B. Sc. Electronic Science (Major)

T. Y. B. Sc. SYLLABUS

DISCIPLINE SPECIFIC COURSE (DSC)

UNDER NATIONAL EDUCATION POLICY 2020

CBCS NEP 2024 Pattern

TO BE IMPLEMENTED FROM

ACADEMIC YEAR 2026-27

DEPARTMENT OF ELECTRONIC SCIENCE

Maharashtra Education Society's

ABASAHEB GARWARE

COLLEGE(AUTONOMOUS)

KARVE ROAD, PUNE 411 004.

Maharashtra Education Society's

Abasaheb Garware College, Pune

Credit Framework for Under Graduate (UG) to be implemented from 2024 – 25 to First Year UG

Level / Difficulty	Sem	Subject-1	Subject-2	Subject-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5 / 100	I	2 (T) + 2 (P)	2(T)+2(P)	2(T)+2 (P)	2 (1T+1P)	2 (T/P)	2 (T) (Generic)	2 (T)	2	--	22
	II	2 (T) + 2 (P)	2(T)+2(P)	2(T)+2 (P)	2 (1T+1P)	2 (T/P)	--	2 (T)	2	2	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor Continue option: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and another as minor and third subject will be dropped.											

Level / Difficulty	Sem	Credits Related to Major				Minor		GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP / OJT / CEP									
5.0 / 200	III	4 (T) + 2 (P)	--	2 (T/P)	2 (FP)	2(T)+2(P)	--	2 (1T+1P)	--	2 (T) (Major Subject Specific)	2 (T)	--	2	22
	IV	4 (T) + 2 (P)	--	2 (T/P)	2 (CEP)	2(T)+2(P)	--	2 (1T+1P)	2 (T/P)	--	2 (T)	--	2	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor														
5.5 /300	V	8(T) + 4(P)	2 (T) + 2 (P)	2 (T/P)	2 (FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T) + 4(P)	2 (T) + 2 (P)	2 (T/P)	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 3 Years		44	8	8	10	18	8	8	6	4	8	4	6	132
Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor														
6.0 /400	VII	6 (T) + 4 (P)	2 (T) + 2 (T/P)	--	4 (RP)	4(RM)(T)		--	--	--	--	--	--	22
	VIII	6 (T) + 4 (P)	2 (T) + 2 (T/P)	--	8 (RP)	0			0	0	0	0	0	22
Total 4 Years		64	16	8	22	22	8	8	6	4	8	4	6	176
Four Year UG Honours with Research Degree in Major and Minor with 176 credits OR														
6.0 /400	VII	10(T) + 4(P)	2 (T) + 2 (T/P)	0	0	4 (RM) (T)			0	0	0	0	0	22
	VIII	10(T) + 4(P)	2 (T) + 2 (T/P)	0	4 (OJT)	0			0	0	0	0	0	22
Total 4 Years		72	16	8	14	22	8	8	6	4	8	4	6	176
Four Year UG Honours Degree in Major and Minor with 176 credits														

M.E.S. Abasaheb Garware College Pune-4.

18-4-24

Principal

MES. Abasaheb Garware College

Pune-4.

Maharashtra Education Society's

Abasaheb Garware College (Autonomous),

Karve Road, Pune

Department of Electronic Science

Structure of T. Y. B. Sc. Electronic Science (NEP 2024 Pattern)

Verticals	Sem	Course Code	Title of Course	Type	Cr
Major Core	V	ELS-301-MJ	Modern Communication Systems	THEORY	2
		ELS-302-MJ	Process Control System	THEORY	2
		ELS-303-MJ	Microcontroller Architecture and Programming	THEORY	2
		ELS-307-MJ	Power Electronics	THEORY	2
		ELS-304-MJP	Electronic Science Practical Course V	PRACTICAL	2
		ELS-305-MJP	Electronic Science Practical Course VI (Project)	PRACTICAL	2
Major Elective (Any one Optional subject and related practical)		ELS-314-MJE	Fundamentals of Artificial Neural Networks	THEORY	2
		ELS-315-MJEP	Electronic Science Practical Course VII based on ELS-314-MJE	PRACTICAL	2
Minor		ELS-343-MN	Sensors and Systems	THEORY	2
VSC		ELS-321-VSC	PLC and SCADA	PRACTICAL	2
FP/CEP		ELS-331-FP	Field Project/Community Enhancement Project	PRACTICAL	2
				Total Credit	22

Verticals	Sem	Course Code	Title of Course	Type	Cr
Major Core	VI	ELS-351-MJ	Analog Circuit Design and Applications	THEORY	2
		ELS-352-MJ	Advanced Digital System Design	THEORY	2
		ELS-358-MJ	Mechatronics and Robotics	THEORY	2
		ELS-359-MJ	Fiber optic communication systems	THEORY	2
		ELS-354-MJP	Electronic Science Practical Course V	PRACTICAL	
		ELS-355-MJP	Electronic Science Practical Course VI (Project)	PRACTICAL	2
Major Elective (Any one Optional subject and related practical)		ELS-366-MJE	Applied Machine learning	THEORY	2
		ELS-367-MJEP	Electronic Science Practical Course VII based on ELS 366-MJ	PRACTICAL	2
VSC		ELS-371-VSC	PCB layout Design and fabrication	PRACTICAL	2
OJT		ELS-381-OJT	On Job Training	INTERNSHIP	4
				Total Credit	22

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ELS-301-MJ: Paper I: Modern Communication Systems

SEMESTER V **CREDITS: 2** **LECTURES: 30**

Course Outcomes:

CO1: Understand the digital modulation techniques.
CO2: Understand different types of pulse modulation techniques.
CO3: Describe the evolution and importance of Mobile communication and cellular communication
CO4: Know the basics of satellite communication systems

UNIT-1: Basics of Digital Communication (16 LECTURES)

