

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE



Syllabus

T.Y.B.Sc. Electronic Science

(FOR AFFILIATED COLLEGES)

FACULTY OF SCIENCE AND TECHNOLOGY

UNDER NATIONAL EDUCATION POLICY

(NEP 2020)

TO BE IMPLEMENTED FROM

ACADEMIC YEAR 2025-26

Credit Distribution Structure for Major, Minor and OE Courses at Level 5.5

Level/ Degree	Semester	Course Type	Course Code	Course Title	Type	Credit	No. of Hrs. to be engaged	
5.5 UG Degree	V	Major Core	ELS-301-MJ	Principles of Semiconductor Devices	Theory	2	30	
			ELS-302-MJ	Embedded System Design	Theory	2	30	
			ELS-303-MJ	Instrumentation and Process Control	Theory	2	30	
			ELS-304-MJ	Communication Electronics	Theory	2	30	
			ELS-305- MJP	Practical Course-V	Practical	2	60	
			ELS-306- MJP	Practical Course-VI	Project	2	60	
		Major Elective	ELS-310-MJ	Nanoelectronics	Theory – (Select any one)	2	30	
			ELS-311-MJ	Fiber Optic Communication		2	30	
			ELS-313- MJP	Major Elective Practical Lab-I	Practical	2	60	
		Vocational Skill Courses	ELS-321- VSC	Sensors, Actuators and Signal Conditioning	Theory / Practical	2	30/60	
		Minor	ELS-311-MN	Python Programming	Theory	2	30	
		FP/CEP	ELS-331-FP	Field Project	Practical	2	60	
		VI	Major Core	ELS-351-MJ	Advanced Embedded Systems	Theory	2	30
				ELS-352-MJ	Digital System Design using Verilog	Theory	2	30
	ELS-353-MJ			Power Electronics	Theory	2	30	
	ELS-354-MJ			Digital Communication	Theory	2	30	
	ELS-355- MJP			Practical Course- VII	Practical	2	60	
	ELS-356- MJP			Practical Course- VIII	Project	2	60	
	Major Elective		ELS-360-MJ	Internet of Things (IoT)	Theory (Select anyone)	2	30	
			ELS-361-MJ	Signals and Systems		2	30	
			ELS-362- MJP	Major Elective Practical Lab -II	Practical	2	60	
	VSC		ELS-371-VSC	PLC Programming	Theory / Practical	2	30/60	
	On Job Training	ELS-381- OJT	On Job Training	Practical/ Internships	4	120		

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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course : Principles of Semiconductor Devices								
Year: III , Level: 5.5				Semester: V				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Core	ELS - 301-MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Understand Crystal Structure of Solids.

CO2: Explain Energy Band structures for different materials.

CO3: Understand and explain the creation of charge carriers in Semiconductors.

CO4: Understand the characteristics of Semiconductor devices.

CO5: Explain detailed theory of p-n junctions and specialized semiconductor devices.

CO6: Explain detailed theoretical background of BJT and FETs.

Unit 1: Energy Bands and Charge Carriers in Semiconductors **[10 Hours]**

Semiconductor materials, Types of solids, Basic Lattice and Cubic Structures, Crystal planes and Miller Indices, Bulk Crystal growth (Czochraslki method).

Bonding forces and Energy bands in semiconductors, Band structure for Metal, Semiconductors and Insulators, Direct and indirect semiconductors, Charge carriers in semiconductors, Effective mass, Intrinsic and extrinsic material, Fermi level and temperature dependence.

Excess carriers in semiconductors: Optical absorption, Photo and Electro-luminescence, Diffusion of carriers.

Unit 2: Direct and Indirect Bandgap Semiconductors **[08 Hours]**

Equilibrium conditions: Contact potential, Space charge at junction.

PN Junction with band diagram: No bias, Forward and Reverse bias junctions

Reverse bias breakdown: Zener and Avalanche breakdown mechanisms.

Metal Semiconductor Junction: Schottky barriers, Forward and reverse bias condition, Rectifying contacts, Ohmic Contacts. Photo voltaic devices: Solar cells (Fill factor and efficiency), LED working and materials, PIN photo-diode.

Unit 3: Bipolar Junction Transistors (BJTs) **[06 Hours]**

BJT: Working: Energy band diagram, Amplification, Switching: Switching cycle.

Important Effects in BJT: Drift in the Base region, Base narrowing, Injection and Thermal Effects, base resistance and emitter Crowding Effect. Photo-transistor : Working, Quantum efficiency

Unit 4: Field Effect Transistors (FETs)

[06 Hours]

Junction FETs: Working, I-V Characteristics

Metal Semiconductor FETs (MESFETs): GaAs MESFET.

MOSFET: Working, output and transfer Characteristics, CMOS.

Control of threshold voltage, Substrate Bias Effects, Sub-threshold Characteristics, Electrical equivalent circuit of MOSFET.

Text / Reference Books:

1. Solid State Electronic Devices by B. G. Streetman and Sanjay Kumar Banerjee, PHI, 6th edition.
 2. Semiconductor Physics and Devices Basic Principles by Donald A. Neaman, TMH, 3rd edition.
 3. Semiconductor Devices: Physics and Technology by S.M.SZE & M.K.LEE, 3rd edition
 4. Principles of Electronic Materials and Devices by S.O. Kasap, 3rd edition, TMH
 5. Semiconductor Materials Devices: Science and Technology by D. N. Bose
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Title of the Course: Embedded System Design								
Year: III, Level: 5.5					Semester: V			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major	ELS-302 MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Understand and explain the fundamental concepts, classification, components, and applications of embedded systems.

CO2: Understand and describe the architecture, features, memory organization, and pin configuration of the AVR ATmega32 microcontroller.

CO3: Develop and implement C programs for ATmega32 including I/O operations, delay generation, bitwise operations, and data conversion techniques.

CO4: Configure ATmega32 hardware connections and interface various input/output devices and sensors using C programming.

CO5: Design, implement, test, and debug simple embedded system applications using ATmega32.

Unit 1: Introduction to Embedded Systems

[06 Hours]

Basic Concepts: Introduction and history, Definition, Embedded system Vs general computing system, Classification: Based on generation, Complexity and performance requirements, Based on deterministic behaviour, Based on triggering, Major Application areas of Embedded Systems, Purpose of embedded system, Elements of embedded system.

Unit 2: Introduction to AVR Microcontroller

[08 Hours]

Criteria for choosing a microcontroller, Introduction to AVR microcontroller, Functional Block diagram of an AVR Microcontroller, AVR family overview (Comparison in ATmega family), CISC and RISC architecture.

AVR ATmega32 Study: Features, General Purpose Registers in AVR, AVR Data memory, I/O memory, Internal data SRAM, Program counter, Status register, Program Space (ROM), ATmega32 Pin Diagram, I/O ports and registers.

Unit 3: AVR Programming using embedded C

[08 Hours]

Introduction embedded to C program, Data Types and time delays with programs, I/O programming. Bit-wise

logic and shift operators, Data conversion programs: Packed BCD to ASCII conversion, ASCII to packed BCD conversion, Binary (hex) to decimal and ASCII conversion.

