Deccan Education Society's

Fergusson College (Autonomous)
Pune - 411004

Curriculum

as per guidelines of

NEP-2020

for

F. Y. M. Sc. (Electronic Science)

With effect from Academic Year

2023-2024

Courses Titles as per NEP-2020 guidelines for Two Year PG program (Science faculty)

M.Sc. (Electronic Science) – First Year

Sem	Paper Code	Paper Title	Type	Credits
I	ELS -501	Analog System Design	Theory	4
	ELS -502	Digital System Design using HDL	Theory	4
	ELS-503 OR	Signals and Systems	Elective –I Theory	4
	ELS -504	Control Systems	Elective –II Theory	
	ELS -510	Research Methodology	Theory	4
	ELS -520	Practical-I	Practical	2
	ELS -521	Practical-II	Practical	2
		Total Semester Credits		20
II	ELS -551	Electromagnetic Theory and Applications	Theory	4
	ELS -552	Embedded Systems	Theory	4
	ELS-553 OR	Industrial Power Electronics	Elective –I Theory	4
	ELS -554	Photonics Networks	Elective –II Theory	
	ELS -560	On Job Training / Field Project	OJT/FP	4
	ELS -570	Practical-III	Practical	2
	ELS -571	Practical-IV	Practical	2
		Total Semester Credits		20
		Total PG-I Credits		40

M.Sc. (Electronic Science) – Second Year

Sem	Paper Code	Paper Title	Type	Credits
III	ELS -601	Data Communication and Networking	Theory	4
	ELS -602	Industrial Process Control	Theory	4
	ELS-603 OR	Modelling and Simulation for Electronic Systems	Elective –I Theory	4
	ELS -604	Digital Image Processing	Elective –II Theory	
	ELS -610	Research Project-1	RP	4
	ELS -620	Practical-V	Practical	2
	ELS -621	Practical-VI	Practical	2
		Total Semester Credits		20
IV	ELS -651	ARM Processor and RTOS	Theory	4
	ELS -652	Internet of Things	Theory	4
	ELS-653 OR	Augmented Reality and Virtual Reality	Elective –I Theory	4
	ELS -654	Mechatronics	Elective –II Theory	
	ELS -660	Research Project-2	RP	6
	ELS -670	Practical-VII	Practical	2
		Total Semester Credits		20
		Total PG-II Credits		40
		Total PG Credits (I + II)		80

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 Ethics**: Demonstrate empathetic social concern and equity centered 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:** 1. Understand concepts and develop applications in the field of Semiconductor technology, Core electronics, Communication/ networking, Digital Electronics, Embedded systems and Automation. 2. 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:** 1. Design and implement the laboratory based applications with capability of data gathering, data visualization, analysis with data interpretation. 2. 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:** 1. Able to design and analyze the concepts and applications in the field of communication/ networking, automation, embedded systems and semiconductor technology. 2. Work successfully in collaborative and multi-disciplinary environments upholding professional and ethical values or pursue higher studies or research.
PSO4	**Entrepreneurial and Social competence:** 1. Design techniques and provides creative, innovative and effective solutions to real world problems using hardware-software co-design tools for future smart electronics system 2. 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		
ELS-501	**Analog System Design (Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs): On completion of the course, the students will be able to		
CO1	Recall all basic concepts from analog electronic devices.	
CO2	Analyze analog electronic systems using discrete components and ICs	
CO3	Apply design analysis for applications using analog circuits	
CO4	Develop different analog circuits for different applications	
CO5	Test and validate different analog circuits.	
CO6	Design of electronic systems for real life applications.	