Introduction, Information capacity, bits, bit rate, baud rate and m-ary coding, Amplitude Shift Keying, Frequency Shift Keying, Phase Shift Keying, Quadrature amplitude modulation

Pulse modulation: PCM Sampling, Signal to quantization noise, PCM Methods, Delta modulation and adaptive delta modulation and generation methods Time Division Multiplexing, Frequency Division Multiplexing

UNIT 2: Mobile, Cellular and Satellite Communication (14 LECTURES)

Introduction, mobile telephone service, cellular phone, frequency reuse, cell splitting, sectoring, segmentation and dualization, cellular telephone topology, roaming and handoffs, network components and call processing. Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Satellite Communication: Introduction to satellite, keplar's law, satellite orbits, geosynchronous satellites, satellite classifications, spacing and frequency allocation, satellite system link models, system parameters, FDM satellite systems, channel capacity, satellite radio navigation

REFERENCE/TEXT BOOKS:

1. Electronic Communication Systems Fundamentals through advanced, Wayne Tomasi, 5th Edition, Pearson Education Press
2. Andrea Goldsmith, Wirelerss communications, (2015) Cambridge University Press
3. D. Tse and P. Viswanathan, Fundamentals of Wireless Communication, (2014) Cambridge University Press.
4. Wireless communication and Networks, Upena Dala, 2015, Oxford University Press.
5. Haykin S. & Moher M., Modern Wireless Communication, Pearson, (2005) 3rd Ed.
6. Yi-Bing Lin - Wireless and Mobile Network Architectures, 2nd Edition, Wiley, 2008.
7. WEB resources: http://nptel.ac.in/courses/

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ELS-302-MJ: Paper II: Process Control Systems

SEMESTER V **CREDITS: 2** **LECTURES: 30**

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

CO1: Familiar with different types of sensors and related systems
CO2: Know different types of measurement systems.
CO3: Understand control parameters in process automation.
CO4: Understand different types of process control systems and their characteristics.

UNIT 1: Process Measurements (14 LECTURES)

Block diagram of instrumentation system, Analog and Digital Modes of Operation, Null and Deflection Methods, Input Output configuration of Instruments and measuring systems, Process Performance Parameters: Generalized measurement systems, zero-order System, First-order System, Second–order System, Dead-Time Element, Specifications and Testing of Dynamic Response. Generalized Data Acquisition system- Elements of a data acquisition system, Single channel Data Acquisition system, Multichannel Data Acquisition system

UNIT 2: Fundamentals of Process Control (16 LECTURES)

Process control principles, Continuous control, discrete state control, composite discrete/continuous control, Process Characteristics, Control system parameters, Architecture of Industrial Automation Systems, Advantages and limitations of Automation Process Control Systems: Two position mode, Multiposition mode, floating control mode, Continuous controller modes: Proportional control, Integral control, Derivative control Composite modes: Proportional-Integral, Proportional derivative, Proportional-integral – derivative (PID)

RECOMMENDED BOOKS:

1. Process Control Instrumentation Technology; Curtis Johnson, Pearson Publication \
2. Instrumentation Devices & Systems, C S Rangan,G R Sarma,V S Mani, TMH
3. Measurement Systems Application and Design, Ernest O Doeblin, Dhanesh N Manik, Tata McGrawHill
4. Elements of Electronic Instrumentation and Measurement, Joseph J. Carr, Pearson Education 5. Modern control technology: components & systems, Kilian, Delmar 6. Process software and digital networks, Bela G Liptak

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ELS-303-MJ: Paper III: Microcontroller Architecture and Programming

SEMESTER V **CREDITS: 2** **LECTURES: 30**

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

CO1: Understand the basics of microcontroller.

CO2: Acquire basic programming skills in C language.

CO3: Understand and acquire basic programming skills for AVR microcontroller.

UNIT 1: Basics of C Programming (14 LECTURES)

Types of Programming languages, Algorithm, flowcharts, instructions, syntax, hex files, linkers, compilers, Basic data types, variables, Structure of C program, Operators in C, Arrays concept, one, two-dimensional and multi-dimensional arrays, pointers, Input output statement, Decision making statements, Control loops, Functions: Library functions and user defined functions.

UNIT 2: AVR Programming using C (16 LECTURES)

Architecture of AVR, Data types for AVR, Time delay generation, I/O programming, Logic operations, Data conversion, Data serialization, Memory allocation in C, Programming Timers, Counters, serial port, interrupts LCD Interfacing, Keyboard interfacing, ADC interfacing, DAC interfacing, External memory interfacing, Stepper motor interfacing.

RECOMMENDED BOOKS:

1. The AVR microcontroller and embedded systems using Assembly and C, Muhamad ali Mazidi, Sarmad Naimi, Sepehr Naimi, PHI publications
2. Microcontrollers: Architecture, Programming, Interfacing and System Design, Rajkamal, Pearson India, ISBN: 9788131759905
3. Let us C, Yashwant Kanetkar, BPB Publications
4. Embedded Systems: Architecture, Programming & Design, Raj Kamal, Tata McGraw Hill publication

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ELS-307-MJ : Power Electronics

SEMESTER V **CREDITS: 2** **LECTURES: 30**

Course Outcomes:

CO1: Understand basics of semiconductor power devices.
CO2: Analyze basic power electronics circuits and demonstrate applications
CO3: Understand basics of motor control
CO4: Understand basics of Electric Vehicle systems

Note: Emphasis should be given to input and out waveforms for power circuits and characteristics of power devices

UNIT 1: Power Semiconductor Devices (20 LECTURES)

Comparative study of power devices(Diodes, Transistors, DIAC, TRIAC, Thyristors/SCR), Protection of power semiconductor devices. Triggering Methods using PUT

