

**Deccan Education Society's
FERGUSSON COLLEGE
(AUTONOMOUS), PUNE**

Syllabus
for

M. Sc.(Electronic Science) Part I
(Semester-I and Semester-II)

With effect from June 2019

From Academic Year
2020-22

Program Structure of M.Sc. (Electronic Science) Part-I

Particulars	Course	Paper Code	Title of Paper	Type of Paper	No. of Credits
M.Sc. Semester- I	Course- 1	ELS4101	Semiconductor Devices and Technology	CORE-1	4
	Course- 2	ELS4102	Network Analysis	CORE-2	4
	Course- 3	ELS4103	Analog and Digital Circuit Design	CORE-3	4
	Course-4	ELS4104	Instrumentation	Elective-1	4
	Course-5	ELS4105	Robotics https://nptel.ac.in/courses/112101098/ OR https://nptel.ac.in/courses/112105249/	Elective-2 MOOCs	4
	Course-6	ELS4106	Digital Image Processing https://nptel.ac.in/courses/117105135/ OR https://nptel.ac.in/courses/117105079/	Elective-3 MOOCs	4
	Course-7	ELS4107	Electronic Science Practical-I	PCORE-1	4
	Course-8	ELS4108	Electronic Science Practical-II	PCORE-2	4
M. Sc. Semester- II	Course-1	ELS4201	Electromagnetic Theory and Applications	CORE-1	4
	Course-2	ELS4202	Industrial Process Control	CORE-2	4
	Course-3	ELS4203	Embedded Systems	CORE-3	4
	Course-4	ELS4204	Power Electronics	Elective-1	4
	Course-5	ELS4205	Digital Signal Processing https://nptel.ac.in/courses/117102060/	Elective-2 MOOCs	4
	Course-6	ELS4206	Analog Circuits and Systems through SPICE Simulation https://nptel.ac.in/courses/117105147/	Elective-3 MOOCs	4
	Course-7	ELS4207	Electronic Science Practical-III	PCORE-3	4
	Course-8	ELS4208	Electronic Science Practical-IV	PCORE-4	4

Program Structure of M.Sc. (Electronic Science) Part-II

Particulars	Course	Paper Code	Title of Paper	Type of Paper	No. of Credits
M.Sc. Semester-III	Course-1	ELS5301	Communication Electronics	CORE-1	4
	Course-2	ELS5302	Advanced Embedded Systems	CORE-2	4
	Course-3	ELS5303	Data Communication and WSN	CORE-3	4
	Course-4	ELS5304	Elective: IoT and Python Programming	Elective-1	4
	Course-5	ELS5305	Moocs: Artificial Intelligence https://nptel.ac.in/courses/106105077/	Elective-2 MOOCs	4
	Course-6	ELS5306	Neural Networks and Applications https://nptel.ac.in/courses/117105084/	Elective-3 MOOCs	4
	Course-7	ELS5307	Electronic Science Practical-V	PCORE-1	4
	Course-8	ELS5308	Electronic Science Practical-VI	PCORE-2	4
M. Sc. Semester-IV	Course- 1	ELS5401	Mechatronics and Manufacturing Automation https://nptel.ac.in/courses/112103174/	Elective-1 MOOCs	4
	Course- 2	ELS5402	IC Technology https://nptel.ac.in/courses/117103066/	Elective-2 MOOCs	4
	Course- 3	ELS5303	CMOS Analog VLSI Design https://nptel.ac.in/courses/117101105/	Elective-3 MOOCs	4
	Course-4	ELS5404	Advanced Linear Continuous Control Systems: Applications with MATLAB Programming and Simulink https://onlinecourses.nptel.ac.in/noc18_ee25/	Elective-4 MOOCs	4
	Course-5	ELS5405	Electronic Science Project	PCORE-1	8*

*** 1 Project credit is equivalent to minimum 5-6 hours (for 8 Credits 40 – 48 Hours per week)**

Skill Component Courses – (for 1 Credit each)

1. **Mastering C language** – for scientific computations, file and database handling, real-world interfacing and graphics programming
2. **Introduction to HDL programming (VHDL/Verilog)**
3. **Matlab Programming and Simulink:** A Practical Introduction to Matlab Programming and Simulink.
4. **LabVIEW:** Introduction to LabVIEW.
5. **PLC/SCADA:** Introduction to PLC/SCADA with hands-on.
6. **Open source hardware platform** (like Arduino, Raspberry pi, Beagle Bone...)
7. Any other equivalent skill component course.

