# 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.
- The Courses categorized as of Core Theory, Practical, General Elective, Special Elective and Project/Internship.
- All Core Theory courses are compulsory.
- The Practical Courses at semester I are compulsory.
- The Student has to offer at least one of the semester II Practical Courses
- The student has to make a choice of **One** Special Elective Group from semester II.
- One Practical Course at semester III is compulsory for all.
- Second semester III Practical course and Project/Internship are linked to the Special Elective Group.
- The theory and practical courses offered under the chosen SpeciL Elective Group will be compulsory.
- Additional courses to complete the 100 credits can be chosen from among the General Elective Theory courses or courses offered by other departments of the University (subject to approval by departmental teaching committee)
- The grades for courses will be based on 50:50 weightage of Continuous Internal Assessment (CIA) and Semester End Examination (SEE)

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## Semester I

| | Credits |
|---|---|
| **Practical Courses** | |
| **EL – 101 Practical I** Experimental Techniques | 4 |
| **EL – 102 Practical II** **C**omputational Techniques | 4 |
| **Core Theory Courses** | |
| **EL – 103 Quantum and Statistical Mechanics** | 2 |
| **EL – 104 Mathematical Methods in Electronics** | 2 |
| **EL – 105 Properties of Electronic Materials – I** | 2 |
| **General Elective Courses** | |
| **EL – 151 Electronic Circuit Design and Analysis –I** | 2 |
| **EL – 152 Power Supplies** | 2 |
| **EL – 153 Electronic Instrument Design** | 2 |
| **EL – 154 Advanced Test & Measurement Instruments** | 2 |
| **EL – 155 C/C++ Programming** | 2 |
| **EL – 156 Computational Methods in Electronics** | 2 |
| **EL – 157 Foundations of Quantum Computing** | 2 |
| **EL – 158 Technical Communication** | 2 |

## Semester II

| | Credits |
|---|---|
| **Practical Courses** | |
| **EL – 201 Practical III** | **4** |
| **EL – 202 Practical IV** | **4** |
| **Core Theory Courses** | |
| **EL– 203 Electromagnetic Fields and Waves** | **2** |
| **EL – 204 Physics of Semiconductor Devices** | **2** |
| **EL– 205 Properties of Electronic Materials – II** | **2** |
| **EL– 206 Digital System Design** | **2** |
| **General Elective Courses** | |
| **EL – 251 Electronic Circuit Design and Analysis –II** | **2** |
| **EL – 252 Power Electronics Devices and Systems** | **2** |
| **EL – 253 Industrial Applications of Optoelectronics** | **2** |
| **EL – 254** Sensors and Actuators | **2** |
| **EL – 255** Elements of Quantum Computing | **2** |
| **EL – 256** DSP: Algorithms and Application | **2** |
| **Special Elective Group Courses** | |
| **Group 1** | |
| **EL – 211 Characterization Techniques** | **2** |
| **EL – 212 Processes in Device Fabrication** | **2** |
| **EL – 213 Semiconductor Foundry Techniques** | **2** |
| **Group 2** | |
| **EL– 221 Embedded System Design** | **2** |
| **EL– 222 Theory of Industrial Process Control** | **2** |
| **EL – 223 Industrial Controllers : PLC and PID** | **2** |
| **Group 3** | |
| **EL – 231 Antenna Design** | **2** |
| **EL– 232 Analog RF Circuit Design** | **2** |
| **EL– 233 Optical Fiber Communication** | **2** |

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## Semester III

| | Credits |
|---|---|
| **Practical Courses** | |
| **EL – 301 Practical V Common Lab** | **4** |
| **EL – 302 Practical VI Special Lab** | **4** |
| **Core Theory Courses** | |
| **EL – 303 VLSI Design** | **2** |
| **EL – 304 Embedded System Applications** | **2** |
| **EL – 305 Digital Communication Technology** | **2** |
| **General Elective Courses** | |
| **EL – 351 Processor Architecture and Design** | **2** |
| **EL – 352 VLSI Subsystem Design** | **2** |
| **EL – 353 Mechatronics** | **2** |
| **EL – 354 DSP systems: Processors and Applications** | **2** |
| **EL – 355 Mobile Communication Systems** | **2** |
| **EL – 356 Data Communication** | **2** |
| **Special Elective Group Courses** | |
| **Group 1** | |
| **EL – 311 CMOS System Design – I** | **4** |
| **EL – 312 CMOS System Design – II** | **4** |
| **Group 2** | |
| **EL – 321 Operating System and RTOS** | **4** |
| **EL – 322 Embedded System Communication Protocols** | **4** |
| **Group 3** | |
| **EL – 331 Communication System Design** | **4** |
| **EL – 332 Microwave & Satellite Communication** | **4** |