Power Circuits: Controller Rectifiers: Half wave and Full Wave(R Load and R/L load)
Inverters: Half bridge and full bridge, Cycloconverters
SMPS Concept of Switched Mode Power Supplies Various schemes of SMPS Design aspects of SMPS, UPS
High frequency heating: Induction Heating: Basic Principle Factors Governing the process Applications, merits &demerits over other systems
Di-electric heating: Basic Principle Factors governing the process, applications, merits & demerits over other system
Motor control : DC motor, Single phase SCR drive, SPEED control of DC motor
AC motor, Induction motor, SPEED control methods of induction motor

UNIT 2: Electric Vehicle (EV) systems (10 LECTURES)

Advantages of Electric Vehicles. Comparative study of EV and Hybrid Vehicles, Types of EVs: Battery Electric Vehicle(BEV),Plug in Hybrid Electric Vehicle(PHEV) Hybrid Electric Vehicle(HEV), Fuel Cell Vechicles
Charging EV: Tickle charge, Charging at home, Charging power station, High power stations

REFERENCE/TEXT BOOKS:

1. Power Electronics by Mohammad Rashid
2. P.C. Sen Power Electronics TMH,New Delhi
3. Alok Jain Power Electronics and Its Applications Penram ,India
4. M D Singh, K B Khanchandani Power Electronics McGraw Hill, New Delhi
5. Ramamurthy Thyrister & its applications East West Press, New Delhi
6. https://nptel.ac.in/courses/108/103/108103009/
7.https://pluginbc.ca/wp/wp-content/uploads/2014/07/EV-Beginners-Guide_Final_Sept2_2014.pdf

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ELS-304-MJP: Paper IV: Practical Course V

SEMESTER V **CREDITS: 2**

There are 15 Experiments in Paper ELS-304-MJP Practical Course- V. One activity as directed in practical course which will be equivalent to 2 experiments.

- Internal Practical Examination (Out of 25): Continuous Internal Assessment · 10 Marks for Internal Examination
  10 Marks for Activity and Performance
  05 Marks for journal and Attendance
- University Semester Practical Examination: One experiment of 3 hours duration 25 Marks

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

CO1: Analyze different design and test procedures for analog circuits and systems.

CO2: Measure different parameters of optical fiber communication systems

CO3: Understand importance of product design and entrepreneurship.

CO4: Develop electronic systems for given application.

LABORATORY EXPERIMENTS (Total 10 experiments)

Group A: Modern Communication System (Any 2)

1. To design, build and test PCM encoder.
2. To design, build and test Delta/Adaptive Delta modulation
3. Study of Satellite communication system
4. Comparative study of GSM, CDMA. 2G, 3G and 4G methods
5. Study of architecture of mobile communication system
6. Study QAM /QPSK techniques
7. Study of BPSK MODEM

Group B: Process Control Systems (Any 3)

1. Simulation of controller modes (P/PI/PD/PID)
2. Design and develop ON/OFF controller using microcontroller.
3. Ladder diagram programming for basic circuits
4. Study of process automation system using ladder diagram (Vending machine/bottle filling plant)
5. Design and Development of ON/OFF temperature control system using Arduino/Raspberry

Group C: Microcontroller Architecture and Programming (Any 4)

1. Simple programs: AVR programming in C using MPLAB or equivalent simulation software for arithmetic, logical operations, memory transfer etc.

2. Code conversions (Decimal to hex, hex to decimal, ASCII to hex , Hex to ASCII, BCD to 7 seg code)
3. Interfacing array of LEDs with AVR board
4. AVR C program to Read Push-button switch and display its status on LED.
5. Interfacing Buzzer with AVR Board.
6. Interfacing 7-Segment LED Display with AVR Board.
7. Interfacing of 16x2 LCD with Arduino board and display message on it.
8. Interfacing 4x4 matrix keyboard with AVR microcontroller.
9. Interfacing temperature sensor LM35 measurement & display on LCD

Group D: Industrial Electronics(Any 4)

1. To study Characteristics of power devices like BJT/MOSFET/IGBT/Triac
2. To design, build and test light dimmer circuit.
3. To design, build and test triggering circuit using PUT.
4. To study High frequency heating / induction heating
5. To demonstrate Class A/B/C/ D commutation circuit.
6. To design, build and test Single phase/Dual converter.
7. To design, build and test Half wave/Full Wave controlled rectifier.
8. To design, build and test 723/78xx voltage regulator.
9. To demonstrate SMPS/UPS
10. Comparative study of different types of EVs

Group E: ACTIVITY: Any one of the following activities will be considered as equivalent to 2 experiments.

1. Any two additional experiments than specified from any Group.
2. Circuit Design and simulation using LTSPICE/Multisim.
3. Industrial /field Visit
4. Hands on training Workshop
5. Do it Yourself Open ended Project

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ELS-305-MJP: Paper V: Practical Course VI (Project)

Semester	Credit	Internal Assessment Marks	External Assessment Marks	Total Marks
V	2	25	25	50

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

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

Guidelines to conduct Practical Course III (Project)

Practical Course VI is a project Course of 2 Credits.

· Internal Continuous Assessment (25 marks)
· University project Examination (25 marks)

This Course should be conducted using following guidelines:

a) In CBCS Pattern, Student has to perform project in Semester V as well as Semester VI. It can perform
   1. separate project for each semester OR
   2. Can perform continuous project carrying sufficient weightage of marks per semester.

b) There should be internal continuous assessment of Project work in the form of Seminars/presentation and continuous work monitoring

c) After completion of project, student has to submit the Project Report in the following format
   i. Title of Project
   ii. Aim and objectives of project
   iii. Literature or Reference work
   iv. Block diagram and its explanation in brief and/or algorithm of software required if any
   v. Design and development of Circuit/system and Simulation required if any
   vi. Circuit Diagram and its working and Program explanation if any
   vii. Experimental Work and PCB Design/fabrication

required if any

viii. Results and Discussion

ix. Applications

x. Future Scope

xi. References

d) There must be observations, interpretations, conclusions, results of the project work. d. Algorithm, program strategy, module wise description of parts etc. be provided in case of projects related with development of computer software.

e) Applications, usefulness, student's contribution in it must be clearly specified. Further extension work may be suggested for better outcome of the project. It is recommended to present the projects in competitions / project exhibitions organized by various authorities.

