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 2023-24

Preamble

This model curriculum content for M. Sc. Electronic Science as per NEP – 2020, is intended to enable the post graduates to respond to the current needs of the industry and equip them with skills relevant for national and global standards. The framework encourages innovation in teaching learning process and appropriate assessment of student learning levels.

Introduction:

M. Sc. Electronic Science is a program which needs to develop a specialized skill set among the graduates to cater to the need of industries. The curriculum is designed to help the learners to analyse, appreciate, understand and critically engage with learning of the subject and also to provide better learning experience to the graduates. Apart from imparting disciplinary knowledge, the curriculum is aimed to equip the graduates with competencies like problem solving and analytical reasoning which provide them high professional competence. The Department/Institute/University is expected to encourage its faculty concerned to make suitable pedagogical innovations, in addition to teaching/learning processes suggested in the model curriculum, so that the Course/Programme learning outcomes can be achieved.

Significance:

In recent years, Electronics has made unprecedented growth in terms of new technologies, new ideas and principles. The research organizations and industries that work in this frontier area are in need of highly skilled and scientifically oriented manpower. This manpower can be available only with flexible, adaptive and progressive training programs and a cohesive interaction among the institutions, universities, and industries. The key areas of study within subject area of Electronics comprise of Semiconductor Devices, Analog and Digital Circuit design, Microprocessors & Microcontroller Systems, Computer Coding/ Programming in high level languages etc. and also modern applied fields such as Embedded Systems, Data Communication, Robotics, Control Systems, Nano Electronics and Nano Electronic Devices etc.

Eligibility criteria

Students who have qualified B.Sc. Electronic Science / Electronics, B.Sc. (IT), B.E. (Electronics/Electronics and telecommunication / Electrical / Instrumentation / IT), B.Sc. General with one of the subjects as Electronics.

Programme Outcomes: M. Sc. Electronic Science

PO1	Aptitude to apply Logic thinking and Basic Science knowledge for problem solving in various fields of electronics both in industries and research. .
PO2	Apply the knowledge of mathematics, science and electronics to the solution of problems
PO3	Provide students with learning experiences that develop broad knowledge and understanding of key concepts of electronics and equip students with advanced scientific/technological capabilities for analyzing and tackling the issues and problems in the field of electronics
PO4	Understand solutions for electronic and allied systems and design system modules or processes that meet the specified needs with appropriate societal and industrial consideration/leading to effective entrepreneurship
PO5	Choose and apply appropriate modern tools/frameworks/platforms, software simulators, techniques, resources, and modern technology and IT tools for solving problems with an understanding of the limitations.
PO6	Function effectively as an individual, and as a member or leader in diverse teams.
PO7	Communicate effectively on activities with the science and technology community and with the society at large, such as, being able to comprehend and write effective reports and make effective presentations

PO8	Ability to design / develop/manage/ operation and maintenance of sophisticated electronic gadgets / systems / processes that conforms to a given specification within ethical and economic constraints.
PO9	Provide students with skills that enable them to get employment in industries or pursue higher studies or research assignments or turn as entrepreneurs.

Programme Specific Outcomes (PSOs)

PSO1: At the end of the two-year M. Sc. Electronic Science programme, the student will understand and be able to explain different branches of Electronics such as Electronic Devices and Circuits, Linear and Digital Integrated Circuits, Communication, Analog and Digital Electronics, Microprocessors, Microcontrollers, Embedded Systems, Smart Sensors, Digital Signal Processing, Embedded System Design, Mobile Communications, etc.

PSO2: Courses in foundational subjects like Network Analysis, Electronic Devices and Circuits, Linear Integrated Circuits, Linear and Digital Integrated circuits, Advanced Microcontrollers, Embedded System Design, etc. have a prominent lab component, offering hands-on training and exercises on numerous practical aspects of crucial importance.

PSO3: An ability to understand the basic concepts in Electronics & Communication and to apply them to various areas, like Electronics, Communications, Embedded systems etc., in the design and implementation of systems.

PSO4: An ability to solve Electronics and communication problems, using latest hardware and software tools, along with analytical skills to arrive at cost effective and appropriate solutions.

PSO5: Skill development by undertaking supervised projects by students with a flexibility to balance between research- and application-oriented work that require innovative approaches.

The Overall course structure is summarized in the table below:

Courses	Credits
Core Courses	
Major Core Theory	42
Major Core Practicals	30
Elective Courses	
Major Elective (Theory)	8
Major Elective (Practicals)	8
Total number of credits for award of PG degree	**88**

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 506 MJ	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 PIC Microcontroller	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 556 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 606 RP	Research Project	**4**
Major Elective Theory (Any one)		
ELS 610 MJ	Fundamentals of Electric Vehicle Technology	2
ELS 611 MJ	Industrial Internet of Things 1	**2**
ELS 612 MJ	Fundamentals and applications of Raspberry PI using Python	**2**
ELS 613 MJ	Nanotechnology	
Major Elective Practical (Any one)		
ELS 613 MJP	Fundamentals of Electric Vehicle Technology Lab	**2**
ELS 614 MJP	Industrial Internet of Things 1 Lab	**2**
ELS 615 MJP	Fundamentals and applications of Raspberry PI using Python Lab	**2**
ELS 616 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	Advance 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 655 RP	Research Project / Internship	**6**
Major Elective Theory (Any one)		
ELS 660 MJ	Advanced Electric Vehicle Technology	**2**
ELS 661 MJ	Industrial Internet of Things 2	**2**
ELS 662 MJ	Digital Image Processing	**2**
ELS 663 MJ	Integrated Circuit (IC) Technology and VLSI	**2**
Major Elective Practical (Any one)		
ELS 663 MJP	Advanced Electric Vehicle Technology Lab	**2**
ELS 664 MJP	Industrial Internet of Things 2 Lab	**2**
ELS 665 MJP	Digital Image Processing Lab	**2**
ELS 666 MJP	Integrated Circuit (IC) Technology and VLSI Lab	**2**
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- I] (Electronic Science)
Major Core Compulsory Theory Course
Semester I: ELS 501 MJ: Analog System Design

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

Course Outcomes:

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

CO1	Understand basic theories with their characteristics and the working of semiconductor devices.
CO2	Design the various electronic device models
CO3	Understand and compare different wideband and narrowband amplifiers using BJT
CO4	Understand the basic theory and design of tuned amplifiers and oscillators with applications
CO5	Study, design and develop Opamp applications with practical considerations.
CO6	Develop skills in the analysis and design of analog systems and their applications

UNIT 1: Basic Semiconductor Devices (1 Credit)

Practical diode characteristics (static and dynamic resistance), temperature effects, switching characteristics, diode breakdown, diode applications in wave shaping circuits BJT construction and biasing, Operation, CC, CB and CB configurations Construction of JFET, types and its operation, parameters of JFET, JFET characteristics, comparison of BJT and JFET, JFET amplifiers MOSFET, depletion and enhancement, biasing of MOSFET, applications

UNIT 2: Frequency Response of Amplifiers (1 Credit)