## Semester IV

| | | Credits |
|---|---|---|
| **EL – 401** | **Project/Internship** | **16** |
| **Special Elective Group Courses** | | |
| **Group 1** | | |
| **EL – 411** | **Architecture and Design of VLSI Systems** | **4** |
| **Group 2** | | |
| **EL – 421** | **Architecture and Design of Embedded Systems** | **4** |
| **Group 3** | | |
| **EL – 431** | **Architecture and Design of Communication Systems** | **4** |

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## EL – 101 Practical I Credits 4

**Experiments covering following aspects:**
Basic semiconductor material characterization
Electronic Device characterization
Basic Circuit Design
Circuit Design with Linear ICs
Familiarization with Test and Measuring instruments
Experimental techniques & observations
Documentation standards

## EL – 102 Practical II Credits 4

**Programs/experiments covering following aspects**:

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

## EL – 103 Quantum and Statistical Mechanics 2

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

Equipartition Theorem, Binomial and related distributions, Phase space, Statistical ensembles, Classical statistical mechanics as related to thermodynamics, Chemical potential and equilibrium, Quantum statistics. Collision time, collision cross section, theory of Viscosity and thermal conductivity.

**Text / Reference Books:**

| | | |
|---|---|---|
| 1. | Quantum Mechanics | Schiff |
| 2. | Quantum Mechanics | Ghatak Loknathan |
| 3. | Statistical Physics | Landau and Lifshitz |
| 4. | Statistical & Thermal Physics | Reif. |

## EL – 104 Mathematical Methods in Electronics 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 / Reference Books:** | | |
|---|---|---|
| 1. | Mathematical methods for Physics | Arfken, A.G. Academic Press. |
| 2 | Digital Signal Processing | Sanjit Mitra |
| 3. | Mathematical methods for physicists and Engineers | M.A. Boas |

## EL – 105 Properties of Electronic Materials I 2

Electrical properties: of metals: Conductivity, reflection and absorption, Fermi surfaces,
Thermo electric phenomena. Conduction in metals oxides, amorphous materials.

Dielectric Properties of materials: Macroscopic electric field, local electric field at an atom, dielectric constant and polarizability, Ferro electricity, anti ferro electricity, phase transition, piezoelectricity, Ferro elasticity, electrostriction.

Optical properties of materials: Optical constants and their physical significance, Kramers – Kronig Relations, Electronic inter bond 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, Electroluminescence.

Properties of nano materials

Defects in crystals and their effects on mechanical, electrical and optical properties. Diffusion in Materials.

**Text/Reference Books:**

| | | |
|---|---|---|
| 1. | Elementary Solid State Physics | M. Ali Omar |
| 2. | Solid State Physics | Dekkar |
| 3. | Introduction to Solid State Physics | C.Kittle |
| 4. | Solid State Physics | Ashcroft, Mermin |
| 5. | Principles of Electronic materials & devices | S.O. Kasap |

## EL – 151 Electronic Circuit Design and Analysis –I 2

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.

| **Text Books:** | | |
|---|---|---|
| 1. | Electronic Circuit analysis and design | D.A.Neaman, McGraw Hill |
| 2. | Analog Circuit Design | Cedra and Smith |
| 3. | Microelectronic Circuits Analysis and Design | Rashid, PWS pub. |
| 4. | Electronic Devices and circuit theory | R.L Boylestad and L.Nashelsky, Pearson |
| 5. | Analysis and Design of Analog Integrated Circuits | Grey and Mayer |

## EL – 152 Power Supplies 2

**Transformers:** Basics and design considerations: voltage transformers, VA ratings for transformers, current transformers, dimmerstats, Transformer cores, transformers for switching power supply

**Recitifiers and filters:** Half wave, full wave and bridge rectifiers, Filter circuits

**Constant Voltage (CV) Power supplies:** Zener regulator, emitter follower regulator, series regulator, shunt regulator, current limiting techniques, SMPS regulator

**Constant Current (CC) and CV/CC Power supplies:** CC sources – using discrete transistor, monolithic transistors, controlled sources, Series regulator type CC supply, Guarded CC supply, Adjustable VL CC supply, CV/CC supply

**Power supplies using ICs:** General purpose regulators, precision regulators, fixed voltage regulators, Switch mode regulators.

