SAVITRIBAI PHULE PUNE UNIVERSITY

SYLLABUS

M.Sc. ELECTRONIC SCIENCE

(FOR AFFILIATED COLLEGES)

FACULTY OF SCIENCE AND TECHNOLOGY

UNDER NATIONAL EDUCATION POLICY

(NEP 2020)

TO BE IMPLEMENTED FROM

ACADEMIC YEAR 2024-25

LEVEL 6.0 (First Year): M.Sc. ELECTRONIC SCIENCE CREDIT FRAMEWORK

`Semester I		
Subject Code	**Name of the Subject**	**Credits**
Major Core		
ELS 501 MJ	Analog System Design	**4**
ELS 502 MJ	Advanced Digital System Design using Verilog	**4**
ELS 503 MJ	Mathematical Methods in Electronics	**2**
ELS 504 MJP	Practical Course I	**2**
ELS 505 MJP	Practical Course II	**2**
ELS 541 RM	Research Methodology	**4**
Major Elective Theory (Any one)		
ELS 510 MJ	Fundamentals of Instrumentation Systems	**2**
ELS 511 MJ	Introduction to Artificial Intelligence and Machine Learning	**2**
ELS 512 MJ	Fundamentals and Applications of PICMicrocontroller	**2**
Major Elective Practical (Any one)		
ELS 513 MJP	Fundamentals of Instrumentation Systems Lab	**2**
ELS 514 MJP	Introduction to Artificial Intelligence and Machine Learning Lab	**2**
ELS 515 MJP	Fundamentals and Applications of PIC Microcontroller Lab	**2**
	Number of credits to be completed in a Semester I	**22**

Semester II		
Subject Code	**Name of the Subject**	**Credits**
Major Core		
ELS 551 MJ	Modern Communication Systems	**4**
ELS 552 MJ	Control Systems	**4**
ELS 553 MJ	Industrial Automation	**2**
ELS 554 MJP	Practical Course III	**2**
ELS 555 MJP	Practical Course IV	**2**
ELS 581 OJT	On Job Training (Internship)	**4**
Major Elective Theory (Any one)		
ELS 560 MJ	Instrumentation Systems and Applications	**2**
ELS 561 MJ	Applications of Artificial Intelligence and Machine Learning	**2**
ELS 562 MJ	Fundamentals and Applications of AVR Microcontroller	**2**
Major Elective Practical (Any one)		
ELS 563 MJP	Fundamentals of Instrumentation Systems Lab	**2**
ELS 564 MJP	Introduction to Artificial Intelligence and Machine Learning Lab	**2**
ELS 565 MJP	Fundamentals and Applications of AVR Microcontroller Lab	**2**
Number of credits to be completed in a Semester II		**22**
Total Credits of Semester I and Semester II		**44**

LEVEL 6.5 (Second Year): M.Sc. ELECTRONIC SCIENCE CREDIT FRAMEWORK

Semester III		
Subject Code	**Name of the Subject**	**Credits**
Major Core		
ELS 601 MJ	Electromagnetics and Microwaves	**4**
ELS 602 MJ	Foundation of Semiconductor Devices	**4**
ELS 603 MJ	Advanced Industrial Electronics	**2**
ELS 604 MJP	Practical Course V	**2**
ELS 605 MJP	Practical Course VI	**2**
ELS 631 RP	Research Project / Internship	**4**
Major Elective Theory (Any one)		
ELS 610 MJ	Fundamentals of Electric Vehicle Technology	**2**
ELS 611 MJ	Fundamentals and Applications of Raspberry PI using Python	**2**
ELS 612 MJ	Digital Signal Processing: Processor and Applications	**2**
ELS 613 MJ	Nanotechnology	
Major Elective Practical (Any one)		
ELS 614 MJP	Fundamentals of Electric Vehicle Technology Lab	**2**
ELS 615 MJP	Fundamentals and Applications of Raspberry PI using Python Lab	**2**
ELS 616 MJP	Digital Signal Processing: Processor and Applications Lab	**2**
ELS 617 MJP	Nanotechnology Lab	**2**
	Number of credits to be completed in a Semester III	**22**

Semester IV		
Subject Code	**Name of the Subject**	**Credits**
Major Core		
ELS 651 MJ	Advanced Embedded System Design	**4**
ELS 652 MJ	Robotics and Mechatronics	**4**
ELS 653 MJP	Practical Course VII	**2**
ELS 654 MJP	Practical Course VIII	**2**
ELS 681 RP	Research Project / Internship	**6**
Major Elective Theory (Any one)		
ELS 660 MJ	Advanced Electric Vehicle Technology	**2**
ELS 661 MJ	Internet of Things	**2**
ELS 662 MJ	Digital Image Processing	**2**
ELS 663 MJ	Integrated Circuit (IC) Technology and VLSI	**2**
Major Elective Practical (Any one)		
ELS 664 MJP	Advanced Electric Vehicle Technology Lab	**2**
ELS 665MJP	Internet of Things Lab	**2**
ELS 666 MJP	Digital Image Processing Lab	**2**
ELS 667 MJP	Integrated Circuit (IC) Technology and VLSI Lab	
Number of credits to be completed in a Semester IV		**22**
Total Credits of Semester III and Semester IV		**44**
Total Credits of Semester I, II, III and IV		**88**

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M.Sc. [Part- II] (Electronic Science)
Major Core Compulsory Theory Course
Semester III: ELS 601 MJ: Electromagnetics and Microwaves

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
04	**4 Hours/Week**	**60**	**30 Marks**	**70 Marks**

Course Outcomes:

At the end of this course, students should be able to

CO1	Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.
CO2	Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.
CO3	Understand the distribution of electromagnetic fields within various transmission line geometries
CO4	Analyze the wave propagation in TE, TM or TEM modes, in structures such as rectangular waveguides
CO5	Use Smith chart to study transmission line applications for circuit elements and impedance matching. Study the performance of Wave Guide.
CO6	Describe working of microwave components, microwave tube and solid-state devices

Unit 1: Electromagnetic Waves (18 Hrs.)

Physical quantities as vectors, concept of gradient, curl, and divergence, concept of rotation operator, covariant and contra-variant vectors, line, surface and volume – integrals, Gauss and Stokes theorem complex plane, polar form of complex number, complex functions. Review of Gauss's law, Faraday's law and Ampere's law, Maxwell's equations and their meaning, electric and magnetic wave equations in time domain and frequency domain, wave propagation in conducting and non- conducting media, skin depth and high frequency propagation, boundary conditions at the interface between two mediums, Poynting's theorem, interpretation of ExH.

Unit 2: Transmission Lines (12Hrs.)

Introduction, types of transmission lines, microstrip lines, two wire transmission line, transmission line equations for voltages and currents, inductance and capacitance per unit length of two wire and coaxial cable transmission line, characteristic impedance, propagation constants, attenuation and phase constants, phase velocity, reflection and transmission coefficients, SWR, line impedance, normalized impedance and admittance, Smith chart construction and applications, single stub and double stub matching.

Unit 3: Waveguides and Components **(15 Hrs.)**

Concept of waveguide, frequency range, relation to transmission lines

Rectangular Waveguides: TM and TE Modes, concept of cut-off frequency, guide impedance, phase velocity, guide wavelength for TE and TM modes,

Circular waveguide introduction only, difference between conducting circular waveguide and Optic fiber. Cavity Resonator, Q factor of cavity resonator.

Waveguide tees, magic tee, hybrid ring, waveguide corners, bends and twists, two-hole directional coupler, hybrid coupler, microwave circulators and isolators.

Unit 4: Microwave Devices **(15 Hrs.)**

Microwave tubes: Klystron, multicavity klystron amplifier, helix and coupled cavity TWT, cylindrical magnetron – construction, principle of operation, performance characteristics and applications.

Microwave solid state devices and circuits: Principle, structure, construction and working of: Gunn diode, LSA diode, READ diode, IMPATT, TRAPATT, tunnel diode.

