Deccan Education Society's

FERGUSSON COLLEGE, PUNE

(AUTONOMOUS)

SYLLABUS UNDER AUTONOMY
FIRST YEAR M.Sc.
ELECTRONIC SCIENCE

SEMESTER - I

Academic Year 2016-2017

M.Sc. Electronic Science - Course structure & Credits Distribution

Semester	Course Code	Course Title	No. of credits
Sem-I	ELS4101	Analogue Circuit Design	04
	ELS4102	Digital System Design using Verilog	04
	ELS4103	Mathematical Methods in Electronics and Network Analysis	04
	ELS4104	Programming with C and C++	04
	ELS4105	Electronic Science Practical Course - I	04
	ELS4106	Electronic Science Practical Course - II	04
	ELS4107	Circuit Simulation and PCB Design	01
Sem-II	ELS4201	Instrumentation and Measurement Techniques	04
	ELS4202	Embedded System Design	04
	ELS4203	Applied Electromagnetics, Microwaves and Antennas	04
	ELS4204	Foundation of Semiconductor Devices	04
	ELS4205	Electronic Science Practical Course - III	04
	ELS4206	Electronic Science Practical Course - IV	04
	ELS4207	Electronic Design Automation (EDA) Tool for Microcontrollers	01

Note: One Credit is equivalent to 15 Contact Hours.

Deccan Education Society’s
Fergusson College (Autonomous), Pune
Faculty of Science
Post Graduate Extra Credits

Semester	Course Code	Title of the Course	No. of Credits
I	XHR0001	Human Rights - I	1
	XCS0002	Introduction to Cyber Security - I / Information Security - I	1
	XSD0003	Skill Development - I	1
II	XHR0004	Human Rights - II	1
	XCS0005	Introduction to Cyber Security - II / Information Security - II	1
	XSD0006	Skill Development - II	1

M.Sc. (Electronic Science)-I

Semester-I

ELS4101: Analogue Circuit Design

[Credit-4]

Objectives:

1. To learn the characteristics and working of electronic devices
2. To study the various device models
3. To study the wideband and narrowband amplifiers using BJT
4. To develop skills in analysis and design of analog circuits
5. To study the designs of opamp applications

Unit-1: Basic Semiconductor Devices

Practical diode characteristics (static and dynamic resistance), temperature effects, switching characteristics, diode breakdown, diode applications in wave shaping circuits.

BJT: construction, biasing and operation, CC, CB and CB configurations.

JFET: Construction, types and operation, characteristics, parameters of JFET, comparison of BJT and JFET, JFET amplifiers.

MOSFET: depletion and enhancement, biasing of MOSFET, applications.

Unit-2: Frequency Response of Amplifiers

BJT models and modeling parameters, equivalent circuits for CE, CB and CC configurations, single stage amplifier, small signal analysis, distortion Design of single stage RC-coupled amplifier with frequency response (f1 and f2) Frequency Response: Low and High frequency equivalent circuit, bode plots, Miller effect, square wave testing, frequency response of multistage amplifiers, different coupling schemes and gain of multistage amplifiers.

Unit-3: Tuned Amplifier and Oscillators

Tuned amplifier design, multistage tuned amplifiers: synchronous and stagger tuning cascade configuration, large signal tuned amplifier

Oscillators: design and analysis of LC and RC oscillators, Hartley, Colpitt's, Miller oscillators, phase shift and Wien-bridge oscillators, crystal oscillators and applications.

Unit-4: Operational Amplifiers and their Applications

Practical consideration in opamp based circuit design, opamp parameters such as dc and low frequency parameters and their significance in design of opamp, closed loop stability analysis and frequency compensation. Inverting and non-inverting amplifiers with design aspects such as input and output impedance, common mode errors and limitations, bandwidth, etc. Bridge and instrumentation amplifier Practical design aspect of integrator and differentiators, such as offset error and stability, bandwidth considerations. Concept and applications of PLL.

Active Filters: transfer functions poles and zeros, Design of active filters - LPF, HPF, BPF and BRF (first and higher orders), Butterworth and Chebyshev filters.