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ELS-314-MJE : Fundamentals of Artificial Neural Network

SEMESTER V **CREDITS: 2** **LECTURES:30**

Course Outcomes: After completing this course student will be able to

CO1: Understand basics of Artificial Neural Networks.

CO2:get familiar with network architecture of ANN

CO3: train the ANN using alogrithms

CO4: know about basics of Artificial Intelligence

UNIT 1: Introduction to Neural Networks and Linear Models (16 LECTURES)

Motivation from biological neurons and historical overview of artificial neural networks; key terminology: neuron, layer, weight, bias, activation; the Perceptron — structure, history (McCulloch & Pitts, Rosenblatt) and its relation to threshold gates; decision boundaries and linear separability; the XOR problem; dot products and matrix notation for neural networks; activation functions and non-linearity — Sigmoid, Tanh, ReLU, Leaky ReLU; comparison of activation functions: range, gradient behaviour, vanishing gradient intuition; universal approximation intuition.

Step-by-step forward pass through a multi-layer network; framing learning as optimization; loss functions — Mean Squared Error (MSE) for regression and Cross-Entropy Loss for classification; overfitting vs. underfitting; train/validation/test splits; derivatives and gradients; gradient descent update rule; learning rate intuition; Batch, Mini-batch, and Stochastic Gradient Descent (SGD); the chain rule of calculus; forward and backward pass; computational graphs and gradient flow; worked backpropagation example; PyTorch `autograd`

UNIT 2: Network Architecture and Training with PyTorch (14 LECTURES)

Architecture of a fully-connected (dense) MLP — input, hidden, and output layers; Universal Approximation Theorem (intuition); depth vs. width; parameter count; PyTorch `nn.Module` overview; tensors, operations, and autograd; defining a network with `nn.Linear`; writing a training loop — forward pass → loss → backward → update; saving and loading models; weight initialisation — Xavier/Glorot intuition

Revisiting overfitting — signs and diagnosis; regularisation techniques — L2 (weight decay) and Dropout; Batch Normalisation; early stopping; the bias–variance trade-off; reading training/validation loss curves; motivation for Convolutional Neural Networks — limitations of fully connected layers for images; convolution intuition — filters, feature maps, stride, padding; pooling layers — max pooling and average pooling; overview of a simple CNN architecture: CONV → ReLU → POOL → FC; visualising what CNN filters learn.

REFERENCE / TEXT BOOKS

1. Nielsen, M. — *Neural Networks and Deep Learning* (free online: neuralnetworksanddeeplearning.com)
2. Goodfellow, I., Bengio, Y. & Courville, A. — *Deep Learning*, MIT Press (free online: deeplearningbook.org)

3. Géron, A. — *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, 3rd Edition, O'Reilly Media
4. CS231n Stanford — Convolutional Neural Networks for Visual Recognition, Lecture Notes (cs231n.github.io)
5. Fast.ai — *Practical Deep Learning for Coders* (course.fast.ai)
6. PyTorch Official Documentation and Tutorials (pytorch.org/tutorials)

Web Resources: http://nptel.ac.in/courses/ | https://www.youtube.com/3blue1brown

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ELS-315-MJEP: Electronic Science Practical Course VII based ANN

SEMESTER V **CREDITS: 2** **PRACTICALS**

Course Outcomes: After completing this course student will be able to

CO1: Understand basics of Artificial Neural Networks.
CO2:get familiar with network architecture of ANN
CO3: train the ANN using alogrithms using python
CO4: know about basics of Artificial Intelligence

1. Python & NumPy warm-up: implement forward propagation for a single layer by hand
2. To implement a single perceptron from scratch and train it to learn AND, OR logic gates
3. To visualise Sigmoid, Tanh, ReLU, and Leaky ReLU activation functions and their derivatives
4. To implement MSE and Cross-Entropy loss functions from scratch and compare loss values
5. To implement gradient descent to minimise a quadratic function and visualise convergence
6. To build and train a simple 2-layer fully connected network in PyTorch for regression
7. To train a neural network for binary classification and visualise the decision boundary
8. To build and train a neural network for multi-class classification and plot a confusion matrix
9. To experiment with SGD and Adam optimisers with different learning rates and compare results
10. To apply Dropout and L2 regularisation to a small network and compare train vs. validation loss

MES ABASAHEB GARWARE COLLEGE (AUTONOMOUS)
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Department of Electronic Science
ELS-343-MN: Sensors and Systems
Discipline Specific Course System: Minor
SEMESTER V CREDITS: 2 LECTURES: 30

Course Outcomes :

CO1 : Understand the significance of measurement techniques.
CO2 : Evaluate the errors in measurement system and statistical analysis process
CO3 : Understand the classification of sensors and their operating principles
CO4 : Implement the basics of sensors and their practical use in Modern Communication Systems.

Unit 1 : Introduction to Sensors and transducers (15 Lectures)

Definition, Sensors, signals and system, Sensors classification, Units of measurement, Error analysis and calibration, Significance of measurement, block diagram of measurement system, methods of measurements, elements and their functions of measurement systems Sensor characteristics, Physical principles of Sensing, Optical components of sensors, Detectors of Humans, Applications of sensors and transducers.

