Fergusson college (autonomous), Pune

Learning Outcomes-Based Curriculum

for

M. Sc.

(Electronic Science)

With effect from June 2019

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 MatlabProgrammingand 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

PO1	Apply the knowledge of basic and applied sciences for understanding semiconductor materials, devices and integrated circuits.
PO2	Design, build and test analog and digital systems with practical constraints for real world problems.
PO3	Demonstrate the ability of selecting basic and advanced tools, equipment/ Instruments for different measurement systems.
PO4	Develops skills regarding selection and understanding performance parameters through data sheets for sensors, actuators, linear and digital ICs.
PO5	Apply the knowledge of Electronic systems in various domains like computers, communication, consumer products, industrial automation, medical, transportation, agriculture and defence.
PO6	Identifies, formulates and provides creative, innovative and effective solutions to real world problems using hardware –software co-design tools for microcontroller / embedded systems.
PO7	Selection, utilisation and analysis using mathematical modelling and simulation software tools (like PSPICE, MATLAB, Simulink, EDA, LabVIEW etc...)and creating new tools for future smartsystems.
PO8	Thinks independently, take initiative, generate the solutions, work in team effectively, prepares proposals, reports and develops capability to lead the team through real life projects.
PO9	Ability to develop research methods including designs and experiments in analyzing and interpreting data with validation of the result outcomes.

Mapping Program Outcomes with Course Outcomes

	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9
Course-1	×						×		×
Course-2	×				×		×		×
Course-3	×	×		×	×		×		×
Course-4	×		×	×	×		×		×
Course-5	×				×				×
Course-6	×				×			×	×
Course-7	×	×	×	×	×	×	×	×	
Course-8	×	×	×		×	×	×		
Course-9	×				×		×		×
Course-10	×	×		×	×		×		×
Course-11	×	×		×	×	×	×		×
Course-12	×			×	×		×		×
Course-13	×				×		×		×
Course-14	×				×		×		×
Course-15	×	×		×	×	×	×	×	
Course-16	×	×		×	×	×	×	×	

ELS4101: Semiconductor Devices and Technology [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning this course student will be able to 1. Explore the structure of solids, charge carriers and energy level 2. Understand carrier transport , generation and recombination processes 3. Discover the semiconductor junctions in BJT, FET, MOSFET and optical devices 4. Know the basic steps in making Integrated circuits	1. Use appropriate ICT tool, wherever necessary, for effective teaching. 2. Use diagrams to discuss different device structures. 3. Use audio-visual media to demonstrate process for IC fabrication. 4. Discuss recent research papers related to course.

Unit 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.
Unit 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
Unit 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.
Unit 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)	

ELS4102: Network Analysis [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning the course student will be able to 1. Analyse the network using different laws and theorems. 2. Identify continuous- and discrete-time signals and systems. 3. Apply Laplace, Fourier and Z transform. 4. Distinguish and use CT and DT filters. 5. Perform Fourier analysis of continuous-time signals and systems.	1. Undertake problem solving activity for different electric circuits. 2. Use appropriate ICT tool, wherever necessary, for effective teaching 3. Use of network theorems for power electronics applications. 4. Discuss various applications of signal analysis with use of mathematical tools. 5. Discuss software's like MATLAB, SCILAB for studying the different units of the course.

Unit 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.
Unit 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).
Unit 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
Unit 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:

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. AlexanderMatthew and N.O.Sadiku, McGraw Hill, TMH.5th edition (2013)
6. Network Analysis, M. E. Van Valkenberg, PHI,3rd edition, (2015)

ELS4103: Analog and Digital Circuit Design [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning the course student will be able to 1. Design and analyze analog electronic systems using discrete components and ICs 2. Design and analyze of various signal conditioning circuits. 3. Use PSPICE for circuit design and analysis,compare performance of analog circuits with simulated results. 4. Design system for real life problem using combinational and sequential circuits. **5.** Use HDL(Verilog) for designing digital systems	1. Discuss different analogue devices and circuits used in various applications 2. Use appropriate EDA tool, wherever necessary, for effective analysis of circuits 3. Undertake circuit designing activity 4. Explore different applications with field visits accompanied by subject experts 5. Discuss syllabus diversity with appropriate ICT tools

Unit I	**Design and analysis of analog circuits** Diode circuits- Rectifiers, switch, clipper, clampers, 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, Schimitt 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, ZvonkoVranesic, 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).

