

COURSE TITLES 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				General Elective Courses			
1)	EL – 101	Practical I Experimental Techniques	4	1)	EL – 151	Electronic Circuit Design and Analysis – I	2
2)	EL – 102	Practical II Computational Techniques	4	2)	EL – 152	Power Supplies	2
3)	EL – 103	Quantum and Statistical Mechanics	2	3)	EL – 153	Electronic Instrument Design	2
4)	EL – 104	Mathematical Methods in Electronics	2	4)	EL – 154	Advanced Test & Measurement Instruments	2
5)	EL – 105	Properties of Electronic Materials - I	2	5)	EL – 155	C/C++ Programming	2
				6)	EL – 156	Computational Methods in Electronics	2
				7)	EL – 157	Foundations of Quantum Computer	2
				8)	EL - 158	Technical Communication	2
Semester II							
Core Courses				General Elective Courses			
1)	EL – 201	Practical III	4	1)	EL-251	Electronic Circuit Design and Analysis-II	2
2)	EL – 202	Practical IV	4	2)	EL-252	Power Electronics Devices & Systems	2
3)	EL – 203	Electromagnetic Fields and Waves	2	3)	EL-253	Industrial Applications of Optoelectronics	2
4)	EL – 204	Physics of Semiconductor Devices	2	4)	EL-254	Sensors and Actuators	2
5)	EL – 205	Properties of Electronic Materials-II	2	5)	EL-255	Elements of Quantum Computing	2
6)	EL – 206	Digital System Design	2	6)	EL-256	DSP : Algorithms and Application	2
				Special Elective Group Courses			
				Group 1			
				1)	EL-211	Characterization Techniques	2
				2)	EL-212	Processes in Device Fabrication	2
				3)	EL-213	Semiconductor Foundry Techniques	2
				Group 2			
				1)	EL-221	Embedded System Design	2
				2)	EL-222	Theory of Industrial Process Control	2
				3)	EL-223	Industrial Controllers: PLC & PID	2
				Group 3			
				1)	EL-231	Antenna Design	2
				2)	EL-232	Analog RF Circuit Design	2
				3)	EL-233	Optical Fiber Communication	2
Semester III							
Core Courses				General Elective Courses			
1)	EL – 301	Practical V Common Lab	4	1)	EL-351	Processor Architecture & Design	2
2)	EL – 302	Practical VI Special lab	4	2)	EL-352	VHDL and Verilog : Testing and Verification	2
3)	EL – 303	VLSI Design	2	3)	EL-353	Mechatronics	2
5)	EL – 304	Embedded System Applications	2	4)	EL-354	DSP Systems: Processors & Applications	2
6)	EL – 305	Digital Communication Technology	2	5)	EL-355	Mobile Communication Systems	2
				6)	EL-356	Data Communication	2
				7)	EL-357	Fundamentals of MEMS Design and Fabrication	4
				8)	EL-358	IC and Microsystems Packaging	2
				9)	EL-359	Surface Mount Technology	2
				Special Elective Group Courses			
				Group 1			
				1)	EL-311	CMOS System Design – I Circuits and Processes	4
				2)	EL-312	CMOS System Design – II : Mask Layouts	4
				Group 2			
				1)	EL-321	Operating System and RTOS	4
				2)	EL-322	Wireless Embedded System Design	4
				Group 3			
				1)	EL-331	Communication System Design	4
				2)	EL-332	Microwave & Satellite Communication	4
Semester IV							
Core Courses				Special Elective Group Courses			
1)	EL – 401	Project / Internship	16	Group 1			
				1)	EL – 411	Architecture and Design of VLSI Systems	4
				Group 2			
				2)	EL-421	Architecture and Design of Embedded System	4
				Group 3			
				3)	EL-431	Architecture and Design of Communication System	4

Semester I

	Credits
Practical Courses	
EL – 101 Practical I Experimental Techniques	4
EL – 102 Practical II Computational 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 Elements of Quantum Computing	2
EL – 158 Technical Communication	2

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, Schrödinger'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: Transformers rated for 230 Volts and 208 volts primary, transformer voltage, current, and turns ratios, step-up and step-down voltage transformers, VA ratings for transformers, current transformers, dimmerstats, Transformer cores – frequency response, size, shapes, copper wire current ratings, Transformer winding techniques – for single output, multiple outputs, center tap, transformers for switching power supply