BJT models and modeling parameters, equivalent circuits for CE, CB and CC configurations, single stage amplifier, small signal analysis, distortion Design of single stage RC-coupled amplifier with frequency response (f1 and f2) Frequency Response: Low and High frequency equivalent circuit, bode plots, Miller effect, square wave testing, frequency response of multistage amplifiers, different coupling schemes and gain of multistage amplifiers

UNIT 3: Tuned Amplifier and Oscillators (1 Credit)

Tuned amplifier design, multistage tuned amplifiers: synchronous and stagger tuning cascade configuration, large signal tuned amplifier Oscillators: design and analysis of LC and RC oscillators, Hartley, Colpitt's, Miller oscillators, phase shift and Wien-bridge oscillators, crystal oscillators, and applications

UNIT 4: Operational Amplifiers and their Applications (1 Credit**)**

Practical consideration in opamp-based circuit design, opamp parameters such as dc and low frequency parameters and their significance in the design of opamp, closed loop stability analysis, and frequency compensation. Inverting and non-inverting amplifiers with design aspects such as input and output impedance, common mode errors and limitations, bandwidth, etc. Bridge and instrumentation amplifier Practical design aspect of integrator and differentiators, such as offset error and stability, bandwidth considerations. Concept and applications of PLL. Active Filters: transfer functions poles and zeros, Design of active filters - LPF, HPF, BPF, and BRF (first and higher orders), Butterworth and Chebyshev filters.

REFERENCES BOOKS:

1. Electronic Devices and Circuits, S. Salivahanan, N. Suresh Kumar, 3rd Edn, McGraw Hill.
2. Electronic Devices and Circuit Theory, Robert Boylestead, Louis Nashelsky, PHI.
3. Design with Operational Amplifiers and Linear IC, Sergio Franco, 3rd Edn, TMH.
4. Electronic Principles, Malvino and Bates, McGraw Hill.
5. Operational amplifier, G.B.Clayton, Elsevier Sci. Tech.
6. Microelectronic Circuits: Analysis and Design, Mohammad H. Rashid, PWS Publishing Company.
7. Pulse, Digital Switching Circuits, Millman Taub, TMH.
8. Electronic devices, Allen Motershed, PHI.
9. Integrated electronics, Millman Halkies, McGraw Hill.

SAVITRIBAI PHULE PUNE UNIVERSITY

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

Major Core Compulsory Theory Course

Semester I: ELS 502 MJ: Advanced Digital System Design using Verilog

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

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

CO1	Understand combinational and sequential logic design techniques.
CO2	Know and understand structure of HDL and Verilog.
CO3	Learn various digital circuits using VERILOG.
CO4	Use Verilog effectively for simulation, verification and synthesis of digital system.
CO5	Learn PLD, CPLD, FPGA, memories and their applications.

UNIT 1: PLDs and Memories (1 Credit**)**
Programmable Logic Devices(PLD): Need of PLD, architecture of simple PLD (SPLD), PROM, PAL, PLA, GAL, Complex Programmable Logic Device (CPLD) and Field Programmable Logic Devices (FPGA) CPLD/FPGA based system design applications - typical combinational and sequential system implementation, LUTs
Memories: types, data storage principle, control inputs, and timings, applications, Random Access Memories (RAM), Static Ram (SRAM), standard architecture, 6 transistor cell diagram, sense amplifier, address decoders, Dynamic RAM (DRAM), different DRAM cells, refresh circuits, role of memories in PLD

UNIT 2: Introduction to Verilog HDL (1 Credit**)**
Introduction, design flow, data types, modules and ports, operators, gate- level modeling, data flow modeling, behavioral modeling, tasks and functions, timing and delays, test bench, types of test bench, comparison between VERILOG and VHDL language

UNIT 3: Combinational Logic Circuit design and Verilog Implementation (1 Credit)
Introduction to combinational circuits, realization of basic combinational functions - magnitude comparator, code converters, multiplexers, demultiplexers, multiplexed display, encoder and decoders, priority encoders, parity generator/checker, arithmetic circuits (adder, subtractor), parallel adder, look ahead carry generator. VERILOG models and simulation of above combinational circuits.

UNIT 4: Sequential Logic Circuit Design and Verilog Implementation (1 Credit**)**
Introduction to sequential circuits, Flip Flops: types, state table, excitation tables, Counters: synchronous, asynchronous, design of counters, up/down counter Shift Registers, ringcounter, Johnson counter.
Finite State Machine (FSM) Design: Mealy and Moore state machines, stepper motor controller,

traffic light control, coffee vending machine.
VERILOG Models and Simulation of above Sequential Circuits.

REFERENCES/BOOKS:

1. Verilog HDL; A Guide to Digital Design and Synthesis, Samir Palnitkar, Pearson Education, 2nd edition, 2003.
2. Verilog HDL synthesis; A Practical Primer, J. Bhaskar, Star Galaxy Publishing, 1998.
3. Digital System Design with VERILOG Design, Stephen Brown, Zvonko Vranesic, TMH, 2nd Edn, 2007.
4. Digital Fundamentals, Floyd and Jain, Pearson Education, ISBN: 8177587633
5. Modern Digital Electronics, R.P Jain, McGraw Hill.
6. Digital systems; Principles and Applications, Tocci, Pearson Education.

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M. Sc. [Part- I] (Electronic Science)
Major Core Compulsory Theory Course
Semester I: ELS 503 MJ: Mathematical Methods in Electronics

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

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

CO1	To know about mathematical tools and techniques for network analysis
CO2	To learn the methods of analysis for CT and DT signals and systems
CO3	To learn concept of mathematical modeling of simple electrical circuits
CO4	To get familiar with role of differential equations in applied electronics
CO5	To solve mathematical methods using MATLAB programming
CO6	To learn various advanced features, graphics and interfacing

UNIT 1: MATLAB Programming Electronic Signals and Mathematical Tools for Circuit Analysis (1 Credit**)**

Introduction to MATLAB: Constants, Variables, Vectors and Matrices Operations, Two Dimensional and Tree Dimensional Plots, Control Structures.

Signals: periodic, non-periodic, Continuous Time (CT) and Discrete Time (DT), special electronic signals (impulse, unit step, sinusoidal, ramp, square wave, staircase) Laplace Transform (LT): definition, LT of standard electronic signals, inverse LT, methods of ILT (partial fraction method), properties of LT (shifting, linear, scaling), initial and final value theorem, Convolution theorem, LT of derivatives and Integrals, solution of DE using LT.

MATLAB exercise: Representation of various signals using MATLAB

To solve the Laplace transform and Inverse Laplace transform using MATLAB.

UNIT 2 Transfer functions, Z transform and Differential Equations. (1 Credit**)**

Concept of Transient and steady state response of systems using transfer function, poles and zeros of transfer function and their significance, applications to simple passive filters such as Low Pass (LP), High Pass (HP), Concept of transfer function of CT and DT systems. Differential Equation, Ordinary Differential Equations (ODE), DE and their occurrences in real life problems, linear differential equation with constant coefficients, partial DE, Introduction to coordinate systems (rectangular, cylindrical and spherical), method of separation evaluate representation of various signals of variables.

MATLAB exercise: Poles and Zeros Plots using MATLAB.

MATLAB Programs for filter application.

