DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction
and
Syllabus of

M.E. (Mechanical Engineering)
MECHATRONICS

With effected from the Academic Year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING
(Autonomous)
Osmania University
Hyderabad–500 007

With effect from academic year 2024-2025

AICTE-Model Scheme
Scheme of Instructions & Examination
M.E. (Mechanical Engineering) 4 Semesters (Full Time)

S. No.	Course Name	Contact hours per week		Scheme of Examination		Credits
		L	P	CIE	SEE	
	SEMESTER-I					
1.	Programme Core-I	3	-	40	60	3
2.	Programme Core-II	3	-	40	60	3
3.	Programme Core-III	3	-	40	60	3
4.	Programme Elective-I	3	-	40	60	3
5.	Programme Elective-II	3	-	40	60	3
6.	Programme Elective-III	3	-	40	60	3
7.	Laboratory-I	0	2	50	-	1
8.	Seminar	0	2	50	-	1
	TOTAL	**18**	**4**	**340**	**360**	**20**
	SEMESTER-II					
1.	Programme Core-IV	3	-	40	60	3
2.	Programme Core-V	3	-	40	60	3
3.	Programme Core-VI	3	-	40	60	3
4.	Programme Elective-IV	3	-	40	60	3
5.	Programme Elective-V	3	-	40	60	3
6.	Open Elective	3	-	40	60	3
7.	Laboratory-II	-	2	50	-	1
8.	Laboratory-III	-	2	50	-	1
9.	Mini Project	-	4	50	-	2
	TOTAL	**18**	**8**	**390**	**360**	**22**
	SEMESTER-III					
1.	Audit Course-I	2	-	40	60	0
2.	Audit Course-II	2	-	40	60	0
3.	Dissertation Phase-I	-	20	100	-	10
	TOTAL	**4**	**20**	**180**	**120**	**10**
	SEMESTER-IV					
1.	Dissertation Phase-II	-	**32**	**100**	**100**	**16**
	GRAND TOTAL	**40**	**64**	**1010**	**940**	**68**

Note: i. Dissertation Phase-II has two parts, CIE - I (Progress Seminar) and CIE – II (Internal Viva- Voce), at the end of 8^{th} week and 16^{th} respectively for evaluation of 50 marks each.

With effect from academic year 2024-2025

M.E (Mechanical Engineering) Specialization: Mechatronics

Type of Course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	ME701	Mechatronics Systems	3	-	-	40	60	3
Core-II	ME702	Industrial Automation	3	-	-	40	60	3
Core-III	ME406	Hydraulic and Pneumatic Systems	3	-	-	40	60	3
Programme Elective-I	ME714	Instrumentation and Sensor Technology	3	-	-	40	60	3
	ME721	Principles of Product Design						
	ME501	Fuzzy Logic and Neural Networks						
Programme Elective-II	ME712	Artificial Intelligence and Machine Learning for Mechatronics	3	-	-	40	60	3
	ME713	Power Electronics and Drives						
	ME714	Communication Protocols						
Programme Elective-III	ME718	Embedded Systems with C	3	-	-	40	60	3
	ME717	Micro Electro Mechanical Systems and Applications						
	ME112	Computer Integrated Manufacturing						
Lab-I	ME751	Mechatronics Lab	-	-	2	50	-	1
Seminar	ME761	Seminar	-	-	2	50	-	1
TOTAL			**18**	**-**	**4**	**340**	**360**	**20**
SEMESTER-II								
Core-IV	ME703	Industrial Robotics	3	-	-	40	60	3
Core-V	ME704	Control of Dynamic Systems	3	-	-	40	60	3
Core-VI	ME717	Microcontroller Architecture and Interfacing	3	-	-	40	60	3
Programme Elective-IV	ME715	Intelligent Manufacturing Systems	3	-	-	40	60	3
	ME716	Innovation and Entrepreneurship						
	ME125	Industry 4.0						
Programme Elective-V	ME112	Design Thinking	3	-	-	40	60	3
	ME104	Process Control System						
	ME416	Digital Manufacturing						
	OE941BM	Medical Assistive Devices						
	OE941CS	Business Analytics						

