switching centers, Hand-off considerations, frequency reuse, roaming, SMS, GSM, GPRS, CDMA and EDGE, Speech coding techniques, Vocoders.

Satellite communication principles and GPS.

**Text Books:**

1. Telecommunication , T.Vishwanathan, PHI
2. Mobile Cellular Telecommunications, W.C.Y. Lee, McGraw Hill.

**Reference Books**

1. Future Developments in Telecommunication, J. Martin, Prentice Hall

**EL – 318 Real Time Operating Systems : Credits 2**

**Real Time Operating Systems:** Introduction to **real-time,** Example **real-time** applications, Hard vs. soft **real time**., Reference model , Classic uniprocessor scheduling, Static scheduling, Dynamic scheduling, Dynamic-priority scheduling, Static-priority scheduling, Dealing with complexities arising in **real systems**, Practical considerations.

Resource sharing, Priority inheritance and priority ceiling protocols, stack resource protocol. **systems** A quick look at some **real systems**

Basic **operating**-system functions needed for **real-time** computing, Overview of operating Systems,

A brief survey of commercial **real-time** and non-**real-time** operating **systems**: Embedded OS, Real Time OS, Hand held OS

Porting RTOS on a Microcontroller based development system board, Programming in Linux, Shell programming, System Programming

Programming in RT Linux

**Text Books:**

1.Embedded systems, Raj Kamal, TMH

2.*Real-Time Systems*, Jane W. S. Liu, , Prentice-Hall, Inc

**Reference Books**

1.Embedded system design:An Introduction to processes tools & Techni1ques, A.S.Berger,CMP books

**EL-319 Sensor Fabrication techniques : Credits 2**

Practical difficulties associated with the fabrication of sensors, technologies such as thin/thick films, silicon micromachining, SAW used in different domains

Electronic components, specifications of commercially available components, modern package like SMDs,

MEMS Technology, What are MEMS, Why silicon, micromachining processes, Different structures in MEMS e.g. Cantilever, grooves, diaphragms, comb lines etc, design considerations, sensors such as accelerometer, pressure, gears, flowmeters etc.

**Text Books:**

1.Sensors & Transducers, Patranabis
2. Measurement Systems (Application & Design), E.D.Doebelin
3.Transducers & Instrumentation, Rangan Mani Sharma
4.Silicon Sensors, Middlehock
5.MEMS sensors, Patranabis

**EL – 403 VLSI Design : Credits 2**

Hierarchical design of VLSIs, interception levels, behavioral description, RTL, Logic circuit, gate, circuits, device, process, Circuit topology to patterning geometry to wafer fabrication, basics of silicon compiler

The cost -volume trade-off, role of design center and foundry, design methodologies, custom and semicustom designs, standard cell, gate array, FPGA, CPLD and PLDs

CAD VLSI tools, simulators for logic, timing, circuit, device and process optimization, Xilinx, Spice, Minmos, Suprem simulation tools, Layout design, assignment, partitioning, placement, global and

channel routing, compaction and verification algorithms and tools, Layout design verifiers, mask pattern generators.
Design of NMOS and CMOS inverter, stick diagrams, colour and monochrome codes in stick diagrams and mask layouts, pull up to pull down ratio, correspondence of design parameters with specifications, mask layout designs for NMOS/CMOS NAND, NOR gates.

**Text Books:**
1. Modern VLSI Design, W.Woulf, Pearson
2. Principles of CMOS VLSI Design, N. H.E. West and K.Eshranghian, PHI
3. Basic VLSI Design , D.A. Pucknell K. Eshraghian, PHI.
4. Digital Integrated Circuit Design, K. Martin, Oxford

**Reference Books:**
1. Introduction to VLSI Systems, Mead C & Conway L.Addison Wesley Pub.
2. Analysis & Design of Digital Integrated Circuits, Hodges & Jackson,McGraw Hill Int. Pub.
3. Integrated Circuit Engineering, Glasser, A.B Sharpe, S McGraw Hill Int. Pub.
4. Large Scale Integration, Howes M.G.Morgan D.V,J. Wiley

**Recommended Journals :**
1. IEEE Trans. On Electron Devices.
2. IEEE Trans. On CAD of VLSL.
3. IEEE Trans. On Semiconductor Manufacturing.

**EL – 404 Industrial controllers: PLC and PID : Credits 2**

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
Control loop characteristics, process equation, process, lead, lag, self regulation, control system parameters, error, variable range, control parameter range, control lag, dead time, cycling, 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. Practical examples.
Application specific selection of transducers for measurement and control of process parameters like, temperature, pressure, flow, level, density, safety and weight, Synchro/servo motors, control valves, solenoids, electropneumatic converters, indicators, annunciators, alarms, displays, recorders

**Text Books:**
1. Microprocessor-Based Process Control, C.D.Johnson,Prentice Hall Inc.New Jercy.

**Reference Books:**
1. Microprocessors – with Applications in process control, S.I.Ahson,TMH Co.Ltd.
2. Instrument Engineer's Handbook– Process Control, B.G. Liptak

**EL – 413 Processor Architecture and Design : Credits 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 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