Rectifiers and filters: Half wave, full wave and bridge rectifiers, Filter circuits

Constant Voltage (CV) Power supplies: Building blocks, Design, characterization. Zener regulator, emitter follower regulator, series regulator, shunt regulator, current limiting techniques, Switching mode regulator

Constant Current (CC) and CV/CC Power supplies: Building blocks, Design, characterization. CC sources – using discrete transistor, monolithic transistors, controlled sources, Series regulator type CC supply, Guarded CC supply, Adjustable VL CC supply, Typical 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: Effect of temperature on leakage current, current gain and power dissipation of active devices, thermal runaway, operation with and without heat silks, 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

Introduction to Electronic Instrumentation and Measurements:

Significant figures, scientific notation, units and physical constants, Averages, decibel etc, Categories of measurement, Factors in making the measurements- accuracy, precision, resolution, repeatability, reproducibility, hysteresis, 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 and 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 Scientific 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 Elements of Quantum Computation 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, Deutsch-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
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EL : 158 Technical Communication 2

1. English as a Second Language (ESL). Functional Grammar. 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
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The Online Writing Labs (OWL) family of websites <http://owl.english.purdue.edu/>;
specifically,
<http://owl.english.purdue.edu/workshops/hypertext/>

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 –II2	
EL – 252 Power Electronics Devices and Systems	2
EL – 253 Industrial Applications of Optoelectronics	2
EL – 254 Sensors and Actuators	2
EL – 255 Foundations 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

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, 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/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, Heterojunctions

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, hysteresis , 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 Circuits, Arithmetic and Logic circuits, Comparison circuits, adder, subtraction, look ahead carry, binary multiplication and division, floating and fixed point arithmetic, ALU design, Finite state machines, Control Unit design

Digital System 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 assisted Turn off (GATT), Bidirectional diode (DIAC), TRIAC, power transistors, power MOSFETS, IGBT's, Gate triggering circuits, series and parallel operations

Phase Controlled Rectifiers : 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 : Basic concepts, classification, series inverter, self commutated inverters, parallel inverters, 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 applications, 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 detection 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, LASCER. 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, electro-thermal, electro-optical 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 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
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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 shift-invariant systems, difference equations. Correlation and convolution. 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 / Reference Books:

1.	Digital Signal Processing: Principles, algorithms and applications	J.G. Proakis 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 etc.

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 Optical 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 etc,

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, 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/Reference Books:

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

EL – 213 Semiconductor Foundry Techniques 2

Clean room techniques:

Clean rooms, class of clean rooms, filters, air curtains, air showers, particle counters, Distill 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, components, Specifications, Controls.

Assembly and packaging:

Package design considerations – electrical, thermal and mechanical, Die Bonding - Eutectic and epoxy, Wire bonding, Package types, package fabrication techniques - ceramic package, glass sealing, plastic moulding, Hermetic sealing, metal can package,

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 design: An Introduction to processes tools and Techniques	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-tuning 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 impedance conversion.

Noise in passive and active devices, equivalent circuits of resistors, capacitors and inductors at low frequency and high frequency, low noise amplifiers, over all noise figure of a receiver system.

Low noise amplifier design using CAD with case study including DC biasing, matching, stability, noise figure and power / voltage gain

Mixers using linear and non-linear concepts, single and double balanced mixers, mathematical analysis of mixers.

Type of RF filters – butterworth, chebyshev, Bessel & elliptic, Design of filters using CAD with case studies.

Crystal and its equivalent circuit, crystal filters

Oscillators using IMPATT, GUNN diodes, MESFET, HEMT transistors.

Text/Reference Books:		
1.	Analog Communication	Kennedy
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 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, electro 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.