Unit 2 : Sensors Systems (15 Lectures)

Presence, Displacement, and Level sensors, Velocity and Acceleration, Force and Strain,, Pressure Sensors, Flow Sensors, Microphones, Humidity and Moisture Sensors, Light Detectors, Temperature Sensors, Chemical and Biological Sensors, Materials and Technologies

RECOMMENDED BOOKS :

1. Sanjay N. Talbar, Akhilesh R. Upadhyay, Instrumentation and Measurement, Dhanpat Rai Publishing Company. Third Edition 2004.
2. **Jacob Fraden, "Hand Book of Modern Sensors: Physics, Designs and Application" Fourth edition, Springer, 2010.**
3. Patranabis.D, Sensors and Transducers, Wheeler publisher, 1994.

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ELS-321-VSC: PLC and SCADA

SEMESTER V **CREDITS: 2** **PRACTICALS**

Course Outcomes :

CO1 : learn ladder programming.
CO2 : design automation systems using ladder programming
CO3 : design particular applications using PLC
CO4 : analyze the PLC systems for various applications.

Practical's based on PLC and SCADA

1. Ladder Programming for basic logic gates
2. Basic ladder diagram programming
3. Use of timers
4. Use of counters
5. Simulation of PLC SCADA system for bottle filling plant, traffic signal control systems
6. Comparative study of different PLC SCADA systems
7. Study of different components of PLC SCADA system
8. Creation of wiring diagram of basic PLC SCADA system using wiring diagram tool
9. Industrial visit
10. Design and development of automation system using identified PLC systems

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ELS-331-FP: Field Project/Community Enhancement Project

Semester	Credit	Practical Hours	Internal Assessment Marks	External Assessment Marks	Total Marks
V	2	60	25	25	50

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

The guidelines regarding the field project are as follows:

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

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ELS-351-MJ Analog circuit Design and Applications

SEMESTER VI **CREDITS: 2** **LECTURES: 30**

Course Outcomes

CO1. Understand basics of analog circuit design
CO2. Analyze waveform generators required for testing different circuits
CO3. Build application circuits using specialized ICs
CO4. Design analog systems using available ICs

UNIT 1: Fundamentals of analog circuit design (16 LECTURES)

Design specifications, selection of amplifier, details of external circuits, avoiding unwanted signals, closed loop stability, importance of external passive elements, avoiding fault conditions, offset nullifying techniques, enhancing output capabilities

Waveform generators : Square wave generators, Crystal controlled Oscillator, Ramp Generator, Triangle wave generator, Sawtooth generator, Sine wave generator: Requirement for sinusoidal oscillations, Wien-bridge and twin-T oscillators. Function Generators: Multi op-amp function generators, function generator IC's.

UNIT 2: Specialized ICs and its applications (14 LECTURES)

Phase Locked Loops and its Applications: Block diagram and operation, Applications as Frequency Multiplier, Frequency Shift Keying

Design of Power Supply: Simple op-amp voltage regulator, Three terminal voltage regulators, Fixed and adjustable voltage regulators (78XX, LM317), Heat sink, Dual power supply (LM320, LM317), Basic switching regulator and its characteristics

Nonlinear circuits: Logarithmic Amplifiers, Log/Antilog Modules, Precision Rectifier, Peak Detector, Sample and Hold Circuits. OP-AMP as Comparator, Schmitt Trigger, Square and Triangular Wave Generator, Monostable Multivibrator, IC Analog Multiplier applications OTA

REFERENCE/TEXT BOOKS:

1. Opamps and linear ICs by Ramakant Gaikwad, Pearson Education
2. Operational Amplifiers by G. B. Clayton 5th Edition
3. John P. Bentley, Principles of measurement systems, Fourth Edition, Pearson Prentice Hall, 2005
4. R. F. Coughlin and F. F. Driscoll, Operational amplifiers and Linear Integrated circuits, Pearson Education (2015)
5. K.L.Kishore, OP-AMP and Linear Integrated Circuits, Pearson (2011)
6. https://nptel.ac.in/courses/108/108/108108114/

MES ABASAHEB GARWARE COLLEGE (AUTONOMOUS)
KARVE ROAD, PUNE 411 004
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ELS-352-MJ: Paper II: Advanced Digital System Design using Verilog

SEMESTER VI **CREDITS: 2** **LECTURES: 30**

Course Outcomes: After completing the course, the students will be able to
CO1: Work on various IC technology options
CO2: Demonstrate Logic simulation, Design verification, Verilog.
CO3: Demonstrate behavioral modeling, Boolean-Equation, Flip-Flops and Latches; multiplexers, encoders, and decoders, synchronizers for asynchronous signals.
CO4: Work on combinational logic; three-state devices and bus interfaces; Registered logic; registers and counters; Resets; Divide and conquer: Partitioning a design.
CO5: Understand and analyze basics of PLA; PAL; Programmability of PLDs; CPLDs; FPGAs

UNIT 1: Modeling of Combination Circuits (15 LECTURES)

Introduction: Design methodology – An introduction; IC technology options Logic Design with Verilog: Structural models of combinational logic; Logic simulation, Design verification, and Test methodology; Propagation delay; Truth-Table models of Combinational and sequential logic with Verilog Logic Design with Behavioral Models: Behavioral modeling; A brief look at data types for behavioral modeling; Boolean-Equation – Based behavioral models of combinational logic; A comparison of styles for behavioral modeling; Behavioral models of multiplexers, encoders, and decoders; Dataflow models of a Linear- Feedback Shift Register; Modeling digital machines with repetitive algorithms. Machines with multicycle operations; Design documentation with functions and tasks; Algorithmic state machine charts for behavioral modeling; ASMD charts; Behavioral models of counters, shift registers and register files; Switch debounce, meta-stability and synchronizers for asynchronous signals; Design example

UNIT 2: Modeling of Sequential ciruits and PLA (15 LECTURES)

Synthesis of Combinational and Sequential Logic: Introduction to synthesis; Synthesis of combinational logic; Synthesis of sequential logic with latches; Synthesis of three state devices and bus interfaces; Synthesis of sequential logic with flip-flops; Synthesis of explicit state machines; Registered logic; State encoding; Synthesis of implicit state machines, registers and counters; Resets; Synthesis of gated clocks and clock enables; Anticipating the results of synthesis; Synthesis of loops; Design traps to avoid; Divide and conquer: Partitioning a design. Programmable Logic and Storage Devices: Programmable logic devices; storage devices; PLA; PAL; Programmability of PLDs; CPLDs; FPGAs; Verlog-Based design flows for FPGAs; Synthesis with FPGAs.