Text / Reference Books:

1. Electronic Devices and Circuits, S. Salivahanan, N. Suresh Kumar, 3rd Edn, McGraw Hill.
2. Electronic Devices and Circuit Theory, Robert Boylestead, Louis Nashelsky, PHI.
3. Design with Operational Amplifiers and Linear IC, Sergio Franco, 3rd Edn, TMH.
4. Electronic Principles, Malvino and Bates, McGraw Hill.
5. Operational amplifier, G.B.Clayton, Elsevier Sci. Tech.
6. Microelectronic Circuits: Analysis and Design, Mohammad H. Rashid, PWS Publishing
7. Pulse, Digital Switching Circuits, Millman Taub, TMH.
8. Electronic devices, Allen Motershed, PHI.
9. Integrated electronics, Millman Halkies, McGraw Hill.

ELS4102: Digital System Design using Verilog

[Credit-4]

Objectives:

1. To understand sequential and combinational logic design techniques
2. To introduce VERILOG
3. To learn various digital circuits using VERILOG
4. To learn PLD, CPLD, FPGA and their applications

Unit-1: HDL for Digital System Design

VERILOG: design flow, EDA tools, data types, modules and ports, operators, gate level modeling, data flow modeling , behavioral modeling, tasks and functions, timing and delays, test bench, types of test bench, comparison between VERILOG and VHDL language.

Unit-2: Combinational Logic

Introduction to combinational circuits, realization of basic combinational functions-magnitude comparator, code converters, multiplexers, demultiplexers, multiplexed display, encoder and decoders, priority encoders, parity generator/checker, arithmetic circuits (adder, Subtractor, binary multiplier), parallel adder, look ahead carry generator, VERILOG models and simulation of above combinational circuits.

Unit-3: Sequential Logic Design and Circuits

Introduction to sequential circuits, Flip flops: types, state table, transition table, excitation tables, timing waveforms, clock generators.

Counters: synchronous, asynchronous, design of counters, up/down counter.

Shift Registers: ring counter, Johnson counter.

Finite State Machine (FSM) Design: Mealy and Moore state machines.

VERILOG Models and Simulation of above Sequential Circuits and FSMs: stepper motor controller, traffic light control, washing machine control, parking controller, coffee vending machine, LCD controller.

Unit-4: PLDs and Memories

Need of PLD, antifuse, architecture of simple PLD (SPLD)-PAL, PLA, Complex Programmable Logic Device (CPLD) and Field Programmable Logic Devices (FPGA), CPLD/FPGA based system design applications - typical combinational and sequential system implementation, estimation of uses of blocks, links, LUTs, etc.

Memories: types, data storage principle, control inputs, and timings, applications, Random Access Memories (RAM), Static Ram (SRAM), standard architecture, transistor cell diagram, sense amplifier, address decoders, timings, Dynamic RAM (DRAM), different DRAM cells, refresh circuits, timings, role of memories in PLD.

Text / Reference Books:

1. Verilog HDL; A Guide to Digital Design and Synthesis, Samir Palnitkar, Pearson Education,
2. Verilog HDL synthesis; A Practical Primer, J. Bhaskar, Star Galaxy Publishing, 1998.
3. Digital System Design with VERILOG Design, Stephen Brown, Zvonko Vranesic, TMH, 2nd Edn,
4. Digital design; Principles Practices, Wakerly, PHI.
5. Modern Digital Electronics, R.P Jain, McGraw Hill.
6. Digital systems; Principles and Applications, Tocci, Pearson Education.
7. Digital Logic and Computer Design, Morris Mano, PHI.

ELS4103: Mathematical Methods in Electronics and Network Analysis

[Credit-4]

Objectives:

1. To get familiar with role of differential equations in applied electronics
2. To know about mathematical tools and techniques for network analysis
3. To learn the methods of analysis for CT and DT signals and systems
4. To learn concept of mathematical modeling of simple electrical circuits

Unit-1: Mathematical modeling of Electrical and Electronic Systems

Concept of modeling, types, mathematical modeling using differential equations, transfer function, analogous physical and electrical quantities.