Text / Reference Books:		
1.	Fiber optics and Optoelectronics	R.P. Khare, Oxford
2.	Optical Fiber Communication Principles and Systems	A. Selvarajan, S.Kar and .Srinivas, TMH
3.	Optical Fiber Communications	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

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 VHDL and Verilog : Testing and Verification	2
EL – 353 Mechatronics	2
EL – 354 DSP systems: Processors and Applications	2
EL – 355 Mobile Communication Systems	2
EL – 356 Data Communication	2
EL – 357 Fundamentals of MEMS Design and Fabrication	4
EL – 358 IC and Microsystems Packaging	2
EL – 359 Surface Mount Technology	2

Special Elective Group Courses**Group 1**

EL – 311 CMOS Systems Design I : Circuits and Processes	4
EL – 312 CMOS System Design II: Mask layouts	4

Group 2

EL – 321 Operating System and RTOS	4
EL – 322 Wireless Embedded System Design	4

Group 3

EL – 331 Communication System Design	4
EL – 332 Microwave & Satellite Communication	4

EL – 301 Practical V : Compulsory Lab 4

Experiments covering following aspects

- (i) Familiarization with contemporary CAD-VLSI tools
- (ii) VHDL coding and Logic/Timing simulations
- (iii) VLSI Mask Design examples
- (iv) Microprocessor/Microcontroller interfacing with MIMIC panels
- (v) PC based instrumentation
- (vi) Virtual instrumentation
- (vii) Digital communication system
- (viii) Signal digitization and PCM
- (ix) MODEM principles, Error Detection and correction

EL – 302 Practical VII: Special Lab 4
(Any one of the Special groups)

SG 1 Microelectronics/VLSI Design

Experiments covering following aspects

- (i) Fabrication techniques: deposition, oxidation, Lithography etching, characterization, etc
- (ii) Analog ASIC Design Flow
- (iii) Schematic circuit drawing and analysis
- (iv) Layout design
- (v) DRC and Circuit extraction
- (vi) Parasitic optimization

SG 2 Embedded System Applications

Experiments covering following aspects

- (i) Target board design
- (ii) Integrated Development Environment
- (iii) Embedded system Applications
- (iv) Embedded system communication protocols
- (v) RTOS
- (vi) JAVA applets design and Web page design

SG 2 Communication Systems

Experiments covering following aspects

- (i) Use Spectrum Analyzer to measure signals & losses
- (ii) Measure of Reflection coefficients, (SWR), etc. of transmission lines, antennas
- (iii) Time Domain Reflectometry using coaxial cables.
- (iv) Design & analysis of antenna using mini- NEC
- (v) RF vector Network Analyser (VNA) study through VSWR, Gain-phase , Smith chart plots, S-parameter measurements
- (vi) Antenna pointing and tracking
- (vii) Retrieving and analyzing Satellite signals and understanding of the receiver chain.

Hierarchical design of VLSIs, interception levels, behavioral description, RTL, Logic circuit, gate, circuits, device and process.

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, FPGA Design Flow, ASIC Design Flow, Fault Modeling and Simulation 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.

Text / Reference 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.	Essentials of VLSI Design	K.Eshranghian, D.A. Pucknell and Ehrangian, PHI
5.	Integrated Circuit Engineering	Glasser, A.B Sharpe, S McGraw Hill Int.

Recommended Journals:

1. IEEE Trans. On Electron Devices.
2. IEEE Trans. On CAD of VLSL.
3. IEEE Trans. On Semiconductor Manufacturing.

Introduction to Embedded Systems characteristics, design metrics, requirements, trends, Microcontroller selection, IDE selection, Hardware / Software Co-design and operating system considerations

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, Buses & protocols, I2C, CAN, FIREWIRE, USB, Bluetooth, Zigbee, IrDA etc

I/O devices for process control and instrumentation, data acquisition systems, Case studies: RF ID, Smart cards, PDA's, Consumer applications, Automotive control

Text / Reference Books:

1.	Computers as Components: Principles of Embedded Computer Systems Design	Wayne Wolf Morgan Kaufmann
2.	Microprocessors & Interfacing Programming & Hardware	D. Hall, McGraw Hill Int. Edition.
3.	Embedded Systems Design	Vahid F. Givargies John WILEY X SONS 2002
4.	Embedded Microcomputer System: Real Time Interfacing	J.W. Valvano, Brooks/Cole, 2000.
5.	The Art of Designing Embedded Systems	Jack Ganssle, Newnes, 1999.
6.	Embedded Systems- Architecture, Programming and Design	2. Raj Kamal, TMH 2003