**Reference Books**

1. Computer organisation, C. Hamacher, Z, Vranesic, S. Zaki, TMH

2. Computer Organisation and design, D.A. Patterson, J.L. Henessye, Morgan Kaufmann,

Computer Architecture and Organisation, Hayes, McGraw Hill

**EL – 414 Mechatronics : Credits 2**

Introduction to mechatronics

Mechanical Systems Components, Dynamics and modeling, Mechanical systems and design: mechatronic approach, control, design process, Load conditions, flexibility, man machine interface

Sensors and instrumentation systems, embedded systems, Drives and actuator, Control Devices, Linear systems, Rotational Drives, Motion Converters

Motion control devices and circuits: pilot devices, control circuits and load circuits, fuses and circuit breakers, enclosures, conductors, lockout, tag out safety

Robots and other motor control systems: Types of robot control, Types of Robot programs,

CNC MACHINES, Parts of a Robot, robot actuators, IO modules

Case studies: Autofocus cameras, Floppy/CD ROM drives, Industrial Robots

**Text Books:**

1. Mechatronics, Bradley, Dawson, Burd and Loader Nelson Thornes

**Reference Books:**

1. Industrial Electronics, Thomas Kissel Prentice Hall of India

2. Robotic Engineering, R.D. Klafter, T.A. Chmielewski, M.Negin, PHI

**EL – 415 Industrial Power Drives : Credits 2**

Basic Electrical and magnetic circuit concepts (Revision come introduction), sinusoidal voltage and currents, phasor presentation, power, reactive power, power factor, single phase and three phase circuits, fourier anaysis of repetitive waveforms, line current distortion, Ampers law, flux density, magnetic reluctance and permeance, Faradays Voltage Induction Law.

Overview of Transformers : Transformer rated for 230 Volts and 208 volts primary, transformer voltage, current, and turns ratios, step-up and step-down transformers, VA ratings for transformers, three-phase transformers, the WYE- connected three-phase transformer, the DELTA- and WYE-connected Three-Phase transformer, DELTA-and WYE-Connected transformers with a neutral terminal.

Motor-Driven Valves : Relays, contractors, and motor starters, variable-frequency drives, DC drives, stepper motors, linear stepper motors, servomotors.

DC Motor Operation : Types of DC motors, AC motors, characteristics of three-phase voltage, Operation of an AC induction motor, connecting motors for Torque speed and horsepower condition, reversing the rotation of a three-phase induction motor, three-phase synchronous motors, capacitor start, induction run motors, capacitor start, capacitor run motors, DC generators.

Application : Aluminum Rolling Mill : Application : Microprocessor-controlled plastic resin dryer and related motor control devices and circuits.

**Books:**

a. Power Electronics, N.Mohan, J.M. Undeland, and W.P. Robbins, John Wilay and Sons, 2003-2004.
b. Power Electronics, M.D.Singh,K.B.Khanchandani,Tata McGrawHill Publishing Co.,New Delhi, 1998.
c. Industrial Electronics, Thomas E. Kissell, Prentice Hall of India, 2003.

**EL – 416 DSP system: Processors and Applications : Credits 2**

DSP processor architecture, Multiplier and acuumulator, ALU, Barrell shifter, Memory and Cache registers, Buses, Peripherals, Circular buffers and other specialized hardware,.
Study 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 Books:**
1.Digital Signal Processing: Principles, algorithms and applications, J.G.Proakias & D.G. Manolakis, PHI
2.Digital Signal processing: Hands on approach, C. Schuler and M. Chugani, TMH
**Reference Books**
1. Discrete Time Signal Processing, A.V. Oppenheim and R.W. Schaffer, PHI
2. Theory and applications of Digital Signal Processing, L.R. Rabiner and B. Gold, Prentice Hall

**EL – 417 VLSI subsystem design : Credits 2**
**Testing and Verification**

Hardware description languages for VLSI design, VHDL and Verilog, programming and subsystem design concepts, design of multiplexer, parity generator leaf cell, adder, subtractor, multiplier, ALU, datapaths and control unit design

Fault Modeling and Simulation, Functional testing, Design for testability, Scan based designs, Boundary scan standards (JTAG), Signature analysis, Built in Self test , Built in logic block observer

**Text Books**
1. CMOS VLSI Design, N.H.E. Weste, K. Eshranghian, Addison Wesley
2. Digital Design Principles, J. Wakerley,Prentice Hall of India
**Reference Books:**
1. Digital Sytems testing and testable design, MIron Abromovici, Melvin Breuer, Arthur Freedman, Jaico Publishing House
2. VHDL, D. Perry,McGraw Hill Int. Edition.

**EL – 418 Data Communication Systems : Credits 2**

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, TCP/IP and Internetworking, network architectures and protocols, network security, ATM Networks, ISDN, BISDN, VoIP, VoDSL, Bluetooth, Wi-Fi WLAN, WAP and Mobile computing.

**Text Books:**
1. Computer Data Communication, Williams
2. Computer Networking, Tannunbam, PHI
**Reference Books**
1. Computer Networks, U.Black, PHI