Unit-2: Differential Equations

Differential Equation, Ordinary Differential Equations (ODE), DE and their occurrences in real life problems, linear differential equation with constant coefficients, partial DE, Introduction to coordinate systems (rectangular, cylindrical and spherical), method of separation of variables, General outline for solution of wave equation in cartesian and cylindrical coordinate system, Bessel DE and zeros of Bessel function and their significance, solution of Laplace equation in spherical coordinate system.

Unit-3: Electronic Signals and Mathematical Tools for Circuit Analysis

Signals: periodic, aperiodic, Continuous Time (CT) and Discrete Time (DT), special electronic signals (impulse, unit step, sinusoidal, ramp, square wave, staircase)

Laplace Transform (LT): definition, LT of standard electronic signals, inverse LT, methods of ILT (partial fraction method), properties of LT (shifting, linear, scaling), initial and final value theorem, LT of derivatives and Integrals, solution of DE using LT, concept of Transient and steady state response

Z-Transform (ZT): definition, inverse ZT (partial fraction and residue method), ZT of standard electronic signals, properties, difference equation and solutions using ZT Concept of transfer function of CT and DT systems,

Laplace transformation of electrical circuits, two port network functions, time and frequency domain response of systems using transfer function, poles and zeros of transfer function and their significance, applications to simple passive filters such as Low Pass (LP), High Pass (HP), Butterworth filters, stability criterion, Routh-Hurwitz criterion, synthesis of transfer function using poles and zeros.

Unit-4: Network Analysis

Network Topology (nodes, tree, graph, branch, mesh, and loop) Network Theorems and Applications to DC and AC Circuits: Thevenin's, Norton's, superposition, maximum power transfer – theorems Mesh, loop and nodal analysis of circuits, T and π networks, state variable method with simple examples.

Text / Reference Books:

1. Advanced Engineering Mathematics, E. Kreyzig, John Wiley and Sons.
2. Network Analysis, G. K. Mittal, Khanna Publication.
3. Circuits and Networks Analysis and Synthesis, A. Sudhakar, Shyam Mohan and Pilli, TMH.
4. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanpriya, McGraw Hill.
5. Network Analysis, M. E. Van Valkenberg, PHI.
6. Network and Systems, Roy Choudhary, Wiley Eastern.
7. Microwave Devices and Circuits, Samuel Y. Liao, 3rd Edition, PHI, 2002.

ELS4104: Programming with C and C++

[Credit-4]

Objectives:

1. To understand basic concepts of C programming language.
2. To learn various advanced features, and graphics in C
3. To learn concepts of object oriented programming in C++
4. To develop programming skills in C/C++ for scientific applications.

Unit-1: Basics of C

C fundamentals: Introduction of high-level programming language, operators and its precedence, various data types in C, storage classes in C.

Control statements: Decision–making and forming loop in programs.

Arrays & pointers: handling character, arrays in C, pointers in C, advanced pointers, structure and union.

Functions: Function Prototyping, passing parameters, returning values, recursion, user defined, pointer to functions.

Unit-2: Advanced Features and Interfacing

Miscellaneous and advanced features: command line argument, dynamic memory allocation, Data files in C, file handling in C.

Graphics in C: graphics-video modes, video adapters, drawing various objects on-screen, plotting simple graphs.

Unit-3: Introduction to C++

Introduction to object–oriented programming (OOP) ,characteristics, input/ outputs in C++,objects, classes, structures, union and enum syntax, elementary operators, function prototypes and miscellaneous types.

Unit-4: Advanced features of C++

Concept of pointers, overloaded operators, classes within classes and constructors, data conversion between objects of different classes.