Differential equation representation and solution using MATLAB.

REFERENCES/BOOKS:

1. Amos Gilat MATLAB : An introduction with applications Wiley India

2. G K Mittal Network Analysis Khanna Publishers , New Delhi

3.Van Valkenberg Network Analysis, 3rd Edition Dorling Kindersley (India) Pvt Ltd.

4. Raj Kumar Bansal, Ashok Kumar Goel, Manoj Kumar Sharma, MATLAB and its Application in Engineering, Pearson Publication.

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M. Sc. [Part- I] (Electronic Science)
Major Core Compulsory Practical Course
Semester I: ELS 504 MJP: Practical Course I

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 this course, student should be able to

CO1	To design and develop different analog and digital systems
CO2	To analyze the circuit performance using different laboratory instruments and equipments
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. Practical based on Analog System Design (Any 6)

1. Bootstrap ramp generator for delay triggering
2. Tuned amplifier small signal / large signal for IF
3. Voltage controlled current source / sink and current mirror and doubler
4. Comparator and Schmitt trigger with single supply operation
5. Second order Butterworth filters (BP and BR)
6. V to F and F to V using commercially available IC
7. Instrumentation amplifier for a given gain
8. PLL characteristics and demonstrate any one application (IC565/CD4046)

B. Practical based on Advanced Digital System Design using Verilog (Any 6)

1. Two digit combinational lock
2. Keyboard encoder
3. Traffic light controller
4. Multiplexed display (Bank token / two digit counter)
5. Bidirectional stepper motor control (Sequence Generator)
6. 4-bit synchronous counter
7. One digit BCD adder
8. Object counter

C. Activity (Equivalent to 3 practicals)

1. Industrial Visit/Field Visit
2. Do it Yourself (Design any one/two experiment given in part A or B other than selected for practical course)
3. Simulation Experiments using different EDA tools

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M. Sc. [Part- I] (Electronic Science)
Major Core Compulsory Practical Course
Semester I: ELS 505 MJP: Practical Course II

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 this course, student should be able to

CO1	To acquire the skill of Verilog programming for digital circuits
CO2	To use MATLAB effectively for solving mathematical problems
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. Practical Based on VERILOG Programming and Implementation on CPLD or FPGA(Any 6)

Use xilinix or equivalent software for simulation and implementation on FPGA (Spartan series)

1. Parity Generator and checker
2. Up-down bit binary counter (minimum 4-bit)
3. Universal shift register
4. Four bit ALU design (structural modelling)
5. Designing of Traffic light Controller
6. Implementation of 8 bit multiplexer
7. Code Converter (BCD to seven Segment)
8. Practical based on state machine (Stepper sequence generator/Vending Machine/traffic light controller)

B. Practicals based on MATLAB Programming (Any 6)

1. Basic MATLAB Operation on Matrix and Study of Various MATLAB Plot Commands.
2. Frequency response from transfer function of a CT system: Low Pass and High Pass and Effect of locations of poles and zeros on the transfer function and corresponding frequency response
3. Plot of various waveforms using MATLAB
4. Phase and frequency response from transfer function of a DT system: Low Pass and High Pass.
5. Transient and steady state response of CT system: LCR series circuit with different inputs.
6. Simulation of transfer function using poles and zeros.
7. Synthesis of periodic waveform from Fourier coefficients.
8. Solution of differential equation with given boundary conditions.

C. Activity (Equivalent to 3 practicals)

1. Industrial Visit/Field Visit
2. Do it Yourself (Design any one/two experiment given in part A or B other than selected for practical course)
3. Seminar/presentation on identified topics related to Electronics

SAVITRIBAI PHULE PUNE UNIVERSITY, PUNE
M. Sc. [Part- I] (Electronic Science)
Major Core Compulsory Theory Course
Semester I: ELS 506 MJ: Research Methodology

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

Course Outcomes:

After completion of this course student will be able to

CO1	Understand right concepts about research
CO2	Understand steps in research methodology
CO3	Understand different types of research methods
CO4	Know about statistical techniques to analyze the research data
CO5	Write research report and proposal
CO6	Get familiar with different presentation techniques

UNIT 1: Essentials of Research (1 Credit)

History of research. Indian, Egyptian, Greek ideas methodologies and research in agriculture, chemistry, metallurgy, medical. Ancient Indian research methodology applications Statistical analysis and its significance. Exploratory and confirmatory research, Planned and ad-hoc methods of data collection, Non-response and methods of recovering the missing response, Various softwares for statistical analysis. Error and noise analysis, curve fitting

UNIT 2: Research Methods and ethics (1 Credit)

Creating questionnaire. Data analysis from answers, Selection of research topic (case study based). Selection of research topic (case study based), Literature search, selection of research topic (case study based), maintaining laboratory records (case study based). Safety in Laboratories, Ethical considerations,

UNIT 3: **Research Skills (1 Credit)**

Writing research paper and/or thesis, making a presentation, writing a research proposal, and patents in Science and technology, Effective verbal and non verbal communication, field data collection, safety in field.

UNIT 4: Case Studies (1 Credit)

Case study description for identified research methods

REFERENCES/BOOKS:

Research Methodology: Methods and Techniques, C. R. Kothari, New Edge International Publisher

SAVITRIBAI PHULE PUNE UNIVERSITY

M. Sc. [Part I] (Electronic Science)
Major Elective Theory Course
Semester I: ELS 510 MJ: Fundamentals of Instrumentation Systems

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

Course Outcomes:

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

CO1	Understand different measurement methods and errors associated with them.
CO2	Know the different standards and calibration methodologies adopted in the measurement systems.
CO3	Know different AC and DC bridges for the measurement of R, L and C.
CO4	Know different types of Oscilloscopes and Analyzers (Analog and Digital).
CO5	To study the techniques involved in various types of instruments.

UNIT 1: Introduction to measurements and measurement systems (1 Credit)

Physical measurement. Forms and methods of measurements. Statistical analysis of measurement data. Standards. Definition of standard units. International standards. Primary standards. Secondary standards. Working standards. Voltage standard. Resistance standard. Current standard. Capacitance standard. Time and frequency standards, Standards for Mass, Length and Volume, Standards of Temperature and Luminous Intensity, IEEE Standards.

Definition and significance of measurement, classification of instruments and types of measurement applications, elements of an instrument / measurement system, active and passive transducers, analog and digital modes of operation, null and deflection methods, input-output configuration of instruments and measurement systems, methods of correction of instruments and measurement systems.

UNIT 2 Measuring instruments and their performance (1 Credit)

Generalized performance characteristics and errors of instruments: Static and dynamics characteristics of measurement system, Errors in measurement: Types of Errors - gross, systematic, environmental errors, systemic errors, computational error, personal error.

Measurement instruments: Measurement techniques for R, L, C, voltage, current, power, energy, frequency and phase.

Specifications, performance parameters and applications: LCR Meter, Analog and Digital millimeters, CRO. Digital storage oscilloscope: specifications, performance parameters and applications. Review of signal sources, synthesized signal source and arbitrary waveform generator. Review of instrumentation for signal analysis - digital frequency meter and spectrum analyzer.