Unit 4: AVR Hardware Connection and interfacing

[08 Hours]

ATmega32 pin connection: Reset with simple circuit, XTAL1–XTAL2 Connection to Crystal Oscillator, Analyzing the hex file, ISP 10-pin Connections for target board.

AVR Interfacing: LED, Switch, Relay, Buzzer, SSD, 16x2 LCD, Keyboard matrix, Stepper motor, DC motor, Sensors: LM35 and LDR.

Text/Reference Books:

1. Introduction to Embedded Systems, K. V. Shibu, TMH publication.
 2. The AVR Microcontroller and Embedded Systems: using Assembly and C, Muhamad ali Mazidi, Sarmad Naimi, Sepehr Naimi, Pearson New International Edition, 2014.
 3. Microcontrollers: Architecture, Programming, Interfacing and System Design, Rajkamal, Pearson India, ISBN: 9788131759905
 4. Embedded Systems: Architecture, Programming & Design, Raj Kamal, Tata McGraw Hill publication.
 5. Let us C, Yashwant Kanetkar, BPB Publications
 6. Embedded System Design, Rajkamal, Pearson Education Press.
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Title of the Course: Instrumentation and Process Control								
Year: III, Level: 5.5					Semester: V			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major	ELS-303-MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Explain the configuration and working principle of measuring instruments.

CO2: Describe the performance characteristics of measuring instruments.

CO3: Analyze the important control parameters in process automation.

CO4: Compare various process control systems and describe the types of controllers used in process control applications.

Unit 1: Fundamentals Of Measurement Systems

[06 Hours]

Block diagram of instrumentation system, Analog and Digital Modes of Operation, Null and Deflection Methods, Input Output configuration of Instruments and measuring systems. Methods of correction for Interfering and Modifying Inputs.

Unit 2: Performance Parameters of Instrumentation System

[08 Hours]

Static and dynamic characteristics, Generalized measurement systems, zero-order System, First-order System, Second-order System, Dead-Time Element, Specifications and Testing of Dynamic Response.

Unit 3: Fundamentals of Process Control

[06 Hours]

Process control principles, Continuous control, discrete state control, composite, discrete/continuous control, Process Characteristics, Control system parameters, Architecture of Industrial Automation Systems, Advantages and limitations of Automation.

Unit 4: Process Control Systems

[10 Hours]

Two position mode, Multiposition mode, floating control mode Continuous controller modes: Proportional control, Integral control, Derivative control Composite modes: Proportional-Integral, Proportional derivative, Proportional-integral derivative (PID). Simple Process Control / Automation Applications: Automatic ON/OFF switching of two lights (basic discrete control application), Temperature control in ovens/heaters/ using proportional/ PI and PID control.

Reference/Text Books:

1. Sawhney, A.K., *A Course in Electrical and Electronic Measurements and Instrumentation*, Dhanpat Rai & Co., New Delhi.
 2. Nakra, B.C. and Chaudhry, K.K., *Instrumentation, Measurement and Analysis*, Tata McGraw-Hill / McGraw Hill Education.
 3. *Measurement Systems Application and Design*, Ernest O Doebelin, Dhanesh N Manik, Tata McGrawHill publication.
 4. Johnson, Curtis D., *Process Control Instrumentation Technology*, Pearson Education.
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Title of the Course: Communication Electronics								
Year: III,				Level: 5.5		Semester: V		
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major	ELS-304-MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Understand fundamental concept of antenna.

CO2: Understand basics of electronic communication.

CO3: Explain continuous wave modulation and its classification.

CO4: Understand basic modulation concepts.

CO5: Explain fundamental of digital modulation.

CO6: Describe different types of Pulse Modulation.

Unit 1: Antenna & Wave Propagation [06 Hours]

Antenna: Basic of wave propagation, Evolution of Dipole antenna, Parameters of Antenna: antenna Gain, directivity, antenna resistance, efficiency, Beamwidth, radiation pattern, problems based on parameters. Concept of Resonant and non-resonant antenna, Yagi-Uda antenna and parabolic antenna.

Unit 2: Fundamentals of Communication [06 Hours]

Importance of communications, Elements of an electronic communication system, types of communication, Electromagnetic spectrum, Bandwidth, Concept of Noise: External and internal, signal-to-noise (S/N) ratio, Noise figure and noise temperature, Need of Modulation, Concept of Modulation.

Unit 3: Continuous Wave Modulation [14 Hours]

Amplitude Modulation and Demodulation: AM modulator using transistor, equation of AM and its derivation, Modulation index, Power Distribution. Concept of sidebands (SSB, VSB, DSB), AM Modulator using transistor, Balanced modulator.

AM Receiver: Demodulator circuit using diode. Concept of super-heterodyne receiver,

characteristics of receiver: Selectivity, sensitivity, image frequency and dynamic range.

Frequency Modulation: FM Basic Equation, frequency spectrum, bandwidth and modulation index, frequency deviation, FM Modulation using varactor diode.

FM Demodulation: Foster-Seeley discriminator.

Pulse Modulation Methods: Introduction to PAM, PWM, PPM.

Unit 4: Introduction to Digital Modulation

[04 Hours]

Advantages of Digital Modulation, Fundamentals of ASK, FSK, PSK

Digital Modulation: PCM, Delta Modulation, Adaptive Delta Modulation (Basic Concepts)

Text/ Recommended Books:

1. Communication Electronics: Principle and applications by Louies E. Frenzel, 3rd edition, TMH
 2. Electronic Communication systems by Kennedy & Davis, Tata McGraw Hill, 5th edition
 3. Electronic Communication by Dennis Roddy & John Coolen, Pearson Education
 4. Antenna Theory: Design & Analysis by Balanis, Wiley Eastern
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Title of the Course: Practical Course V								
Year: III, Level: 5.5					Semester: V			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major	ELS-305-MJP	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Understand basic principles and characteristics of semiconductor devices through experiments.

CO2: Develop embedded system applications using Embedded C with ATmega16/32.

CO3: Apply instrumentation techniques for measurement and basic process control.

CO4: Design and study communication circuits and modulation techniques.

CO5: Analyze experimental results and develop practical problem-solving skills in electronics systems.

Experiments (Any 12) + Activity / Study tour report / Assignments / Demonstration / Virtual lab

Group A: List of Practicals based on Principles of Semiconductor Devices. (Any 2)

1. Energy band gap measurement.
2. Measurement of Fill factor and Efficiency of Solar cell.
3. Study of Photo-transistor (L14G3) as an event counter.
4. Measurement of Reverse recovery time of diode.
5. Four Probe method.

Group B: List of Practicals based on Embedded System Design using Embedded C programming (ATmega16/32) (Any 6).

1. Arithmetic and logical operations.
2. Code conversions: Packed BCD to ASCII conversion, ASCII to packed BCD conversion, Decimal to hex, hex to decimal, ASCII to hex and Hex to ASCII.
3. LED/OLED Array Interfacing.
4. Push-button/switch interfacing to ON/OFF buzzer.