**Protection techniques:**Protection against transients, RFI suppression, current limiting, voltage limiting,

**Heat Sinks:** thermal runaway, operation with and without heat sinks, heat sink ratings, capabilities, practical considerations and mounting, heat sinks for ICs

**Text / Reference Books:**

| | | |
|---|---|---|
| 1. | Simplified design of linear Power supplies | John D. Lenk, Butterworth-Heinemann |
| 2. | Simplified design of switching power supplies | John D. Lenk, Butterworth-Heinemann |
| 3. | Regulated power supplies | Irving M Gottlieb, TAB books |
| 4. | Practical Design of Power Supplies | Ron Lenk, IEEE press +McGraw hill |
| 5. | Electric Power Transformer Engineering | James H. Harlow, CRC Press |

## EL – 153 Electronic Instrument Design 2

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.

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.

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

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

Integration, production and logistics.

**Text / Reference Books:**

| | | |
|---|---|---|
| 1. | Electronic Instrument Design | H.R. Fowler, Oxford |
| 2. | Principles of Instruments and systems | R.G. Gupta, TMH |
| 3. | Industrial Electronics | T.E. Kissell, PHI |
| 4. | Instrument Engineer's Handbook– Process Control | B.G. Liptak |

## EL – 154 Advanced Test & Measurement Instruments 2

**Introduction to Electronic Instrumentation and Measurements**:

Significant figures, scientific notation, units and physical constants, Averages, decibel etc, measurement accuracy, precision, resolution, repeatability, reproducibility, hysterisis, sensitivity, range etc., Errors in measurement-theoretical, static, dynamic, instrument insertion.

**Test and measuring instruments:**

Principle of operation, Block diagram and description, components, Specifications, Controls, Making measurements with the instrument

Signal Generators - AF, function, RF, pulse, Arbitrary waveform, Cathode Ray Oscilloscope (Analog, Digital), Digital Storage Oscilloscopes, medical oscilloscopes, Sampling oscilloscopes

AF/RF power meter, Frequency meters, LCR meters, Electrometer, Spectrum analyzers, Impedance analyzer, Network analyzers, Lock-in-amplifiers, Semiconductor parameter analyzer

**Probes, cables and connectors**:

Test leads, shielded cables-cable impedance, cable insulation, problems, flat cables, low capacitance probes, high voltage probes, current probes, special probes, binding posts, BNC connectors, N-type connectors, OSM connectors,

**Text / 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 |
| 5. | Elements of Electronic Instrumentation and Measurements | J. J. Carr, Pearson |

## EL-155 C/C++ Programming 2

**C fundamentals**: Identifiers and keywords, Data types, Constants, Variables and Arrays, Declarations of variables, Expressions, Statements. Arithmetic Operators, Unary Operators, Relational and Logical Operators. Control Statements

**Pointers** : fundamentals, pointer declarations, passing a pointer to a function, pointers and one dimensional arrays, operations on pointers, pointers and multidimensional arrays, arrays of pointers.

**Functions :** Defining a function, accessing a function, passing arguments to a function.

**File (I/O):** File operations-open and close a data file, creating a data file, processing a data file.

**Data Structures** : Multidimensional arrays definition implementation multidimensional arrays in control loops, pointers to multidimensional arrays.

**Stacks and queues array implementation** : Definition of stacks and queues, Terminology, implementation using arrays.

**Link Lists, stacks and queues :** Implementation of stacks and queues using link list, Binary trees, and Graphs

**Symbol tables :** Hashing techniques terminology and implementation

**Text/Reference Books:**

| | | |
|---|---|---|
| 1. | Let Us C | Yashwant Kanetkar, BPB Publication |
| 2. | Understanding pointers in C | Yashwant Kanetkar, BPB Publication |
| 3. | The C Language Programming | Kernighan and Ritchie, Prentice Hall |
| 4. | Data structures using C and C++ | Yedidyah Langsam, Moshe Augenstein, Aaron Tenenbaum, Prentice Hall |

## EL–156 Computational Methods in Electronics 2

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

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

Introduction to Parallel computing, grid networking and clustering of computers

**Text / Reference Books:**

| | | |
|---|---|---|
| 1. | Numerical Recipes: The art of Scietific Computing | William H. Press, Saul A.Teukolsky, William T. Vetterling, Brian P. Flannery |
| 2. | Computer oriented numerical methods | V. Rajaraman |
| 3. | Applied parallel computing | J. J. Dongarra, Jerzy Waśniewski, Kaj. Madsen |

## EL – 157 Foundation of Quantum Computing 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

**Text/Reference Books:**

| | | |
|---|---|---|
| 1. | Quantum computation and quantum Information | M.A. Nielsen and I.L. Chuang |

## EL : 158 Technical Communication 2

1. English as a Second Language (ESL).Functional Grammer. Sentence clarity, sentence fragments, independent and dependent clauses, dangling modifiers, sentence punctuation patterns, subject/verb agreement. Transitions and transitional devices.