Text / Reference Books:

1. Microwave Devices and Circuits,by Samuel Y. Liao, PHI, 3rd Edition, 2002.
2. Principles of Electromagnetics, by N. Sadiku, Oxford University Press.
3. Electromagnetics with Applications, by Kraus and Fleiseh, McGraw Hill, 5th Edn, 1999.
4. Fundamentals of Applied Electromagnetics, by Fawwaz T. Ulaby, Eric Michielssen, Prentice Hall 6 Edition
5. Microwave and Radar Engineering with Lab Manual, by Vinith Chauhan, University Science Press (An Imprint of Laxmi Publications Pvt. Ltd.)
6. Microwave Engineering by Annapurna Das, SISIR K DAS , 3rd edition McGraw Hill Education (India) Private Limited
7. Microwave engineering Concepts and Fundamentals by Ahmad Shahid Khan, CRC Press

SAVITRIBAI PHULE PUNE UNIVERSITY

M.Sc. [Part- II] (Electronic Science)

Major Core Compulsory Theory Course

Semester III: ELS 602 MJ: Foundation of Semiconductor Devices

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
04	4 Hours/Week	60	30 Marks	70 Marks

Course Outcomes:

At the end of this course, student should be able to

CO1	Learn the important concepts related to semiconductor technology.
CO2	Perform the analysis and design of semiconductor devices (electrostatics and current-voltage characteristics) from fundamental principles.
CO3	Learn how to extract device parameters by suitable experiments.
CO4	Learn the fundamentals of circuit design and observe how device properties and device design impact circuit behavior (e.g. dc and ac response, noise etc.)
CO5	Learn basic knowledge and concepts of Semiconductor materials and devices
CO6	Learn IC design and fabrication technologies.

Unit I: Basics of Semiconductor Electronics (12 Hrs.)

Energy bands and classifications, Band gap: direct and indirect, Atomic bonds in semiconductors, Commonly used semiconductors, Effect of temperature on semiconductors, Intrinsic and Extrinsic semiconductors, Carrier Concentration, Conductivity and Mobility, Carrier Generation and Recombination, compound semiconductors (III-V and II-VI group), properties of degenerate and non- degenerate semiconductors and their applications, Measurement of the energy gap, Measurement of the effective mass of carriers by using cyclotron resonance experiment, Measurement of a carrier lifetime, Haynes-Shockley experiment.

Unit 2: Junction Devices (1 Credit) (18 Hrs.)

PN junction diode, breakdown mechanism in p-n junction diode, junction, and diffusion capacitance. P-I-N diode, intrinsic layer, Principle of operation, P-I-N diode, applications of P-I-N diode.

Zener diode: phenomenon of reverse bias breakdown, Principle of operation and applications, Schottky diode, Varactor diode: Principle of operation, structure and applications,

Tunnel diode: Principle of operation, structure and applications,

BJT: Terminology, electrostatics and performance parameters, Eber-Moll model, two port model, hybrid – pi model, device models in spice

Modern BJT structures – polysilicon emitter BJT, Heterojunction bipolar transistor (HBT).

Unit 3: FET and MOSFET Devices (1 Credit) (18 Hrs.)

JFET: Principle of operation, working, applications, MOSFET: accumulation, depletion mode, inversion mode and C-V characteristics of MOS capacitor, Constructional details I-V Characteristics, and Principle of operation of depletion type and enhancement type MOSFET, equivalent circuit of MOSFET, short channel and narrow width effect, MOSFET scaling and hot

electron effect, charged-coupled devices (CCD) types of charged coupled device (SCCD and BCCD) application of charged coupled devices.

Unit 4: IC Technology (1 Credit) (12 Hrs.)

Introduction to Integrated Circuit Technology, Types of IC's, Custom and semicustom designs, standard cell, gate array, FPGA, CPLD and PLDs, FPGA Design Flow, design center and foundry. Moore's law, IC fabrication technologies; nMOS fabrication, CMOS fabrication approaches.

Text / Reference Books:

1. Semiconductor Physics and Devices Basic Principles, by Donald A. Neamen, TMH, 4th Edition (2003).
2. Semiconductor Device fundamentals, by Robert F. Pierret, Pearson Education
3. Solid State Electronics Devices, by Streetman, PHI, 5th Edition, (2006)
4. Semiconductor Device Physics and Design, by Umesh K. Mishra, Jasprit Singh, Springer Publication
5. Semiconductor Physical Electronics, by Sheng S. Li, 2e Springer Publication.
6. Analysis & Design of Analog Integrated Circuits, P. Gray, P. Hurst, S. Lewis, R. Meyer, Wiley
7. Application Specific Integrated Circuits, M.J. S. Smith, Addison-Wesley
8. Basic VLSI Design- Douglas A. Pucknell.

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M.Sc. [Part- II] (Electronic Science)
Major Core Compulsory Theory Course
Semester III: ELS 603 MJ: Advanced Industrial Electronics

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
02	2 Hours/Week	30	15 Marks	35 Marks

Course Outcomes:

At the end of this course, student should be able to

CO1	Get knowledge about various power electronic devices
CO2	Understand the use of power devices and there I-V characteristics.
CO3	Learn rectifiers for different power electronic applications.
CO4	Understand the fundamental principle of different industrial actuators.

Unit-I: Introduction to Power Electronics (18 Hrs.)

Introduction to Power electronics: Solid State switching devices (Power Diode, BJT, MOSFET, Thyristor, TRIAC, DIAC, SCR, GTO, IGBT, IGCT)

Different turn ON methods for SCR (Forward voltage triggering, Gate triggering, dV/dt triggering, thermal triggering). Gate trigger circuits –General block diagram of a Thyristor gate trigger circuit, Resistance firing circuit, Resistance Capacitance firing circuit, Resistor Capacitor full wave trigger circuit. SCR triggering using UJT, PUT. Synchronized UJT triggering) and Turn OFF methods (Class A, B, C, D, E, F) of Thyristor.

Unit-2: Convertors and Actuators (12 Hrs.)

Industrial Convertors: AC-DC current converters (rectifiers), AC- AC current convertors (AC choppers), DC- DC current convertors, DC-AC current convertors (inverter).

Industrial Actuators: (valves, relays, contactors, variable frequency drives, dc drives, motors).

Reference books:

1. S. K. Bhattacharya and S. Chatterjee, “Industrial Electronics & Control”, Tata Mc Graw Hill, 2003.
2. Instrumentation: Devices and Systems, Edited by C. S. Rangan, G. R. Sarma, V. S. V. Mani, Tata McGraw-Hill, 1983
3. Electrical Measurements and Instrumentation Edited by Uday A. Bakshi, Late Ajay V. Bakshi Technical Publications, 01-Nov-2020
4. Charles A. Schuler and William.L. Mc. Namee, “Indistrial Electronics and Robotics:, International McGraw Hill, 1986.
5. Thyrister & its applications , Ramamurthy East West Press, New Delhi

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

M.Sc. [Part- II] (Electronic Science)

Major Core Compulsory Practical Course

Semester III: ELS 604 MJP: Practical Course V

Credits	Practical Hours	Total Practical	Continuous Internal Assessment	End Semester Examination
02	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

At the end of this course, student should be able to

CO1	Understand the principle of Electric field and Magnetic field on various conductors.
CO2	Design and develop circuit for Measurement/Determination of performance parameters of semiconductor devices.
CO3	Analyze the circuit performance using different laboratory instruments and equipment.
CO4	Use the knowledge to design the applications useful for society/industry

Group A: Practical based on Electromagnetics and Microwaves (Any **FIVE**)

1. To study the characteristics of Klystron tube
2. To determine the standing wave ratio and reflection coefficient of a given waveguide
3. To determine the characteristics of a microstrip transmission line
4. Measurement of primary-secondary coupling factor of a given transformer using LCR meter (calculation of transformer model parameters expected)
5. To study VI Characteristics of GUNN Diode.
6. Study of PIN diode as a microwave switch.
7. To study different types of microstrip transmission lines
8. Impedance matching using Smith Chart.
9. Operation of Vector Signal Generator and Analyzer
10. To plot Equipotential contours and field lines for given charge distribution using C / MATLAB.
11. Use of Smith chart for transmission line parameters and verify using C.
12. Use of MATLAB for potential distribution in a region bound by two conductors.
13. To study different waveguides or waveguide parameters using simulation tool (any available)

Group B: Practical based on Foundation of Semiconductor Devices (Any **FIVE**)

1. Measurement of conductivity/resistivity of given sample using four probe method at different Temperature.
2. Measurement/Determination of Hall Co-efficient using Hall Effect Method.
3. Measurement of energy gap (Eg) of semiconductor device.
4. Designing and analysis of Crystal Oscillator using transistor.
5. Study of frequency response of Common source JFET amplifier.
6. Determination of h-Parameters of BJT.
7. Measurement of threshold voltage in linear and saturation region of MOSFET.
8. Measurement of I-V characteristics of MOS capacitor
9. Study of I-V characteristics of impact Avalanche Transit time (IMPATT) Diode.
10. Study of I-V characteristics of TRAPATT Diode

Activity: (Any 1: Equivalent to 2 Practicals)

1. Industrial Visit/Field Visit
2. Do it yourself (Design and develop circuit of any one/two experiment given in part A or B other than selected for practical course for Measurement/Determination of performance parameters of semiconductor devices)
3. Seminar/presentation on identified topics related to semiconductor devices in Electronics

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Core Compulsory Practical Course
Semester III: ELS 605 MJP: Practical Course VI

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

CO1	The course enables students to understand and apply the principles of amplifiers in temperature measurement.
CO2	It provides hands-on experience in PLC programming and its application
CO3	The course equips students with the skills to design and calibrate measurement devices for various physical quantities like light intensity, pressure, and temperature.
CO4	It also introduces students to the design and testing of practical devices such as smoke detectors and soil moisture measurement tools.