5. LDR and relay Interfacing to switch ON/OFF an AC bulb.
6. Seven Segment Display Interfacing (to display 0 to 9).
7. 16×2 LCD Interfacing.
8. Temperature sensor LM35/PT100 Interfacing & display on LED/OLED/LCD.
9. DC motor Interfacing (Clockwise and Anticlockwise).
10. Stepper motor Interfacing.
11. 4×4 matrix Keyboard Interfacing.

Group C: List of Practicals based on Instrumentation and Process Control. (Any 2)

1. Design, build and test On/Off controller using temperature Sensor.
2. Design, build and test of PID controller.
3. Design, build and test zero order system for the Measurement of displacement using potentiometer
4. Simulation of controller modes (P/PI/PD/PID)
5. Design and Development of ON/OFF temperature control system using Arduino
6. Industry Visit.

Group D: List of Practicals based on Communication Electronics (Any 2)

1. Amplitude modulation using transistor /OTA CA3080.
 2. Build and test Balance modulator and demodulator using IC 1496.
 3. FM generation using VCO/IC8038/Varactor diode.
 4. Study of Frequency Shift Keying (FSK) using XR 2206.
 5. Demonstration of PAM/PWM/PPM.
 6. Study of Delta Modulation / Adaptive Delta modulation
 7. To design, build and test PCM encoder.
 8. Radiation pattern of Antenna using smith chart.
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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course : Practical Course VI(Project)								
Year: III, Level: 5.5				Semester: V				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Core	ELS- 306-MJP	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

- CO1: Understand basic methodology of selection of topic for project
- CO2: Understand how to do literature review for selected topic for project
- CO3: Apply the knowledge for design and development of the selected project
- CO4: Use different software and hardware for testing , validation and verification of circuits for successful outcome of project
- CO5: Understand documentation process in the form of presentation and project report
- CO6: Understand process of systematic development of electronic system and Development of skills for successful outcome.

Guidelines to conduct Practical Course III

Practical Course III is a project work of 2 Credits.

- Internal project Examination (15 marks)
- External project Examination(35 marks)

The project work should be followed with following guidelines

- a) The name and subject of the project type must be well defined.
 - b) Planning of the work must be specified.
 - c) Theoretical, reference work must be provided.
 - d) Pilot experimentations / Preparations must be specified.
 - e) Typical design aspects, theoretical aspects, aim and objectives of the work must be specified in detail.
 - f) The actual work done must be reported along with experimentation procedures.
 - g) There must be observations, interpretations, conclusions, results of the project work.
 - h) Algorithm, program strategy, module wise description of parts etc be provided in case of projects related with development of computer software.
 - i) Applications, usefulness, student's contribution in it must be clearly specified.
 - j) Further extension work may be suggested for better outcome of the project.
 - k) It is recommended to present the projects in competitions / project exhibitions organized by various authorities.
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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020)Syllabus)

Title of the Course: Nanoelectronics								
Year: III , Level: 5.5					Semester: V			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS-310- MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Understand properties of nanomaterials

CO2: Know the physics of nanoelectronic devices and their working principles

CO3: Get familiar with various nanomaterial synthesis and characterization techniques

CO4: Discuss the applications and future trends of nanoelectronics

Unit 1 — Fundamentals Nanoelectronics

[06 Hours]

Fundamentals of Nanotechnology and its scope, Properties of Nanomaterials: Electronic Properties - Band structures, Mobility, resistivity, Optical Properties - Photo conductivity, Photovoltaic effect, optical absorption and transmission, photoluminescence.

Unit 2: Synthesis and Characterization Techniques for Nanomaterials

[08 Hours]

Synthesis of Nanomaterial:- Top-down , bottom-up methods, Physical Methods:- Physical vapour Deposition, Molecular Beam Epitaxy, Chemical Methods :- Sol-Gel Method, Sonochemical synthesis

Characterization Techniques for Nanomaterials :- Structural characterization techniques: -X-ray diffraction (XRD) technique.

Optical and Electron Microscopy:-Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunnelling Microscopy, AFM

Spectroscopic Techniques:-UV visible spectroscopy

Unit 3: Nanoelectronic Materials and Devices

[08 Hours]

Nanoelectronic materials: Carbon nanomaterials:- fullerenes, carbon nanotubes, grapheme.

Low dimensional semiconductor nanomaterials :- Quantum well, Quantum wire and Quantum dot

Nanoelectronic Devices:- Quantum well laser, Quantum dot laser, Resonant Tunneling diode , Coulomb Blockade, Single- Electron Transistor

Unit 4: Applications

[08 Hours]

Applications: Sensors, logic circuits, emerging memory devices, Challenges: Integration challenges, Environmental, reliability aspects

Future Trends: Wearable, flexible nanoelectronics

Text/Reference Book:-

1. *Nanotechnology: Principles and Practices* by Sulabha K. Kulkarni (Springer) .
 2. Introduction to Nanoelectronics Science, nanotechnology, Engineering and Applications, V. Mitin ,Viatcheslav A. Kochelap , Michael A. Stroscio Vladimir, Cambridge University Press 2008 .
 3. "Introduction to Nanoscience and Nanotechnology" by Gabor L.Hornyak, Joydeep
 4. Dutta,H.F.Tibbals, and John J. Moore.
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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Major Elective Practical Lab-I								
Year: III, Level: 5.5					Semester: V			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS-313-MJP	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Understand quantum mechanical effects in nanoscale devices.

CO2: Analyze different properties of nanomaterials..

CO3: Simulate nano-device characteristics.

CO4: Understand different characterization techniques of nanomaterial

Experiments (Any 12) + Activity / Assignments/Demonstration

List of Practicals based on Nanoelectronics (Any 12)

(Simulation may be carried out using any suitable software platform)

1. Morphological analysis of nanoparticles using SEM.
2. Investigation of Surface morphology of nanoparticles using TEM.
3. To study Surface morphology of nanoparticles using AFM..
4. Analysis of crystalline structure of nanoparticles using XRD
5. Determination of optical properties of nanoparticles using UV-VIS spectroscopy.
6. Synthesis of silver/gold nanoparticle
7. Synthesis of ZnO nanoparticles
8. Synthesis of CdS/TiO₂ nanoparticles
9. Experimental or simulation based resistivity measurement using Four probe methods
10. Experimental or simulation based Photoconductivity in Semiconductor..
11. Experimental or simulation based I-V characteristics of Shockley diode .
12. Study of applications of different Nanoelectronic nanodevices..
13. To study the comparative analysis of various synthesis techniques for nanoparticles
14. Writing a research article on future trends in nanoelectronics
15. Visit to research lab..

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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Fiber Optics Communication								
Year: III, Level: 5.5				Semester: V				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS –311-MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: To learn about optical fiber communication systems.

CO2: To comprehend various optical fiber properties.

CO3: To understand the fundamental optical elements of fiber optic communication.

CO3: To develop, execute, and evaluate the use of optical fiber cables

Unit 1: Basics of Optical Fiber

[10 Hours]

Block diagram of the optical fiber communication system, Ray theory transmission, refractive index, Total internal reflection, acceptance angle, numerical aperture, skew rays, Types and specification of optical fiber, Propagation of light in optical fiber for meridional rays, definition of fiber joints, connectors and splicer, Advantages of optical fiber communication

Unit 2: Different losses in Optical Fiber

[07 Hours]

Definition of Attenuation, Absorption, Material absorption losses, linear and nonlinear scattering losses, bending losses, dispersion: Chromatic and intermodal dispersion, pulse broadening due to dispersion, fiber scattering loss measurement and fiber numerical aperture measurement.