2. Technical Reading and Information grasping : Evaluating sources of information, resources for documenting sources in the disciplines, searching the world wide web. Documenting electronic sources. Making sense out of technical documents: research papers, technical reports, manuals,etc.

3. The Writing Process. Creating a thesis statement, developing an outline, pre-writing, refinement. Proofreading your writing; parallels in proofreading and debugging. Starting the writing process.

4. Academic, Technical, and Scientific Writing. Adding emphasis in writing. Annotated bibliographies. Avoiding plagiarism. Conciseness and clarity. Establishing arguments. Logic in argumentative writing. Paragraphs and paragraphing. Quoting, paraphrasing, and summarizing.Sentence variety. Starting the writing process. The rhetorical situation. Transitions and transitional devices. Using appropriate language. Writing a research paper, avoiding plagiarism, documenting electronic sources, quoting, paraphrasing, and summarizing. Effective workplace writing: accentuating the positives, prioritizing your
concerns for effective business writing. memo writing, email etiquette, revision in business writing, tone in business writing, model letters for various purposes. Parallel structure in professional writing. Writing a white paper/technical report. Writing report abstracts. Manuals and documentation

5. Job Search Writing. Action verbs to describe skills, jobs, and accomplishments in employment documents. Accentuating the positives. Prioritizing your concerns for effective job search writing. Audience analysis: tailoring employment documents for a specific audience. Resume design: introduction to resumes, resume structure, when to use two pages or more, scannable resumes. Cover letters: quick tips, preparing to write a cover letter, writing your cover letter.Academic and business cover letters. Writing a job acceptance letter. Writing the curriculum vitae. Writing the personal statement/statement of purpose. Appearing for an interview.

6. Making Effective Presentations. Audience analysis. Presentation slides and their cognitive impact. Anticipating questions from audience. Handling questions from audience.

**Text/Reference Books:**

| | | |
|---|---|---|
| | Essentials of Technical Communication | Sunil Gokhale |

The Online Writing Labs (OWL) family of websites http://owl.english.purdue.edu/; specifically, http://owl.english.purdue.edu/workshops/hypertext/

## EL – 201 Practical III: Circuits & Systems Lab 4

**Experiments covering following aspects**
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 4

**Experiments covering following aspects credits 4**
(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 2

Revision of Electrostatics and Magnetostatics

Maxwell's equations, correspondence of field and circuit equations, wave equation, Poynting vector theorem, propagation, plane waves in free space, through media, lossless and lossy Transmission lines, standing wave and standing wave ratio, characteristic impedance, line impedance and admittance, impedance matching, λ/4 transformer, Smith chart, application to high frequency devices, transients, plane normal incident wave on dielectric boundary.

Waveguides, propagation modes in conducting rectangular and cylindrical boundaries, dielectric waveguides and optical fibers.

Directional couplers and microwave cavities, waveguide measurements.

**Text/Reference 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 Physics of Semiconductor Devices 2

PN junctions : Equilibrium Conditions, Forward and reverse biased junctions, Steady State conditions, Reverse bias breakdown, Transient and A C conditions, Metal Semiconductor junctions, Heterojuctions

Construction, principle of operation, and applications of Tunnel diode, PIN diode, Varactor diode and Zenner diode.

Bipolar junction transistors : Fundamentals of operation, Amplification, Minority carrier distributions and terminal currents, Ebers-Moll model, Switching, 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.

Negative conductance devices – IMPATT, TRAPATT, Gunn diode, masers

Power Devices : p-n-p-n diode, Semiconductor Controlled Rectifier

**Text/Reference 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–205 Properties of Electronic Materials II 2

Semiconductors : Intrinsic and extrinsic semiconductors, Carrier concentrations at equilibrium, Temperature dependence of carrier concentrations, Drift of carriers in electric and magnetic fields, conductivity and mobility, Carrier lifetime and photoconductivity, Diffusion of carriers, Steady state carrier injection, Gradients in quasi-fermi levels

Magnetic Properties of Materials: Dimagnetism, paramagnetism, various contributions to para and dia magnetism, Adiabatic demagnetization, Paramagnetic susceptibility, Ferromagnetism,
ferrimagnetism, ferrites, antiferromagnetism, curie 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.