EL – 305 Digital Communication Technology 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, Companding, 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 / Reference 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
3.	Fundamentals of Error Correcting Codes	W. Cary Huffman, V Pless. Cambridge University Press
4.	Electronic Communication Systems	W. Tomasi, Pearson
5.	Wireless Communications Principles and Practice	T.S.Rappaport. Pearson Edu.Asia.
6.	Principles of Communication	Taub and Schilling, TMH

EL – 351 Processor Architecture and Design 2

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

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

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

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

EL – 352 VHDL and Verilog : Testing and Verification 2

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 / Reference Books

1.	CMOS VLSI Design	N.H.E. Weste, K. Eshraghian, Addison Wesley
2.	Digital Design Principles	J. Wakerley, Prentice Hall of India
3.	Digital Sytems testing and testable design	Miron Abromovici, Melvin Breuer, Arthur Freedman, Jaico Publishing House
4.	VHDL	D. Perry, MaGraw Hill Int. Edition.

EL – 353 Mechatronics 2

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 – Levers, Gears, pulleys, screws, electromechanical drives

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 /Reference Books:

1.	Mechatronics	Bradley, Dawson, Burd and Loader Nelson Thornes
2.	Industrial Electronics	Thomas Kissel Prentice Hall of India
3.	Robotic Engineering	R.D. Klafter, T.A. Chmielewski, M.Negin, PHI

EL – 354 DSP system: Processors and Applications 2

DSP processor architecture, Multiplier and accumulator, ALU, Barrel shifter, Memory and Cache registers, Buses, Peripherals, Circular buffers and other specialized hardware,.

Study of architecture, assembly language and specific applications of TI, AD and Motorola DSP processors

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

Text / Reference Books:

1.	Digital Signal Processing: Principles, algorithms and applications	J.G. Proakis and D.G. Manolakis, PHI
2	VLSI Digital Signal Processing Systems: Design and Implementation	K.K.Parhi, John Wiley , 1999
3.	Digital Signal processing: Hands on approach	C. Schuler and M. Chugani, TMH
4.	Theory and applications of Digital Signal Processing	L.R. Rabiner and B. Gold, Prentice Hall
5.	Discrete Time Signal Processing	A.V. Oppenheim and R.W. Schaffer, PHI

EL – 355 Mobile Communication Systems 2

Mobile communication systems, cellular concepts, role of base station and mobile switching centers, Hands-off considerations, frequency reuse, roaming, SMS, GSM, GPRS, CDMA and EDGE, Speech coding techniques, Vocoder.

ATM, SDH, SONET, Physical Layers, Interfaces, Signaling, IP routing, MPLS, VPN, Metropolitan Ethernet Services, Control plane and forwarding plane, architecture.

Telecommunication Network management overview, Wireless Network fundamentals, OSI model layers, architecture, broadband systems.

Introduction to Emerging technologies IP multimedia systems, GSM/CDMA, Wi-Fi, Wi-Max, Blue Tooth, 3G/4G & Next Gen. Networks (NGN), IP/ mobile TV, Long Haul systems.

Text /Reference Books:

1.	Telecommunication	T.Vishwanathan, PHI
2.	Mobile Cellular Telecommunications,	W.C.Y. Lee, McGraw Hill
3.	Future Developments in Telecommunication,	J. Martin, Prentice Hall

EL – 356 Data Communication Systems 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, Internetworking – Repeaters, bridges, routers and gateways. Introduction to Routing protocols TCP/IP and Internetworking, TCP/IP protocol suite TCP/IP Sockets Client-Server, computing, Name Service, Application protocols over TCP/IP, IPV6, network architectures and protocols, Web server, SMIP server, DNS server, network security, ATM Networks, ISDN, BISDN, VoIP, VoDSL, VPN, MPLS-VPN, Metro-E network, VOIP.

High speed LANs – Fast and Gigabit Ethernet, FDDI. Wireless LANs. Bluetooth, Wi-Fi WLAN, WAP and Mobile computing.