Unit	Contents
I	**Design and Analysis of Analog Circuits** Transistor (BJT, FET, MOSFETs) circuits- Designing of Biasing methods, Amplifiers, Classification of amplifiers, differential and multistage amplifiers, Design of single stage RC coupled amplifier, Frequency response of multistage amplifier, Tuned amplifier design, multistage tuned amplifiers**:** synchronous and stagger tuning, cascade configuration, large signal tuned amplifier
II	**Linear IC Applications** Applications of I to V and V to I converters, Instrumentation amplifiers- types and applications, instrumentation applications, Transducer Bridge amplifiers, Monolithic timer, monolithic waveform generators, V to F and F to V convertors Voltage references – theory and applications, Voltage regulators - linear regulators, low dropout (LDO) regulators, monolithic switching regulators – theory and applications Practical Log/ Antilog amplifiers, Analog multipliers applications. Phase Locked loops (PLL) – characteristics, types of phase detectors, analog and digital PLLs, applications of PLL
III	**Active Filters – Design and Analysis** Active filters: Transfer functions poles and zeros, First and second order filters, KRC Filters, Multiple Feedback Filters, Cascade Design, State Variable and Biquad Filters, Filter approximations, Switched Capacitor Filters, Universal Filters
IV	**Data Converters and Applications** Digitization fundamentals, Performance specifications of D-A and A-D converters, DA conversion techniques, multiplying DAC and its applications, (Weighted resistor and capacitor DAC's, potentiometric DAC's, current and voltage outputs, voltage and current mode segmentation) Analog- digital conversion techniques: DAC based successive approximation, charge redistribution, pipelined converters, integrating converters, oversampling converters, Σ - Δ converters. Application of DAC's and ADC's

Text / Reference Books:

1. Design with Operational Amplifiers and Analog Integrated Circuits: Sergio Franko
2. Electronic Devices and Circuits, S. Salivahanan, N Suresh Kumar 3rd edn, TMH
3. Basic Electronics and Linear Circuits: N. N. Bhargava, D. C. Kulshreshtha, S. C. Gupta
4. Pulse Digital & Switching waveforms: Millman Taub
5. Operational Amplifiers: Clayton
6. Analysis and Design of analog integrated Circuits, Grey and Mayer.
7. Art of Electronics, Horwitz, Hill
8. Electronic Fundamental and Applications, J.D. Ryder
9. Transistor circuit Analysis and Design, Franklin C.Fitchen
10. Integrated Circuits: Botkar,

F.Y. M.Sc. Semester I		
ELS-502	**Digital System Design using HDL (Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	Understand the different types of HDL	
CO2	Discuss the concept of sequential and combinational logic design techniques.	
CO3	Differentiate between PLD, CPLD, FPGA and their applications.	
CO4	Design and develop the combinational and sequential circuits using HDL.	
CO5	Test and validate use of HDL (Verilog) for designing digital systems.	
CO6	Evaluate various Finite State Machine (FSM) applications using HDL.	

Unit	Contents
I	**HDL for Digital System Design** **VERILOG:** VLSI Design flow- **behavioral style**, the **dataflow style, Gate style** and **structural style** - Data types - Constants - Assignment Statement - Operators – Conditional Expressions - Statement types - Vector operations – Bit selects - Functions - Gate level modeling. test bench.
II	**Modelling Combinational Circuits** 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
III	**Modelling Sequential 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.
IV	**PLDs and Memories** Need of PLD, architecture of simple PLD (SPLD)-PAL, PLA, Complex Programmable Logic Device (CPLD) and Field Programmable Logic Devices (FPGA) CPLD/FPGA based system design, Architecture of FPGA - Floor Plan and Routing - Timing Model for a FPGA . **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. Digital systems; Principles and Applications, Tocci, Pearson Education.
6. Digital Logic and Computer Design, Morris Mano, PHI.

F.Y. M.Sc. Semester I		
ELS-503	**Signals and Systems** **(Elective –I Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	Study of basic signals.	
CO2	Identify, 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	Describe the network functions with poles and zeros of network functions.	
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	Contents
I	**Electronic Signals and Systems** Concept of signal and signal processing, classification of signals, Continuous-Time (CT) and Discrete-Time (DT), deterministic and non-deterministic, periodic and aperiodic, even and odd, energy and power signals etc. Singularity functions for signals, Classification of systems, static and dynamic, linear and non-linear, Time variant and Time invariant , casual and non-casual , stable and unstable.
II	**Laplace Transform and Fourier Analysis** 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.
III	**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 Inverse Z-Transform
IV	**Applications of CT and DT Systems** 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 DT Signals and Systems. Basic concepts of digital signal processing, digital filters – IIR, FIR.