Program Outcomes (POs) for M. Sc. Programme	
PO1	Disciplinary Knowledge: Demonstrate comprehensive knowledge of the discipline that form a part of an postgraduate programme. Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PO2	Critical Thinking and Problem solving: Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	Social competenc : Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise and help reach conclusion in group settings.
PO4	Research-related skills and Scientific temper: Infer scientific literature, build sense of enquiry and able to formulate, test, analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	Trans-disciplinary knowledge: Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	Personal and professional competence: Perform independently and also collaboratively as a part of team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	Effective Citizenship and Ethi: Demonstrate empathetic social concern and equity centred national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	Environment and Sustainability: Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	Self-directed and Life-long learning: Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Program Specific Outcomes (PSOs) for M. Sc. Electronic Science	
PSO No.	Program Specific Outcomes(PSOs) Upon completion of this programme the student will be able to
PSO1	Academic competence: (i) Understand concepts and develop applications in the field of Semiconductor technology, Core electronics, Communication/ networking, Digital Electronics, Embedded systems and Automation. (ii) Demonstrate, classify, calculate and execute real world problems by experimenting a wide range of solutions to real world problems in the field of Electronics.
PSO2	Personal and Professional Competence: (i) Design and implement the laboratory based applications with capability of data gathering, data visualization, analysis with data interpretation. (ii) Prepare to collect and construct the data with the professional technical report writing skills along with precise presentation with effective communication skills and professional ethics.
PSO3	Research Competence: (i) Able to design and analyze the concepts and applications in the field of communication/ networking, automation, embedded systems and semiconductor technology. (ii) Work successfully in collaborative and multi-disciplinary environments upholding professional and ethical values or pursue higher studies or research.
PSO4	Entrepreneurial and Social competence: (i) Design techniques and provides creative, innovative and effective solutions to real world problems using hardware-software co-design tools for future smart electronics system (ii) Develop effective communication skills in writing and orally; demonstrate the ability to listen carefully and present complex disciplinary information in a clear and concise manner to different groups.

F.Y. M.Sc. Semester I		
Title of the Course and Course Code	Semiconductor Devices and Technology (ELS4101)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall Basic concept of the structure of solids, charge carriers and energy level.	
CO2	Discuss basic idea of doping , p-n junction diode and its V-I characteristics using graphical and mathematical methods.	
CO3	Illustrate and identify the fabrication methods of integrated circuits.	
CO4	Explain the physical characteristics such as electronic structure and transport properties, and current-voltage characteristics of semiconductors.	
CO5	Apply the knowledge of semiconductors to illustrate the functioning of basic electronic devices.	
CO6	Specify and classify the semiconductor devices for special applications.	

Unit. No.	Title of Unit and Contents
I	Semiconductor material properties Crystal structure of solids: Semiconductor materials, types of solids, basics of Crystallography, space lattice, atomic bonding, and unit cell, Miller indices, imperfections and impurities in solids Allowed & forbidden energy bands, Electric conduction, density of states, Statistical laws, Fermi-Dirac probability function, the distribution function and the Fermi energy. 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.
II	Physics of semiconductors and pn junction Carrier transport phenomena: charge, effective mass, state & carrier distributions, Carrier drift, carrier diffusion, resistivity, Hall Effect. Non-equilibrium excess carriers in semiconductors: Carrier generation and Recombination, Quasi-Fermi Energy levels. The pn junction: Basic Structure of the pn junction, Zero applied bias, Reverse applied bias, Junction breakdown, pn junction current, generation and recombination currents, Metal semiconductor junctions
III	Basics of Semiconductor Devices BJT: Bipolar transistor action, Eber-Moll model, hybrid – pi model, Non-ideal effects. FETs: JFET and MESFET concepts, characteristics. Small signal equivalent circuit. MOSFETs: MOS and MOSFET Structure, Capacitance- Voltage characteristics, small signal equivalent circuit Optical Absorption, Solar Cell- I-V Characteristics, Photo detector, photodiode, PIN photodiode, Avalanche photodiode, phototransistor Photoluminescence and Electroluminescence.