List of Practicals on Advanced Industrial Electronics (Any 10)

1. To study Characteristics of power devices like BJT/MOSFET/IGBT/Triac
2. Half Controlled Bridge Rectifier with R-LOAD, RL-LOAD
3. Fully Controlled Bridge Rectifier with R-LOAD, RL-LOAD
4. Step Down Chopper using MOSFET
5. Step Up Chopper using MOSFET
6. Single-Phase PWM Inverter using IGBT
7. Gate firing circuits for SCR's
8. To study, understand and design gate drive circuits for MOSFET.
9. To study, understand and design gate drive circuits for IGBT.
10. SCR Series Inverter
11. SCR Parallel Inverter
12. To design, build and test triggering circuit using PUT.
13. To study High frequency heating / induction heating
14. Single-Phase Cycloconverter
15. Single Phase AC Regulator With Resistive Load
16. Study and construct a simple crane using a solenoid as an electromagnet to pick up small metal objects.
17. Study and construct a door lock mechanism using solenoid.
18. Controlling the flow of a liquid or gas using solenoid valve.
19. Study and construct an electric bell using a solenoid.

Activity: (Any 1: Equivalent to 2 Practicals)

1. Study and survey of Solenoids.
2. Study and survey of Smart sensors.
3. Study and survey of dosing Pumps.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Core Compulsory Practical Course
Semester III: ELS 631 RP: Research Project/Internship

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
4	**8 Hours/Week**	**-**	**30 Marks**	**70 Marks**

Students will undertake projects/Internship to enhance their understanding in various emerging areas. This will help to equip students with the current trends and will instill in them a spirit of enquiry and scientific temperament.
The 4 credit project- based course will be evaluated for a total of 100 marks. Internal Assessment will be based on continuous evaluation of the student. The student will be evaluated on ability to search, read and assimilate literature related to the project, regularity and perseverance at experiments and maintenance of data notebooks.

Course Objectives:

1. To enable the students to undertake research projects/ Internship that are relevant and important.
2. To apply pre-learnt concepts to design research problem with help of literature survey.
3. To enable students to do sufficient groundwork in terms of preparing the outline of research plan which includes grants, infrastructural requirements and procurement of resources.
4. To allow students the opportunity to develop a thorough research proposal.
5. To encourage research culture which includes exploring collaborative project ideas.
6. To understand the importance of document design by compiling Technical Report on the Project /Research work carried out.

Outcomes:

1. Students will do the ground work for research in terms of identifying a relevant research topic (relevance will be decided based on the subject).
2. Identifying the queries and literature review.
3. Define well formulated specific objectives that help develop the overall research methodology.
4. Expose themselves to the responsibilities and ethics in industrial environment.
5. On completion of the course, student will be able to Understand, plan and execute a Research projects/ Industrial project /Project in individual or with team.

Execution of Research projects/ Industrial project /Project

- The project can be undertaken in house or in an industry or in a research/ service organization.
- Project can select by individual student.
- Project group shall consist of not more than 2 students per group.

- Research projects/ Industrial project /Project work should be carried out in the Design / Projects Laboratory.
- Project designs ideas can be necessarily adapted from recent issues of electronic design magazines. Application notes from well known device manufacturers may also be referred.
- Use of Hardware devices/components is mandatory.
- Layout versus schematic verification is mandatory.
- Assembly of components and enclosure design is mandatory.

Report writing: A project report with following contents shall be prepared:

- Title of Project
- Aim and objectives of project.
- Literature or Reference work.
- Block Diagram
- Circuit Diagram
- Selection of components, calculations.
- Experimental work performed.
- Simulation Results
- PCB Art work
- Testing Procedures
- Enclosure Design
- Results, discussion and conclusion.
- Applications
- Future Scope
- References
- Project report contain header of project title and footer with name of student

CIE Evaluation shall be done with marks distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing / analysis 25%
- Demonstration & Presentation 20%
- Report writing 20%

End Semester Evaluation (ESE):
The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. Evaluation will be done in batches, not exceeding 6 students in one batch.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Theory Course
Semester III: ELS 610MJ: Fundamentals of Electric Vehicle Technology

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	2 Hours/Week	30	15 Marks	35 Marks

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

CO1	Identify EV concepts, EV configurations and various EV parameters for better understanding of the EV technology.
CO2	Compare the EV propulsion system and electric motors for vehicular applications & power electronics converters required for their control.
CO3	Analyze DC motor & induction motor drives and discuss methods for controlling them.
CO4	Understand soft switching and hard switching converters.

UNIT 1: Introduction to Electric Vehicle (EV) & Hybrid Electric Vehicle (HEV) (15 Hrs.)

Introduction to EV & HEV. Introduction: Past, Present & Future of EV, Current Major Issues. Comparison of EV Vs IC Engine. EV System: EV Configuration: Fixed & variable gearing, single & multiple motor drive. In-wheel drives EV Parameters: Weight, size, force, energy & performance parameters

UNIT 2: Electric Motor, EV Motor Drives and required Power Electronics and Control (15 Hrs.)

EV Propulsion- Electric Motor, DC Motor: Type of wound-field DC Motor, Speed control of DC Motor Induction Motor Drive, Comparison of EV power devices, introduction to power electronics converter, four quadrant DC chopper, Three-phase full bridge voltage-fed inverter, Soft-switching EV converters, comparison of hard-switching and soft-switching converter.

List of Reference Book:

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Theory Course
Semester III: ELS 611 MJ: Fundamentals and Applications of Raspberry PI using Python

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	2 Hours/Week	30	15 Marks	35 Marks

Course Outcomes:

After completion of the course, students will be able to

CO1	Understand the working of Raspberry Pi, its features, its Programming and how various components can be used with Raspberry Pi.
CO2	Understand the use of Single board Computer (Such as Raspberry Pi) for an embedded system application.
CO3	Develop familiarity with tools used to develop in an embedded environment.
CO4	Apply programming knowledge to various applications using Raspberry pi

UNIT 1: Architectural details of Raspberry Pi (12 Hrs.)

Single boards computer block diagram, types, Comparison of SBC models, Specifications, Introduction to Raspberry Pi, Comparison of various Raspberry Pi Models, Understanding SoC architecture and SoCs used in Raspberry Pi, Basic version Broad Com processor, Arm11 processor, Pin description of Raspberry Pi, On-board components of Raspberry Pi and their functions, I/O devices (Storage, display, keyboard and mouse), Network access devices,

UNIT 2: Programming using Python (18 Hrs.)

Introduction to Raspbian OS (Operating System), different types of Operating Systems, Installation and configuration, Preparing SD Card for OS Installation, Image Downloading.

Basic Python Programming (Script programming): Python Introduction, Python vs. Other Languages, Applications of Python, Interpreted Languages, use of Python shell and execute programs, General Purpose I/O (GPIO) and their control using Python, Use of the GPIO library to access the GPIO pins, Variables, Keywords, Operators and Operands, Data Types in Python, Flow Control structures, Conditional statements (If…Then…else), Functions: I/O function (GPIO, Digital), Time functions, Library functions Basic Arithmetic Programs: Addition, Subtraction, Multiplication, Division

Basic interfacing: LED, Switch, LCD, Interfacing sensors and Actuators to Raspberry Pi using Python.