RECOMMENDED BOOKS:

1. Michael D. Celetti: Advanced Digital Design with the Verilog HDL, PHI, 2013
2. PeterJ. Asheden: Degital Design –An Embedded Systems Approach Using VERILOG, ELSEVIER 2013.
3. Stephen Brown, Zvonko Vranesic: Fundamentals of Digital Logic with Verilog Design, Tata Mc- Graw Hill 2009

MES ABASAHEB GARWARE COLLEGE (AUTONOMOUS)
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ELS 358-MJ : Mechatronics and Robotics

SEMESTER VI **CREDITS: 2** **LECTURES: 30**

Course Outcomes:

This course provides through understanding of different systems in mechatronics and robotics. At the end of this course, student should be able to

CO1	Identify different components or blocks in any mechatronic system
CO2	Analyze mechatronic systems using system models and dynamic responses using transformation methods
CO3	Distinguish different sensing and actuating mechanisms used in mechatronics and robotic systems
CO4	Compare different control mechanisms used in robotic systems

Unit-1: Introduction to Mechatronics and Robotics

Basics of mechatronic systems: sensors and transducers: digital sensors for motion measurement, torque and tactile sensors, vibration sensors, control systems

Brief history of robots, types of robots– components and structure, kinematic arrangements (configurations),

Classification of robots based on control method, power source, applications and coordinate systems, Application areas of robots

DC Motor-: types, basic construction and working, brushed and brushless DC motor driver circuits, and speed control

AC motors- basic idea of single phase and three phase motors and their speed control

Stepper motors- types, construction, features, specifications, control of drives.

Unit-2: Mechanical and electrical actuation systems

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,

Text / Recommended Books:

1. Mechatronics by W.Bolton, 4th Edition, Pearson.
2. Mechatronics System Design, by DevdasShetty and Richard Kolk, 2nd Edition, Cengage Learning.
3. Robotics Engineering – An integrated approach. By Richard W. Klafter, Thomas A. Chmielewski and Michael Negin, PHI Learning Pvt. Ltd.
4. Robot Dynamics and Control, Spong and M. Vidyasagar, Wiley Student Edition
5. Robotics: Fundamental Concepts and Analysis, Ashitava Ghoshal, Oxford Higher Education
6. Robotic Engineering: An integrated approach, Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Prentice-Hall India

MES ABASAHEB GARWARE COLLEGE (AUTONOMOUS)
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ELS-359-MJ : Optics and Fiber Optic Communication

SEMESTER VI **CREDITS: 2** **LECTURES: 30**

Course Outcomes

CO1. To acquire Knowledge of optical fiber communication system
CO2. To understand different parameters of optical fibers.
CO3. To learn essential optical components of Fiber Optic Communication.
CO4. To analyze and integrate fiber optical network components in variety of networking schemes.

UNIT 1: Overview of Optics and Optical Fiber Communication

History of fiber optic systems, block diagram, Fiber material, fiber cables and fiber fabrication, fiber joints, fiber connectors, splicer. Propagation of light in optical fiber, acceptance angle, numerical aperture. Types and specification of optical fiber, Advantages of optical fiber communication, applications.

Transmission Characteristic of Optical Fiber: Attenuation, absorption, linear and nonlinear scattering losses, bending losses, modal dispersion, waveguide dispersion and pulse broadening. Dispersion shifted and dispersion flattened fibers. Measurement of optical parameters, attenuation and dispersion

UNIT 2: Optical Sources and Detectors

Coherent and non-coherent sources, quantum efficiency, modulation capability of optical sources. Working principle and characteristics of - LEDs, Laser diodes. Modulation of laser diodes. PIN and APD. Noise analysis in optical detectors.

Optical Networks: Architecture of optical transport networks (OTNs), network topologies, Introduction of Synchronous optical networking (SONET) and synchronous digital hierarchy (SDH).

REFERENCE/TEXT BOOKS:

1. Optical fiber communication – Principles and practice, J.M. Senior, PHI
2. Fiber optics and Optoelectronics, R.P. Khare, Oxford University Press.
3. G. Kaiser Optical fiber communication McGraw Hill
4. Fiber optical communication Technology by Djafar Mymbaev & Lowell L, Scheiner. (Pearson)

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ELS-354-MJP : Electronic Science Practical Course V

SEMESTER VI **CREDITS: 2** **PRACTICALS**

Course outcomes:

CO1: Analyze different design and test procedures for analog circuits and systems
CO2: Measure different parameters of optical fiber communication systems
CO3: Understand importance of product design and entrepreneurship
CO4: Develop electronic systems for given application

LABORATORY EXPERIMENTS (Total 12 expts)

Group A: Analog Circuit Design and Applications (any 4)

1. To design, build and test wave shaping circuits (Integrator / differentiator circuit)
2. To design, build and test Op-amp based clipper and clampers
3. To design, build and test Log amplifier using op-amp
4. To study gain bandwidth product of inverting/ non-inverting amplifier.
5. To design, build and test Regulated power supply using IC 723 (Low and High Voltage,1A Current)
6. To design, build and test Function generator using 8038/2206 or any equivalent IC
7. To design, build and test second order Butterworth active Low Pass/ High Pass/ Band Pass/ Band Reject Filter (any two)
8. To Study PLL and measure lock range and capture range of PLL (IC565/ CD4046/ XR2211 or any equivalent IC