Text / Reference Books:

1. Signals and Systems, Allan V. Oppenheim et al, 2nd Edition., Prentice Hall of India Pvt. Ltd., 1997.
2. Signals and Systems, P. Ramesh Babu et al, 4th Edition, Scitech publishers, 2010.
3. Signals and Systems, Haykin. S and Van Been. B., 2nd Edition, John Wiley & Sons, 2003.
4. Linear Systems and Signals, Lathi, B. P., 2nd Edition, Oxford University Press 2006.
5. Fundamentals of Signals and Systems, Roberts, M.J., 1st Edition, Tata McGraw Hill, 2007.
6. Digital Signal Processing, S. Salivahanan et al., 2nd Edition, Tata McGraw Hill, 2009.
7. Signals and Systems, H P Hsu, 2nd Edition, Tata McGraw Hill, 2008.
8. Signals and Systems Using MATLAB, Luis F. Chaparro Department of Electrical and Computer Engineering, University of Pittsburgh, Academic Press is an imprint of Elsevier.
9. Circuits and Networks Analysis and Synthesis, A. Sudhakar, Shyam Mohan and Pilli, TMH, 5th edition, (2015)
10. Network Analysis , G. K. Mittal, Khanna Publication, 14th edition, (2011)

F.Y. M.Sc. Semester I		
ELS-504	**Control Systems** **(Elective –II Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	To familiarize with concepts related to the operation analysis and stabilization of control systems. To understand the open loop and closed loop (feedback) systems	
CO2	Understand various types of control systems.	
CO3	Evaluate the compensation technique that can be used to stabilize control systems.	
CO4	To understand time domain and frequency domain analysis of control systems required for stability analysis	
CO5	To understand the compensation technique that can be used to stabilize control systems.	
CO6	Design control systems that meet design specifications.	

Unit	Contents
I	**Control System Modelling** Basic Elements of Control System, Open loop and Closed loop systems – Differential equation -Transfer function, Modelling of Electric systems, Translational and rotational mechanical systems –Block diagram- reduction Techniques –Signal flow graph, LTI system.
II	**Time Response Analysis** First Order Systems – Impulse and Step Response analysis of second order systems – Steady state errors – P, PI, PD and PID Compensation
III	**Stability Analysis** Stability, Routh-Hurwitz Criterion, Root Locus Technique, Construction of Root Locus, Stability, Dominant Poles, Application of Root Locus Diagram Nyquist Stability Criterion – Relative Stability. Frequency Response Analysis: Frequency Response – Bode Plot, Polar Plot, Nyquist Plot –Frequency Domain specifications from the plots – Constant M and N Circles–Nichol's Chart – Use of Nichol's Chart in Control System Analysis. Series, Parallel, series-parallel Compensators – Lead, Lag, and Lead Lag Compensators
IV	**State Variable Analysis & Digital Control Systems** State space representation of Continuous Time systems –State equations –Transfer function from State Variable Representation –Solutions of the state equations – Concepts of Controllability and Observability –State space representation for Discrete time systems. Sampled Data control systems –Sampling Theorem – Sample &o Hold –Open loop & Closed loop sampled data systems.
Text / Reference Books: 1. Modern Control Engineering, K. Ogata, PHI, 1998.	

2. Automatic Control Systems, B.C. Kuo, PHI, 1997.
3. An Introduction to Feedback Control, K. Morris, Academic Press, 2001.
4. Control Systems Engineering, J. Nagrath, M. Gopal, New Age Publication (4/e), 2010.
5. Control Engineering, A. Ramakalyan, Vikas, 2003.
6. Modern Control Systems, R.C. Dorf and R.H. Bishop, Pearson, 1999.

F.Y. M.Sc. Semester I		
ELS-510	**Research Methodology (Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	Learn the various aspects of the research process, framing useful research questions, research design, data collection, analysis, writing and presentation	
CO2	Understand the research problem, methods/techniques to be adopted	
CO3	Apply statistical tools for analysing the data while performing their research	
CO4	Develop skills in qualitative and quantitative data analysis and presentation	
CO5	Analyse for fitting, errors in the measurements and able to withdraw conclusions from the analysed data	
CO6	Execute a quality research paper and patents in science and technology	