	LEDs: Internal and External quantum efficiency. LASER Diodes: Stimulated emission and population inversion, optical cavity, threshold Current, device structure and characteristics.
IV	IC fabrication technology Crystal growth, epitaxy, oxidation, lithography, doping, etching, isolation methods, metallization, bonding, Thin film deposition and characterization Techniques: XRD, TEM, SEM, EDX, Thin film active and passive devices. MOS technology and VLSI
Reference Books: 1. Semiconductor Physics and Devices Basic Principles, Donald A. Neamen, TMH, 3rd Edition (2003) 2. Solid State Electronics Devices, Streetman, PHI, 5th Edition, (2006) 3. Physics of Semiconductor Devices, 3rd Edition, John Wiley, (2007) 4. Integrated circuits , K.R. Botkar, Khanna publishers, 10 th edition, (2012)	

Title of the Course and Course Code	Network Analysis (ELS4102)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the network functions with poles and zeros of network functions.	
CO2	Identify and differentiate between continuous- and discrete-time signals and systems. Infer and evaluate transient response, Steady state response, network functions	
CO3	Acquire and apply knowledge about the application of Fourier series, Fourier transform and Laplace transform in signal representation with analysis of linear time invariant systems. Apply computer mathematical and simulation programs to solve various real life multidisciplinary topics through circuit solution.	
CO4	Analyse the circuit using Kirchhoff's law and Network simplification theorems.	
CO5	Evaluate two-port network parameters	
CO6	Perform and analyze the frequency response of electric circuits to obtain the correlation between time domain and frequency domain response specifications	

Unit. No.	Title of Unit and Contents
I	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, Two port network parameters - Z, Y, ABCD and h parameters. State variable method of circuit analysis, AC circuit analysis.

II	Continuous-Time Systems and the Laplace Transform Signals: periodic, aperiodic, Continuous Time (CT) and Discrete Time (DT), special electronic signals (impulse, unit step, sinusoidal, ramp, square wave, staircase), Continuous-Time Systems, LTI Continuous-Time Systems. Introduction Laplace Transform (LT). The Two-Sided Laplace Transform, The One-Sided Laplace Transform, Inverse Laplace Transform, Analysis of LTI Systems, two port network functions. Time and frequency domain response of systems using transfer function, poles and zeros of transfer function and their significance. Fourier method of waveform analysis: Fourier series and Fourier Transform (in continuous domain only).
III	Theory of Discrete-Time Signals and Systems Sampling Theory, Discrete-Time Signals and Systems, Discrete Fourier transform (DFT), Fast Fourier transform (FFT), Z-Transform (ZT): Introduction, Laplace Transform of Sampled Signals, Two-Sided Z-Transform, One-Sided Z-Transform, One-Sided Z-Transform Inverse
IV	Application of Continuous-Time Systems and Discrete-Time Signals Application in circuit analysis, Solution of Problems, Application to Control and Communications 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, Bode Plots. Introduction to the Design of Discrete Filters, Applications of Discrete-Time Signals and Systems. Basic concepts of digital signal processing, digital filters – IIR, FIR.
Reference Books: <ol style="list-style-type: none"> 1. Signals and Systems Using MATLAB, Luis F. Chaparro Department of Electrical and Computer Engineering, University of Pittsburgh, Academic Press is an imprint of Elsevier. 2. Network Analysis, G. K. Mittal, Khanna Publication, 14th edition, (2011) 3. Circuits and Networks Analysis and Synthesis, A. Sudhakar, Shyam Mohan and Pilli, TMH, 5th edition, (2015) 4. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanpriya, McGraw Hill, TMH, 3rd edition, (2007) 5. Fundamentals of Electric Circuits, Charles K. Alexander Matthew and N.O.Sadiku, McGraw Hill, TMH.5th edition (2013) 6. Network Analysis, M. E. Van Valkenberg, PHI, 3rd edition, (2015) 	

Title of the Course and Course Code	Analog and Digital Circuit Design (ELS4103)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall all basic concepts from analog and digital electronics.	
CO2	Explain analog electronic systems using discrete components, ICs and design various electronic circuits.	