REFERENCES/BOOKS:

1. Measurement Systems, Applications and Design, by Ernest O. Doeblin and Dhanesh N. Manik, 5thEdition, TMH
2. A Course in Electrical and Electronic Measurements and Instrumentation, by A.K. Sawhney,DhanpatRai.
3. Electronic Instrumentation, by Kalsi, TMH.
4. Modern Electronic Instrumentation and Measurements Techniques, by Cooper and Helfrick, PHI

SAVITRIBAI PHULE PUNE UNIVERSITY

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

Major Elective Theory Course

Semester I: ELS 511 MJ : Introduction to Artificial Intelligence and Machine Learning

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

Course Outcomes:

This course provides students in depth knowledge about different types of Artificial Intelligence and Machine Learning. At the end of this course, student should be able to

CO1	Evaluate Artificial Intelligence (AI) methods and describe their foundations.
CO2	Analyze and illustrate how search algorithms play vital role in problem solving, inference, perception, knowledge representation and learning.
CO3	To understand concept of machine learning
CO4	To Recognize the characteristics of machine learning strategies
CO5	Apply suitable machine learning techniques for data handling and to gain knowledge from it.

UNIT 1: Introduction to Artificial Intelligence (AI) (1 Credit)

Basic Definitions and terminology, Foundation and History of AI, Overview of AI problems, Evolution of AI,- Applications of AI, Classification/Types of AI. Artificial Intelligence vsMachine learning. Intelligent Agent: Types of AI Agent, Concept of Rationality, nature of environment, structure of agents. Turing Test in AI.

*Problem Solving***:-** Search Algorithms in Artificial Intelligence: Terminologies, Properties of search Algorithms, Types of search algorithms: uninformed search and informed search, State Space search Heuristic Search Techniques: Generate-and-Test; Hill Climbing; Properties of A* algorithm, Best-first Search; Problem Reduction.

UNIT 2: Introduction to Machine Learning (ML) (1 Credit)

Introduction to Machine Learning Introduction, Components of Learning , Learning Models , Geometric Models, Probabilistic Models, Logic Models, Grouping and Grading, Designing a Learning System, Types of Learning, Supervised, Unsupervised, Reinforcement, Perspectives and Issues, Version Spaces, PAC Learning, VC Dimension.

*Supervised and Unsupervised Learning***:-** Supervised and Unsupervised Learning Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perception, Multilayer Perception, Support Vector Machines: Linear and Non-Linear, Kernel Functions, K Nearest Neighbors. Introduction to clustering, K-means clustering, K-Mode Clustering.

REFERENCE BOOKS:

1. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI., 2010 2. S Kaushik, Artificial Intelligence,Cengage Learning, 1st ed.2011.

2.Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.

3.Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson.

4.Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT.

5.CharuC.Aggarwal,“DataClassificationAlgorithmsandApplications”,CRCPress,2014.

6.Charu C. Aggarwal, “DATA CLUSTERING Algorithms and Applications”, CRC Press, 2014.

7.Kevin P. Murphy ”Machine Learning: A Probabilistic Perspective”, The MIT Press, 2012

SAVITRIBAI PHULE PUNE UNIVERSITY

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

Major Elective Theory Course

Semester I: ELS 512 MJ: Fundamentals and Applications of PIC Microcontroller

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

Course Outcomes:

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

CO1	Understand features and architecture of PIC microcontroller.
CO2	Understand fundamentals of PIC microcontroller.
CO3	Demonstrate how to interface PIC microcontroller with different peripherals.
CO4	Understand the C language programming for interfacing of PIC microcontroller.

UNIT 1: Introduction to PIC18F458 Microcontroller (1 Credit)

Introduction to PIC microcontrollers. Pin diagram, block diagram and features of PIC18F458. Comparison of PIC18F458 with other PIC microcontrollers, Introduction to File registers: WREG, SFR, GPR, STATUS register, Program Counter and Program ROM space in the PIC, Data memory, RISC Architecture, Pipelining, I/O Ports and their functions. Timer 0 in PIC18F458: Block diagrams. Timer 0 registers: T0CON, INTCON. Serial Port Registers: SPBRG, TXREG, RCREG, TXSTA, RCSTA, and PIR1. ADC Register: ADCON0 and ADCON1. Interrupt vs Polling, Interrupt Service Routine, Sources of interrupts in PIC18.

UNIT 2: Programming and Interfacing PIC18F458 Microcontroller (1 Credit)

Introduction to PIC C programming: advantages, data types, and operators. I/O programming in C, Programs for bit manipulation, generation of delay and wave forms, Code conversion: Packed BCD to ASCII, ASCII to Packed BCD, Hex to decimal, Decimal to Hex. Timer programming: Steps to program Timer 0, C programs to generate delay and waveform using Timer 0, counter programming. Serial Port programming: Steps and C program to transmit data serially, steps and C program to receive data serially (Without interrupt). Hardware interface for LEDs, 7 segment display, LCD and switch interfacing, ADC Programming without interrupt, DAC interfacing (square wave, staircase, triangular, sine), LM35 interfacing, dc and stepper motor interfacing.

REFERENCES/BOOKS:

1. PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC18, Muhammad Ali Mazidi, Rolin D. McKinlay and Danny Causey, Pearson Education International, 2008.
2. PIC microcontrollers-programming in basic by Milan Verle.

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Practical Course
Semester I: ELS 513 MJP: Practical Course based on Fundamentals of Instrumentation Systems

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 this course, student should be able to

CO1	To understand working of basic instrumentation systems
CO2	To analyze the circuit performance using different laboratory instruments and equipments
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. List of practicals (Any 10)

1. Design build and test rms to dc converter for voltage measurement of ac signal
2. Displacement measurement using LVDT, signal conditioning and DPM
3. Temperature measurement using PT100, signal conditioning and DPM
4. Temperature measurement using thermocouple with cold junction compensation
5. Design build and test IR transmitter and receiver (TSOP1738 or similar) for object detection
6. To build and test current telemetry (4 to 20 mA)
7. Ultrasonic transmitter and receiver, distance measurement
8. Pressure measurement using strain gauge
9. RPM measurement using various methods
10. Design and calibrate light intensity meter using photodiode or LDR and the necessary signal conditioning and display.
11. Use of strain gauge to measure stress on a cantilever made of material known quantity
12. Hot wire anemometer

B. Activity(equivalent to 5 practicals)

1. **MOOC / NPTEL COURSES** (Min 4 weeks)
2. NPTEL Course on "Electrical Measurements and Electronics Instruments"

Link of the Course: https://nptel.ac.in/courses/108/105/108105153/

3. Simulation using EDA Tools (at least 5)

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Practical Course
Semester I: ELS 514 MJP: Practical Course based on Introduction to Artificial Intelligence and Machine Learning

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 this course, student should be able to

CO1	To understand basics of Artificial Intelligence and Machine Learning
CO2	To analyze the circuit performance using different laboratory instruments and equipments
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. List of Practical based on Artificial Intelligence and Machine learning using MATLAB / Python/PROLOG/Octave

1. Perform elementary mathematical operations in Python/ Octave/MATLAB like addition, multiplication, division and exponentiation.
2. Perform elementary logical operations in Python /Octave/MATLAB (like OR, AND, Checking for Equality, NOT, XOR).
3. Create, initialize and display simple variables and simple strings and use simple formatting for variable.
4. Perform basic operations on matrices (like addition, subtraction, multiplication) and display specific rows or columns of the matrix.
5. Write a Program to Implement Breadth First Search.
6. Write a Program to Implement Depth First Search.
7. Write a program to implement Hill Climbing Algorithm
8. Write a program to implement A* Algorithm.
9. Create two test sets which are separable with a perceptron without a bias node.
10. Study of Linear Regression.