Unit	Contents
I	History of research. Indian, Egyptian, Greek ideas methodologies and research in agriculture, chemistry, metallurgy, medical. Ancient Indian research methodology applications.
II	Statistical analyses and its significance, Exploratory and confirmatory research, Planned and ad-hoc methods of data collection, Non-response and methods of recovering the missing response, Various software for statistical analysis. The module will consist of case studies of the research performed in various subjects using statistical methods, Error and noise analysis, curve fitting.
III	Literature search, selection of research topic (case study based), maintaining laboratory records (case study based). Safety in Laboratories, Ethical considerations, effective verbal and non-verbal communication, field data collection, safety in field.
IV	Writing research paper and/or thesis, making a presentation, writing a research proposal, and patents in Science, technology.
Text / Reference Books:	

1. 'History of the Scientific Methods,' Martin Shuttleworth, https://explorable.com/history-of-thescientific-method.
2. 'The Statistical Analysis of Experimental Data' by, John Mandel, ISBN: 0486646661, ISBN13: 9780486646664
3. Research Methodology Methods and Technology, C. R. Kothari and GAURAV GARG second edition, New Age International (P) Ltd., Publishers (2004)
4. Research Methodology: Techniques and Trends, D P Kothari , Umesh Kumar B Dubey , First edition, CRC Press (2022)
5. A Guide to Research Methodology An Overview of Research Problems, Tasks and Methods, Shyama Prasad Mukherjee, CRC Press (2020)
6. Research methodology a step-by-step guide for beginners, Ranjit Kumar, third edition, SAGE Publications Ltd (2011).
7. Research Methodology: An Introduction, Stuart Melville and Wayne, Juta & Company Limited (2004).
8. Practical Research Methods, Catherine Dawson, howtobooks,
9. Practical Research: Planning and Design, Leedy, P. D. and Ormrod, J. E., 2004 Prentice Hall.
10. Intellectual property rights and Copyright. Satarkar, S. V., Ess Ess Publications (2000)

F.Y. M.Sc. Semester I		
ELS-520	**Practical – I** **(Practical)**	**Credits:** 2 **Hours:** 60
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	

Students should perform 12 Practical.

Analog Circuit Design (Any 6-8)

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. Temperature measurement using PT100, signal conditioning and DPM
13. Temperature measurement using thermocouple with cold junction compensation

Digital Circuit Design (Any 4-6)

1. Keyboard Encoder with latches
2. Traffic Light Controller
3. Multiplexed Display
4. Bidirectional stepper motor controller (sequence Generator)
5. Binary- Gray and Gray- Binary Code Converter
6. Object counter (use of MMV, counter)
7. Two-digit combinational lock
8. One digit BCD adder and 8 bit-adder/ subtractor
9. RPM measurement using various methods

P Activity: Equivalent to TWO Experiments

F.Y. M.Sc. Semester I		
ELS-521	**Practical – II** **(Practical)**	**Credits:** 2 **Hours:** 60
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 those	

Students should perform 12 Practical.

Digital System Design using HDL (Verilog/VHDL) (Any 4-6)

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

Signals and Systems (MATLAB/ Octave /C program) (Any 4-6)

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. Basic Practical on Signals using Code to generate unit Impulse, unit step, exponential sequence, sinusoidal sequence
10. Moving average filter: smoothing random variation in data
11. Convolution: Linear, Circular

Control Systems (MATLAB/ Octave /C program) (Any two)

1. Different Toolboxes in MATLAB, Introduction to Control Systems Toolbox.
2. Plot the pole-zero configuration in s-plane for the given transfer function.
3. Simulation of P, PD, PI, PID controller.
4. Determine the transfer function for a given closed loop system in block diagram representation.
5. Plot the unit step response of the given transfer function and finds delay time, rise time, peak time, and peak overshoot.
6. Stability analysis using Bode plot.

Note: Any other equivalent practical

Activity: Equivalent to TWO Experiments

F.Y. M.Sc. Semester II		
ELS-551	**Electromagnetic Theory and Applications (Theory)**	**Credits:** 4 **Hours:** 60
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	Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwaves	
CO5	Analyse the nature of electromagnetic wave propagation in guided medium	
CO6	Design different antennas based on their characteristics for different applications	