Text / Reference Books:

1. Computer programming in C, V. Rajaraman, Pearson Education, 2nd edition, 2003.
2. The C programming language, Dennis Ritchie, Pearson Education, 2nd edition, 2003.
3. Graphics programming in C, Roger T. Stevens, BPB Publications.
4. Programming with C, Byron S. Gottfried, Schaum Outline Series, Tata McGrawHill.
5. Programming in C, Stephen G. Kochan. CBS.
6. Let us C++, Yashavant P. Kanetkar, BPB Publications.
7. Object oriented programming in C++, Robert Lafore, Galgotia Publications.
8. Programming with C++, John Hubbard, Schaum Outline Series, Tata McGrawHill.

ELS4105: Electronic Science Practical Course - I

[Credit-4]

Group A: Analog Circuit Design = 7

Group B: Digital Electronics = 3

Group C: Activity = 2

[A] Practical based on Circuit Design

1. Bootstrap ramp generator for delay triggering
2. Blocking oscillator
3. Tuned amplifier small signal / large signal for IF
4. Transistor based microphone amplifier
5. Voltage controlled current source / sink and current mirror and doubler
6. Comparator and Schmitt trigger with single supply operation
7. Second order Butterworth filters (BP and BR)
8. Waveform generation: Quadrature Oscillator, Bubba Oscillator
9. V to F and F to V using commercially available IC
10. Instrumentation amplifier for a given gain
11. Low current negative power supply using IC555 / dual power supply using single battery
12. PLL characteristics and demonstrate any one application (IC565/CD4046)

[B] Practical based on Digital Design

1. Two digit combinational lock
2. Keyboard encoder with latches
3. Traffic light controller
4. Multiplexed display (Bank token / two digit counter)
5. Bidirectional stepper motor control (Sequence Generator)
6. One digit BCD adder and 8-bit adder / subtractor
7. Object counter (use of MMV, counter)
8. Binary-Gray and Gray-Binary code converter

[C] Activity: Equivalent to TWO Experiments

ELS4106: Electronic Science Practical Course - II

[Credit-4]

Group A: Verilog programming, CPLD/FPGA = 6

Group B: Mathematical Methods for Electronics (C/MATLAB/PSICE) = 4

Group C: Activity = 2

[A] Practical Based on VERILOG Programming and Implementation on CPLD/ FPGA

1. Combinational Logic
    a. Parity Generator and checker
    b. Hamming Code Generator
    c. Manchester code Generator
2. Sequential Logic
    a. Up-down bit binary counter (minimum 4-bit)
    b. Universal shift register
3. Four bit ALU design (structural modelling)
4. Keyboard Scanning
5. Designing of Traffic light Controller
6. Implementation of 8 bit multiplexer
7. LCD controller
8. Code Converter (BCD to seven Segments)
9. State machine (Stepper sequence generator/Vending Machine/ Washing Machine)
10. Barrel shifter

[B] Practical based on C / MATLAB / PSPICE

1. Phase and frequency response of a CT system: Low Pass and High Pass
2. Phase and frequency response of a DT system: Low Pass and High Pass
3. Transient and steady state response of CT system: LCR series circuit
4. Simulation of transfer function using poles and zeros
5. Synthesis of periodic waveform from Fourier coefficients
6. Solution of differential equation with given boundary conditions
7. Analysis of a given dc electrical circuit
8. Effect of locations of poles and zeros on the transfer function and corresponding frequency response

[C] Activity: Equivalent to TWO Experiments

ELS4107: Circuit Simulation and PCB Design
[Credit-1]

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FIRST YEAR M.Sc.
ELECTRONIC SCIENCE

SEMESTER - II

Academic Year 2016-2017

Semester-II

ELS4201: Instrumentation and Measurement Techniques

[Credit-4]

Objectives:

1. To understand the configurations and functional descriptions of measuring instruments
2. To understand the basic performance characteristics of instruments
3. To understand the working principles of various types of sensors and transducers and their use in measuring systems
4. To study the techniques involved in various types of instruments
5. To understand the relevance of electronics with other disciplines

Unit-1: Introduction to Measurement and Measurement Systems

Definition and significance of measurement, classification of instruments and types of measurement applications, elements of an instrument / measurement system, active and passive transducers, analog and digital modes of operation, null and deflection methods, input-output configuration of instruments and measurement systems, methods of correction of instruments and measurement systems Generalized performance characteristics of instruments: static characteristics and static calibration, meaning of static calibration, true value, basic statistics, least– squares calibration curves, calibration accuracy versus installed accuracy, combination of components errors in overall system accuracy calculations, theory validation by experimental testing.