**Text/Reference Books:**

| | | |
|---|---|---|
| 1. | Elementary Solid State Physics | M. Ali Omar |
| 2. | Solid State Electronics Devices | Ben G. Streetman |
| 3. | Introduction to Solid State Physics | C.Kittle |
| 4.. | Principles of Electronic materials & dev | S.O. Kasap |

## EL – 206 Digital System Design 2

Combinatorial logic circuits and Sequential Ciruits, Arithmetic and Logic circuits, Comparison circuits, adder, subtractor, carry look ahead adder, binary multiplication and division, floating and fixed point arithmetic, ALU design, Finite state machines, Control Unit design

Digital Sytem design concepts, approaches, programmable logic devices PLAs ,PALs, CPLD, FPGA Architectures. PLD based System design applications like Washing machine, Wending machine, traffic lights etc

**Text / Reference Books:**

| | | |
|---|---|---|
| 2. | Digital System design | Gajeski |
| 2. | Digital system design and Principles | Wakerly,PHI |
| 3. | Digital Electronics: Fundamental Concepts and Applications | C. E. Strangio |

## EL – 251 Electronic Circuit Design and Analysis –II 2

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.

| **Text Books:** | | |
|---|---|---|
| 1. | Electronic Circuit analysis and design | D.A.Neaman, McGraw Hill |
| 2. | Analog Circuit Design | Cedra and Smith |
| 3. | Microelectronic Circuits Analysis and Design | Rashid, PWS pub. |
| 4. | Electronic Devices and circuit theory | R.L Boylestad and L.Nashelsky, Pearson |
| 5. | Operational Amplifiers | G.B.Clayton |
| 6. | Analysis and Design of Analog Integrated Circuits | Grey and Mayer |

## EL – 252 Power Electronics Devices and Systems 2

**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, power transistors, power MOSFETS, IGBT's, Gate triggering circuits, series and parallel operations

**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, microprocessor based firing schemes.

**Inverters** : series, self commutated, parallel, single-phase bridge voltage source inverter, three phase bridge, voltage control of single phase and three phase inverters, current source inverters, PWM inverters.

**Uninterruptible power supplies:** classification – online, standby, off line, line interactive, universal, rotary and hybrid static/rotary, design considerations, performance evaluation, applications, control techniques, energy storage devices – battery, flywheel, fuel cell

**AC Regulators**: Single phase, three phase.

Power Line Disturbances, Power conditioners

**Text / Reference Books:**

| | | |
|---|---|---|
| 1. | Power Electronics | N.Mohan, J.M. Undeland, and W.P. Robbins, John Wiley |
| 2. | Power Electronics | M.D. Singh, K.B. Khanchandani, TMH |
| 3. | Industrial Electronics | T. E. Kissell, PHI |
| 4. | Fundamentals of Power Electronics | R. W. Erickson, D. Maksimovic |
| 5. | Uninterruptible power supplies | A, King and W. Knight, McGraw Hill |
| 6. | Uninterruptible power supplies | J.Platts, J. S. Aubyn. P. Peregrinus, IEE power series. |

## EL–253 Industrial Applications of Optoelectronics 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 / Reference 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 254 Sensors and Actuators 2

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 / Reference Books:**

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

## EL – 255 Elements of Quantum Computiation 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.

**Text/Reference Books:**

| | | |
|---|---|---|
| 1. | Quantum computation and quantum Information | M.A. Nielsen and I.L. Chuang |

## EL – 256 DSP Algorithms and Applications 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 time 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. Discrete Fourier transforms and FFT techniques. Applications to spectrum analyzer, speech processing, audio CD Player, AM detector, echo cancellor.