Unit 3: Optical Sources and Detectors

[07 Hours]

Light-Emitting Diodes Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation of an LED, Laser Diodes, Laser Diode Modes and Threshold Conditions, External Quantum Efficiency, Single-Mode Lasers, Modulation of Laser Diodes, Detectors: PIN and APD, Photodetector

Unit 4: Power launching and Coupling**[06 Hours]**

Source to Fiber power launching, Numerical Aperture, Lensing schemes for coupling improvement, laser diode to fiber coupling, Mechanical misalignment and their types in fiber-to-fiber joint.

Text / Reference Books:

1. Optical fiber communication – Principles and practice, J.M. Senior, PHI
 2. Fiber optics and Optoelectronics, R.P. Khare, Oxford University Press
 3. Optical fiber communication, G. Keiser McGraw Hill 5Th Edition
 4. Optical Fibers and Fiber Optic Communication System- Dr. Subir Kumar Sarkar
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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus)

Title of the Course: Major Elective Practical Lab 1								
Year: III, Level: 5.5				Semester: V				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS – 313-MJ	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: To learn about optical fiber communication systems.

CO2: To comprehend various optical fiber properties.

CO3: To understand the fundamental optical elements of fiber optic communication.

CO4: To develop, execute, and evaluate the use of optical fiber cables

List of Practicals(Any 10)

1. To design and build fiber optic Transmitter
2. To design and build fiber optic receiver
3. To measure propagation loss in optical fibers
4. To measure bending loss in optical fibers
5. To set up fiber optic voice link
6. To measure Numerical Aperture of given optical fiber.
7. To study transmission through a gap between fibers.
8. To study different types of coupling in optical fiber.
9. To study the power budget of fiber optic communication system
10. To study step index optical fiber using simulation
11. To study graded index optical fiber using simulation
12. Industry visit

Activity: Hands on training workshop/survey of various optical fibers available in market/study of fiber optic sensors in various applications(equivalent to 2 expts)

Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Sensors, Actuators and Signal Conditioning								
Year: III, Level: 5.5					Semester: V			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
VSC	ELS-321-VSC	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Identify and explain the working principles of different **sensors and actuators** used in electronic measurement and control systems.

CO2: Design and implement **signal conditioning circuits** such as bridge amplifiers, instrumentation amplifiers, and filter circuits for sensor interfacing.

CO3: Develop and test **sensor-based applications** using temperature, optical, gas, motion, and ultrasonic sensors.

CO4: Interface and control **actuators** such as relays, DC motors, and stepper motors using suitable driver circuits.

CO5: Analyze and process **sensor data** using techniques such as filtering and noise reduction to obtain reliable measurements.

Experiments (Any 12) + Study tour report / Assignments/Demonstration / Virtual lab.

OR

Experiments (Any 08) + Minimum 3-days workshop

List of Practicals based on Sensor, Actuators, Signal Conditioning Circuits.

1. To design and implement a compulsory mini project based on sensors or actuators.
2. To design, develop and test a bridge amplifier for a thermistor.
3. To measure temperature using an LM35 temperature sensor.
4. To design, develop and test an instrumentation amplifier.
5. To design, develop and test a signal conditioning circuit for optical sensors (LDR / Photodiode / Phototransistor).
6. To design and implement a soil moisture detector or smoke detector circuit.
7. To study the working and applications of smart sensors.
8. To design and implement a relay circuit for AC device control.
9. To control a stepper motor using the ULN2003 driver IC.

10. To control a DC motor using a transistor driver circuit.
 11. To measure distance using an ultrasonic sensor.
 12. To design and test an application circuit using an MQ-series gas sensor.
 13. To design and implement a safety application using an IR/PIR sensor.
 14. To design and test an application circuit using a digital temperature and humidity sensor (DHT11/DHT22).
 15. To design and study the frequency response of an active low-pass filter using an operational amplifier.
 16. To implement a Kalman filter algorithm to remove noise from sensor data and obtain accurate measurements.
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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Python Programming								
Year: III, Level: 5.5					Semester: V			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Minor	ELS-311-MN	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: To understand the basics of programming.

CO2: To know about the script language Python

CO3: To get familiar with different data types, statement and loops used in Python

CO4: To develop python programs for various identified problems

Unit 1: Introduction to Python Programming [08 Hours]

Introduction to python as scripting language and comparison with programming language, Advantages, features and applications of Python. Basic structure of Python program, keywords and identifiers, variables and data types, input and output statements, Operators, conditional statements (if, if-else, nested if, elif).

Demonstration of python programs on:

1. Basic calculator operations.
2. Even-odd numbers or prime numbers

Unit 2: Control Structures and Functions [08 Hours]

Looping statements: for loop, while loop, break, continue and pass statements, nested loops. Functions: defining and calling functions, function arguments, return statement, recursive functions, scope of variables.

Demonstration of python programs on:

1. Factorial of number (Recursive).
2. Fibonacci Series.

Unit 3: Data Structures and File Handling [08 Hours]

Python data structures: lists, tuples, sets and dictionaries, operations on data structures. String handling and string operations.

File handling: opening and closing files, reading and writing files, text file operations.

Demonstration of python programs on:

1. Variable swapping of numbers
2. Create/rename/delete files.

Unit 4: Python for Scientific and Electronic Applications

[06 Hours]

Introduction to scientific computing in Python. Introduction to Python libraries: NumPy and Matplotlib. Basic array operations using NumPy. Plotting graphs using Matplotlib: line graph, bar graph and scatter plot. Basic idea of Python communication with hardware such as Arduino using serial communication. Applications of Python in electronics, automation and data analysis.

Demonstration of python programs on:

1. Use of NumPy.
2. Ohm's Law: Graph plotting using Matplotlib

Text/Reference Books:

1. An Introduction to Python Programming: A Practical Approach, Dr. Krishna Kumar Mohbey, Dr. Brijesh Bakariya, First Edition 2022, BPB Publications.
 2. Introduction to Python Programming, Gowrishankar S., Veena A., CRC Press
 3. Texts in Computational Science and Engineering, "Programming for Computations – Python", Svein Linge, Hans Petter, Langtangen, Springer
 4. Texts in Computational Science and Engineering, "A Primer on Scientific Programming with Python", Hans Petter Langtangen, Fifth Edition, Springer.
 5. Python for Science and Engineering, Hans-Petter Halvorsen
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Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course : Field Project								
Year: III , Level: 5.5				Semester: V				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Field Project	ELS - 331-FP	00	02	02	60	15	35	50

As per NEP 2020, students of B Sc. Semester V need to perform a Field Project (FP) for TWO (2) credits i.e. 50 Marks.