REFERENCES/BOOKS:

1. Python Programming: A Modern Approach, Vamsi Kurama, Pearson
2. BeginnersGuide-4thEd-Eng_v2, Gareth Halfacree
3. Python Programming A Modular Approach with Graphics, Database, Mobile, and Web Applications, Sheetal Taneja,
4. Naveen Kumar, Pearson
5. Programming with Python, A User's Book, Michael Dawson, Cengage Learning, India Edition
6. Think Python, Allen Downey, Green Tea Press

7. Core Python Programming, W. Chun, Pearson
8. Introduction to Python, Kenneth A. Lambert, Cengage

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Theory Course
Semester III: ELS 612 MJ: Digital Signal Processing: Processor and Applications

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	2 Hours/Week	30	15 Marks	35 Marks

Course Outcomes:

After completion of the course, students will be able to

CO1	To get acquainted to fundamental aspects of Digital Signal Processing (DSP)
CO2	To become aware of mathematical background required for DSP
CO3	To learn design of digital filters and implementation on digital Signal Processor
CO4	To study DSP applications

Prerequisites: Laplace transform, z-transform (ZT), inverse z-transform (IZT), Fourier series, ROC, Pole-zero plot, types of signal and system.

Unit-1: Mathematical Tools for DSP and Digital Filter Design (18 Hrs.)

Fourier Transform (FT): Definition, Properties, Discrete Fourier Transform (DFT) and its inverse DFT, properties of DFT, Discrete Time Fourier Transform (DTFT) and IDTFT, properties of DTFT. Convolution: Linear, Circular convolution, Linear filtering method based on DFT.

Fast Fourier Transform (FFT), Radix 2 FFT algorithm: Decimation in time (DIT) and Decimation in Frequency (DIF), Correlation.

Digital Filter Design: Introduction, advantages, disadvantages, types – FIR and IIR. Finite Impulse Response (FIR) Filter: Concept, Linear phase FIR filter (only) advantages. Finite Impulse Response (IIR) Filter: Impulse Invariant Method.

Unit-2 Applications of DSP and its Processor (12 Hrs.)

Introduction to Fixed point Digital Signal Processors, TMS320X series DSP- Architecture, central processing unit, program control, programming issues, system issues, Introduction to floating point Digital Signal Processors.

Applications of DSP (only concept and block diagram): Adaptive Noise Cancellation, Adaptive Equalization, Data Transmission over Telephone Channels, Voice processing: generation, speech encoder, Noise Reduction and Echo Cancellation, Motion control and positioning, RADAR, SONAR, image processing.

Text Book:

1. Digital Signal Processing: S. Salivahan, Fourth Edition, McGraw Hill Education PVT. LTD., 2019.
2. Digital Signal Processing Using MATLAB V.4: Vinay K. Pingale, John Proakis, PWS Publishing.
3. Digital Signal Processing, N. G. Palan, Technova Publication.
4. TMS320F2812 DSP Processor Manual

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE

M.Sc. [Part- II] (Electronic Science)

Major Elective Theory Course

Semester III: ELS 613MJ: Nanotechnology

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	2 Hours/Week	30	15 Marks	35 Marks

Course Outcomes:

At the end of this course, students should be able to

CO1	Understand basic theories of physical properties of semiconductors
CO2	Design the various electronic device models
CO3	Understand important properties of electrons in solids
CO4	Understand the basic physics behind synthesis of nanomaterials by physical and chemical methods

UNIT 1: Properties and Synthesis of Nanomaterials (15 Hrs.)

Properties of Nanomaterials

Classification of materials: - Metal, Semiconductor, Insulator

Electronic Properties: - Band structures, Mobility, resistivity, relaxation time

Optical Properties: - Photo conductivity, Photovoltaic effect, optical absorption & transmission, photoluminescence, electroluminescence, LED, Concept of phonon.

Synthesis of Nanomaterials: -

Physical Methods: -Physical Vapour Deposition (PVD), Molecular Beam Epitaxy, Electric Arc Deposition, DC sputtering.

Chemical Methods: - Chemical bath deposition, Sonochemical synthesis, Sol-gel.

UNIT 2: Spectroscopic Techniques and applications (15 Hrs.)

Spectroscopic Techniques

UV visible spectroscopy, Infrared Spectroscopy, Raman Spectroscopy, Photoluminescence (PL), Photoelectron Spectroscopy (X-Ray Photoelectron Spectroscopy).

Applications of Nanomaterials:- Automobiles, Sport and toys, Textiles, Cosmetics, Medical field- Imaging, drug delivery, Cancer therapy, tissue repair. Agri and food, Space, defense and engineering

REFERENCES BOOKS:

1. Semicondcutor Devices, Physics and Technology, S. M. Sze, 3rd Edn., Wiley
2. Nanotechnology-Principle and Practices, Sulabha Kulkarni, 3rd Edn, Capital Publishing Co.
3. Introduction to Nanoelectronics Science, nanotechnology, Engineering and Applications, V. Mitin ,Viatcheslav A. Kochelap , Michael A. Stroscio Vladimir, Cambridge University Press 2008 .

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Practical Course
Semester III: ELS 614 MJP: Fundamentals of Electric Vehicle Technology Lab

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

CO1	Understand the features and architecture of Electrical Vehicles.
CO2	Understand the fundamentals of Motors.
CO3	Demonstrate various components of Electrical Vehicle.
CO4	Understand field work in EV workshop.

List of Practicals on Fundamentals of Electric Vehicle Technology (Any 09)

1. Study of Past, Present & Future of Electrical Vehicles with current major issues (Technical Report).
2. Comparative study of different types of EVs
3. Practical study of DC Motor driver circuits.
4. Practical study of BLDC motor.
5. Practical Study of Current Converters.
6. Practical Study of Three-phase Full Bridge Rectifier.
7. Implementation of the velocity profile of servo control.
8. Study of PMDC motor torque speed characteristics.
9. Basic Practical Study of DC-DC Converter (Chopper).
10. Study of various wheel parameters of Electrical vehicles.
11. Design soft switching EV Converters.
12. Design hard-switching EV Converters.

Activity: (Any 1: Equivalent to 3 Practicals)

1. Mini project on Electrical Vehicle.
2. EV Industrial Visit.
3. Publication of one research paper in a National/International conference proceeding.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science) Major
Elective Practical Course
Semester III: ELS 615 MJP: Fundamentals and Applications of Raspberry PI using Python Lab

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	**4 Hours/Week**	**15**	**15 Marks**	**35 Marks**

Course Outcomes:

CO1	Understand the various python commands for rpi.
CO2	To install and run the Python interpreter.
CO3	Understand Strings, Lists, Tuples and Dictionaries in Python.
CO4	To write python programs for rpi for various applications.

List of Practicals on Fundamentals and Applications of Raspberry PI using Python (Any 10)

1. Arithmetic operations using python programming.
2. OS installation on SD card.
3. Programming of Raspberry Pi to control LEDs attached to the GPIO pins.
4. Programming of Raspberry Pi to get feedback from a switch connected to the GPIO pins.
5. Programming of Raspberry Pi to detect temperature using temperature sensor.
6. Programming of Raspberry Pi to detect light intensity using photocell sensor.
7. Programming of Raspberry Pi for Motion detection.
8. Programming of Raspberry Pi for interfacing camera module.
9. Programming of Raspberry Pi for Obstacle detection using Ultrasonic/Distance sensor.
10. Programming of Raspberry Pi for Servo motor control.
11. Python Program for dc motor/stepper motor interfacing to RPi (Clockwise/ Anticlockwise).
12. Raspberry pi interfacing with IR sensor.
13. Raspberry pi interfacing with LCD.
14. Raspberry pi interfacing with OLED.
15. Programming of Raspberry Pi for Matrix keyboard / Touch screen interfacing.
16. Programming of Raspberry Pi for Fire sensor interfacing.
17. Interfacing of RPi to Real Time Clock display on LCD / HyperTerminal (I2C)

Activity: (Any 1: Equivalent to 2 Practicals)

1. Simulation of any 2 practicals from above mentioned list using Proteus/Multisim/Pspice/Labview software.
2. Industrial Visit.
3. Designing of target board for Raspberry Pi

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Practical Course
Semester III: ELS 616 MJP: Digital Signal Processing: Processor and Applications Lab

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	**4 Hours/Week**	**15**	**15 Marks**	**35 Marks**

Course Outcomes:

CO1	Study of different signal using MATLAB.
CO2	Understand fundamentals of Digital Filters and techniques.
CO3	Study of various transform techniques using MATLAB.
CO4	Understand tradeoffs in complexities between the two classes of filters-FIR and IIR.