Unit-2: Static Dynamic Characteristic of Measurement System

Static sensitivity, linearity, threshold, noise floor, resolution, hysteresis and dead space, scale readability, span, generalized static stiffness and input impedance, loading effect Dynamic characteristics: generalized mathematical model of measurement system, operational transfer function, sinusoidal transfer function, zero-order instrument, first order instrument, second order instruments, step response, ramp response, frequency response of first –order instruments and second order instruments Errors in measurement: Types of Errors - gross, systematic, environmental errors, systemic errors, computational error, personal error etc.

Unit-3: Motion Measurement

Methods of transduction, primary sensing elements and transducers, electrical transducers, classification of transducers Motion and dimensional measurement: fundamental standards, relative displacement- translational and rotational, calibration, resistive potentiometers, resistance strain gauge, differential transformers, variable–inductance and variable–reluctance pickups, eddy current, non contacting transducers, capacitance pickups, piezoelectric transducers, digital displacement transducers (translational and rotary encoders), ultrasonic transducers, detailed discussion of strain gauges, LVDT and synchros Relative velocity: translational and rotational, calibration, average velocity from measured dx and dt, tachometer encoder methods, laser based methods, stroboscopic methods, translational–velocity transducers (moving coil and moving magnet pickups) Relative acceleration measurements: seismic (absolute) displacement pickups, seismic (absolute) velocity pickups, seismic (absolute) acceleration pickups(accelerometers).

Unit-4: Process Parameter Measurements

Force, Torque and Shaft Power: standards and calibration, basic methods of, bonded strain gauge, differential transformer, piezoelectric, variable reluctance/ FM oscillator digital system, torque measurement on rotating shafts

Pressure and Sound Measurement: standards and calibration, dead weight gauges and manometers, low pressure measurement - Mcleod gauge, Knudsen gauge, viscosity, thermal conductivity, ionization, sound level meter, microphone, capacitor microphone

Flow measurement: Pitot-static tube, Yaw tube, hot wire and hot film anemometers, Laser Doppler anemometer, Gross Volume Flow Rate- rotameter, turbine, ultrasonic flow meter, electromagnetic flow meters

Temperature and Heat Measurement Transducers: standards and calibration, bimetallic thermometers, liquid in glass thermometers, pressure thermometers, RTD, thermocouples, thermistors, semiconductor based temperature sensors, detailed discussion on basics of thermocouples, laws of thermocouples, cold junction compensation; thermistor types, materials used, application circuits, LM35.

Radiation Fundamentals: detectors, optical pyrometers, IR imaging systems, heat flux sensing- slug type sensors, Gorden gauge.

Text / Reference Books:

1. Measurement Systems, Applications and Design, Ernest O. Doeblin and Dhanesh N. Manik, 5th Edition, Tata McGraw Hill.
2. A Course in Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai & Co.
3. Electronic Instrumentation, Kalsi, TMH.
4. Modern Electronic Instrumentation and Measurements Techniques, Cooper and Helfrick, PHI.

ELS4202: Embedded System Design

[Credit-4]

Objectives:

1. To understand the basics of embedded system
2. To understand the architecture, assembly language and interfacing of different 8-bit microcontrollers
3. To learn embedded C programming
4. To learn software techniques to embed codes in to the systems
5. To learn communication standards and protocols

Unit-1: Introduction to Embedded System

Embedded System: components, examples, development cycle of embedded system, embedded System Development Environment - algorithm, flow chart, IDE, ICE, programmer

Processor Architectures: Harvard architecture, Von-Neumann architecture, RISC and CISC.