The guidelines regarding the field project are as follows:

- 1) The total time allocation for the student to carry out field project is 60 hours.
- 2) Students should participate in field-based projects under the supervision of faculty.
- 3) Assignment of project topics to individual students or groups of students (3 to 5 students in one group) and one faculty member from the department will act as Guide for the student or group of students.
- 4) If the project can include any of the following: e.g. Sample collection/Data collection/ Experimental base, mini projects or DIY projects
- 7) The student should compile all the relevant data and carry out its analysis.
- 8) A project report should be written individually in the standard format (2 Copies): Index, Introduction, Materials, Methods, Result, Conclusion/output, References (Numeric citation type) etc.
- 10) The oral /poster presentation for all the projects should be arranged in the department. To evaluate the project, examiner should be appointed by HoD.
- 11) The total project work including preparation of questionnaire to presentation evaluated for 2 credits (50 Marks).
- 12) The scheme of evaluation for field project is given below –
 - 1 Student Overall Performance 20
 - 2 Submission of FP Report 20
 - 3 Presentation (PPT or Poster) 10
 4. Total 50

Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Advanced Embedded Systems								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Core	ELS-351-MJ	02	00	02	30	15	35	50

Course Outcomes: After completion of this course student will be able to

- CO1: Explain the architecture and programming of AVR timers and counters to generate delays and waveforms.
- CO2: Apply interrupt programming techniques in AVR microcontrollers using timer and external interrupts.
- CO3: Interface analog and digital peripherals such as ADC and DAC with AVR microcontrollers using Embedded C.
- CO4: Implement embedded applications such as waveform generation and motor control using PWM techniques.
- CO5: Describe advanced embedded system applications including PIC/ARM microcontrollers, automotive electronics, robotics, and biomedical systems.

Unit 1: AVR Timer Programming in C [10 Hours]

Introduction to Timers, Timer 0, 1 and 2 block diagram. **Timers 0 Programming:** TCCR0, TIFR, examples of delay calculation, steps and program for delay and square wave generation, prescaler and generating a large time delay. **Timer 2 Programming:** TCCR2, ASSR, program for delay generation. **Timer 1 Programming:** TCCR1A, TCCR1B, program for delay generation. Counter 0 Programming.

Unit 2: AVR Interrupt Programming [08 Hours]

Interrupts vs polling, Interrupt service routine, Interrupt Vector Table for the ATmega32 (External and Timer interrupt), Sources of interrupts, Enabling and disabling an interrupt, SREG, TIMSK, GICR, MCUCR, MCUCSR, GIFR registers, Interrupt priority, Interrupt programming for timers and external interrupts.

Unit 3: Interfacing Peripherals to AVR [06 Hours]

ADC Interfacing: Characteristics of the ADC, Digital data output, ATmega32 ADC features, ADMUX and ADCSRA Registers, Steps and programming of ADC using polling.
 DAC0808 Interfacing: waveform generation (staircase, ramp, triangular and square wave) and dc motor control using PWM.

Unit 4: Advanced Embedded Systems and applications**[06 Hours]**

Introduction and comparative study of advanced microcontroller (Features and applications of PIC and ARM), Automotive Electronics: Electronic Fuel Injection, Anti-lock Braking System, Electronic Stability Control, Adaptive Cruise Control, Airbag Deployment, Automotive Navigation Systems. Robotics: Sensors, Actuators, Embedded Intelligence and types of Robots. Biomedical Applications, Brain Machine Interface-Block diagram,

Text/Reference Books:

1. The AVR Microcontroller and Embedded Systems: using Assembly and C, Muhamad ali Mazidi, Sarmad Naimi, Sepehr Naimi, Pearson New International Edition, 2014.
 2. Embedded Systems: An Integrated Approach by LyLa B. Das, Pearson,
 6. Introduction to Embedded Systems, K. V. Shibu, TMH publication.
 7. Microcontrollers: Architecture, Programming, Interfacing and System Design, Rajkamal, Pearson India, ISBN: 9788131759905
 8. Embedded Systems: Architecture, Programming & Design, Raj Kamal, Tata McGraw Hill publication.
 9. AVR Microcontrollers: Hardware, Software and Interfacing, *Siddharth Garg*.
 10. Programming and Customizing the AVR Microcontroller, *Dhananjay V. Gadre*.
 11. Embedded Systems: A Contemporary Design Tool, *James K. Peckol*.
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Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Digital System Design Using Verilog								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Core	ELS-352- MJ	02	00	02	30	15	35	50

Course Outcomes: After completion of this course student will be able to

CO1: Understand and explain the fundamental concepts Verilog Programming.

CO2: Understand the different modelling styles used in Verilog.

CO3: Develop Verilog codes for different Combinational circuits.

CO4: Develop Verilog codes for different Sequential circuits.

CO5: To Study the basics of Programmable Logic Devices (PLD).

Unit 1: Introduction to Verilog [06 Hours]

Overview of HDL, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, Test Benches, Verilog Modules, Delays.

Introduction to Language Elements: Keywords, Identifiers, White Space Characters, Comments, Format, Integers, Reals and Strings, Logic Values, Data Types-net types, undeclared nets, scalars and vector nets, Register type, Parameters, Expressions, Operands, Operators.

Unit 2: Gate Level and Data flow Modeling Styles in Verilog [08 Hours]

Gate level modeling: Introduction, built in Primitive Gates, multiple input gates, Tri-state gates, MOS switches, bidirectional switches, gate delay, array instances, implicit nets, Examples (both combinational and sequential logic circuits)

Data flow Modeling: Continuous assignment, net declaration assignments, delays, net delays.

Examples of gate level and data flow modelling.

Unit-3 Behavioral Modeling in Verilog [08 Hours]

Structured procedures, initial and always, blocking and non-blocking assignments, delay control,

event control, conditional statements, multiway branching, loops, sequential and parallel blocks, Verilog codes for Combinational Circuit: Binary to Gray, Gray to Binary, encoder, multiplexer, demultiplexer

Verilog codes for Sequential Circuit: Flip-Flop: SR, D, T and JK Flip Flop, Decade Counter, 4-bit binary up counter.

Unit 4: Programmable Logic Devices

[08 Hours]

Introduction of Programmable Logic Array (PLA), Programmable Array Logic (PAL), Programmability of PLDs, Simple PLDs (SPLD), Complex PLDs (CPLDs), Field-Programmable Gate Arrays (FPGA).

Text/Reference Books:

1. Verilog HDL: A Guide to Digital Design & Synthesis, Samir Palnitkar, SunSoft Press, ISBN: 978-81-775-8918-4.
 2. Fundamental digital logic with Verilog design by Stephen Brown and Zvonka Vrenesic, Mc Graw Hill Publication, ISBN 0-07-282315-1 ISBN 0-07-121322-8.
 3. Digital Fundamentals, Floyd and Jain, Pearson Education, ISBN: 8177587633.
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Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science:2024 Pattern (NEP 2020) Syllabus

Title of the Course: Power Electronics								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Core	ELS-353-MJ	02	00	02	30	15	35	50

Course Outcomes: After completion of this course student will be able to

CO1: To get introduced to basics of power electronics and familiar with Power Electronic Devices, circuits and applications

CO2: To learn about power devices and protections of devices

CO3: To study various types of power circuits

CO4: Understand basics of motor control.