CO3	Apply design analysis for analog and digital circuits
CO4	Analyze different analog and digital circuits
CO5	Test and validate designing of analog and digital circuits.
CO6	Design and develop the systems for real life problem using combinational and sequential circuits

Unit.No.	Title of Unit and Contents
Unit I	Design and analysis of analog circuits Diode circuits- Rectifiers, switch, clipper, clippers, voltage multipliers, Transistor (BJT, FET, MOSFETs) circuits- Biasing methods, operating point and stability, Amplifiers, Classification of amplifiers, differential and multistage amplifiers, Concept of feedback, Hartley, Colpitt's and Phase Shift oscillators, Voltage regulated ICs and regulated power supply, Circuit Design and Analysis using PSPICE – Schematics, attributes and types of analysis in PSPICE, use of PROBE.
Unit II	Design and analysis using Linear ICs Operational Amplifiers (OPAMP)-characteristics and Applications- Integrator, Differentiator, Wave-shaping circuits, Oscillators, Schmitt trigger circuit, Non-sinusoidal oscillators and timing circuits, Signal conditioning circuits, comparator, Schmitt trigger, Current to voltage, voltage to current, voltage to frequency, frequency to voltage converters, Active filters, log and antilog circuits, Multivibrators, Phase Locked loop
Unit III	Digital System Design concepts- Logic Families, Boolean algebras and minimization techniques, basic combinatorial and Sequential Circuits, Data converters, Finite state machines, state variables, state table, state diagrams, Sequential Circuits and FSMs applications.
Unit IV	PLD: Architecture of simple PLD (SPLD)-ROMs, PAL, PLA, Complex Programmable Logic Device (CPLD) and Field Programmable Logic Devices (FPGA), Introduction to VERILOG, VERILOG Models and Simulation of combinational and sequential systems CPLD/FPGA based system design applications
Reference Books: 1. Electronic Devices and circuit theory: R. L Boylestad and L. Nashelsky, Pearson (2011) 2. Electronic Circuit analysis and design: D. A. Neamen, McGraw Hill (2003) 3. Digital Design: with introduction to Verilog HDL, Morris Mano, Pearson (2013) 4. Modern Digital Electronics, R.P Jain, McGraw Hill (2011) 5. Verilog HDL: A Guide to Digital Design and Synthesis, Samir Palnitkar, Pearson Education, 9 th Ed, (2013). 6. Verilog HDL synthesis: A Practical Primer, J. Bhaskar, Star Galaxy Publishing, (1998). 7. Digital System Design with VERILOG Design, Stephen Brown, Zvonko Vranesic, TMH, 9 th Edn, (2012). 8. Design with Operational Amplifiers & Analog Integrated Circuits, Sergio Franco, 3rd Edition, (2007). 9. Fundamentals of Digital Circuits, A. Anand Kumar, PHI, 2 nd edition, (2010).	

Title of the Course and Course Code	Instrumentation (ELS4104)	Number of Credits : 04
Course Outcome (COs)		
On completion of the course, the students will be able to:		
CO1	Define the working principles of sensors/transducers for various fields.	
CO2	Discuss applications of various transducers in industry.	
CO3	Experiment the measurement principles of various physical parameters in the laboratory.	
CO4	Relate the usage of various instrumentation standards.	
CO5	Evaluate electrical measurement systems.	
CO6	Specify and use various sensors/transducers in bio-medical and industrial applications.	

Unit. No.	Title of Unit and Contents
I	Transducers , Methods of transduction, primary sensing elements and transducers, electrical transducers, classification of transducers types of transducers- Resistance, Inductance, Capacitance, Piezoelectric, Thermoelectric, Hall effect, Photoelectric
II	Measurement of displacement, velocity, acceleration, force, torque, strain, temperature, pressure, flow, humidity, thickness, pH.
III	Measuring Equipment -Measurement of R, L and C, Bridge and Potentiometers, voltage, current, power, energy, frequency/time, phase Digital Multimeters, CRO, Digital Storage Oscilloscope, Spectrum Analyzer
IV	Biomedical Instruments - ECG, EEG, Blood Pressure Measurements, MEMS and its applications Sensors for IoT applications.