ELS4104: Instrumentation [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning this course student will be able to 1. Know working principles of sensors /transducers and their applications. 2. Understand measurement principles of various physical parameters. 3. Explore electrical measurement systems. 4. Able to use of various transducers in bio-medical and industrial applications. **5.** Able to read datasheets and select various transducers for various applications.	1. Diagrammatically represent the construction and working principle of Transducers and Sensors. 2. Use ICT tool, whenever necessary, for Animation, Comparison charts. 3. Demonstrate use of Instruments in different fields. 4. Undertake problem solving activity. 5. Conduct visit to Instrumentation Facility.

Unit 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
Unit II	**Measurement** of displacement, velocity, acceleration, force, torque, strain, temperature, pressure, flow, humidity, thickness, pH.
Unit 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
Unit 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, DhanpatRai& Co (2007)
2. Electronic Instrumentation, Kalsi, TMH (2009)
3. Bio medical instrumentation , 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. Doeblin and Dhanesh N. Manik, 5thEdition, 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)

ELS4107: Electronic Science Practical - I
[Credits - 4]

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

ELS4108: Electronic Science Practical - II
[Credits - 4]

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

ELS4201: Electromagnetic Theory and Applications [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning this course student will be able to 1. Understand basic concepts of electrostatics and magneto statics. 2. Analyse Maxwell's equation in different forms. 3. Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwaves. 4. Analyse the nature of electromagnetic wave propagation in guided medium that are used in microwave applications. **5.** Select antennas based on their characteristics for different applications	1. Use diagrams and charts to discuss Electromagnetic Theory 2. Diagrammatically represent various concepts 3. Use appropriate ICT tool, wherever necessary, for effective teaching 4. Demonstrate live application using appropriate circuits 5. Exploring for the designing of various applications

Unit 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.
Unit 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
Unit 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
Unit 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:

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,JosephA.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

ELS4202: Industrial Process Control [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning of this course, students will be able to 1. Identify the basic elements of process control system. 2. Explore the operational modes of various process Controllers. 3. Select different control parameters for the optimal performance of control system. 4. Develop the PLC program for discrete state process control.	1. Discuss the different types of control systems with appropriate ICT tool. 2. Discuss the role of different controllers PI, PD and PID etc. in Process control. 3. Undertake Problem solving activity. 4. Hands on training on PLC programming. 5. Conduct industry visit to any power electronics industry .

Unit 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
Unit 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
Unit 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
Unit 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)

ELS4203: Embedded Systems [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning of this course, students will be able to 1. Explore different components and software tools in embedded systems. 2. Distinguish between microprocessor and microcontroller architectures. 3. Understand different microcontroller architectures and instruction set. 4. Acquires ability to design and interface different types devices with microcontroller. 5. Explore popular communication protocols for embedded systems.	1. Use appropriate ICT tool, wherever necessary, for effective teaching. 2. Discuss different architecture for microprocessor, microcontrollers 3. Demonstrate various interfacing circuits using EDA tools. 4. Discuss various real time industrial applications

Unit 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)
Unit 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.
Unit 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

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.

ELS4204: Power Electronics [Credits - 4]

Course Outcomes	Suggested Pedagogies
After learning of this course, students will be able to 1. Explore operating principle, construction and characteristics of power devices. 2. Analyse the various types of power converters. 3. Use power devices and circuits in industrial applications. 4. Obtain the specifications and design power converters as per requirement.	1. Use appropriate ICT tool, wherever necessary, for effective teaching. 2. Discuss various real time industrial power applications. 3. Undertake designing and Problem solving activity.