CO5: To study applications of power electronics

Unit 1: Introduction to Power Electronics [08 Hours]

Definition of power electronics, Applications of power electronics, classification of power Semiconductor devices. Power Devices: Power Diodes-(Construction and Structure, V-I Characteristics, Switching Characteristics). Power Transistor: Power BJT, MOSFET, IGBT (Construction and Structure, V-I Characteristics). DIAC, TRIAC: (Construction, Structure and Advantages).

Unit 2: Power Devices [08 Hours]

Thyristors / Silicon Controlled Rectifiers: (Construction, V-I characteristics, Two transistor Model, Turn-on / Turn-off behavior, Thyristor protection: High voltage, high current, dv/dt and di/dt protection, gate protection, thermal protection). Gate triggering Circuits using PUT.

Unit 3: Power Circuits [09 Hours]

Concept of single phase, Concept of three phase.

Controller Rectifiers (Single Phase): Half wave and Full Wave (R Load and R/L load),

Choppers and their types (Class A, Class B, Class C, Class D, Class E).

Inverters: Half Bridge and full Bridge inverter (operations, voltage- current waveform),
Cycloconverter (Single Phase Cycloconverter).

Unit 4: Applications of Power Electronics

[05 Hours]

Concept of PWM Regulator, Switching Mode Power Supply(SMPS), Buck Regulator, Boost Regulator, Buck- Boost regulators, UPS (Block Diagram and Types)

Text/Reference Books:-

1. M.H. Rashid Power electronics: Circuits, Devices and Applications ,Third Edition (2004), Pearson Education
 2. M. D. Singh, K.B. Khanchadani, Power Electronics, Third Edition (2006) John Wiley & Sons
 4. P.C.Sen Power Electronics Tata Mc Graw Hill, (1998)
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Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Digital Communication								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major core	ELS-354-MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

- CO1: Understand fundamental concept of Digital communication.
- CO2: Compare various error detection and correction codes.
- CO3: Compare various digital modulation techniques.
- CO4: Distinguish various multiple-access techniques for mobile communications.
- CO5: Explain Cellular Communication system.
- CO6: Apply frequency-reuse concept in mobile communications,
- CO7: Demonstrate Wireless Communication Technologies.

Unit -1: Fundamentals of Communication Systems [04 Hours]

Block Diagram and Elements of Digital Communication system, advantages of digital communication system, Communication channel Characteristics: bit rate, baud rate and bandwidth.

Error Detection Code: CRC, Hamming code.

Unit 2: Pulse Code Modulation Techniques [10 Hours]

Types of digital modulation techniques and their advantages, concept of coherent and non-coherent detection.

Shift keying techniques: Block diagram of transmitter and receiver with its working principle for Amplitude Shift Keying (ASK), Frequency Shift keying (FSK), Phase Shift keying (PSK), Differential Phase Shift keying (DPSK), Quadrature Phase Shift keying (QPSK), waveforms.

Quadrature amplitude modulation (QAM): Need, Block diagram of transmitter and receiver with its working principle. Compare the salient feature of the given types of digital modulation techniques: ASK, FSK, PSK.

Unit -3: Multiplexing and Multiple Access Technique**[10 Hours]**

Multiplexing: Concept of Time Division Multiplexing (TDM), Frequency Division Multiplexing (FDM)

Multiple Access techniques: Need, Time Division Multiple Access (TDMA), Frequency Division Multiple Access (FDMA), Advantages of TDMA over FDMA

Unit 4: Modern communication Techniques**[06 Hours]**

Global system for mobile communications (GSM): GSM services, GSM Architecture.

Bluetooth, WIFI, LIFI, RFID, GPS, Basics of General Packet Radio Service (GPRS), MODEM.

Text/Recommended Books:

1. Wireless Communication Principles and practices by Theodore S. Rappaport, 2nd Edition, Pearson.
 2. Wireless Communications and Networks, 2nd edition, William Stallings (2009), Pearson Education, India.
 3. Advanced Electronic Communication Systems, Wayne Tomasi, Sixth Edition.
 4. Mobile Communications, 2nd edition, Jochen Schiller (2009), Pearson Education, India.
 5. Modern Digital and Analog Communication Systems, B. P. Lathi, (3rd Edition), Oxford Publication.
 6. Principles of Communication Systems, Taub & Schilling, (2nd Edition), Tata McGraw Hill Publication.
 7. S. Haykin, Communication systems, John Wiley 2001.
 8. Bhattacharya Amitabh, "Digital Communication", Tata McGraw-Hill, 1st Ed., 2006.
 9. Andreas F. Molisch (2006), Wireless Communications, Wiley –India, New Delhi
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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Practical Course VII								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Core	ELS-355 MJP	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Develop embedded system applications using Embedded C with ATmega16/32 microcontroller.

CO2: Design and simulate digital circuits using Verilog HDL.

CO3: Analyze and test power electronic circuits and power devices.

CO4: Understand digital communication techniques and related circuits.

CO5: Apply practical skills to design, test and analyze electronic systems.

Experiments (Any 12) + Activity / Study tour/Industry Visit / Assignments / Demonstration / Virtual lab

Group A: List of practicals based on Advanced Embedded Systems using Embedded C programming (ATmega16/32). (Any 4)

1. Delay generation using Timer 0 in LED blinking / Square wave generation.
2. Traffic light control system, using Timer 0.
3. Event counter using Counter 0 and display on LED/OLED/LCD.
4. Use of External Interrupt (INT0) to ON/OFF LED/OLED or buzzer.
5. ADC interfacing to read temperature using temperature sensor and display on LED/OLED/LCD.
6. ADC interfacing to measure light intensity using LDR/ Phototransistor L14G3 and display on LED/OLED/LCD.
7. Waveform generation using DAC (Staircase, Ramp/Triangular and Square wave).
8. PWM programming to control speed of dc motor/Servo Motor/brightness of LED/OLED.

Group B: List of practicals based on Digital System Design using Verilog. (Any 3)

Using Xilinx 9i or updated versions design and simulation following combinational and sequential circuits. Use of behavioral/schematic/gate level modeling styles for the designing.

1. 4:1 Multiplexer and 1:4 De-multiplexer.
2. 4 line to 2 line Encoder and 2 line to 4 line Decoder.
3. Binary to Gray and Gray to Binary Convertors.
4. RS/JK/T/D Flipflops.
5. 4 bit binary Up/Down Counters.
6. 4 bit Shift Registers (SIPO/SISO/PISO/PIPO).
7. Sequence generator for stepper motor.

Group C: List of practicals based on Power Electronics. (Any 3)

1. Study Characteristics of power devices like BJT/MOSFET/IGBT/Triac
2. Design, build and test Half wave/Full Wave controlled rectifier.
3. Design, build and test light dimmer circuit / fan regulator circuit
4. Design, build and test 723/78xx voltage regulator.
5. Design, build and test Single phase/Dual converter.
6. Design, build and test Emergency light.
7. Study Mains over voltage/under voltage Protector
8. Study of DC motors, AC motors.
9. Study of SMPS/UPS.
10. Study High frequency heating / induction heating.