Reference Books:

1. A Course in Electrical and Electronic Measurements and Instrumentation, A.K. Sawhney, Dhanpat Rai & Co (2007)
2. Electronic Instrumentation, Kalsi, TMH (2009)
3. Bio medical instrumentatio , R.S.Khandpur, 2nd edition, Tata McGraw hill (2004)
4. Sensors and transducers, principles and applications, R.Y.Borse (2012)
5. Measurement Systems, Applications and Design, Ernest O. Doebelin and Dhanesh N. Manik, 5th Edition, Tata McGraw Hill (2009)
6. Modern Electronic Instrumentation and Measurements Techniques, Cooper and Helfrick, PHI (2006).
7. Sensors and Transducers, A. D. Shaligram, Edition: 1(2014)

Title of the Course and Course Code	Electronic Science Practical - I (ELS4107)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Learn the advanced analysis facilities available in DSO, arbitrary function generators, Logic analyser to study the digital signals	
CO2	Summarize analog/digital circuit analysis techniques and different signal conditioning circuits.	
CO3	Experiment analog electronic circuits using discrete components and ICs.	
CO4	Integrate different electronic devices to implement and build electronic applications	
CO5	Evaluate different electronic circuits and review the analog and digital circuits.	
CO6	Develop ability to design, build and test analog/digital application circuits	

Any 10 Practical

1. Bootstrap ramp generator for delay triggering
2. Tuned amplifier small signal / large signal for IF
3. Transistor based microphone amplifier
4. Voltage controlled current source / sink and current mirror and doubler
5. Comparator and Schmitt trigger with single supply operation
6. Second order Butterworth filters (BP and BR)
7. Waveform generation: Quadrature Oscillator, Bubba Oscillator
8. V to F and F to V using commercially available IC
9. Instrumentation amplifier for a given gain
10. Low current negative power supply / dual power supply using single battery
11. PLL characteristics and demonstrate any one application (IC565/CD4046)
12. Keyboard encoder with latches
13. Bidirectional stepper motor control (Sequence Generator)
14. Binary-Gray and Gray-Binary code converter
15. Object counter (use of MMV, counter)
16. RPM measurement using various methods
17. Study and calibration of a rotameter for flow measurement.
18. Design build and test rms to dc converter for voltage measurement of ac signal

Activity: Equivalent to TWO Experiments

Note: Any other equivalent practical

Title of the Course and Course Code	Electronic Science Practical - II (ELS4108)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		

CO1	Outline and recall Verilog programming for CPLD/FPGA boards
CO2	Represent with DC and AC circuit analysis techniques using MATLAB/SCILAB.
CO3	Implement digital systems on CPLD/FPGA boards
CO4	Analyze complicated circuits using different network theorems and acquire skills of using MATLAB software for electrical circuit studies.
CO5	Develop expertise in design and development and simulation of digital circuits with Verilog.
CO6	Design making EDA/CAD software for creating schematic diagrams and PCB layout for Simple Analog/Digital circuits with testing and troubleshooting them

Any 6/7 Practical [Verilog]

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

Any 3/4 Practical [MATLAB /C program]

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
9. Any other equivalent experiments.

Activity: Equivalent to TWO Experiments

Note: Any other equivalent practical

F.Y. M.Sc. Semester II		
Title of the Course and Course Code	Electromagnetic Theory and Applications (ELS4201)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Recall basics of Electromagnetics concepts	
CO2	Explain basic concepts of electrostatics and magnetostatics	
CO3	Classify Maxwell's equation in different forms.	
CO4	Analyse the nature of electromagnetic wave propagation in guided medium	
CO5	Test and examine the phenomena of wave propagation in different media and its interfaces	
CO6	Design different antennas based on their characteristics for different applications	

Unit. No.	Title of Unit and Contents
I	Electrostatics - Vector calculus, Coulomb's law, Gauss's Law, Electric Dipole, Polarization in Dielectrics, Continuity equation, Laplace and Poisson's equations Magnetostatics - BiotSavert's law, Ampere's law and electromagnetic induction, Magnetic Dipole.
II	Electromagnetic Waves Maxwell's equations and Wave equations, Plane wave propagation in free space, dielectrics and conductors, boundary conditions, skin depth, Poynting theorem, Reflection and refraction, polarization, interference, coherence and diffraction
III	Transmission lines – Types of transmission lines, Transmission line parameters and equations, reflections and voltage standing wave ratio, line impedance, normalized impedance and admittance, Smith chart construction and applications, single stub and double stub matching Waveguides - Concept of waveguides, frequency range, relation to transmission lines, Rectangular waveguides: TM and TE Modes Microwave Sources and Devices -Reflex Klystron, Magnetron, TWT, Gunn diode, IMPATT diode, Crystal Detector and PIN diode. Radar – block diagram of Radar, frequencies and power used, Radar range equation
IV	Antennas – Retarded potential and Hertzian dipole, Radiation fields of elemental dipoles, antenna patterns and radiation parameters, Thin Linear Antenna, Antenna Arrays, Receiving Antennas, Travelling Wave Antenna, Yaggi-Uda Antenna, Broadband Antennas, Aperture Antennas, Frii's free space receiver power equation.
Text / Reference Books: <ol style="list-style-type: none"> 1. Microwave Devices and Circuits- Samuel Y. Liao, PHI, 3rd Edition, 2002. 2. Principles of Electromagnetics- N. Sadiku, Oxford University Press. 3. Schaum's Electromagnetics, Second Edition, Joseph A. Edminister, 2nd edition 	