Group B: Fiber Optics and fiber optic Communication (any 4)

Note: Use fiber optic demonstration kits

1. To measure propagation loss in optical fibers
2. To measure bending loss in optical fibers
3. To set up fiber optic voice link
4. To measure Numerical Aperture of given optical fiber.
5. To study different methods of optical fiber terminations and polishing
6. To study fiber optic sensors and their applications
7. To design, build and test fiber optic Transmitter
8. To design, build and test of fiber optic Receiver
9. Visit to telecom facility for observing splicing, alignment, fusing, OTDR operation, connectorization, types of connectors, couplers and cables

Group C: Advanced Digital System Design using Verilog (any 4)

Note: Use appropriate tools/language to implement the following experiment:

1. Design, develop, and verify a Verilog module that implements Logic gates (All logic gates)
2. Design, develop, and verify a Verilog module that implements Half adder and full adder.

3. Design, develop, and verify a Verilog module that implements 2:1 MUX and 1:2 DEMUX
4. Design, develop, and verify a Verilog module that implements a SR Flip-Flop
5. Design, develop, and verify a Verilog module that implements a JK Edge-Triggered Flip-Flop
6. Design, develop, and verify a Verilog module that produces a 4-bit output indicating the number of 1s in an 8 bit input word.
7. Design, develop, and verify a Verilog module that implements a Universal Shift Register and then implement a bidirectional ring counter capable of counting in either direction, beginning with first active clock edge after reset.
8. Design, develop, and verify a Verilog module that implements a counter whose modulus value $n \leq 10$

Group D: Mechatronics and Robotics Practicals(any 4)

1. Interfacing sensors(DHT11/LM 35/PIR/LDR/Photosensors) to Microcontroller/Raspberry PI/Arduino
2. Speed control of DC motor using Microcontroller/Raspberry PI/Arduino
3. Speed control of AC motor using Microcontroller/Raspberry PI/Arduino
4. Step control of Stepper motors using Microcontroller/Raspberry PI/Arduino
5. Interfacing LCD/TFT to Microcontroller/Raspberry PI/Arduino
6. Interfacing 7 seg Display to Microcontroller/Raspberry PI/Arduino
7. Interfacing Soleniods to Microcontroller/Raspberry PI/Arduino
8. Design and development of pick and place robot using Microcontroller/Raspberry PI/Arduino
9. Mini Project equivalent to 2 expts
10. Industry visit
11. Workshops/hands on training

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ELS-355-MJP: Electronic Science Practical Course VI (Project)

Semester	Credit	Internal Assessment Marks	External Assessment Marks	Total Marks
V	2	25	25	50

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

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

Guidelines to conduct Practical Course III (Project)

Practical Course VI is a project Course of 2 Credits.

· Internal Continuous Assessment (25 marks)
· University project Examination (25 marks)

This Course should be conducted using following guidelines:

a) In CBCS Pattern, Student has to perform project in Semester V as well as Semester VI. It can perform
   1. separate project for each semester OR
   2. Can perform continuous project carrying sufficient weightage of marks per semester.

b) There should be internal continuous assessment of Project work in the form of Seminars/presentation and continuous work monitoring

c) After completion of project, student has to submit the Project Report in the following format

xii. Title of Project
xiii. Aim and objectives of project
xiv. Literature or Reference work
xv. Block diagram and its explanation in brief and/or algorithm of software required if any
xvi. Design and development of Circuit/system and Simulation required if any
xvii. Circuit Diagram and its working and Program explanation if any
xviii. Experimental Work and PCB Design/fabrication

required if any

xix. Results and Discussion

xx. Applications

xxi. Future Scope

xxii. References

d) There must be observations, interpretations, conclusions, results of the project work. d. Algorithm, program strategy, module wise description of parts etc. be provided in case of projects related with development of computer software.

e) Applications, usefulness, student's contribution in it must be clearly specified. Further extension work may be suggested for better outcome of the project. It is recommended to present the projects in competitions / project exhibitions organized by various authorities.

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ELS-366-MJE : Applied Machine Learning

SEMESTER VI **CREDITS: 2** **LECTURES:30**

Course Outcomes: After completing the course, the students will be able to
CO1: understand basics of machine learning.
CO2: understand basics of NLP
CO3: understand basics of deep learning
CO4: use of these concepts for implementation of machine learning

UNIT 1: The ML Landscape, Data, and Regression (14 LECTURES)

What is Machine Learning — the AI vs. ML vs. Deep Learning hierarchy; types of ML: supervised, unsupervised, and reinforcement learning; the ML workflow: data collection → preprocessing → model → evaluation → deployment; when not to use machine learning; real-world applications in vision, NLP, recommendation systems, and healthcare; types of data: numerical, categorical, images, and text; data preprocessing — handling missing values, normalisation, and standardisation; feature engineering and feature selection — correlation and importance scores; exploratory data analysis (EDA) with Pandas and Matplotlib; train/validation/test split and k-fold cross-validation; data leakage — definition and consequences; Linear Regression — hypothesis, cost function, and normal equation; Polynomial Regression and feature transformation; evaluation metrics: MAE, MSE, RMSE, R^2; Ridge and Lasso regularisation.