B. Activity (Equivalent to 5 practicals)

1. Simulation Experiments (at least 5) using available tools
2. MOOCs course relevant to AI and ML
3. Study of at least 3 ML tools

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Practical Course
Semester I: ELS 515 MJP: Practical Course based on Fundamentals and Applications of PIC Microcontrollers

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

Course Outcomes:

CO1	Understand features and architecture of PIC microcontroller.
CO2	Understand fundamentals of PIC microcontroller.
CO3	Demonstrate how to interface PIC microcontroller with different peripherals.
CO4	Understand the C language programming for interfacing of PIC microcontroller.

A. List of Practicals on PIC16/18Fxx interfacing (Any 12)

1. Simple PIC C Program for arithmetic and logical operations.
2. PIC C Program for Code conversion: Packed BCD to ASCII/ASCII to Packed BCD, Hex to decimal/Decimal to Hex.
3. PIC C Program for LED array and switch interfacing.
4. PIC C Program for LDR and relay interfacing.
5. PIC C Program for Two-digit 7-segment display (multiplexed/non-multiplexed) interfacing.
6. PIC C Program for LCD / Dot matrix display interfacing.
7. PIC C Program to generate square wave using Timer 0 for delay.
8. PIC C Program for voltage measurement using ADC and display output on LED/LCD.
9. PIC C Program for LM35 interfacing using ADC and display output on LED/LCD.
10. PIC C Program for DAC interfacing (square wave, staircase, triangular, sine).
11. PIC C Program for dc motor interfacing (Clockwise/ Anticlockwise).
12. PIC C Program for stepper motor interfacing (Clockwise/ Anticlockwise).
13. PIC C Program for Two digit frequency counter or event counter using timer.
14. PIC C Program for DC motor control using PWM / intensity control of LED.
15. PIC C Program for Matrix keyboard / Touch screen interfacing.
16. PIC C Program for Graphic LCD interfacing.
17. PIC C Program for Real Time Clock display on LCD / HyperTerminal (I2C).
18. PIC C Program for Zigbee communication.

B. Activity (equivalent to 3 practicals)

1. Simulation of any 2 practicals from above mentioned list using Proteus/Multisim/Pspice/Labview software.
2. Simulation of any 2 practicals other than above mentioned list using Proteus/Multisim/Pspice/Labview software.
3. Designing of target board for PIC16/32.

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Core Compulsory Theory Course
Semester II: ELS 551 MJ: Modern Communication System

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

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

CO1	To Study Antenna Basics
CO2	To learn various digital modulation techniques.
CO3	To learn error detection and correction code.
CO4	To Know the various communication standards for connected autonomous Vehicles
CO5	To understand Intelligent transport system.

UNIT 1: Antenna Basics (1 Credit)

Introduction, basic antenna parameters, patterns, beam area, radiation intensity, beam efficiency, directivity and gain, antenna apertures, effective height, bandwidth, radiation, efficiency, antenna temperature and antenna field zones.
*Antenna Type*s:- Horn antennas, rectangular horn antennas, helical Antenna, Yagi-Uda array, corner reflectors, parabolic reflectors, log periodic antenna, lens antenna, antenna for special applications – sleeve antenna, turnstile antenna, omni- directional antennas, antennas for satellite antennas for ground penetrating radars, embedded antennas antenna for remote sensing.

UNIT 2: Digital Communication (1 Credit)
Digital Communication Pulse modulation, Pulse amplitude modulation, pulse width modulation, pulse position modulation, Delta modulation, Adaptive delta modulation, Digital modulation techniques- ASK, FSK, PSK, QAM, M-ary digital modulation techniques. Digital baseband transmission. Coding Techniques- Introduction to the Coding, Alpha - Numeric coding, Parity Check Coding, Hamming Code, Concept of Systematic Code, RZ, NRZ, Manchester code, AMI, Error Detection and Error Correction.

UNIT 3: Advanced Communication System (1 Credit)
Satellite Communication, Satellite for Television applications: Direct-To-Home (DTH) and Cable TV. Voice and Data communication, Earth observation (Remote Sensing) applications, Military applications. GSM ,Principle of digital telephony. Cellular Phones concept, Frequency reuse, Capacity expansion techniques- Cell splitting and cell sectoring, working of a typical cellular system.

UNIT 4 : Introduction to Intelligent Vehicular Communication (1 Credit)

Evolution, Vehicular Networks and ITS, Vehicular Communication Standards/ Technologies – DSRC, IEEE 802.11p WAVE, IEEE 1609, IEEE 802.15.7 - Visible Light Communication(VLC), 4G/5G-Device to Device (D2D), 6G Cellular Networks and Connected Autonomous Vehicles, Operational Scenario – Collision Avoidance.

REFERENCES/BOOKS:

1. Antenna Theory Analysis and Design - C A Balanis, 2nd ED, John Wiley, 1997
2. Antennas and wave propagation - G S N Raju: Pearson Education 2005
3. Electronic Communication Systems, George Kennedy and Bernard Davis Publ. Tata McGraw Hill.
4. Electronic communications, Dennis Roddy and John Coolen, Pearson Publ.
5. Paul, A., Chilamkurti, N., Daniel, A. and Rho, S. "Intelligent vehicular networks and communications: fundamentals, architectures and solutions". Elsevier, 2016.
6. Peter B. Kenington, 'RF and baseband techniques for software defined radio", Artech House Mobile Communication, 2005.

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Core Compulsory Theory Course
Semester II: ELS 552 MJ: Control Systems

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

Course Outcomes:
This course provides application based on knowledge to provide a basic understanding of the concepts and techniques involved in designing control schemes for dynamic systems. At the end of the course, student should be able to

CO1	Compare different control loop systems such as open loop, closed loop control strategies such as feedback, feed forward etc.
CO2	Analyze the control systems using different mathematical techniques such as transfer function and different stability criterion
CO3	Analyze and Distinguish different types of analog and digital controllers and control modes
CO4	Identify components of control systems
CO5	Analyze dynamic systems for their stability and performance, and design controllers (such as Proportional-Integral-Derivative) based on stability and performance requirements
CO6	Design, develop and implement control systems for given applications

UNIT 1: Control System Basics (1 Credit)
Introduction to Control, Closed loop control and functional elements in it, open-loop control, continuous and discrete state control, control strategies such as feedback, feed forward and adaptive control, Mathematical models of systems, concept of transfer function and its use, method of obtaining transfer function, Effect of Poles and zeros

UNIT 2: Control System Analysis (1 Credit)
Block diagram of control system, rules of block diagram reductions and examples thereof Concept of stability, Routh stability criterion, Roth- Hurwitz criterion, Root locus steps in drawing root locus, Use of root locus and examples thereof. Frequency response methods of control system analysis, Bode plots method to plot and examples thereof, Nyquist plots, method to plot and examples thereof, process loop tuning and control system evaluation, Open loop transient response method, Zeigler- Nichols method.