4. Field and Wave Electromagnetics – David K. Chang, 3rd edition, Pearson education, 2009
5. Electromagnetics with Applications- Kraus and Fleiseh, McGraw Hill, 5th Ed, 1999.
6. Electromagnetics, J.D. Kraus, 4th Edn, McGraw Hill, 1992

Title of the Course and Course Code	Industrial Process Control (ELS4202)	Number of Credits : 04
Course Outcome (COs)		
On completion of the course, the students will be able to:		
CO1	Identify the different control systems in the real time applications.	
CO2	Explain the basic elements of the process control system, PLC and SCADA.	
CO3	Classify the operational modes of various process Controllers.	
CO4	Explain appropriate sensors and actuators for a given automation system.	
CO5	Select different control parameters for the optimal performance of the control system.	
CO6	Develop the PLC program for discrete state process control.	

Unit.No.	Title of Unit and Contents
I	Introduction to Process Control Introduction to Control System, Open loop and closed loop control system, Feedback and Feed forward system, Process-Control Block Diagram, Control System Evaluation Analog and Digital processing
II	Controller Principles Process characteristics, Control system parameters, Discontinuous modes, Continuous controller Modes (Proportional, Integral, and Derivative Control mode), Composite Control Modes (Proportional-Integral (PI), Proportional-Derivative (PD), PID controllers) Analog Controllers: General features, Electronic Controllers, Pneumatic Controllers Final control: Final control operation, Signal conversions, Power Electronics, Actuators, Control Elements
III	Control loop Characteristics Control system Configuration, Multivariable Control System, Control System Quality and Stability, Process-loop tuning, Stability criterion: Routh-Hurwitz and Nyquist plot
IV	Programmable logic controller PLC Controllers: Controllers, Hardware, Internal architecture, PLC systems, Input-output devices, I/O processing, Ladder and functional block programming, Timer, Counter, Introduction to SCADA

References:

1. Process Control Instrumentation Technology, Curtis D. Johnson, Eighth Edition, (2008)
2. Control System-I, U.A. Bakshi, V.U. Bakshi, Technical Publications, 3rd Edition, (2012)
3. Programmable Logic Controllers, W. Bolton, 4th Edition, 2006
4. Practical SCADA for Industry David Bailey BEng, Bailey and Associates, Perth, Australia (2003)

Title of the Course and Course Code	Embedded Systems (ELS4203)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	Describe the concept of embedded system, microcontroller, different components and software tools in embedded systems and their interactions.	
CO2	Understand the internal architecture and interfacing of different peripheral devices with Microcontrollers.	
CO3	Apply and Analyze various real time algorithms in building embedded systems and their integrated peripherals using IDE programming tools in high level programming languages as C.	
CO4	Analyze and develop embedded hardware and software development cycles and tools.	
CO5	Evaluate and understand different concepts of sensors, memory interface, and types of communication protocols.	
CO6	Design and develop programming skills in embedded systems for various applications.	

Unit.No.	Title of Unit and Contents
I	Introduction to Embedded System Embedded System: Embedded system, components, and examples. Embedded System Development Environment - algorithm, flow chart, IDE, programmer, Tools used for designing, testing and debugging. Processor Architectures: Harvard architecture, Von-Neumann architecture, RISC and CISC. Overview of architectures of Intel family of processors (x86 family)
II	AVR and PIC Microcontroller Introduction to Microcontrollers, specifications, features, selection criteria for a microcontroller, Memory hierarchy and their interfaces. Input- Output interfaces synchronous and asynchronous transfers, interrupts, Timer/Counter, PWM.