List of Practicals on Digital Signal Processing using MATLAB (Any 10)

1. Basic Practical on Signals using Code to generate unit Impulse, unit step, exponential sequence
2. Linear Convolution: With and without using built in function.
3. Circular Convolution: With and without using built in function.
4. Cross correlation: With and without using built in function.
5. Auto-correlation: With and without using built in function.
6. Program for computing DFT of a sequence.
7. Program for computing DFT of a sequence using Decimation-In-Time FFT
8. Program for computing DFT of a sequence using Decimation-In-Frequency FFT.
9. Program for computing the spectrum of two sinusoids using FFT.
10. Study of Sampling theorem, Aliasing and its effect.
11. Program for design and demonstration of Butterworth/Chebyshev LPF.
12. Program for design and demonstration of Butterworth/Chebyshev HPF.
13. Program for design and demonstration of FIR-HPF filter using windowing techniques.
14. Program for design and demonstration of FIR-LPF filter using windowing techniques.
15. Program for up-sampling a sinusoidal signal by factor L.
16. Study of AM modulation and demodulation.
17. Demonstration experiment on image processing.
18. Study of TMS320X Processor
19. Blinking on-board LED of TMS320.
20. Acquisition of signal from ADC
21. Waveforms Generation using 12 BIT DAC
22. Access LCD in the Micro 2812 Development Board
23. Creating A Pulse Width Modulated Signal with A Fixed Duty Cycle

Activity: (Any 1: Equivalent to 2 Practicals)

1. MATLAB programs of DSP for any 2 practicals other than above list
2. Any 2 Practicals from above list using DSP Kit.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Practical Course
Semester III: ELS 617 MJP: Nanotechnology Lab

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

CO1	Understand synthesis of nanomaterial
CO2	Understand optical characteristic of nanomaterial
CO3	List out, identify and handle various equipment in the laboratory
CO4	Understand how to characterize nanomaterial

List of Practical for Nanotechnology (Any 10)

1. Review: Synthesis of Nanomaterial
2. Review: Chemicals used for synthesis of nanomaterial
3. Review of recent application of nanomaterial
4. Synthesis of Au nanoparticles by chemical method
5. Absorption study (UV-Vis) of Au nanoparticles
6. Synthesis of Ag nanoparticles by chemical method
7. Absorption study (UV-Vis) of Ag nanoparticles
8. Synthesis of CdS nanoparticles by chemical method
9. Absorption study (UV-Vis) of CdS nanoparticles
10. Synthesis of ZnO nanoparticles by chemical method
11. Absorption study (UV-Vis) of ZnO nanoparticles
12. Synthesis of TiO_2 nanoparticles by chemical method
13. Absorption study (UV-Vis) of TiO_2 nanoparticles
14. Determining energy bandgap of semiconductor using UV spectroscopy
15. XRD study of any of the above synthesized material
16. SEM micrograph study of any of the above synthesized material
17. PL study of any of the above synthesized material

Activity: (Any 1: Equivalent to 2 Practicals)

1) Visit to research lab
2) Study and survey of applications of nanotechnology.
3) Write a research article.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Core Compulsory Theory Course
Semester IV: ELS 651MJ: Advanced Embedded System Design

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
4	**4 Hours/Week**	**60**	**30 Marks**	**70 Marks**

Course Outcomes:
This course provides students in depth knowledge about Advanced Embedded System Design. At the end of this course, student should be able to

CO1	Comprehensive Understanding of ARM Cortex-M3 Processor Architecture
CO2	Understand advanced Programming Features and System Behavior
CO3	Learn different communication protocols
CO4	Proficiency in Cortex-M3 Programming and Advanced Features
CO5	Hands-On Implementation Skills for LPC176X and Peripheral Programming
CO6	Proficiency in Real-Time Operating Systems (RTOS) Concepts and Case Studies

UNIT 1: ARM Cortex-M3 Processor Architecture (15 Hrs.)

Introduction: What Is the ARM Cortex-M3 Processor, Background of ARM and ARM Architecture,Cortex-M3 Processor Applications, Registers, Operation Modes, MemoryMaps, The Pipeline, Bus Interfaces on the Cortex-M3, Other Interfaces on the Cortex-M3, Exceptions, Built-In Nested Vectored Interrupt Controller, Interrupt Behavior, Cortex-M3 Programming, Exception Programming, Advanced Programming Features and System Behavior, The Memory Protection Unit, Other Cortex-M3 Features, Debug Architecture, Debugging Components, Choosing a Cortex-M3 Product, Development Tools, Development Using the GNU Tool Chain.

UNIT-2 : ARM Cortex-M3 Processor Implementation (15 Hrs.)

LPC176X Introduction, Features, Applications, Device, information, Architectural overview, ARM Cortex-M3 processor, Block diagram, Memory maps, Clocking and Power control functions, Nested Vectored Interrupt Controller, Pin configuration, Pin connect block, GPIO, Ethernet, UART, CAN, SPI, I2C, Timer, Repetitive Interrupt Timer, System Tick Timer, PWM,Motor control PWM, ADC, DAC, RTC, WDT.

Programming: GPIO, LCD, UART, Timer, PWM, ADC, DAC, RTC

Unit-3 : Introduction to Operating Systems (15 Hrs.)

Brief history of OS, Operating system basics and types of operating systems The BIOS and Boot Process: BIOS Actions, Operating System, Boot Process System calls, files, processes, design and implementation of processes, communication between processes Memory Management: segmentation and paging Memories: virtual, cache etc.

Unit-4: Real Time Operating Systems (RTOS) (15 Hrs.)

Operating System basics, Types of Operating Systems, Tasks, Process, Threads, Multiprocessing and Multi tasking, Task Scheduling, Threads-Processes-Scheduling putting them together, Task Communication, Task Synchronization, Device Drivers, How to choose an RTOS.

CASE STUDIES OF RTOS: RT Linux, Micro C/OS-II, Vx works, embedded linux, tiny OS and basic concepts of android OS.

Text / Reference Books:

1. The Definitive Guide to the ARM CORTEX-M3 2nd edition, by Joseph Yiu.
2. Using the Free RTOS Real Time Kernel ARM Cortex-M3 Edition, by Richard Barry
3. UM10360 LPC176x/5x User manual.
4. Operating Systems Concept, Galvin, John Willey and Sons
5. Operating System Concepts and Techniques,M. Naghibzadeh.

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M.Sc. [Part- II] (Electronic Science)
Major Core Compulsory Theory Course
Semester IV: ELS 652 MJ: Robotics and Mechatronics

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
4	4 Hours/Week	60	30 Marks	70 Marks

Course Outcomes:

At the end of this course, students should be able to

CO1	Identify different components or blocks used in Robotics
CO2	Study of Operating Systems and Working Principals of Robotic Systems.
CO3	Compare different control mechanisms used in robotic systems
CO4	Identify different components or blocks in any mechatronic system.
CO5	Analyze mechatronic systems using system models and dynamic responses using transformation methods.
CO6	Distinguish different sensing and actuating mechanisms used in mechatronics and robotic systems

UNIT 1: Basic of Robotics (12 Hrs.)

Introduction: Definition and Classification of Robots, Laws of Robotics, Applications of Robots, Basic Components of Robot Systems.
Sensors in robot: Touch Sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.
Applications of robots: Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications.

UNIT 2: Robotics Design Concepts (12 Hrs.)

Basic Components of a Robot System: The Manipulator, Sensory Devices, Controller, Power Conversion Unit, An Implementation of a Robot Controller, Defining Robot Positions
Components and Structure of Robots: Symbolic Representation of Robots, Degrees of Freedom and Workspace, Robot manipulators types, Common Kinematic Arrangements, Accuracy and Repeatability,

UNIT 3: Mechanical and electrical actuation systems (18 Hrs.)