Text/Reference Books:

1.	Data Networks	D. Bertsekas, R. Gallagher
2.	Computer Networking	Tanenbaum, PHI
3.	Computer Networks	U.Black, PHI

EL – 357 Fundamentals of MEMS Design and Fabrication**4****Pre-requisite: Microfabrication processes and Techniques**

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

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

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

Overview of finite element stress analysis

Scaling laws in miniaturization: scaling in geometry, scaling in electrostatic forces, scaling in electromagnetic forces, scaling in electricity

MEMS Design: Design considerations, Process design, Mechanical design, Mechanical design using finite element method, MEMS Design Analysis,

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

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

Reliability Overview

Design Rules and DRC

Text / Reference Books:

1.	An Introduction to Microelectromechanical Systems Engineering	Nadim Maluf
2.	The Micromachined Transducers Sourcebook,	Gregory T.A. Kovacs, McGraw-Hill, Inc., 1998.
3.	Microsystem Design	Stephen D. Senturia, , Kluwer Publishers, 2001
4.	Fundamentals of Microfabrication	Marc Madou

EL – 358 IC and Microsystems Packaging**2**

Numbers in the bracket indicate number of lectures

Introduction: Package function and hierarchy, evolution of packages, PWB, SMT and Hybrid Circuits, Technology drivers, Single chip packages, Multichip Modules Introduction to Packaging Technologies, Silicon Efficiency and other packaging parameters

Package Design Considerations: Electrical design considerations: Receivers and Transmitter attributes, Signal distribution, Power distribution, Noise containment, Low loss transmission systems, Package modeling, Wiring and terminals: Wiring hierarchy, Wiring models, Rent's rule, Package wireability issues, Thermal design: Thermal design basics and its considerations, Measurements, Cooling methods and issues, Introduction to issues in package reliability: Environmental effects, Thermal mismatch and fatigue, Types of thermal failures, Other assorted failure processes

Packaging Processes: Process description, process and reliability issues, applications for: C4 and Flip chip, Chip bonding, Wire Bonding, Tape Automated Bonding (TAB), Sealing

Ceramic Packages: Materials and fabrication processes for Alumina ceramic packages and Low Temperature Ceramic packages, Thick film paste technology, Post fire processes, Brazing, CBGA, Concepts of integrated ceramic packaging

Plastic Packages: Types of plastic packages, Comparison with ceramic packages, Moulding compounds and lead frames, Moulding processes, Applications and future trends

Thin Film Packages: Thin film materials and processes, Comparison with Thick film packages, Emerging technologies and trends

Polymers in Packaging: Polyimides: Types in use, usage, applications and comparison, Polymeric dielectrics, photosensitive polyimides and epoxies

MEMS Packaging Issues and Solutions: Types of MEMS devices and their packaging needs, Contemporary packaging solutions

Packaging Summary and Future
 Future trends in microelectronics and MEMS and the packaging needs, Application driven solutions

Text / Reference Books:		
1.	Microelectronics Packaging Handbook, Parts I, II, III	Rao R. Tummala, Eugene J. Rymaszewski and Alan G. Klopfenstein
2.	Micro- and Opto- Electronic Materials and Structures, Volume I and II	Ephraim Suhir, Y. C. Lee and C. P. Wong
3.	The Electronic Packaging Handbook	Glenn R. Blackwell
4.	Flip Chip Technologies	John L. Lau
5.	Ball Grid Array Technology	John L. Lau
6.	Electronic materials Handbook, Volume 1: Packaging	Merrill L. Minges,
7.	Multi layered low temperature co fired ceramic (LTCC) Technology,	Yoshihiko Imanaka

EL – 359 Surface Mount Technology 2

Types of Surface Mounting, Benefits of Surface Mounting, Surface Mount Components, Resistors, capacitors, transistors, SOICs and SOPs, BGA's CCGA, PBGA, TBGA

Substrate Materials: Ceramic, Porcelain zed Steel, Graphite Epoxy Constraining Core Substrates Compliant Layer Substrates, Glass Epoxy Substrates

SMT Equipment: Component Placement, Pick-and-Place , Solder Paste Screen Printer, Curing/Baking Oven, Reflow Soldering, Cleaning, Wave Soldering

Quality Control, Inspection Repair, and Testing
 Statistical Quality Control, Solder Joint Inspection, Visual Inspection, Automated Inspection, Repair Equipment and Processes, Assembly Testing, Fixtures for ATE Testing