Unit	Contents
	Prerequisite: Vector algebra, concept of gradient, curl and divergence, line, surface and volume integrals, Gauss and Stokes theorem, complex plane, polar form of complex number, complex functions, orthogonal functions and relation with Laplace equations.
I	**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 mediums, Poynting theorem and its applications. Reflection and refraction, polarization, interference, coherence and diffraction
II	**Transmission lines** – Types of transmission lines, micro strip lines, Transmission line parameters and equations for voltage and currents, inductance and capacitance per unit length of two wire and coaxial cable, transmission line characteristics impedance, propagation constant, attenuation constant and phase constant, phase velocity, reflection and transmission coefficients, voltage standing wave ratio, line impedance, normalized impedance and admittance, S parameters, Smith chart construction and applications, single stub and double stub matching, impedance measurement
III	**Waveguides and Components -** Concept of waveguides, frequency range relation to transmission lines, Rectangular waveguides, Circular waveguide, TM, TE and TEM Modes, concept of cut- off frequency, guide impedance, phase velocity, guide wavelength for TE, TM modes, and power losses in rectangular waveguide, applications to TE, TM modes Wave guide components- Load, Tuner, Isolator, Power measuring (couplers) **Microwaves, Sources and Devices** -Reflex Klystron, Magnetron, TWT, tunnel diode, Gunn diode, IMPATT diode, Crystal Detector and PIN diode. **Radar** – block diagram of Radar, frequencies and power used, Radar range equation
IV	**Antennas Parameters**, **Characteristics**- Antenna patterns, Radiation Intensity, Impedance Matching, VSWR and reflected power, Front to back ratio, Antenna Polarization, Radiation intensity, Directivity Gain, Power Gain, Beamwidth,

	Antenna Bandwidth, Effective area, Frii's free space receiver power equation. antenna temperature, Signal to noise ratio Antenna types- Hartzian dipole, λ/2 antenna, Small loop antenna, Antenna arrays, Microstrip antennas, Thin Linear antenna, Receiving Antennas, Travelling Wave Antenna, Yagi-Uda Antenna, Broadband Antennas, Aperture Antennas

Text / Reference Books:

1. Principles of Electromagnetics, N. Sadiku, Oxford University Press.
2. Microwave Devices and Circuits, Samuel Y. Liao, PHI, 3rd Edition, 2002.
3. Electromagnetics, J.D. Kraus, 4th Edn, McGraw Hill, 1992
4. Schaum's Electromagnetics, Second Edition, Joseph A. Edminister, 2nd edition
5. Field and Wave Electromagnetics, David K. Chang, 3rd edition, Pearson education
6. Electromagnetics with Applications, Kraus and Fleiseh, McGraw Hill, 5th Ed, 1999.

F.Y. M.Sc. Semester II		
ELS-552	**Embedded Systems (Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	Describe the different microcontroller architectures, understand instruction sets with examples.	
CO2	Discuss different components and software tools in embedded systems.	
CO3	Demonstrate different types of interface devices with microcontrollers.	
CO4	Study the concepts of OS and RTOS	
CO5	Evaluate popular communication protocols for embedded systems.	
CO6	Design and interface different types of devices with microcontrollers. and Synthesize different protocols.	

Unit	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 architecture. Comparison between microprocessor and microcontroller.
II	**AVR / PIC Microcontroller** Introduction to Microcontrollers, AVR microcontroller history and features, selection criteria for a microcontroller, Architecture and Assembly language programming, Pipelining, Instruction set, addressing modes, Brach, call and time delay loop, I/O port programming, Arithmetic and logical Instruction programming, AVR Hardware Connection, Basic Timer, Watchdog Timer, Interrupt, PWM, Serial Port programming, Embedded C Programming,

III	**Communication Protocols and Interfacing** **Serial Communication protocols**: UART, I2C, SPI, CAN, USB, JTAG, Modbus, **Parallel Communication protocols:** ISA, AMBA, PCI, **Wireless Communication Protocols:** Bluetooth, WiFi, Zigbee, MQTT, LoRaWAN. **Real world interfacing:** LCD, Keyboard interfacing, ADC, DAC and Sensor interfacing, Stepper motor, DC motor, RTC, Using C programming, GPS, GSM and RFID Interfacing.
IV	**Introduction to OS and RTOS** Operating system basics and types of operating systems, the BIOS and Boot Process: BIOS Actions, Process Management, Memory Management: segmentation and paging, Memories- virtual, cache etc. Overview and features of RTOS: RTOS concepts and definitions, structure of a real time system, hard real time system vs. soft real time system, RTOS building blocks, Real-Time Kernel.