UNIT 2: Unsupervised Learning and Deep Learning for Vision(16 LECTURES)

Unsupervised learning — learning without labels; k-Means clustering — step-by-step algorithm and the elbow method for choosing k; hierarchical clustering overview; dimensionality reduction and the curse of dimensionality; Principal Component Analysis (PCA) — intuition and variance explained; t-SNE for visualisation; applications: customer segmentation, anomaly detection, and data visualisation; recap of CNNs — why they work for images; deeper CNN architectures: AlexNet and VGG at a conceptual level; Transfer Learning — pretrained models and fine-tuning; data augmentation — flipping, cropping, and colour jitter; practical computer vision tasks: image classification and object detection overview

REFERENCE / TEXT BOOKS

1. Géron, A. — *Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow*, 3rd Edition, O'Reilly Media
2. Chollet, F. — *Deep Learning with Python*, 2nd Edition, Manning Publications
3. Goodfellow, I., Bengio, Y. & Courville, A. — *Deep Learning*, MIT Press (free online: deeplearningbook.org)
4. Nielsen, M. — *Neural Networks and Deep Learning* (free

online: neuralnetworksanddeeplearning.com)
5. O'Neil, C. — *Weapons of Math Destruction*, Crown Publishers
6. Scikit-learn Official User Guide (scikit-learn.org/stable/user_guide.html)
7. **Web Resources:** http://nptel.ac.in/courses/ | https://fast.ai | https://kaggle.com/learn

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ELS-367-MJEP: Electronic Science Practical Course VII based on ELS 366-MJ

SEMESTER VI **CREDITS: 2** **LECTURES:30**

Course Outcomes: After completing the course, the students will be able to
CO1: understand basics of machine learning.
CO2: understand basics of NLP
CO3: understand basics of deep learning
CO4: use of these concepts for implementation of machine learning

1. To perform Exploratory Data Analysis: summary statistics, distributions, correlation heatmaps, and missing value identification
2. To build a full preprocessing pipeline using Scikit-learn's Pipeline and ColumnTransformer
3. To fit linear and polynomial regression models to predict house prices and compare performance
4. To train and compare Logistic Regression, k-NN, and Decision Tree classifiers using accuracy, F1-score, and ROC curves
5. To train a Random Forest classifier, extract feature importance scores, and tune hyperparameters using GridSearchCV
6. To apply k-Means clustering and use the elbow method and PCA to visualise customer segments
7. To handle class imbalance in fraud detection data and evaluate classifier performance using ROC curve and AUC
8. To load a pertained ResNet-18 model, freeze the convolutional base, and fine-tune it on CIFAR-10
9. To build a ML classifier for human activity recognition from smartphone accelerometer and gyroscope data (Assignment)
10. To independently apply the complete ML workflow — EDA, preprocessing, model selection, tuning, and evaluation — on a new dataset

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ELS-371-VSC: PCB Layout Design and Fabrication

SEMESTER VI **CREDITS: 2** **PRACTICALS**

Course Outcomes: After completing the course, the students will be able to
CO1: Understand basics of PCB.
CO2: Know about the PCB design technology.
CO3: Know about different soldering techniques. Note: This course should be taught in laboratories for getting hands on experience

PCB Designing, Fabrication, Component Mounting and Testing using Standard Procedures (Hardware)

A. Analog Electronic Circuits

1. Verification of Thevenin theorem
2. Designing of RC Low Pass Filter and High Pass Filter circuits
3. To study current-Voltage characteristics of a p-n junction diode (forward bias and reverse bias)
4. Designing of Centre tapped full wave rectifier – without and with shunt capacitance filter.
5. Simple circuit to glow an LED
6. Design, fabrication, and testing of a 9 V power supply with Zener regulator
7. Design and study of voltage divider biasing.
8. Designing of a CE based amplifier of given gain

B. Digital Electronic Circuits

1. To verify and design AND, OR, NOT and XOR using NAND gates
2. Design a Half adder and Full Adder
3. Design a Half Subtractor and Full Subtractor

PCB Design Softwares recommended

KiCAD (Open Source Electronics Design Automation Suite) https://www.kicad.org/
EasyEDA (Online PCB Design Tool) https://easyeda.com/
PADS - Siemens EDA (PCB Design Software)
https://eda.sw.siemens.com/enUS/pcb/pads/
Any other similar PCB designing software

RECOMMENDED BOOKS:

1. Printed circuit Board –Design & Technology by Walter C. Bosshart, Tata McGraw Hill
2. Printed Circuit Board –Design, Fabrication, Assembly and Testing, R.S.Khandpur, TATA McGraw Hill Publisher

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ELS-381-OJT: On Job Training

S. No.	Courses	Suggested Schedule	Duration	Suggested Activities	Credits
1	• 3-year UG degree • 4-year UG degree (Honours) • 4-year UG degree (Honours with Research)	After (4th) Semester	60 -120 hours	Hands-on Training/Short Research Project Seminar attendance Read assigned journals to prepare for seminars Study certain entrepreneurs Social projects Study of the enterprises/ farmers	02-04
2	4-year UG Degree (Honours with Research)	8th Semester	One Semester	(i) HEI may adopt Research Methodology, Research Tools and Techniques, Research Ability Enhancement and Policy Framework Courses (ii)Dissertation/Thesis/Project Work/Research project	08 12

a) Students will apply for research internships on their own or through the mentor of their parent HEI by registering at the internship portal. The HEI should ensure that such a student has an appropriate orientation for research through research ability enhancement courses as a part of the curriculum.
b) Interns will be selected by host organizations based on their selection criteria. The host organization will arrange to inform the potential intern through the portal itself or through the mail and will ask for confirmation or for acceptance.
c) If a student fails to get an internship in physical mode, then the host institute should have a provision for digital or group internship.
d) On receipt of an offer of internship, the student will arrange to consult the internship supervisor, obtain due permission from the parent institution and join the concerned host organization for an internship as per the suggested schedule.
e) The student may undergo an internship in the supervisor's lab/ working space at the host organization. During the period of internship, the parent HEI through the internship supervisor and mentor, will arrange to keep track of the activities and performance of students as interns at the host organization, based on periodic reports submitted by students.
f) On completion of Internship, intern will prepare internship report and get it endorsed by mentor.

8.0 EVALUATION

Internship

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