Text/Reference Books:		
1.	Surface Mount Technology: Principles and Practice, 2nd Edition	Ray Prasad ISBN 0-412-12921-3
2.	Electronics Manufacturing Processes,	Thomas L. Landers, et al., 1994, ISBN: 0-13-176470-5
3.	Electronic Assembly Fabrication,	Charles Harper, McGraw-Hill, 2002

EL-311 : CMOS Systems Design I : Circuits and Processes

4

Introduction: Typical Chip / Layout Structures, Substrates And Wells, Soft Connects / Multiples Stamps, Chip Development Flow: From Product Definition To Sales, Component Of Cost, Die Size And Yield, Key Design Parameters, The Quad Model.

Introduction To CMOS Processes : Basic Processing Steps (Doping, Photolithography, Etching, Deposition), CMOS Inverter Cross Section, MOS Device Design Equations, Electrical Interaction Of Layers, NMOS And PMOS Cross Section And Operation.

Circuits : R-C Circuits And Single Transmission Line, Metal Line Resistances And Capacitance, Simple Static CMOS Gates, Inverting And Non-Inverting Gates, CMOS Inverter, Complex Static CMOS Gates, Special CMOS Gates.

Circuit Characterization And Performance Estimation : Pull Up To Pull Down Ratio, Correspondence Of Design Parameters With Specifications, Switching Characteristics, Transistor Sizing, Power Dissipation, Design Margining, Scaling Of Device Dimensions.

Special Topics : Drawn Vs Actual Geometries, Bent Gates, Self Heating, Electromigration, EDS And NACS, Latch-Up, Hierarchy, CAD Tools.

Text / Reference Books:

1.	CMOS Circuit Design, Layout and Simulation,	R.Jacob Baker, Harry W. Li, David E. Boyce, PHI
2.	Principles Of CMOS VLSI Design : A Systems Perspective	Neil Weste, Kamran Eshraghian And Michael Smith, Addison Wesley.
3.	Digital Integrated Circuits	Jan M.Rabaey, Prentice Hall Of India, New Delhi.
4.	Basic VLSI Design	D.A. Pucknell And Kamran Eshraghian, PHI.
5.	"VLSI Technology"	S.M.Sze, TMH

EL-312: CMOS System Design II : Mask Layouts 4

Layouts I: Stick Diagrams, Colour and Monochrome Codes In Stick Diagrams, Geometric Layout/ Process Design Rules, Layout Of Basic Cells. Techniques Commonly Used To Reduce Si Areas In Layouts.

Layouts II: Sample Layout, Layout Methodology And Quality Guidelines, Diffusion Capacitance, Matched / Standard Cells.

Layouts III: CMOS Logic Gate Design, Mask Layout Designs For NMOS/CMOS, NAND, NOR Gates, 2 Input Multiplexer, Layout Optimization For Performance, Clocking Strategies, I/O Structures.

Layout IV: Extracting Circuits From Layout, Split Gates, Cell Layout, Schematic And Layout Transistor Densities.

Mixed Signal Circuits and Layouts: Nonlinear Analog Circuits, Dynamic Analog Circuits, Data Converter Fundamentals, DAC and ADC.

Text / Reference Books:

1.	CMOS Circuit Design, Layout and Simulation,	R.Jacob Baker, Harry W. Li, David E. Boyce, PHI
2.	Principles Of CMOS VLSI Design : A Systems Perspective	Neil Weste, Kamran Eshraghian And Michael Smith, 2 nd Edition, Addison Wesley, 2001.
3.	Digital Integrated Circuits	Jan M.Rabaey, Prentice Hall Of India, New Delhi.
4.	Basic VLSI Design	D.A. Pucknell And Kamran Eshraghian, PHI.
5.	"VLSI Technology"	S.M.Sze, TMH

EL – 321 Real Time Operating Systems 4

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

Hard/soft real time, Static scheduling, Dynamic scheduling, functional decomposition, Hardware-software trade-offs in embedded system. Distributed operating systems concept, file systems, mode of computation, load balancing, event ordering, synchronization, distributed mutual exclusion, drinking philosophers problem, deadlocks in distributed systems. Resource sharing, Priority inheritance and priority ceiling protocols, stack resource protocol, Performance Metrics of RTOS