**Text / Reference Books:**

| | | |
|---|---|---|
| 1. | Digital Signal Processing: Principles, algorithms and applications | J.G. Proakias and D.G. Manolakis, PHI |
| 2. | Digital Signal processing: Hands on approach | C. Schuler and M. Chugani, TMH |
| 3. | Discrete Time Signal Processing | A.V. Oppenheim and R.W. Schaffer, PHI |
| 4. | Theory and applications of Digital Signal Processing | L.R. Rabiner and B. Gold, Prentice Hall |

## EL – 211 Characterization Techniques 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, Energy Dispersive X-ray Analysis (EDAX), Electron Spectroscopy for Chemical Analysis (ESCA), secondary ion mass spectrometry (SIMS)

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

**Microscopic Techniques :**
Operating Principles, electron beam generation, Interaction of electron beam with matter, Components, *Detectors,* Vacuum System and Components, Control Console*,* Sample preparation, Performance Limitations, Interpretation of micrographs, commercially available equipments of the techniques Otical microscope, Scanning Electron Microscope (SEM), Transmission Electron microscope (TEM),

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

**Measurement of electrical parameters of semiconductor materials:**
Resistivity- two probe and four probe methods, Dielectric constant, 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- 212 Processes in Device Fabrication 2

Properties of silicon wafers: Mechanical, Electrical, structural, Si wafer growth techniques

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, straggling, 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/Reference Books:**

| | | |
|---|---|---|
| 1. | VLSI Technology | S.M. Sze |
| 2. | VLSI Fabrication Principles | S.K. Gandhi |

## EL – 213 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, laboratory hazards and their prevention.

**Fabrication Equipment :**
Wafer cleaning and etching baths, Ultrasonic cleaners, Spin coater, Baking furnaces, Mask preparation techniques – co-ordinato graph, 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 : Principle of operation, Block diagram and description

**Assembly and packaging:**
Package design considerations – electrical, thermal and mechanical, Die Bonding, Wire 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 – 221 Embedded System Design 2

Design of Embedded systems, Microcontroller architectures, microcontroller based system design,.

Development and troubleshooting tools, single board microcomputer kits, simulators, In Circuit Emulators , Logic analyzer.

Application examples, temperature monitoring and control system, DC motor speed controller, ECG data acquisition and monitoring system, electrical characterization systems for semiconductor parameter analysis

**Text / Reference Books:**

| | | |
|---|---|---|
| 1. | The 8051 Microcontroller Architecture, Programming and Applications | K.J. Ayala, Penram Int. Pub. |
| 2. | Embedded system design | F. Vahid,T. Gargivis John Wiley and Sons |
| 3. | Embedded system designAn Introduction to processes tools and Techni1ques | A.S. Berger, CMP Books |
| 4 | Computers as Components: Principles of Embedded Computer Systems Design | Wayne Wolf Morgan Kaufmann |

## EL – 222 Theory of Industrial Process Control 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 / Reference Books:**

| | | |
|---|---|---|
| 1. | Automatic Control Systems | B.C. Kuo PHI. |
| 2. | Modern Control Systems | R.C. Dorf and R.H. Bishop, Addison Wesley |
| 3. | Fundamentals of Modeling and Analyzing Engineering Systems | P.D. Cha, J.J. Rosenberg and C.L. Dym, Cambridge Univ. Press |
| 4. | Control Engineering Theory and Practice | M.N. Bandopadhyay, PHI |

## EL – 223 Industrial controllers: PLC and PID 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 / Reference Books:**


| | | |
|---|---|---|
| 1. | Microprocessor-Based Process Control | C.D.Johnson Prentice Hall Inc.New Jercy. |
| 2. | Industrial Electronics | T.E. Kissell, PHI |
| 3. | Microprocessors – with Applications in process control | S.I.Ahson TMH Co.Ltd. |
| 4. | Instrument Engineer's Handbook– Process Control | B.G. Liptak |

## EL – 231 Antenna Design 2

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

Designing of microstrip antenna (two lab sessions)

Designing of horn or Yagi-Uda or Helical antenna (two lab sessions)

**Text/Reference Books:**

| | | |
|---|---|---|
| 1. | Antennas | J.D. Kraus, TMH, Co. Ltd. |
| 2. | Antenna theory | C. A. Balanis, John Wiley & sons |

## EL – 232 Analog RF Circuit Design 2

Feedback concepts, with mathematical derivation, stability considerations,

Impedence matching, maximum power transfer theorem, reflectron, transmission concepts, VSWR, Smith chart, case study of tuning an antenna, Baluns, $\lambda/4$ & $\lambda/2$ lines used for impedence 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 |
| 2. | Microwave devices, circuits & Subsystems for Communication Engineering | Glover, Pennock, Shepherd |

## EL – 233 Optical Fiber Communication 2

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 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. 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 / Reference Books:**

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