UNIT 3: Analog and Digital Controllers (1 Credit)
Classification of controllers, Controller terms Discontinuous controllers: On-OFF Controller, three position controller Continuous controllers: Proportional, Integral and Derivative Control Composite control modes: PI, PD and PID controllers. Derivative overrun and integral windup in PID control mode Design of analog controller circuits for above modes characteristics and applications

UNIT 4: Control System Components and System Examples (1 Credit)

Principle and characteristics of control values, synchro-servo motors, Solenoids, actuators, annunciators, alarms, recorders, Standard Graphics Symbols for Process Control and Instrumentation Control system examples: Speed control system, position control systems, temperature and level control systems, reel drives, tension control system for paper

REFERENCES/BOOKS:

1. Control Systems, U.A. Bakshi and V. U. Bakshi, Technical PublicationsPune
2. Modern Control Engineering , Katsuhiko Ogata , Prentice Hall.
3. Process control instrumentation technology, C. D Johanson, PHI.
4. Control system engineering, Nagrath and Gopal, New age international limited
5. Process control: Principles and applications, Surekha Bhanot, Oxford University Press 2nd Edition.
6. Control Engineering Noel. M. Morris, 3rd Edition Mac Graw Hill.
7. Control engineering theory and practice, N.M. Bandhopadhyay, PHI.
8. Instrument Engineers' Handbook, Vol. 1: Process Measurement and Analysis, Bela G. Liptak, CRC Press.
9. Automatic Control Systems, Kuo B.C., Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition, 1991.

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Core Compulsory Theory Course
Semester II: ELS 553 MJ: Industrial Automation

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

Course Outcomes:
The objectives of this course is to understand the basic concept of Industrial Automation and PLC programming. At the end of this course, student should be able to

CO1	Identify different components of automation system.
CO2	Know about the basics of programmable logic controllers and their components.
CO3	Interface given I/O devices with appropriate PLC module.
CO4	Prepare the PLC ladder program for given application
CO5	Develop PLC based systems by programming different components in PLC.

UNIT 1: Introduction to Industrial Automation and PLC (1 Credit)

Need and benefits of Industrial Automation, Automation Hierarchy, Basic components of automation system, description of each component, Types of automation system: - Fixed, programmable, flexible.

Programmable Logic Controller (PLC): Introduction, limitations of relays, brief history, advantages of PLCs over electromagnetic relays. Concept of PLC, Building blocks of PLC, Functions of various blocks, Processor memory organization, Scan cycle, Different programming languages, PLC manufacturers.

UNIT 2: PLC Programming (1 Credit)

PLC ladder diagram, Basic components and their symbols in ladder diagram, Fundamentals of ladder diagram. Basic instructions like latch, reset. Timer instructions, retentive timers, resetting of timers. Counter instructions like up counter, down counter, resetting of counters. Arithmetic Instructions, Comparison instructions, sequencer.

Ladder Diagram Programming: Programming based on basic instructions, timer, counter, and comparison instructions using ladder program.

Applications of PLCs: Car parking, Sequential starting of motors, Traffic light, Bottle filling plant.

REFERENCES/BOOKS:

1. Industrial Automation and Process Control, Stenerson Jon, PHI Learning, New Delhi.
2. Programmable Logic Controllers Programming Methods and Applications, John R. Hackworth and Fredrick D. Hackworth, Jr., Pearson Education
3. Introduction to PLCs by Gary Dunning, McGraw Hill
4. Programmable Logic Controllers, W. Bolton.
5. Programmable Logic Controllers, Frank D. Petruzella, Third Edition, Tata McGraw Hill Education Private Limited.
6. Module on PLCs and their Applications by Rajesh Kumar, NITTTR Chandigarh.

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Core Compulsory Practical Course
Semester II: ELS 554 MJP: Practical Course III

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 this course, student should be able to

CO1	To understand different communication systems
CO2	To analyze the circuit performance using different laboratory instruments and equipments
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. Practical based on Modern Communication System (Any 6)

1. Delta modulation
2. Design PCM encoder/ decoder system
3. Design of FSK transmitter and receiver
4. Time division Multiplexing
5. Study and analysis of QAM
6. Telemetry Applications
7. Design of Binary Phase Shift Keying
8. Design and test Yagi-Uda antenna with power reflectors
9. To plot directivity pattern of a given antenna
10. To Study Hamming Code for error detection and correction

B. Practical based on Control Systems (Any 6)

1. Design of temperature controller using PID
2. Design and implement ON-OFF Controller
3. Design and implement P / PI / PID controller
4. Design and study water level control system
5. Problem solving using root locus method
6. Flow control using solenoid valve
7. To study the position / velocity control of dc servo motor
8. Flow control using solenoid valve

C. Activity (Equivalent to 3 practicals)

1. Industrial Visit/Field Visit
2. Do it Yourself (Design any one/two experiment given in part A or B other than selected for practical course)
3. Simulation Experiments using different EDA tools (at least 3)

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Core Compulsory Practical Course
Semester II: ELS 555 MJP: Practical Course IV

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 this course, student should be able to

CO1	To acquire the skill of programming for circuits
CO2	To use MATLAB effectively for solving mathematical problems
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. Simulation experiments of Modern Communication Systems and Control Systems (Any 6)

1. Use of MATLAB for directivity pattern for simple antennas
2. Use of MATLAB for Phase shift keying (PSK)/FSK
3. Use of MATLAB for Generation and reception of BPSK/QPSK
4. Study of GSM architecture and signaling techniques. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant system using suitable software (MATLAB or any other software)
5. State space model for classical transfer function using suitable software -Verification. (MATLAB or any other software)
6. Plot the pole-zero configurations in s-plane for the given transfer function (MATLAB or any other software)
7. Plot unit step response of given transfer function and find peak overshoot, peak time. (MATLAB or any other software)
8. Write a program to find the transfer function of a given closed loop control system. (MATLAB or any other software)

B. Practicals based on Industrial Automation (Any 6)

1. Introduction to Ladder Programming (any 2)
    a. Develop and simulate Logic gates and Booleanequations.
    b. Develop and Simulate Ladder program for simple on-off applications.
    c. Develop and Simulate Ladder program for timer applications.
2. Basic Ladder programming practicals (any 2)
    a. Develop and Simulate Ladder program for counter applications.
    b. Develop and Simulate Ladder program for cascading of timers & counters.
    c. Develop and Simulate Ladder program for Alarm Annunciator System
3. Ladder programming for identified applications (any 2)
    a. Develop and Simulate Ladder program for Comparison Instruction/ Logical Instruction.
    b. Develop and Simulate Ladder program for Mathematical Instruction/Special Mathematical instructions.