Group D: List of practicals based on Digital Communication. (Any 2)

1. Study QAM /QPSK techniques.
 2. Study of BPSK MODEM.
 3. Design, build and test Time division multiplexing/Frequency division multiplexing.
 4. Design, build and test hamming code error detection circuit
 5. Study of GSM.
 6. Study of architecture of mobile communication system.
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Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course : Practical Course VIII(Project)								
Year: III, Level: 5.5				Semester: VI				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Core	ELS - 356-MJP	00	02	02	60	15	35	50

Course outcomes: After completion of this course student will be able to

- CO1: Understand basic methodology of selection of topic for project
- CO2: Understand how to do literature review for selected topic for project
- CO3: Apply the knowledge for design and development of the selected project
- CO4: Use different software and hardware for testing , validation and verification of circuits for successful outcome of project
- CO5: Understand documentation process in the form of presentation and project report
- CO6: Understand process of systematic development of electronic system and Development of skills for successful outcome.

Guidelines to conduct Practical Course III

Practical Course III is a project work of 2 Credits.

- Internal project Examination (15 marks)
- University project Examination(35 marks)

The project work should be followed with following guidelines

- a) The name and subject of the project type must be well defined.
 - b) Planning of the work must be specified.
 - c) Theoretical, reference work must be provided.
 - d) Pilot experimentations / Preparations must be specified.
 - e) Typical design aspects, theoretical aspects, aim and objectives of the work must be specified in detail.
 - f) The actual work done must be reported along with experimentation procedures.
 - g) There must be observations, interpretations, conclusions, results of the project work.
 - h) Algorithm, program strategy, module wise description of parts etc be provided in case of projects related with development of computer software.
 - i) Applications, usefulness, student's contribution in it must be clearly specified.
 - j) Further extension work may be suggested for better outcome of the project.
 - k) It is recommended to present the projects in competitions / project exhibitions organized by various authorities.
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Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Internet of Things (IoT)								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS-360-MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: To understand the fundamentals of IoT.

CO2: To understand IoT architecture.

CO3: To understand various IoT protocols and technologies.

CO4: To understand the concept of Internet of Things in the real-world scenario.

Unit 1: Fundamentals of Internet of Things [04 Hours]

Definition and characteristics of IoT, Functional Block Diagram of IoT, Introduction to M2M, Differences between IoT and Machine-to-Machine (M2M) communication.

Unit 2: IoT Architecture [08 Hours]

Physical and logical architecture of IoT,

Functional blocks: sensors, actuators, gateways, cloud services, Communication models and APIs.

IoT design Methodology-Steps.

Unit 3: IoT communication technologies and IoT Protocols [12 Hours]

IoT enabling Technologies Cloud computing (IaaS, PaaS, SaaS), Big Data Analytics., Wi-Fi, Bluetooth, Zigbee, RFID, Z-Wave, LoRaWAN, Sigfox

Application Layer Protocol (HTTP: CoAP, WebSocket, MQTT, XMPP, DDS, AMQP)

Unit 4: IoT Case Studies & Applications [06 Hours]

IoT system for: Weather Monitoring, Smart Healthcare Systems, Smart Agriculture/Irrigation system, Home Automation Systems.

Text/Reference Books:

1. Internet of Things, A hands of approach, Harshdeep Bhaga, Vijay Madiseti.
2. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things, David Hanes, Cisco Press, ISBN-13: 978-1-58714-456-1, ISBN-10: 1-58714-456-5, 20173

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T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Major Elective Practical Lab -II								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS-362-MJP	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Plot standard signals using any simulation tool.

CO2: To find Laplace Transform of differential equation.

CO3: Demonstrate oversampling and anti-aliasing filter.

CO4: Reconstruction of signal s using Fourier Series.

Experiments (Any 12) + Activity / Study tour report / Assignments /Demonstration / Virtual lab

1. To interface Seven Segment/LCD to Arduino/Raspberry pi
2. To interface Keyboard interfacing to Arduino/Raspberry pi
3. To interface Servomotor to Arduino/Raspberry pi and write a program to make it ON or OFF
4. To interface digital sensor/push button to Arduino/Raspberry pi and write a program to make LED ON when button pressed or sensor detection.
5. To interface motor to Arduino/Raspberry pi and write a program to turn ON motor when push button is pressed.
6. To interface DHT 11/any temperature sensor to Arduino/Raspberry pi and write a program to print temperature and/ or humidity.
7. To interface Bluetooth to Arduino/Raspberry pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Soil Moisture detection/Smoke detector to Arduino/Raspberry pi and write a program to indicate PH level of Soil.
9. To interface Ultrasonic sensor to Arduino/Raspberry pi.
10. To use MQTT protocol for identified application using Arduino.
11. To use ZigBee protocol for identified application using Arduino.
12. To use CoAP protocol for identified application using Arduino.

Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Signals and Systems								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS-361-MJ	02	00	02	30	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: Define and classify signals.

CO2: Understand and represent elementary signals such as unit step, unit impulse, ramp, exponential, and sinusoidal signals.

CO3: Classify systems as continuous/discrete, linear/nonlinear, time-invariant/time-variant, static/dynamic.

CO4 : Apply Laplace Transform to solve differential equations, Use properties

CO5 : Digitization of Analog Signals

Unit 1: Fundamentals of Electronic Signals

[04 Hours]

Definition, Classification of signals: Periodic and aperiodic, Even and odd signals

Elementary signals: unit step, unit impulse, and unit ramp, exponential and sinusoidal signals

Types of Systems: Definition: Systems, Continuous Time systems, Discrete time systems, Static and dynamic systems, Time variant and time invariant systems, linear and nonlinear systems

Unit 2: Laplace Transform

[10 Hours]

Laplace transform: Definition, Properties, LT by using standard tables, First shifting theorem, LT of Differential equation and integral, initial value theorem & Final value theorem. Inverse Laplace transform: Definition, ILT by standard tables, ILT by partial fractions method, application RC circuit, RL circuit.

Unit 3: Fourier series

[06 Hours]

Fourier analysis: Definition, Fourier series and Formulae for Fourier Coefficients, Fourier series analysis of periodic signals such as square wave, triangular wave

Unit 4: Digitization of Analog Signals**[10 Hours]**

Analog to Digital conversion of signals, concept of sampling of CT signals, aliasing effect, oversampling and antialiasing filters, concept of quantization and quantization error, encoding, Introduction to DSP systems.

Text/Reference Books:

1. Network Analysis: G. K. Mittal, Khanna Publishers
 2. Signals and systems by J. S. Chitode, Technical publications
 3. Digital Signal Processing: S. Salivahan, A. Valuraj, C. Gnanapriya, Tata McGraw Hill Publications
 4. Signals and systems by Anand kumar
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Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course: Major Elective Practical Lab -II								
Year: III, Level: 5.5					Semester: VI			
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Major Elective	ELS-362-MJP	00	02	02	60	15	35	50

Course Outcomes: After completion of this course student will be able to

CO1: Plot standard signals using any simulation tool.

CO2: To find Laplace Transform of differential equation.

CO3: Demonstrate oversampling and anti-aliasing filter.

CO4: Reconstruction of signal s using Fourier Series.

Experiments (Any 12) + Activity / Study tour report / Assignments /Demonstration / Virtual lab

List of Practicals based on Signal and systems.