Unit-2: Bus Standards and Communication

Communication Protocols: I2C bus- specification, general characteristics, bus signals, and address mechanism, Serial Peripheral Interface (SPI): specifications, master slave configuration.

Bus Standards: RS 232, RS 485, USB, Bluetooth, Zigbee.

Controller Area Network (CAN): specifications, basic concepts, frame types, bus signals, error handling and addressing.

Unit-3: AVR Microcontroller

Architecture (Atmega16), instruction set, addressing modes, memory organization, timers, I/O, ADC, interrupts, serial communication Design of General Purpose Target Board: reset, oscillator circuit, derivatives of AVR Basic Assembly Programs: arithmetic, logical, code converter, block data transfer, I/O programming.

‘C’ Programs: ADC, timer, I/O ports, interrupts, Inter-Integrated Circuit (I2C), serial communication, PWM. Real world interfacing with the microcontrollers and programming in C: DAC, LED, SSD, dot matrix display, and LCD displays (text and graphic), keyboard and motors (DC, stepper, and servo), I2C and SPI based RTC, EEPROM, DAC and ADC, coding assembly in C and code optimization.

Unit-4: PIC Microcontroller

Architecture (PIC18F4550, 18F458), instruction set, addressing modes, memory organization, timers, I/O, ADC, interrupts, serial communication Design of General Purpose Target Board: reset, oscillator circuit, derivatives of PIC Basic Assembly Programs: arithmetic, logical, code converter, block data transfer, I/O programming.

‘C’ Programs: ADC, timer, I/O ports, interrupts, I2C, serial communication, PWM Real world interfacing with the microcontrollers and programming in C: DAC, LED, SSD, dot matrix display, and LCD displays (text and graphic), keyboard and motors (DC, stepper, and servo), I2C and SPI based RTC, EEPROM, DAC and ADC, coding assembly in C and code optimization.

Text / Reference Books:

1. AVR Microcontroller and Embedded Systems using Assembly and C, Mazidi and Naimi, Pearson education, 2011.
2. Embedded C Programming and the Atmel AVR, Barnett, Larry D. O’Cull and Sarah A. Cox, Delmar, Cengage Learning, 2007.
3. PIC Microcontroller and Embedded Systems, Mazidi, Mckinlay and Causey, Pearson Education.
4. C Programming for Embedded Systems, Kirk Zurell, Pearson Education.
5. Programming in C, Stephen Kochan, Hayden Books/Macmillan.

ELS4203: Applied Electromagnetics, Microwaves and Antennas

[Credit-4]

Objectives:

1. To introduce to students the concepts of electromagnetics
2. To understand the theory of transmission lines and wave guides
3. To study various parameters of antennas
4. To study various methods of generation of microwaves

Prerequisite: Physical quantities as vectors, concept of gradient, curl, and divergence, concept of rotation operator, covariant and contra-variant vectors, line, surface and volume – integrals, Gauss and Stokes theorem complex plane, polar form of complex number, complex functions, Cauchy-Riemann conditions, orthogonal functions and relation with Laplace equation.

Unit-1: Electromagnetic Waves

Review of Maxwell’s equations and their meaning, continuity equation, electric and magnetic wave equations in time domain and frequency domain, wave propagation in conducting and non-conducting media, skin depth and high frequency propagation, boundary conditions at the interface between two mediums, Poynting theorem and its applications.

Unit-2: Transmission Lines

Types of transmission lines, microstrip lines, two wire transmission line, transmission line equations for voltages and currents, inductance and capacitance per unit length of two wire and coaxial cable transmission line, characteristic impedance, propagation constants, attenuation and phase constants, phase velocity, reflection and transmission coefficients, SWR, line impedance, normalized impedance and admittance, Smith chart construction and applications, single stub and double stub matching, applications to reflection of EM-waves at interfaces for normal incidence.

Unit-3: Waveguides and Components

Concept of waveguides, frequency range, relation to transmission lines.

Rectangular Waveguides: TM and TE Modes, concept of cut-off frequency, guide impedance, phase velocity, guide wavelength for TE and TM modes, Applications to TE mode in rectangular waveguide, power losses in rectangular waveguide, introduction circular waveguide.