Unit 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
Unit 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 wave and dual converters, Single phase series converters, 12-pulse converters, Power factor improvement techniques **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 **DC-DC converters:** step-up and step-down converters; Buck, Boost, Buck-Boost and Cuk regulators, Sepic converters **Inverters:** Performance parameters, single-phase bridge inverter, 3 Phase inverters-120° and 180°conduction, voltage control methods, current source inverters **Static Switches:** Single phase and three phase AC switches, DC Switches, Solid state and Microelectronic Relays, Applications
Unit III	**Applications of Power Electronics** **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 **AC Power supplies (UPS):** switch mode AC Power supplies, Introduction to resonant and bidirectional AC Power supplies **DC drives:** Basic characteristics of DC motors, Operating modes, single phase and 3 phase drives, DC –DC converter Drives **AC drives:** Induction motors drives - squirrel cage and wound rotor motor, Performance characteristics, control methods Synchronous motor drives - cylindrical rotor, sailent pole, Reluctance, Permanent magnet, switched reluctance- motors, control methods **Brushless DC and AC Motors and Stepper Motor:** types and Control **Electric Utility Applications:** High voltage DC transmission, Flexible AC Transmission systems (FACTs), shunt and series var compensators

	Applications: Integral half cycle/cycle control, space heating and air conditioning, HF fluorescent lightning, modern electric welding
Unit IV	**Practical Design Considerations** 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

Text / Reference Books:

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, DraganMaksimovic, Springer (2010).
6. Power Electronics, Daniel Hart, Tata McGraw-Hill Education, 2011.

ELS4207: Electronic Science Practical - III
[Credits - 4]

Any 7 Practical

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)
8. Displacement measurement using LVDT
9. Temperature measurement using PT100, signal conditioning and DPM
10. Temperature measurement using thermocouple with cold junction compensation
11. Design build and test IR transmitter and receiver (TSOP1738 or similar) for object detection
12. To build and test current telemetry (4 to 20 mA)
13. Ultrasonic transmitter and receiver, distance measurement
14. Pressure measurement using strain gauge
15. Design and calibrate light intensity meter using photodiode or LDR and the necessary signal conditioning and display
16. To study the measurement of weight using Strain gauge.
17. To Study the measurement and control of temperature using Thermistor

Any 3 practical

1. Buck converter/ Boost converter/ Buck- Boost converter
2. Stepper motor control using current mode PWM
3. AC-DC Converter
4. Emergency light control
5. DC motor speed control using PWM
6. 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

ELS4208: Electronic Science Practical - IV
[Credits - 4]

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 coxial 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

Electronic Science Practical Course - I and II (SEM-I)

Course Outcomes:

1. The ability to analyse and design analog electronic circuits using discrete components and ICs.
2. Develop ability to design build and test application circuits
3. Simulation of various analog and digital circuits using software like PSPICE/MATLAB
4. Developing expertise in design and development and simulation of digital circuits with Verilog.
5. Learn the advanced analysis facilities available in DSO and arbitrary function generators
6. Use of Logic analyser to study the digital signals
7. Hands on experience for design, simulation and development of digital circuit with Verilog
8. Implantation of digital systems on CPLD/FPGA boards
9. Learn EDA/CAD software for creating schematic diagrams and PCB layout for Simple analog/Digital circuits
10. PCB making and testing

Electronic Science Practical Course - III and IV (SEM-II)

Course Outcomes:

1. Hands on experience on various IDE to write ASM/ embedded C programs for 8-bit microcontrollers
2. Interface different I/O devices with microcontroller
3. Use of various communication protocols
4. Design of development board for embedded systems
5. Implementation of Real time application using developed board
6. Select appropriate passive or active transduces/sensor for measurement of physical parameter.
7. Design of appropriate signal conditioning system
8. Measurement of various electrical parameters with accuracy, precision and resolution