1. Study and generation of basic signals (unit step/unit ramp/unit impulse) using MATLAB/other tool.
2. Generation of sinusoidal and exponential signals using MATLAB/other tool
3. Computation of Laplace Transform of standard signals using MATLAB/other tool
4. Solution of differential equations using Laplace Transform using MATLAB/other tool
5. Analysis/simulation of Laplace Transform of RC circuit using MATLAB/other tool
6. Analysis/simulation of Laplace Transform of RL circuit using MATLAB/other tool
7. Basic simulation of DSP system(Using any simulation tool)
8. Study of aliasing effect.
9. Demonstration of oversampling and anti-aliasing filter.
10. Study of encoding of sampled signals.
11. Compute and plot the Fourier Series representation of a square wave and verify the harmonic components.
12. Reconstruction of signals using Fourier Series.(Use MATLAB/other tool)
13. Compute and plot the Fourier Series representation of a triangular wave and verify the harmonic components.

Savitribai Phule Pune University, Pune
T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course : PLC Programming								
Year: III , Level: 5.5				Semester: VI				
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
Vocational Skill Course	ELS-371-VSC	00	02	02	60	15	35	50

Course Outcomes: After completing the course, the students will be able to

CO1: To learn different programming languages of PLC.

CO2: To implement all the Logic Gates in Ladder Logic.

CO3: To use PLC timers and counters for the various applications.

CO4: To design and implementation of different applications of PLC.

Experiments based on PLC Programming (Any 12)

1. To study about Programmable Logic Controller(PLC)
 2. To study hardware and software associated with PLC
 3. To understand Simple Ladder program (Logic gates)
 4. To study ladder diagram for On-Delay timer for identified application.
 5. To study ladder diagram for Off-Delay timer for identified application
 6. To study ladder diagram for UP counter for identified application
 7. To study ladder diagram for DOWN counter for identified application
 8. To study harnessing used in Programmable logic controller
 9. To study different PLCs used in various applications in industries
 10. To Study computational / arithmetic instructions used in PLC ladder programming
 11. To use Ladder programming for Automatic Staircase lighting
 12. To use Ladder programming for Traffic light controller
 13. To use Ladder programming for bottle filling plant
 14. Industry visit/workshop/hands on training.
 15. Mini Project based on PLC
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Savitribai Phule Pune University, Pune

T.Y.B.Sc. Electronic Science: 2024 Pattern (NEP 2020) Syllabus

Title of the Course : On Job Training(OJT)								
Year: III,			Level: 5.5			Semester: VI		
Course Type	Course Code	Credit Distribution		Credits	Allotted Hours	Allotted Marks		
		Theory	Practical			CIE	ESE	Total
OJT	ELS-381- OJT	00	04	04	120	30	70	100

An internship is gaining first-hand experience by an individual besides comprehending the way of working in an organisation, leading to improve the skill aptitude for a specific job or job role and building research capabilities with learning opportunities. Internships should be such organized that benefits the research intern as well as the internship providing organization. Following are the intended objectives of engaging undergraduate students in internship for employability and research internship programmes:

1. **Integration of workshop with workplace:** To see the internship in a broader, integrated and holistic manner where the delivery of the classroom is aligned with outcomes of the workplace. The objectives of the internship need to be designed with the intention of integrating workshop / classroom / lab/research lab learnings with the workplace (organisation / enterprise / start-ups / corporate / farmlands / artisans / gig workers / Non-government organisations (NGOs)/research & development organisations, higher education institutions (HEIs), etc).
2. **Understanding of the world of work:** To provide undergraduate students with an opportunity to improve their understanding of the experiences, challenges, and opportunities of the real world of work, as well as to set their expectations and behaviour in accordance with the demands, culture, and values of current and emerging jobs.
3. **Hybrid model learning:** To broaden learning opportunities by combining physical and digital modes of learning while working in industry, corporate, research & development organisations, workplace, within or outside HEIs, blended with a mentor or research expert and as per the need and convenience.
4. **Developing research aptitude:** To create and facilitate conditions that allow students in their quest for knowledge, its discovery, learn, understand and sharpen research acumen, familiarising with analytical tools and techniques with appropriate usage, research methodologies, data analysis, integrity and ethical behaviour, manuscripts preparations, identification of appropriate journals, patent and intellectual property rights, and their application in solving research/complex/real-life problems.
5. **Exposure in emerging technologies:** To provide exposure to emerging technologies/ automation and how it can support, facilitate, improve and reinforce work processes/ culture/ job roles/art and craft, including the traditional areas of

collaboration culture to promote research, academic and professional developments.

- 8. Cultivate a sense of Social Imagery and Citizenship Responsibility:** To develop a sense of social imagery (issues) and philanthropic versatility among the graduating students that will facilitate towards the development of an attitude towards citizenship responsibility.
- 9. Stimulate collaborative influence:** To promote HEIs collaboration, industry-academia partnership will be developed to provide collaborative internships, apprenticeships, and research opportunities to the students in the predefined areas of importance which will lead institutions, universities, organisations, academicians, and students to collaborate on how to learn with one another.
- 10. Enhancing professional competency:** The internship should not only focus on employability or research capabilities; there is also a need for professional principles, ethics, values, and integrity which will enable them to gain perspective, practice, develop as competency and perform professional tasks in the way that the employment market demands.

Each undergraduate student may complete an internship of 2-4 credits during after the 4th semester of the UG degree programme focussing on Hands-on Training/Short Research Project. However, the student who has to go for a 4-year UG degree (Honours with Research) programme will be required to choose courses as given Table 1 during the 8th semester.

Table 1: Activities, Suggested Duration along with a corresponding number of credits of Internship Programme:

S. No.	Courses	Suggested Schedule	Duration	Suggested Activities	Credits
1	<ul style="list-style-type: none"> • 3-year UG degree • 4-year UG degree (Honours) • 4-year UG degree (Honours with Research) 	After (4 th) Semester	60 -120 hours	Hands-on Training/Short Research Project Seminar attendance Read assigned journals to prepare for seminars Study certain entrepreneurs Social projects Study of the enterprises/ farmers	02-04
2	4-year UG Degree (Honours with Research)	8 th Semester	One Semester	(i) HEI may adopt Research Methodology, Research Tools and Techniques, Research Ability Enhancement and Policy Framework Courses (ii)Dissertation/Thesis/Project Work/Research project	08 12

8.0 EVALUATION

Internship

1. The parent HEI will examine/evaluate the student's performance following its evaluation method.
2. The evaluation of the internship will be carried out at the following stages:
 - a) The interns will be evaluated by research internship supervisor based on their efforts and research output.
 - b) The interns will be evaluated through seminar presentation or viva-voce at the HEI, (marks will be given by a group of experts from HEI including the supervisor).
3. At HEI, the intern will be evaluated through a seminar/viva voce on his work, by a duly constituted expert committee (One Internal and One external), on the following suggestive aspects.
 - i. Activity logbook and evaluation report of Internship Supervisor
 - ii. Format of presentation and the quality of the intern's report
 - iii. Acquisition of skill sets by the intern
 - iv. Originality and any innovative contribution
 - v. Significance of research outcomes
 - vi. Attendance

Reference: (<https://nqr.gov.in/>)