Overview of Other RTOS/EOS, Hand held OS, Porting RTOSLinux & RTLinux Internals, Programming in Linux & RTLinux, Programming in Linux, Shell programming, System Programming, Programming in RT Linux, Configuring & Compiling RTLinux

Text / Reference Books:		
1.	Real-Time Systems	Jane W. S. Liu, Prentice-Hall,
2.	Real-Time Systems -- Scheduling, Analysis, and Verification.	Cheng A.M.K. Wiley
3.	Operating Systems Concepts.	Silberschatz A, et al , Wiley
4.	Operating Systems: Design and Implementation.	A. Tanenbaum & A. Woodhull, Prentice-Hall
5.	Embedded Linux: Hardware, Software, and Interfacing	Dr. Craig Hollabaugh

EL 322 Wireless Embedded Systems Design 4

Wireless embedded system design: Protocol Design and Validation, Network Embedded Systems (Operating Systems and programming), Bluetooth and IrDA, LAN - IEEE 802.11, RFID, GSM and GPRS, Ubiquitous Computing

Wireless Sensor Networks and ZigBee: design implications of energy, and otherwise resource-constrained nodes; network self-configuration and adaptation; localization and time synchronization; collaborative processing, distributed feature extraction & programming sensor networks.

Protocol Design and Validation, Network Embedded Systems (Operating Systems and programming), The Internet Protocols: IPv4, IPv4 addressing, IP options, ICMP. Multicast: Multicast addressing and forwarding, IGMP, IPV6, Routing: Routing and forwarding, distributed routing information, RIP, OSPF, Transport over IP: UDP, TCP, SCTP, RTP., Application protocols : DNS, Telnet, FTP, HTTP., Web Programming : HTML , cascaded style sheets, JavaScript : Basics and objects in Java script, DHTML, CGI scripting, XML : defining data for web applications.

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

Text / Reference Books:		
1.	TCP/IP Illustrated Volume 1, The Protocols	W.Richard Stevens, Pearson
2.	Operating Systems: Design and Implementation.	A. Tanenbaum & A. Woodhull, Prentice-Hall
3.	Web programming building Internet Applications	Chris Bates, II'nd ed, Wiley

1. 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.

Superheterodyne radio receiver,

Video signal transmission and reception using wire & wireless and optical fiber media.

Optical devices, LEDs, lasers, gratings, isolators, reflectors, etc.

2. Experiments for 2 credits.

OTDR – concepts and measurements

Simulation of losses, etc

Optical spectrum analyzer study and use free space optics.

Text Books

1.	Television Engineering and Video systems	R.G.Gupta, TMH
2.	Principles of Communication Systems	Taub & Schilling.
3.	Electronic communication technique	Paul H.Young,Prentice Hall

Reference Books:

1.	Electronic Communication Systems,	G. Kenedy 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

Revision of Transmission concepts from RF and microwave antennas, propagation of em waves, ground, duct and sky wave propagation, Noise in communication systems, sources and types of noise.

Advanced topics on reflector antennas, Design consideration of parabolic dishes, wave guides and components, Microwave tubes, Microwave semiconductor devices, Microwave Links and Relay Station Tropo scatter links.

Detailed description of Satellite Communication: Basic Earth station, G/T figure of merit, prime focus offset feed, casse grain feed. LNAs and HPAs, Ground communication equipment (GCE). down and up conversion,

Space craft antennas, transponders, etc.

Satellite Link Design

Intelsat, Inmarsat, Insat systems.

Text / Reference Books:

1.	Electronics Communication Systems	G.Kennedy & B.Davis, TMH Co.Ltd.
2.	Satellite Communication	T.Pratt & C.W.Bostian, John Wiley & Sons.
3.	Introduction to Satellite Communication	Scolnik

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
EL – 401	Project/Internship	16

Project or internship related to the Special elective group

EL – 411 Architecture and Design of VLSI System 4

Design & analysis of power supply networks : Voltage drop analysis modes, linear system solution techniques, Models for power distribution networks.

Noise considerations for digital IC's : Why has noise become a problem, Noise effects in digital designs, static noise analysis, electrical analysis, fixing noise problems.

Tools for chip package codesign : Digital system codesign issues, mixed signal codesign issues, I/O buffer interface standard.