III	Communication Protocols and Interfacing Communication Protocols: I2C, SPI, CAN etc... Interfacing with the microcontrollers and programming in C: Keyboard, display SSD, dot matrix display, and LCD display (text and graphic), sensors, signal conditioning, ADC's, EEPROM, DAC, Motors (DC, stepper, and servo), RTC.
Reference Books <ol style="list-style-type: none"> 1. AVR Microcontroller and Embedded Systems using Assembly and C, Mazidi and Naimi, Pearson education, 2013. 2. PIC Microcontroller and Embedded Systems, Mazidi, Mckinlay and Causey, Pearson, 2008 3. Education. Programming & Customizing the AV R microcontroller- Dhananjay V Gadre, 11th Edition, Tata McGraw-Hill Education, 2009. 4. Embedded C Programming & Atmel AVR – Richard Barnett – Thomson Publication. 	

Title of the Course and Course Code	Power Electronics (ELS4204)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	List and outline protection and driver circuits of power devices	
CO2	Identify and classify various power - devices, converters and applications.	
CO3	Illustrate various applications of power converters for domestic, laboratory and industrial applications.	
CO4	Explain the various types of power converters and their applications.	
CO5	Determine the various performance parameters of power converters.	
CO6	Design power converters as per given specifications.	

Unit. No.	Title of Unit and Contents
I	Introduction to Power Devices and Circuits Introduction to Power Electronics and linear electronics, power devices, power circuits, concept of load, Application areas, and Basic concepts of electrical and magnetic circuits Power diodes: static and switching characteristics, types, SiC diodes Power BJT, MOSFET, IGBTs: Construction, working, steady state and switching characteristics, base /gate drive circuits Thyristors: SCR Characteristics, two-transistor model, turn-on and turn-off methods, thyristor types, gate drive circuits
II	Power Circuits Rectifiers: single phase half-wave, center-tapped full wave and bridge rectifiers, three phase rectifiers, performance parameters Controlled rectifiers: Single phase and three phase – half-wave, semi-full

	<p>wave and dual converters, Single phase series converters, 12-pulse converters, Power factor improvement techniques</p> <p>AC voltage controllers: ON-OFF control, phase control, single phase Bidirectional controller, 3-phase Bi-directional controller and their types, PWM control, Single and three phase cycloconverters</p> <p>DC-DC converters: step-up and step-down converters; Buck, Boost, Buck-Boost and Cuk regulators, Sepic converters</p> <p>Inverters: Performance parameters, single-phase bridge inverter, 3 Phase inverters-120° and 180° conductions, voltage control methods, current source inverters</p> <p>Static Switches: Single phase and three phase AC switches, DC Switches, Solid state and Microelectronic Relays, Applications</p>
III	<p>Applications of Power Electronics</p> <p>DC power supplies: switch mode DC power supplies, flyback, forward, push pull, half bridge, full bridge-converters, resonant DC power supplies, Current mode and voltage mode PWM, resonant power supplies, bidirectional power supplies</p> <p>AC Power supplies (UPS): switch mode AC Power supplies, Introduction to resonant and bidirectional AC Power supplies</p> <p>DC drives: Basic characteristics of DC motors, Operating modes, single phase and 3 phase drives, DC –DC converter Drives</p> <p>AC drives: Induction motors drives - squirrel cage and wound rotor motor, Performance characteristics, control methods</p> <p>Synchronous motor drives - cylindrical rotor, salient pole, Reluctance, Permanent magnet, switched reluctance- motors, control methods</p> <p>Brushless DC and AC Motors and Stepper Motor: types and Control</p> <p>Electric Utility Applications: High voltage DC transmission, Flexible AC Transmission systems (FACTS), shunt and series var compensators</p> <p>Applications: Integral half cycle/cycle control, space heating and air conditioning, HF fluorescent lightning, modern electric welding</p>
IV	<p>Practical Design Considerations</p> <p>Snubber circuits - Turn-on and turn-off and over voltage snubbers, isolation methods, Cooling and heat sinks, reverse recovery transients, supply and load side transients, Voltage protections, Current protection methods, EMI standards, sources and shielding methods</p>
<p>Text / Reference Books:</p> <ol style="list-style-type: none"> 1. Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid, 3rd Edition, Pearson (2016) 2. Power Electronics: Converters, Applications, and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd Edition, Wiley (2011). 3. Power Electronics: A First Course, Ned Mohan Wiley (2012). 4. Power Electronics Handbook, edited by Muhammad Rashid, Elsevier (2008) 5. Fundamentals of Power Electronics, Robert W. Erickson, Dragan Maksimovic, Springer (2010). 6. Power Electronics, Daniel Hart, Tata McGraw-Hill Education, 2011. 	