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 AVR microcontroller- Dhananjay V Gadre, 11th Edition, Tata McGraw-Hill Education, 2009.
4. Embedded C Programming & Atmel AVR – Richard Barnett – Thomson Publication.
5. Operating System Concepts and Techniques, M. Naghibzadeh,
6. Operating Systems Concept, Galvin, John Willey and Sons
7. Operating Systems, Achyut Godbole,TMH
8. MicroC/OS-II The Real-Time Kernel, Jean J. Labrosse, Elsevier

F.Y. M.Sc. Semester II		
ELS-553	**Industrial Power Electronics** **(Elective –I Theory)**	**Credits:** 4 **Hours:** 60
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	Contents
I	**Introduction to Power Devices and Protections** **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 **Practical Design Considerations** Snubber circuits, isolation methods, Cooling and heat sinks, reverse recovery transients, supply and load side transients, Voltage and Current protections, EMI standards, sources and shielding methods
II	**Power Circuits** **Rectifiers:** single phase and, three phase rectifiers, performance parameters **Controlled rectifiers:** Single phase and three phase – half-wave, semi-full wave and dual converters, Power factor improvement techniques **AC voltage controllers:** ON-OFF control, phase control, single phase and three phase ac voltage controllers, and cycloconverters **DC-DC converters:** step-up and step-down converters; Buck, Boost, Buck-Boost and Cuk regulators, Sepic converters **Inverters:** Performance parameters, single-phase and Phase inverters-voltage control methods, current source inverters **Static Switches –** AC and DC switches, solid state switches
III	**Applications of Power Electronics-I** **DC power supplies:** switch mode DC power supplies types, resonant DC power supplies, bidirectional power supplies **AC Power supplies (UPS):** on line, off line and line-interactive UPS and selections of components **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 – types and 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
IV	**Applications of Power Electronics-II** **Power Electronics in clean energy:** Solar and Wind Renewable Energy Systems, fuel cell energy systems, electric cars, hybrid cars. **Applications:** Induction and dielectric heating and switch mode welding, Electronic ballast, Battery charging, wireless power transfer (WPT) system.

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, M. D. Singh and K.B. Khanchandani, TMH Education (2008)
4. Power Electronics, Drives, and Advanced Applications, Vinod Kumar, Ranjan Kumar Behera Dheeraj Joshi, and Ramesh Bansal, CRC Press (2020)
5. Fundamentals of Power Electronics, Robert W. Erickson, Dragan Maksimovic, Springer (2010).
6. Power Electronics , Daniel Hart, Tata McGraw-Hill Education, 2011.

F.Y. M.Sc. Semester II		
ELS-554	**Photonic Networks (Elective –II Theory)**	**Credits:** 4 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	Classify and describe working of optical fiber with different modes of signal propagation	
CO2	Describe the transmission characteristics and losses in optical fiber communication	
CO3	Explain the differences in the design of data plane, the control plane, the routing, switching, the resource allocation methods, the network management and protection methods	
CO4	Determine and describe working of optical fiber with different modes of signal propagation	
CO5	Evaluate the advances in networking and switching domains and the future trends	
CO6	Design and analyze the architectures and the protocol stack	

Unit	Contents
I	**Optical System Components** Light Propagation in optical fibers – Loss & bandwidth, System limitations, Nonlinear effects; Solitons; Optical Network Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.
II	**Optical Network Architectures** Introduction to Optical Networks; SONET / SDH, Metropolitan-Area Networks, Layered Architecture; Broadcast and Select Networks – Topologies for Broadcast Networks, Media Access Control Protocols, Wavelength Routing Architecture
III	**Packet Switching and Access Networks** The optical layer, Optical Network Nodes, Routing and wavelength assignment, Traffic Grooming in Optical Networks, Architectural variations- Linear Light wave networks, Logically Routed Networks Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronization, Broadcast OTDM networks, Switch-based networks, Contention

	Resolution Access Networks – Network Architecture overview, Optical Access Network Architectures and OTDM networks.
IV	**Network design and management** Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion, Wavelength stabilization, Overall design considerations, Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

Text / Reference Books:

1. Optical Networks: A Practical Perspective 3 rd Edition, 2010 by R Ramaswamy and Kumar N Sivarajan (Text)
2. WDM Optical Networks Concepts, Design and Algorithms, 2002 – Sivaram Murthy and Mohan Guruswamy
3. Optoelectronic Packaging by Alan R. Mickelson, Nagesh R. Basavanhally, Yung-Cheng Lee
4. Wdm Technologies: Active Optical Components, Volume 1 By Niloy K. Dutta, MasahikoFujiwara
5. Optoelectronics and Photonics: Principles and Practices S. O. Kasap,, Pearson Education (2009)
6. Optoelectronics: An Introduction : J. Wilson and J. F. B. Hawkes,, Prentice Hall India (1996)
7. Optics : Ajoy Ghatak, Tata McGraw Hill, New Delhi (2005)
8. Introduction to fiber optics, Ghatak A.K. and Thyagarajan K., Cambridge Univ. Press. (1998)

F.Y. M.Sc. Semester II		
ELS-560	**On Job Training/ Field Project (OJT/FP)**	**Credits:** 4 **Weeks:** 4

Aim:

Create two-way link between the industries/establishments and the College so as to utilize the trained manpower.

Objectives:

1. Demonstrate the broad role and importance of technically qualified personnel to industries and business sectors
2. To provide work experience enabling students to apply what they learnt in the college and acquire new skills.
3. To give students an opportunity to establish interest in industrial/ commercial activities.
4. To provide foundation to prepare students to work efficiently in their jobs after the training.

Instructions to Students:

1. Students can approach the OJT office at end of the semester of their study in the college for training positions in the following semester.
2. They can also go for OJT with one/two courses in a semester by suitably registering their courses without hindrance to the OJT schedule.
3. The OJT is for 4 weeks during which period they have to work with a supervisor in the assigned place and will be monitored by OJT/ teaching staff from the college.
4. After the completion of training, they have to submit a report and do a presentation in the college.

F.Y. M.Sc. Semester II		
ELS-570	**Practical – III** **(Practical)**	**Credits:** 2 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	Understand the operation of power electronic devices and its applications. Design and analyze power converter circuits and learn to select suitable power electronic devices by assessing the requirements of application fields.	
CO2	Distinguish the speed control of DC motor using converters.	
CO3	Analyse and design power electronic circuits using discrete components and ICs.	
CO4	Realization of Smith chart and the basics of drawing a Smith chart	
CO5	Test and validate the simulation results of various concepts related to Electromagnetics	
CO6	Design the different power electronic circuits using MATLAB/Simulation.	

Students should perform 12 Practical.

Electromagnetic Theory and Applications (Any 3-4)

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

Industrial Power Electronics (Any 6-9)

1. Buck converter/Boost converter/Buck- Boost converter
2. Stepper motor control using current mode PWM
3. Transformer Parameter Testing
4. AC to DC Converter
5. RMS to DC converter
6. Emergency light control
7. DC motor speed control using PWM
8. AC and DC static switches applications
9. DC and AC Chopper
10. Two-quadrant chopper
11. Power factor improvement methods
12. Single phase converter fed separately excited ½ H.P. DC Motor
13. Three phase converters fed separately excited ½ H.P. DC Motor

Note: Any other equivalent practical

Activity: Equivalent to TWO Experiments

1. Optical fiber communication- transmitter and receiver
2. Setting up fiber optic voice link
3. Design Build and test digital data communication system
4. Study of different physical equipment for networking.
5. Any other activity equivalent to two practicals.

F.Y. M.Sc. Semester II		
ELS-571	**Practical – IV (Practical)**	**Credits:** 2 **Hours:** 60
Course Outcome (COs) On completion of the course, the students will be able to		
CO1	List and outline 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	Design and interface different types of devices with microcontrollers. and Synthesize different protocols.	
CO6	Test and validate the simulation results of various concepts related to Electromagnetics using software like MATLAB/ Octave.	

Students should perform 12 Practical.

Embedded System AVR/PIC (any 6-9)

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. ZigBee communication
14. GPS module Interfacing
15. GSM module Interfacing
16. RFID Reader Interface
17. Bluetooth Module Interfacing

Electromagnetic Theory and Applications (any 4-6)

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

Activity: Equivalent to TWO Experiments