Optical Fiber: principles of operation and construction, difference between conducting circular waveguide and fiber Different methods of excitation of TE and TM modes in waveguides Cavity Resonators, Q factor of cavity resonators.

Unit-4: Electromagnetic Radiation

Potentials of electromagnetic fields, retarded potential, radiation from oscillating dipole, concept of near zone and radiation zone, radiation resistance, role of antenna in exciting different TE, TM modes in wave guides.

Antenna Parameters: gain, directivity, power, aperture, Friis equation, radiation pattern.

Application Areas: antenna temperature, Signal to Noise Ratio (SNR), remote sensing, RADAR equation.

Antennas Types: $\lambda/2$ antenna, antenna arrays, horn antennas, parabolic dish antennas, End fire antenna – Yagi Uda, patch antenna, microstrip antennas EMI and EMC.

Generation of Microwaves: principle, physical structure and working of - Gunn Effect diodes, magnetron oscillator, reflex Klystron oscillator.

Note: In the case of antennas and microwave devices, mathematical analysis of equivalent circuits and processes is not expected.

Text / Reference Books:

1. Microwave Devices and Circuits, Samuel Y. Liao, PHI, 3rd Edition, 2002.
2. Principles of Electromagnetics, N. Sadiku, Oxford University Press.
3. Electromagnetics with Applications, Kraus and Fleiseh, McGraw Hill, 5th Edn, 1999.
4. Electromagnetics, J.D. Kraus, 4th Edn, McGraw Hill, 1992.

ELS4204: Foundation of Semiconductor Devices

[Credit-4]

Objectives:

1. To introduce crystal structure with reference to semiconductors
2. To introduce quantum and statistical mechanics
3. To understand the characteristics of semiconductor devices
4. To introduce theory of diode, transistor and FETs

Unit-1: Theory of solids, quantum and statistical mechanics

Crystal structure of solids: Semiconductor materials, types of solids, basics of crystallography, space lattice atomic bonding, unit cell, Miller indices imperfections and impurities in solids, methods for semiconductor crystal growth. Introduction to Quantum Mechanics: Principles of quantum mechanics, Schrodinger wave equation, and Applications of Schrodinger's wave equation for bound state potential problems. Introduction to quantum theory of solids: Allowed & forbidden energy bands, electrical conduction in solids, extensions to three dimensions, density of states, Statistical mechanics: Statistical laws, Fermi-Dirac probability function, the distribution function and the Fermi energy.

Unit-2: Physics of semiconductors

Semiconductor in equilibrium: Charge carriers in semiconductors, dopant atoms and energy levels, extrinsic semiconductors, Statistics of donors and acceptors, charge neutrality, position of Fermi energy level.

Carrier transport phenomena: charge, effective mass, state & carrier distributions, Carrier drift, carrier diffusion, graded impurity distribution, resistivity, Hall Effect.

Non-equilibrium excess carriers in semiconductors: Carrier generation and Recombination, characteristics of excess carriers, ambipolar transport, quasi-Fermi Energy levels, excess carrier lifetime, surface effects.

Unit-3: Basics of Semiconductor Devices

Diode: Junction terminologies, Poisson's equation, built-in potential, depletion Approximation, diode equation, Qualitative and Quantitative analysis, Reverse-bias Breakdown, avalanching, zener process, C-V characteristics, Transient response.

BJT: Terminology, electrostatics and performance parameters, Eber-Moll model, Two port model, hybrid – pi model, device models in spice , Modern BJT structures – polysilicon emitter BJT, Heterojunction bipolar transistor (HBT).

FETs: JFET and MESFET - Junction terminologies, characteristics, ac response, spice models.

MOSFET: Fundamentals, Capacitance- voltage characteristics, I-V characteristics, Qualitative Theory of Operation, ID - VD Relationship, ac response, spice models.