Mechanical actuation systems: mechanisms and their role in mechatronic systems, translational and rotational motion – degrees of freedom, kinematic chains – examples of links, toggle linkage, slider-crank etc. cams, gears – types, gear trains, gear ratios, uses of rotation-to-translational motion – rack and pinion, ball screw and links, Ratchet and pawl, belt and chain drives, bearings– types and uses, consideration of moment of inertia and torque for motor selection
Electrical actuation systems: Relays and applications with driver circuits.

UNIT 4: Dynamics and Robot Control (18 Hrs.**)**

Dynamics: deriving dynamical equations of a manipulator by deriving Euler–Lagrange equations by forming Lagrangian of a system Trajectory planning and generation, joint space schemes, Joint space schemes with via points. Cartesian straight line motion and circular motion, trajectory planning for orientation, difficulties in trajectory planning Independent Joint Control: basic structure of feedback control system, dynamics of PMDC motor, DC motor control system, set-point tracking using PD and PID compensator, Drive- train dynamics, trajectory interpolation Force control– static force / torque relationships, natural and artificial constraints, stiffness and compliance.

REFERENCES BOOKS:

1. Robot Engineering: An Integrated Approach, Klafter.R.D, Chmielewski.T.A, Prentice Hall of India Pvt. Ltd.
2. Robot Dynamics and Control, Spong and M. Vidyasagar, Wiley Student Edition.
3. Robotics: Fundamental Concepts and Analysis, Ashitava Ghoshal, Oxford Higher Education.
4. Industrial Robotics Technology: Programming and Applications, Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, Tata –McGraw Hill Pub. Co.
5. Mechatronics by W.Bolton, 4th Edition, Pearson.

SAVITRIBAI PHULE PUNE UNIVERSITY

M.Sc. [Part II] (Electronic Science)

Major Core Compulsory Practical Course

Semester IV: ELS 653 MJP: Practical Course VII

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	**4 Hours/Week**	**15**	**15 Marks**	**35 Marks**

Course Outcomes:

CO1	Programming Proficiency for Arithmetic and Logical Operations
CO2	Code Conversion Competency:
CO3	Hands-On Experience in Microcontroller Interfacing
CO4	Advanced Microcontroller Interfacing Skills.

List of Practicals on Advanced Embedded System Design (Any 10)

1. Simple ARM C Program for arithmetic and logical operations.
2. ARM C Program for Code conversion: Packed BCD to ASCII/ASCII to Packed BCD, Hex to decimal/Decimal to Hex.
3. ARM C Program for LED array and switch interfacing.
4. ARM C Program for LDR and relay interfacing.
5. ARM C Program for Two-digit 7-segment display/LCD (multiplexed/non-multiplexed) interfacing.
6. ARM C Program for Graphic LCD interfacing
7. Interfacing matrix keyboard to 32-bit microcontroller.
8. ARM C Program for LM35 interfacing using ADC and display output on LED/LCD.
9. ARM C Program for DAC interfacing (square wave, staircase, triangular, sine).
10. ARM C Program for dc motor/stepper motor interfacing (Clockwise/ Anticlockwise).
11. ARM C Program for Two digit frequency counter or event counter using timer.
12. ARM C Program for DC motor control using PWM / intensity control of LED.
13. ARM C Program for Matrix keyboard / Touch screen interfacing.
14. ARM C Program for Real Time Clock display on LCD / HyperTerminal (I2C).
15. Programming UART of 32-bit microcontroller.
16. Implementation of Multitasking using RTOS.
17. Implementation of Semaphore using RTOS.
18. Implementation of Mailbox using RTOS.

Activity: (Any 1: Equivalent to 2 Practicals)

1) Industrial Visit.
2) Mini Project.
3) Simulation study of any 2 Practicals from above list.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Core Compulsory Practical Course
Semester IV: ELS 654 MJP: Practical Course VIII

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

CO1	Understanding the development of Basic Robotic System.
CO2	Study of different motor drive for robotics application.
CO3	Study the Various Control Circuits for controlling motor drive.
CO4	Set up and implement mechatronic systems such as servo control using basic components like motors, sensors and actuators.

List of Practicals on Robotics and Mechatronics (Any 10)

1. Study of a DC servo motor.
2. Study of AC servo motor, its speed control/position control.
3. Study of BLDC motor, its speed control/position control.
4. Temperature Based Servo Motor Speed Control Using Arduino/Raspberry Pi.
5. Temperature Based Flow Control System Using Arduino/Raspberry Pi.
6. Temperature Based DC Motor Speed Control Using Arduino/Raspberry Pi.
7. Study of PMDC motor, its speed control.
8. Implementation of velocity profile of servo control.
9. Study of different components of Robots
10. Study of controller (Microcontroller/Arduino/Any other)
11. Study of motor driver circuits
12. Step wise movement of Servo motor
13. Rotation of DC motor in Clockwise and Anticlockwise direction
14. Study of Gear and Gear Ratios / Gear Train.
15. Distance measurement using ultrasonic sensor.
16. Positioning and orientation of Robot arm.
17. Design, built and program Robot for wireless control.
18. Study of linear variable differential transformer.
19. Using simulation software simulate 3 DOF Planer robot.
20. Using simulation software simulate 5 DOF robotic arm.
21. Analysis and Synthesis of 2DOF Planar Robot Using MATLAB

Activity: (Any 1: Equivalent to 2 Practicals)

1. Analysis and Synthesis of 2 DOF Planar Robot Using MATLAB
2. Develop obstacle avoiding robotic car.
3. Market Survey / Review of any advanced technology (related to the course).
4. Industrial / institutional / Research Center visit.
5. Using any software simulate 3 DOF Planer robot

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Core Compulsory Practical Course
Semester IV: ELS 681 RP: Research Project/Internship

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
6	12 Hours/Week	-	50 Marks	100 Marks

Students will undertake projects/Internship to enhance their understanding in various emerging areas. This will help to equip students with the current trends and will instill in them a spirit of enquiry and scientific temperament.

The 6 credit project- based course will be evaluated for a total of 200 marks. Internal Assessment will be based on continuous evaluation of the student. The student will be evaluated on ability to search, read and assimilate literature related to the project, regularity and perseverance at experiments and maintenance of data notebooks.

Objectives:

1. To facilitate substantial data collection for the proposed research work/Internship.
2. To carry out research following ethical aspects of research activities.
3. To compile and communicate the findings/conclusions / results obtained in the science community through various means of communication.
4. To enable students to put together a research paper that can be published or presented at conferences.

Course Outcomes:

1. Carry out a substantial research-based project.
2. Apply the knowledge for design and development of the selected project.
3. Use different software and hardware for testing, validation and verification of circuits for successful outcome of project.
4. Capacity development to analyze data and process research findings.
5. Use research findings to advance education theory and practice.
6. Focus on quality review of the research papers and may be published in peer reviewed journals or may be presented in conferences / seminars.
7. Expose themselves to the responsibilities and ethics in industrial environment.
8. Write Technical reports / research projects.

Execution of Research projects/ Industrial project /Project

- The project can be undertaken in house or in an industry or in a research/ service organization.
- Project can select by individual student.
- Project group shall consist of not more than 2 students per group.
- Research projects/ Industrial project /Project work should be carried out in the Design / Projects Laboratory.
- Project designs ideas can be necessarily adapted from recent issues of electronic design magazines. Application notes from well-known device manufacturers may also be referred.

- Use of Hardware devices/components is mandatory.
- Layout versus schematic verification is mandatory.
- Assembly of components and enclosure design is mandatory.

Guidelines for Project:

This Course should be conducted using following guidelines:

a) Project topic having weightage of 120 hours should be selected for this course.

b) The project experiment should be open ended.

c) It may be based on any topics of the syllabus.

d) There should be internal continuous assessment of project work in the form of seminars / presentation and continuous monitoring of work.

e) After completion of project, student has to submit the project report in the following format.

1) Title of Project
2) Aim and objectives of project.
3) Literature or Reference work.
4) Block diagram / Circuit diagram and its explanation in brief.
5) Design and development of hardware part of the project.
6) Design and development of software part of the project.
7) Experimental work performed.
8) Results, discussion and conclusion.
9) Applications
10) Future Scope
11) References

f) There must be observations, interpretations, conclusions, results of the project work.

g) Algorithm / flowchart, program strategy, module wise description of parts etc. be provided in case of projects related with programming.

h) Applications, usefulness, student's contribution must be clearly specified.

i) Further extension work may be suggested for better outcome of the project.

j) The presentation should be given by the student related to whatever work performed during project.

k) Demonstration of the model developed during project work should be included.