4. Develop and Simulate Ladder program for Data movement instructions/ Program Ladder programming practicals (any 2)
   - **a.** Develop and Simulate Ladder program for Batch Mixer/any process application**.**
   - b. Develop and Simulate Ladder program for any process using sequencer
   - c. To Identify Components/sub-components of a PLC, Learning functions of different modules of a PLC system available in laboratory.
5. Develop and Simulate Ladder program for pulse counting using limit switch/proximity sensor.
6. Develop and Simulate Ladder program for bottle filling plant.
7. Develop and Simulate Ladder program for traffic light control.
8. Develop and Simulate Ladder program for Object counter - On-off control.
9. Develop and Simulate Ladder program for Car parking.
10. Develop and Simulate Ladder program for Sequential starting of motors.
11. Develop and Simulate Ladder program for automated elevator control.
12. Develop and Simulate Ladder program for tank water level control.

C. Activity (Any one) (Equivalent to 3 practicals)

1. Industrial Visit/Field Visit
2. Do it Yourself (Design any one/two experiment given in part A or B other than selected for practical course)
3. Market Survey of PLCs currently used in various industries for automation

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Compulsory Course
Semester II: ELS 556 OJT: On Job Training
Credits : 4

Evaluation Guidelines

1. Weekly report from students
2. Attendance record
3. Certificate from the industry of completion of on job training/ internship
4. Viva in presence of industry experts and internal examiner

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Theory Course
Semester II: ELS 560 MJ: Instrumentation Systems and Applications

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

Course Outcomes:
This course provides students in dept knowledge about different types of communication techniques. At the end of this course, student should be able to

CO1	Understand the Concepts of Sensors/Transducers, classify and evaluate static and Dynamic Characteristics of Measurement Systems.
CO2	Choose the proper sensor comparing different standards and guidelines for measurements of Temperature and Humidity.
CO3	Choose the proper sensor comparing different standards and guidelines for measurements of Force, Pressure, Stress and Flow
CO4	Choose the proper sensor comparing different standards and guidelines for measurements of Displacement, Vibration, Acceleration and Level
CO5	Explore sensors to profound areas like environmental, Agricultural and bio-medical equipment and sustainability.
CO5	Explore IoT based applications of Sensors and Transducers.

UNIT 1: Sensors and Systems (1 Credit)
Temperature Measurement: Units of Temperature Measurement / Temp Measurement Scales; Broad Classification of Temperature Transducers, RTD, Thermocouple, Thermistors, Optical Fiber Sensors. (Basic Principle of Working, Selection Criteria, Installation and Calibration, Signal Conditioning (e.g Instrumentation Amplifier), IR Temperature Sensor: MLX90614 ESF Non-Contact Human Body Infrared Temperature Measurement Module.
Humidity: Hygrometer, Soil Humidity Sensor, Soil Hygrometer
Pressure s: Strain gauge (Load Cell using Strain gauge), Piezoelectric Transducer, Solid State Pressure Sensors, Differential Pressure Transducer flow measurement
Flow: Orifice, Venturi, Nozzle flow meter (only Descriptive), Pneumatic sensors (bellows, diaphragm), Ultrasonic and Hall effect Sensors for flow Measurement
Displacement: Potentiometer, Strain-gauged element, Capacitive element, Differential transformers, Eddy current proximity sensors, Inductive and Capacitive Proximity switch, Optical encoders.

UNIT 2: **Instrumentation Systems and applications (1 Credit)**

Basic Concept of Data Acquisition Systems (Block Diagram Understanding), Basic Concept of IoT, Sensor Interface in IoT systems.

Case Study 1: IoT based Agriculture/Greenhouse systems.(Block Diagram) consist of Optical Sensors, Electro-Chemical Sensors, Mechanical Sensors Dielectric Soil Moisture Sensors, Air Flow Sensors may be considered
Case Study 2: IoT based Healthcare Systems.(Block Diagram) consist of ECG Module, Temperature, ,Humidity, Accelerometer, Oxygen Level, Heart Rate sensors)
Case Study 3: IoT based Automobile Sector (Engine Management System) consist of Fuel Level, Ignition, Exhaust Sensors

REFERENCES/BOOKS:

1. Electrical and Electronics Measurements and Instrumentation, by Sawhney A. K , Dhanpat Rai & amp; Sons, 4th Edition, 1994.
2. Sensors and Transducers, by D. Patranabis, Prentice Hall India Learning Private Limited.
3. Instrument Engineers Handbook Process Control, by Liptak, Elsevier exclusive
4. Instrumentation and Sensors Handbook,by John G. Webster, CRC Press.

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Theory Course
Semester II: ELS 561 MJ: Applications of Artificial Intelligence and Machine Learning

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

Course Outcomes:
This course provides students in depth knowledge about different types of Artificial Intelligence and Machine Learning. At the end of this course, student should be able to

CO1	To Demonstrate knowledge of reasoning and knowledge representation for solving real world problems
CO2	To Identify and integrate more than one techniques to enhance the performance of learning
CO3	To learn Ensemble and Probabilistic Learning
CO4	To acquire theoretical Knowledge on setting hypothesis for pattern recognition.

UNIT 1: Knowledge and Reasoning (1 Credit)

Knowledge-Based Agent in Artificial intelligence: Architecture, Approaches to designing a knowledge-based agent, knowledge representation: Techniques of knowledge representation, Propositional logic, Rules of Inference, First-Order Logic, Forward Chaining and backward chaining in AI, Reasoning in Artificial intelligence: Types of Reasoning and Probabilistic reasoning, Uncertainty.

UNIT 2: Ensemble and Probabilistic Machine Learning (1 Credit)

Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost, Stacking. Gaussian mixture models - The Expectation-Maximization (EM) Algorithm, Information Criteria, Nearest neighbor methods - Nearest Neighbour Smoothing, Efficient Distance Computations: the KD-Tree, Distance Measures
Reinforcement Learning and Evaluating Hypotheses:Introduction, Learning Task, Q Learning, Non deterministic Rewards and actions, temporal-difference learning, Relationship to Dynamic Programming, Active reinforcement learning, Generalization in reinforcement learning. Motivation, Basics of Sampling Theory: Error Estimation and Estimating Binomial Proportions, The Binomial Distribution, Estimators, Bias, and Variance

REFERENCES/BOOKS:
1. Introduction to Artificial Intelligence & Expert Systems, Dan W Patterson, PHI., 2010 2. S Kaushik, Artificial Intelligence, Cengage Learning, 1st ed.2011.
2. Ric, E., Knight, K and Shankar, B. 2009. Artificial Intelligence, 3rd edition, Tata McGraw Hill.
3. Luger, G.F. 2008. Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson.
4. Alpaydin, E. 2010. Introduction to Machine Learning. 2nd edition, MIT.

5. Charu C.Aggarwal, “Data Classification Algorithms and Applications”,CRCPress,2014.
6. Charu C. Aggarwal, “DATA CLUSTERING Algorithms and Applications”, CRC Press, 2014.
7. Kevin P. Murphy ”Machine Learning: A Probabilistic Perspective”, The MIT Press, 2012
8. Jiawei Han and Micheline Kambers and JianPei, “Data Mining Concepts andTechniques”,3rd edition, Morgan Kaufman Publications, 2012.