Unit-4: Optoelectronics Devices

Optical Absorption, Solar Cell- I-V Characteristics, conversion efficiency, solar spectral irradiance, types of solar cells. Photo detector, photodiode, PIN photodiode, Avalanche photodiode, photo transistor Photoluminescence and Electroluminescence.

LEDs: Internal and External quantum efficiency.

LASER Diodes: Stimulated emission and population inversion, optical cavity, threshold current, device structure and characteristics.

Text / Reference Books:

1. Semiconductor Physics and Devices Basic Principles, Donald A. Neamen, TMH, 3rd Edition (2003)
2. Semiconductor Device fundamentals, Robert F. Pierret, Pearson Education
3. Solid State Electronics Devices, Streetman, PHI, 5th Edition, (2006)

ELS4205: Electronic Science Practical Course – III

[Credit-4]

Group A: Instrumentation = 7

Group B: Electromagnetics, Microwave = 3

Group C: Activity = 2

[A] Practical based on Instrumentation and Measurement System

1. Design build and test rms to dc converter for voltage measurement of ac signal
2. Displacement measurement using LVDT, signal conditioning and DPM
3. Temperature measurement using PT100, signal conditioning and DPM
4. Temperature measurement using thermocouple with cold junction compensation
5. Design build and test IR transmitter and receiver (TSOP1738 or similar) for object detection
6. To build and test current telemetry (4 to 20 mA)
7. Ultrasonic transmitter and receiver, distance measurement
8. Pressure measurement using strain gauge
9. RPM measurement using various methods
10. Design and calibrate light intensity meter using photodiode or LDR and the necessary signal conditioning and display
11. Use of strain gauge to measure stress on a cantilever made of material known quantity
12. Hot wire anemometer

[B] Practical based on Electromagnetics, Microwaves, Antennas

1. To study the characteristics of Klystron tube
2. To determine the standing wave ratio and reflection coefficient of a given waveguide
3. To plot directivity pattern of a given antenna
4. To determine a characteristics of a microstrip transmission line
5. Design and test Yagi-Uda antenna with power reflectors
6. Measurement of primary-secondary coupling factor of a given transformer using
7. LCR meter (calculation of transformer model parameters expected)

[C] Activity: Equivalent to TWO Experiments

ELS4206: Electronic Science Practical Course – IV

[Credit-4]

Group A: Microcontrollers = 7

Group B: Electromagnetics (C/MATLAB) =3

Group C: Activity = 2

[A] Practical on AVR/PIC Interfacing Practical on AVR (3/4)

1. Interfacing of LED array to generate different sequences, use of timer for delay generation
2. Matrix Keyboard interface with LCD
3. DAC interfacing (sine, staircase, triangular, square wave) use of timer
4. Use of ADC
5. DC motor control using PWM / Intensity control of LED – with CCP
6. Serial EEPROM / EEPROM interface using SPI protocol
7. Real time clock (RTC)
8. Stepper motor Interfacing
9. Dot matrix rolling display

Practical on PIC (3/4)

1. Any four Practical on PIC Interfacing
2. Two-digit 7-segment display (multiplexed) interfacing
3. LCD / keyboard Interfacing
4. Bidirectional stepper motor interfacing
5. Real Time Clock display on LCD / HyperTerminal (I2C)
6. Use of internal EEPROM
7. DAC interfacing (square wave, staircase, triangular, sine) use of timer
8. On-off controller with hysteresis (ADC)
9. Two digit frequency counter or event counter using timer / interrupt
10. Matrix keyboard / Touch screen
11. Graphic LCD interfacing
12. Zigbee communication
13. DC motor control using PWM / intensity control of LED

[B] Practical on Electromagnetics (C / MATLAB)

1. To plot Equipotential contours and field lines for given charge distribution
2. Use of Smith chart for transmission line pattern and verify using C
3. Use of MATLAB for potential distribution in a region bound by two conductors
4. Use of MATLAB for directivity pattern for simple antennas

[C] Activity: Equivalent to TWO Experiments

ELS4207: Electronic Design Automation (EDA) Tool for Microcontrollers **[Credit-1]**