CIE Evaluation shall be done with marks distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing / analysis 25%
- Demonstration & Presentation 20%
- Report writing 20%

End Semester Evaluation (ESE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. Evaluation will be done in batches, not exceeding 6 students in one batch.

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M.Sc. [Part II] (Electronic Science)
Major Elective Theory Course
Semester IV: ELS 660 MJ: Advanced Electric Vehicle Technology

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	2 Hours/Week	30	15 Marks	35 Marks

Course Outcomes:

At the end of the course student will be able to

CO1	Identify HEV concepts, HEV configurations and various HEV parameters for better understanding of the HEV technology
CO2	Understand different Batteries and Batteries Characteristics
CO3	Understand different types of Battery Chargers
CO4	Analyze Battery Charging Infrastructure and Different Charging Stations

UNIT 1: HEV (Hybrid Electric Vehicle) (12 Hrs.)

Configuration of HEV (Series, Parallel, Series-parallel &Complex),
Power Flow control, Examples.
Power flow control in all HEV configurations.
Examples of HEV system performance.

UNIT 2: Energy Sources & Charging (18 Hrs.)

Different Batteries and Ultra-capacitors,
Battery characteristics (Discharging & Charging)
Battery Chargers: Conductive (Basic charger circuits, microprocessor-based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging),
Battery indication Methods Charging Infrastructure: Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move and-charge zone.

List of Reference Book

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel
4. https://www.niti.gov.in/sites/default/files/202108/HandbookforEVChargingInfrastructureImplementation081221.pdf

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Theory Course
Semester IV: ELS 661 MJ: Internet of Things

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	2 Hours/Week	15	15 Marks	35 Marks

Course outcomes:
This course enables students to know about basics of Internet of things and technologies used for the same.

CO1	Understand framework of Internet of things
CO2	Identify architecture, structure and security as well as privacy aspects in IoT
CO3	Understand Internet of Things technology
CO4	Design, develop and implement IoT systems for different applications

Unit 1: Fundamentals of IoT and Applications (15 Hrs.)
History of IoT, About objects/things in the IoT, The identifier in the IoT, Enabling technologies of IoT: Identification technology, Sensing and actuating technology, Connected objects' communication, Overview and Motivations IoT Definitions, General Observations, ITU-T Views, Working Definition, IoT Frameworks, Basic Nodal Capabilities.
Examples of Applications: Smart Metering/Advanced Metering Infrastructure, e-Health/Body Area Networks, City Automation, Automotive Applications, Home Automation, Smart Cards, Tracking (Following and Monitoring Mobile Objects).

Unit 2: IoT Mechanisms, Key Technologies and securities (15 Hrs.)
Structural Aspects of the IoT, Environment Characteristics, Traffic Characteristics, Scalability, Interoperability, Security and Privacy, Open Architecture.
Key Technologies: Device Intelligence, Communication Capabilities, Mobility Support, Device Power, Sensor Technology, RFID Technology: Introduction, Principle of RFID, Components of an RFID system, Satellite Technology**.**
Elements of IoT Security: Vulnerabilities of IoT, Security Requirements, Challenges for Secure IoTs, Threat Modeling: Threat Analysis, Use Cases and Misuse Cases, Activity Modeling and Threats, IoT Security Tomography.

Text/Reference books:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications
2. Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Willy Publications
3. Parikshit N. Mahalle& Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M.Sc. [Part- II] (Electronic Science)
Major Elective Theory Course
Semester IV: ELS 662 MJ: Digital Image Processing

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	2 Hours/Week	30	15 Marks	35 Marks

Course Outcomes:

At the end of this course, students should be able to

CO1	Understand the basics of digital image processing.
CO2	Comprehend the theoretical approach towards digital image processing.
CO3	Acquaintance with different image processing techniques and algorithms used in digital image processing.
CO4	Impart the knowledge of students through various real-life applications using MATLAB.

UNIT 1: Fundamentals of Digital Image Processing (13 Hrs.)

Introduction, application fields of DIP, image sensing and acquisition, overview of image representation and modelling techniques. The light and the electromagnetic spectrum. Elements of visual perception: luminance, brightness, contrast, hue, saturation and Mach band effect. Color image fundamentals: RGB and HIS models. Basic concepts of sampling and quantization, two-dimensional sampling theory, practical limitations in sampling (aliasing effect). Digital image representation, spatial and intensity resolution, image interpolation. The relationship between image pixels: neighbors, logical and arithmetic operation on images.

UNIT 2: Digital Image Processing Techniques and its Implementation (18 Hrs.)

Image Enhancement: transformation functions, histogram processing, image observation and noise models, fundamentals of spatial filtering, spatial operations like smoothing and sharpening spatial filters, false and pseudo color. Spatial and Transform features extraction: image pyramids, the Haar transform, Hough transform. Image Segmentation: fundamentals, point, line and edge detection, segmentation using morphological watersheds, edge detection, thresholding, region representation and description. Classification techniques: basic rules, need, unsupervised and supervised classification.

REFERENCES BOOKS:

1. Digital Image Processing - Rafel C. Gonzalez, Richard E. Woods, Pearson Third Edition, 2008.
2. Digital Image Processing using MATLAB - Rafel.C.Gonzalez, Richard .E.Woods and Steven L. Eddins, Second Edition, Pearson 2017.

3. Fundamentals of Digital Image Processing - Anil.K.Jain, Pearson, 2002.
4. Digital Image Processing - Keenneth R Castleman, Pearson Education, 1995.
5. Digital Image Processing - S Jayaraman, S Esakkirajan, T Veerakumar, Second Edition, McGraw Hill, 2020.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Theory Course
Semester IV: ELS 663 MJ: Integrated Circuit (IC) Technology and VLSI

Credits	Teaching Hours	Total Lectures	Continuous Internal Assessment	End Semester Examination
2	**2 Hours/Week**	**30**	**15 Marks**	**35 Marks**

Course Outcomes:
At the end of this course, student should be able to

CO1	To understand basic of Integrated Circuit (IC) Technology.
CO2	To know MOS Technology.
CO3	To understand design rules to be followed for drawing the layout of circuits
CO4	To know basics of thin films and deposition methods and VLSI fabrication processes.

UNIT 1: Introduction to Integrated Circuit (IC) and MOS Technology (15 Hrs.)
Introduction to Integrated Circuit (IC) Technology, Evolution of IC Technology, Advantages of VLSI, CMOS Logic : Inverter, NAND gate, NOR gate, Compound gates, Pass Transistors and Transmission Gates. nMOS Fabrication, CMOS Fabrication, BiCMOS Technology, Design Process of MOS devices: MOS Layers, Stick diagrams: Encoding for nMOS, CMOS and BiCMOS. nMOS design style, CMOS design style. Design rules and layout: Lambda-based design rules, Contact cuts, Brief Introduction to VLSI software's: Magic VLSI layouttool and Electric VLSI design system.

UNIT 2: VLSI Process Technology (15 Hrs.)
Wafer Fabrication, Thin Film Growth Thin Film Deposition Methods (in Brief): Chemical Bath deposition (CBD, SILAR), Spin-coating, Chemical Vapour Deposition. Diffusion: Four Probe method and Hall-Effect Measurement., Lithography (in Brief): Electron Beam lithography, X-ray lithography, Ion-beam lithography, Photo lithography, Etching (in Brief): Dry etching, Wet etching, Metallization, Assembly and Packaging.

REFERENCE BOOKS:

1. 'Basic VLSI Design', Douglas A. Pucknell and Kamran Eshraghian, 3rd Edition,Prentice Hall India, (1994).
2. 'VLSI Design', Partha Pratim Sahu, McGraw Hill Education, (2013).
3. 'CMOS VLSI Design - A Circuits and Systems Perspective', Neil H. E. Weste andDavid Money Harris, 4th Edition, Pearson Education, Inc., (2011).
4. 'Principles of CMOS VLSI Design: A Systems Perspective', Neil H. E. Weste andKamran Eshraghian, Addison Wesley Longman Publishing Co. (1985).
5. 'Modern VLSI Design - IP-Based Design', Wayne Wolf, 4th Edition, Prentice Hall,(2009).