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Theory Course
Semester II: ELS 562 MJ: Fundamentals and Applications of AVR Microcontroller

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

Course Outcomes:

This course provides students in dept knowledge about different types of communication techniques. At the end of this course, student should be able to

CO1	Understand features and architecture of AVR32 microcontroller.
CO2	Understand fundamentals of AVR32 microcontroller.
CO3	Demonstrate how to interface AVR32 microcontroller with different peripherals.
CO4	Understand the C language programming for interfacing of AVR32 microcontroller.

UNIT 1: Introduction to AVR32 Microcontroller (1 Credit)

Introduction to AVR32 microcontrollers. Pin diagram of ATmega32, block diagram and features of AVR32. Comparison of AVR32 with other AVR microcontrollers, General Purpose registers, Memory Organization: AVR Data Memory, I/O Memory (SFRs), Internal data SRAM, AVR STATUS Register (SREG), Program Counter and Program ROM space in the AVR, RISC vs CISC, Pipelining, I/O Ports and their functions. Timer 0 in AVR32: Block diagram. Timer 0 registers: TCCR0, TIFR. Serial Port Registers: UDR, UBRR, UCSRA, UCSRB, UCSRC. ADC Register: ADCSRA and ADMUX.

UNIT 2: Programming and Interfacing AVR32 Microcontroller (1 Credit)

Introduction to AVR C programming: advantages, data types, and operators. I/O programming in C, Programs for bit manipulation, generation of delay using functions, Code conversion: Packed BCD to ASCII, ASCII to Packed BCD, Hex to decimal, Decimal to Hex. Timer programming: Steps to program Timer 0 in normal mode, C programs to generate delay and waveform using Timer 0, counter programming. Serial Port programming: Steps and C program to transmit data serially, steps and C program to receive data serially (Without interrupt). Hardware interface for LEDs, 7 segment display, LCD and switch interfacing, ADC Programming without interrupt, DAC interfacing (square wave, staircase, triangular, sine), LM35 interfacing, dc and stepper motor interfacing.

REFERENCES/BOOKS:

1. The AVR Microcontroller and Embedded Systems: Using Assembly and C, Muhammad Ali Mazidi, and Naimi, Pearson education, 2011.
2. Embedded C Programming and the Atmel AVR, Barnett, Larry D. O'Cull and Sarah A. Cox, Delmar, Cengage Learning, 2007.
3. C Programming for Embedded Systems, Kirk Zurell, Pearson Education

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Practical Course
Semester II: ELS 563 MJP: Practical Course based on Instrumentation Systems and Applications

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 this course, student should be able to

CO1	To understand working of basic instrumentation systems
CO2	To analyze the circuit performance using different laboratory instruments and equipments
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. List of practicals (Any 10)

1. To study and calibration of PT – 100 as a temperature sensor and its signal conditioning circuit
2. Study of temperature measurement using LM 35.
3. Study of Strain gauge as load sensor and its signal conditioning circuit
4. RPM measurement using various methods
5. Design build and test IR transmitter and receiver (TSOP1738 or similar) for object Detection
6. Study of optical sensors: LDR and photo diode and their signal conditioning circuit
7. Study of linear displacement transducer and its signal conditioning circuit
8. Measurement of displacement using strain gauge based displacement transducer. Measurement of displacement using magnetic pickup.
9. Measurement of load using strain gauge based load cell.
10. Measurement of water level using strain gauge based water level transducer
11. Measurement of temperature by thermocouple
12. Study of storage oscilloscope and determination of transient response of RLC Circuit.
13. Determination of characteristics of a solid state sensor/fibre-optic sensor
14. Design and test a signal conditioning circuit for any transducer

B. Activity (equivalent to 5 practicals)

1. NPTEL Course on “Electrical Measurements and Electronics Instruments”
2. Link of the Course: https://nptel.ac.in/courses/108/105/108105153/
3. Simulation using EDA Tools(At least 5)
4. Project like experiment

SAVITRIBAI PHULE PUNE UNIVERSITY

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

Major Elective Practical Course

Semester II: ELS 564 MJP: Practical Course based on Applications of Artificial Intelligence and Machine Learning

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 this course, student should be able to

CO1	To understand basics of Artificial Intelligence and Machine Learning
CO2	To analyze the circuit performance using different laboratory instruments and equipments
CO3	To acquire the skills useful for working in electronics industry/research
CO4	To debug the circuits and systems to get the solutions for different problems
CO5	To use the knowledge to design the applications useful for society/industry

A. List of Practical based on Artificial Intelligence and Machine learning using MATLAB / Python/PROLOG/Octave

1. To study bagging phenomenon
2. To write a program to implement Tic-Tac-Toe game
3. To write K nearest neighbor algorithm
4. To understand AI through key application areas
5. To Study of different learning techniques in AI.
6. To Use of Temporal and spatial reasoning in AI.
7. To Implement of Search Strategies in AI.
8. To Study Forward Chaining.
9. To Study Binomial Distribution.
10. To Study Random forest Tress.

B. Activity (Equivalent to 5 practicals)

1. Simulation Experiments using available tools (at least 5)
2. MOOCs course
3. Study of AI tools currently used various fields

SAVITRIBAI PHULE PUNE UNIVERSITY
M. Sc. [Part I] (Electronic Science)
Major Elective Practical Course
Semester II: ELS 565 MJP: Practical Course based on Fundamentals and Applications of AVR Microcontrollers

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

Course Outcomes:

CO1	Understand features and architecture of AVR microcontroller.
CO2	Understand fundamentals of AVR microcontroller.
CO3	Demonstrate how to interface AVR microcontroller with different peripherals.
CO4	Understand the C language programming for interfacing of AVR microcontroller.

A. List of Practicals on AVR16/32 Interfacing (Any 12)

1. Simple AVR C Program for arithmetic and logical operations.
2. AVR C Program for Code conversion: Packed BCD to ASCII/ASCII to Packed BCD, Hex to decimal/Decimal to Hex.
3. AVR C Program for LED array and switch interfacing.
4. AVR C Program for LDR and relay interfacing.
5. AVR C Program for Two-digit 7-segment display/LCD (multiplexed/non-multiplexed) interfacing.
6. AVR C Program to generate square wave using Timer 0 for delay.
7. AVR C Program for LM35 interfacing using ADC and display output on LED/LCD.
8. AVR C Program for DAC interfacing (square wave, staircase, triangular, sine).
9. AVR C Program for dc motor/stepper motor interfacing (Clockwise/ Anticlockwise).
10. AVR C Program for Two digit frequency counter or event counter using timer.
11. AVR C Program for DC motor control using PWM / intensity control of LED.
12. AVR C Program for Matrix keyboard / Touch screen interfacing.
13. AVR C Program for Graphic LCD interfacing.
14. AVR C Program for Real Time Clock display on LCD / HyperTerminal (I2C).
15. AVR C Program for Zigbee communication.

B. Activity (equivalent to 3 practicals)

1. Simulation of any 2 practicals from above mentioned list using Proteus/Multisim/Pspice/Labview software.
2. Simulation of any 2 practicals based on Arduino using Proteus/Multisim/Pspice/Labview software.
3. Designing of target board for AVR16/32