Title of the Course and Course Code	Electronic Science Practical – III (ELS4207)	Number of Credits : 04
Course Outcome (COs)		
On completion of the course, the students will be able to:		
CO1	Identify some modules related to industrial control automation using PLC hardware.	
CO2	Articulate the basic concepts of the phenomena of reflection and transmission of electromagnetic fields.	
CO3	Analyse and design power electronic circuits using discrete components and ICs.	
CO4	Identify, integrate and demonstrate with interfacing hardware circuits for a real time embedded system application	
CO5	Select different sensors and transducers and implement applications using them.	
CO6	Design and develop various application of converter circuits, PLC based applications.	

Any 7 Practical

- To study the characteristics of Klystron tube
- To determine the standing wave ratio and reflection coefficient of a given waveguide
- To plot directivity pattern of a given antenna
- To determine characteristics of a microstrip transmission line
- Design and test Yagi-Uda antenna with power reflectors
- Measurement of primary-secondary coupling factor of a given transformer using LCR meter (calculation of transformer model parameters expected)
- Displacement measurement using LVDT
- Temperature measurement using PT100, signal conditioning and DPM
- Temperature measurement using thermocouple with cold junction compensation
- Design build and test IR transmitter and receiver (TSOP1738 or similar) for object detection
- To build and test current telemetry (4 to 20 mA)
- Ultrasonic transmitter and receiver, distance measurement
- Pressure measurement using strain gauge
- Design and calibrate light intensity meter using photodiode or LDR and the necessary signal conditioning and display
- To study the measurement of weight using Strain gauge.
- To Study the measurement and control of temperature using Thermistor

Any 3 practical

- Buck converter/ Boost converter/ Buck- Boost converter
- Stepper motor control using current mode PWM
- AC-DC Converter
- Emergency light control
- DC motor speed control using PWM
- AC and DC static switches applications

7. Firing angle control for ac-dc converter
 8. AC motor speed control
 9. Study of AC and/ or DC motor drive
- [Activity: Equivalent to TWO Experiments]

Note: Any other equivalent practical

Title of the Course and Course Code	Electronic Science Practical – IV (ELS4208)	Number of Credits : 04
Course Outcome (COs) On completion of the course, the students will be able to:		
CO1	List and outline various microcontrollers interfacing concepts to develop embedded systems.	
CO2	Summarize embedded C programming required to develop real time embedded systems using different microcontrollers.	
CO3	Demonstrate and execute different embedded hardware applications.	
CO4	Integrate and implement interface of various peripherals with AVR / PIC Microcontroller.	
CO5	Test and validate the simulation results of various concepts related to Electromagnetics using software like MATLAB.	
CO6	Design, develop and implement PLC programming.	

Any 7 Practical

1. Interfacing of LED array to generate different sequences
2. Two-digit 7-segment display (multiplexed) interfacing.
3. LCD Interfacing
4. Graphic LCD interfacing
5. Dot matrix rolling display
6. keyboard Interfacing
7. Interfacing various types of sensors, calibrating the same and displaying on LCD
8. DAC interfacing.
9. Use of internal EEPROM
10. DC / Stepper motor Interfacing /intensity control of LED
11. SPI / I2C protocol
12. Real time clock (RTC)
13. Real Time Clock display on LCD
14. ZigBee communication
15. GPS module Interfacing
16. GSM module Interfacing
17. RFID Reader Interface
18. Bluetooth Module Interfacing

Any 3 Practical

1. To plot Equipotential contours and field lines for given charge distribution
2. Use of MATLAB for potential distribution in a region bound by two conductors
3. Use of MATLAB for directivity pattern for simple antennas
4. Use of MATLAB to plot the contours of the voltage and the field lines for square coaxial cable
5. Use of MATLAB to plot magnetic field lines of solenoids.
6. Use of MATLAB to determine electric field at a point.

[C] Activity: Equivalent to TWO Experiments

Note: Any other equivalent practical