6. 'Silicon Processing for the VLSI Era: Process technology', Stanley Wolf, Richard N. Tauber, Lattice Press, (1986).
7. 'VLSI Fabrication Principles: Silicon and Gallium Arsenide', Sorab K. Ghandhi, 2nd Edition, John Wiley & Sons, Inc., (1994).

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Practical Course
Semester IV: ELS 664 MJP: Advanced Electric Vehicle Technology Lab

Credits	Practical Hours	Total Practicals	Continuous Internal Assessment	End Semester Examination
2	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

At the end of the course student should be able to

CO1	Understand the practical parameters of Hybrid Electrical Vehicles.
CO2	Understand the fundamentals of Batteries
CO3	Demonstrate various components of Electrical Vehicle.
CO4	Understand various simulations in EV designing.

List of Practicals on Advanced Electric Vehicle Technology (Any 09)

1. Comparative analysis of EV and HEV. (Theoretical)
2. Study and analysis of power flow control in all HEV configurations.
3. Practical study of battery chargers. (Charging & Discharging process)
4. Design and study 4-cell battery.
5. Practical study of Ultra Capacitor.
6. Study and make a model of the Battery Swapping Station.
7. Study and make a model of Public Charging Infrastructure.
8. Study and make a model of the Fast Charging Station.
9. Program for LED array and switch interfacing. (Use any Software/Controller)
10. Program for DC motor control using PWM. (Use any Software/Controller)
11. MATLAB simulations for EV- Motors.
12. MATLAB simulations for EV-Lights.

Activity: (Any 1: Equivalent to 3 Practicals)

1. Practical design of two-wheeler Electrical Vehicle.
2. Visit the Battery manufacturing industry.
3. Visit the Battery charging station.
4. Publication of one research paper in a National/International journal.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Practical Course
Semester IV: ELS 665 MJP: Internet of Things Lab

Credits	Practical Hours	Total Practical	Continuous Internal Assessment	End Semester Examination
2	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

This practical course develops practical skills amongst students for use of IoT in various applications. At the end of the course student should be able to

CO1	Install and implement IoT systems using different microcontrollers
CO2	Demonstrate interfacing of LED, Buzzer, button and sensors to Arduino/Raspberry pi
CO3	Design, develop and implement IoT systems for basic applications such as ON/OFF LED etc
CO4	Understand methodology to design IoT systems

IoT based Experiments using Raspberry pi/NodeMCU/Arudino with ESP8266 (Any 10):

1. To get familarize with and perform necessary installation procedure.
2. Study of App or framework like BLYNK IoT; Installation and necessary steps.
3. IoT based program to interface LED/buzzer with ESP8266 and turn ON/OFF from BLYNK App.
4. IoT based program to interface LED/buzzer with ESP8266 and start blinking of LED when push button is pressed from BLYNK App/website.
5. IoT based program to interface LDR with ESP8266 and display notification on BLYNK App/website.
6. IoT based program to interface PIR with ESP8266 and display notification of human detection on BLYNK App/website.
7. IoT based program to interface optocoupler/IR pair with ESP8266 and display event detection on BLYNK App/website.
8. IoT based program to interface DHT11 sensor with ESP8266 and display temperature and humidity on BLYNK App/website.
9. IoT based program to interface MQ135 sensor module with ESP8266 and display air quality on BLYNK App/website.
10. IoT based program to interface MQ2/MQ7 sensor module with ESP8266 and display gas level on BLYNK App/website.
11. IoT based program to interface ultrasonic sensor o with ESP8266 and display distance measured on BLYNK App/website.
12. IoT based program to interface stepper motor with ESP8266 and control rotation from BLYNK App/website.

13. IoT based program to interface servo motor with ESP8266 and control rotation from BLYNK App/website.
14. IoT based program to interface dc motor with ESP8266 and control speed from BLYNK App/website.
15. IoT based program for home automation to interface relay with ESP8266 and turn ON/OFF bulb connected to relay from BLYNK App.
16. IoT based program for smart irrigation to interface soil moisture sensor with ESP8266 and turn ON/OFF water pump and display notification on BLYNK App.

Activity (Any 1: equivalent to 2 Practicals)

1. Simulation for any 3 practicals from above list using Proteus/Multism.
2. Designing of an IoT based mini project.
3. Use of different widgets from BLYNK App.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Practical Course
Semester IV: ELS 666 MJP: Digital Image Processing Lab

Credits	Practical Hours	Total Practical	Continuous Internal Assessment	End Semester Examination
2	4 Hours/Week	15	15 Marks	35 Marks

Course Outcomes:

CO1	Understand the basic mathematical operation used in digital image processing.
CO2	Implementation of syntax and tools essential for image processing in MATLAB software.
CO3	Familiarization with different image processing algorithms using MATLAB software.
CO4	Impart the knowledge of students practically by implementing the algorithms for various real-life applications using MATLAB.

List of Practicals on Digital Image Processing Lab (Any 10)

1. Implementation of image enhancement techniques in MATLAB.
2. Implementation of color image enhancement techniques in MATLAB.
3. To provides the thresholding in MATLAB.
4. Evaluation of digital image using histogram equalization in MATLAB.
5. Study & implementation of different point operation techniques in MATLAB.
6. Study & implementation of spatial operation filtering techniques in MATLAB.
7. Study of edge detection technique using different operator in MATLAB.
8. Study of region representation technique using different operator in MATLAB.
9. Study and implementation of a segmentation techniques in MATLAB.
10. Study and implementation of morphological watersheds algorithm in MATLAB.
11. Implementation of boundary representation in MATLAB.
12. Implementation of boundary detection in MATLAB.
13. Study image restoration application using filtering techniques in MATLAB.
14. Implementation of unsupervised classification techniques in MATLAB.
15. Implementation of supervised classification techniques in MATLAB.

Activity (Any 1: equivalent to 2 Practicals)

1. Implement a case study on any one real life application using various image processing techniques studies in the theory (equivalent to 3 experiments).
   Make a report of not more than 10 page with the details viz. introduction, flowchart, program, result and discussion, conclusion, references.
2. Market survey / review of any advanced technology (related to the course).
3. Industrial / institutional / research centre visit.

SAVITRIBAI PHULE PUNE UNIVERSITY
M.Sc. [Part II] (Electronic Science)
Major Elective Practical Course
Semester IV: ELS 667 MJP: Integrated Circuit (IC) Technology and VLSI Lab

Credits	Practical Hours	Total Practical	Continuous Internal Assessment	End Semester Examination
2	**4 Hours/Week**	**15**	**15 Marks**	**35 Marks**

Course Outcomes:

At the end of this course, student should be able to

CO1	To understand basics of Stick diagram and Layout design.
CO2	To acquire the skills useful for drawing Stick diagram and Layout design.
CO3	To acquire the skills required for thin film deposition and Characterization.
CO4	To use software tools to draw the Layout design.

List of Practicals on Integrated Circuit (IC) Technology and VLSI (Any 10)

1. Draw the circuit diagram and stick diagram and the layout according to lambda based design rules for nMOS inverter.
2. Draw the circuit diagram and stick diagram and the layout according to lambda based design rules for CMOS inverter.
3. Draw the circuit diagram and stick diagram and the layout according to lambda based design rules for nMOS NAND Gate.
4. Draw the circuit diagram and stick diagram and the layout according to lambda based design rules for CMOS NAND Gate.
5. Draw the circuit diagram and stick diagram and the layout according to lambda based design rules for nMOS NOR Gate.
6. Draw the circuit diagram and stick diagram and the layout according to lambda based design rules for CMOS NOR Gate.
7. Draw the circuit diagram and stick diagram and the layout according to lambda based design rules for nMOS 4-way multiplexer.
8. Deposit the thin/thick film by any suitable method.
9. Characterization and Analysis of the thin/thick film.
10. Deposit the photoresist material and transfer pattern using the mask on it.
11. Four Probe Experiment. – Resistivity of Si Wafer.
12. Hall-effect Experiment - Doping Profile.

Activity (Any 1: equivalent to 2 Practicals)

1. Layout Design using Magic/Electric VLSI Software tools (at least 4)
2. MOOCs course relevant to VLSI Design.