Layout tools for analog integrated circuits and mixed signal systems on chip : Analog layout problems and approaches, Analog cell layout strategies, mixed signal system layout.

Design for Manufacturability in the Nanometer regime : Yield loss mechanisms, logic design for manufacturing, parametric design for manufacturing methodologies, yield-aware physical synthesis.

Mixed-signal noise coupling in SoC design : Mechanisms and effects of Mixed signal noise coupling, mixed signal noise measurement and validation, Application to placement and power distribution synthesis.

Text/Reference Books

1.	EDA for IC Implementation, Circuit Design and Process Technology	Louis Scheffer, Luciano Lavagno, Grant Martin
2.	The VLSI handbook, 2 nd edition	Wai-Kai Chen
3.	CMOS Circuit Design, Layout and Simulation	R. Jacob Baker, Harry W. Li, David E. Boyce

Embedded processor architectures and microarchitectures. VLIW, EPIC, and SIMD, domain-specific embedded processors, configurable/reconfigurable embedded systems, HW/SW computing architectures. Single processor – coprocessor architecture, multiprocessor architectures, architectures for DSP and multimedia,

Constrained and optimized HW/SW system design, Behavioral description, Models and implementation of basic HW and SW components, their interfaces, synthesis and code generation, Scheduling of access, Prediction and analysis of constrained and optimized design, Partitioning algorithms and tools, Design for testability considerations.

Reconfigurable Computing, FPGA Architectures, FPGA Design Cycle, Coarse-grained Reconfigurable Devices and Multi-FPGA Systems, Integration Platforms and IP core based architectures, FPGA embedded processors Reconfigurable Computing Applications in bioinformatics, Image processing, Cryptography, Fault tolerant systems, etc

Text / Reference Books:

1.	Computers as Components: Principles of Embedded Computer Systems Design	Wayne Wolf Morgan Kaufmann
2.	Readings in Hardware/Software Co-Design	G. Micheli, R.Ernst, and W.Wolf, Morgan Kaufman
3.	Hardware/Software Co-Design Principles and Practice	J.Staunstrup and W.Wolf, Kluwer Academic.
4.	FPGA based system design	Wayne Wolf, Prentice Hall, 04
5	Advanced FPGA Design	Steve Kilts,Wiley Inter-Science

HFSS, NEC or any equivalent software for the study of antennas.

Wireless Standards : Advanced Mobile Phone Service, Global System for Mobile Communication, CDMA, General Considerations

Communication system design: Intersymbol interference, Random processes and noise, sensitivity and dynamic range, Power efficiency of modulation schemes, noncoherent detection

Transmitter Architectures : Direct-Conversion Transmitters, Two-step Transmitters, Receiver Architectures : Heterodyne Receivers, Homodyne Receivers, Image-Reject Receivers, Digital-IF Receivers, Subsampling Receivers. . LNAs concepts and working: General Consideration, Input Matching, Bipolar LNAs, CMOS LNAs.Downconversion Mixers: General Considerations, Bipolar Mixers, CMOS Mixers, Noise in Mixers, Transceiver Performance Tests.

Case Studies: Motorola's FM Receiver, Philips' Pager Receiver, Philips' DECT Transceiver, Philips'DECT Transceiver, Lucent Technologies' GSM Transceiver, Philips' GSM Transceiver.

RF Synthesizer Architectures: Integer-N Architecture, Fractional-N Architecture, Dual Loop Architectures, Direct Digital Synthesis, Phase-Locked Loops : Basic PLL, Charge-Pump PLLs, , Noise in PLLs, Phase Noise at Input, Phase Noise of VCO, Frequency Multiplication.

Artificial intelligence, navigation using GPS, astronomical techniques relevant to communication.

Text/Reference Books:

1.	Multi-Standard CMOS Wireless Receivers: Analysis and Design	Xiaopeng Li, Ismail, Mohammed, Springer Vol. 675
2.	Wireless Communications Systems and Networks	Mohsen Guizan, Springer, 2004
3.	GPS for geodecy	P.J.G. Teunissen A. Klensberg
4..	GPS Inertial navigation,	Mohinder S. Krewal, L.R.Weill, Agnus P. Andhen