Open Elective	OE943ME	Industrial Safety	3	-	-	40	60	3
	OE941ME	Operations Research						
	OE942CE	Cost Management of Engineering Projects						
	OE942ME	Composite Materials						
	OE941EE	Waste to Energy						
	OE941LA	Intellectual Property rights						
	OE942EE	Power Plant Control and Instrumentation						
	OE942BM	Medical Imaging Techniques						
	OE941EC	Elements of Embedded Systems						
	OE941CE	Green Building Technology						
mc	MC070	Mini Project	-	-	4	50	-	2
Lab-II	ME753	Computational Lab for Mechatronics	-	-	2	50	-	1
Lab-III	ME754	Robotics Lab	-	-	2	50	-	1
TOTAL			**18**	**-**	**8**	**390**	**360**	**22**
SEMESTER-III								
Audit Course-I	AC 030 ME	Research Methodology in Mechanical Engineering	2	-	-	40	60	0
Audit Course-II	AC 031	English for Research Paper Writing						
	AC 032	Disaster Mitigation & Management						
	AC 033	Sanskrit for Technical Knowledge						
Audit Course-II	AC 034	Value Education	2	-	-	40	60	0
	AC 035	Stress Management by Yoga						
	AC 036	Personality Development Through Life Enlightenment Skills						
	AC 037	Constitution of India						
	AC 038	Pedagogy Studies						
	AC 039	E-Waste Management						
	ME781	Dissertation Phase-I	-	-	20	100	-	10
		TOTAL	**4**	**-**	**20**	**180**	**120**	**10**
SEMESTER-IV								
	ME782	Dissertation Phase-II	-	-	32	100	100	16
		GRAND TOTAL	**40**	**-**	**64**	**1010**	**940**	**68**

CIE: *Continuous Internal Evaluation* ***SEE:*** *Semester End Examination*

Program Outcomes (PO) –Mechatronics

1) Apply knowledge of math, science, and mechatronic engineering disciplines to solve real life industrial and societal problems.
2) Build prototype, test analyse and interpret the results in the design of mechatronic systems, processes or products.
3) Independently analyse complex problems with their course background and dissertation work carried out during program.
4) Develop knowledge of computer-based mechatronics engineering tools for modelling simulation and optimization.
5) Implement mechatronic system/process which is environment friendly with appropriate consideration for public health and safety.
6) Understand professional and ethical responsibilities towards society and the environment.
7) Work as a member of multi-disciplinary teams.
8) Communicate technical matters through visual, verbal and written modes.
9) Recognize the importance of continued learning due to constantly evolving technologies and develop entrepreneurial skills.
10) Exhibit effective project management skills to conceive and develop a project plan.

With effect from academic year 2024-2025

SEMESTER -I

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
Mechatronics Systems
(Core-I) (ME701)

L	T	P	C
3	0	0	3

ME701	MECHATRONICS SYSTEMS					
(Core-I)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To understand the importance of automation in industry and various industrial standard sensors and process parameters to control the production process.
- To learn PLC hardware, and practice the PLC programming and simulation in real systems.
- To get knowledge on industrial standard data communication protocols, SCADA, centralized and de-centralized control.
- To get introduced to factory layout, Total Integrated Automation on factory and Industry 4.0.
- To get exposure on building automation using sensors, controllers and actuators

COs	Description	Blooms Level
CO1	Understand the need of process parameter measurement and control.	L2
CO2	Select, configure and program the PLC by interfacing the sensors and actuators and other input and output devices for automation	L4
CO3	Understand and compare various data communication protocols. Able to compare centralized, decentralized and smart control system.	L3
CO4	Select and apply suitable sensor, control and actuation for factory automation. Also, they can simulate the same using software.	L3
CO5	Select appropriate sensor, controller and actuation.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	3	3
CO2	2	-	-	3	3
CO3	2	-	-	3	3
CO4	1	-	-	3	3
CO 5	3	-	-	3	3

UNIT I :
What is Mechatronics, System, Measurement system, General system configuration ,Building blocks of Mechatronics system, Control system, microprocessor based controllers, Mechatronics in manufacturing and products, Mechatronics & Technology, Conventional vs Mechatronics

UNIT II:
Introduction, Machine Structure, Guide ways – Classification, Friction & Anti friction, other guide way, Drive system – Servo principle, servomotors, drive optimizations, Drive protection, selection criteria for drives, power supply for CNC, electricpanel cooling, Mechanical Transmission system, Mechanism used to convert rotary motion to linear motion, Torque transmitting elements, Spindle bearing, Antifriction bearings, Hydrostatic & HydrodynamicBearings, Direct and Indirect measuring system, Tool monitoring and changing system.

UNIT III
Introduction, guide ways – LM guide ways, tychoways, rolling elements Aerostatic & Hydro static guide ways – its assembly precautions, Ball screw and nut – assembly technique alignment, fitting and dismantling, failures and thermal displacement, Feedback elements – Preferred mounting positions of linear scale assembly, incremental angle encoder, Assembly care of mounting of proximity switch, Spindle bearings – general assembly precautions, misalignment, noise and vibration.

UNIT IV:
Loading & data presentation elements, Magnetic recordings and data acquisition systems, Displays, Data acquisition systems.

UNIT V:
Linear systems – Pneumatic rams – Rod & rod less type, Pneumatic diaphragms & bellows, Hydraulic cylinders, Motor and ball screw / lead screw, Direct linear electrical actuators, Solenoids & other forms of electrical actuators

REFERENCES:
1. System design- Devdas Shetty & Richard A Kolk, PWS Publications – 6th reprint 2024
2. Mechatronics- Electronics control systems in Mechanical Engineering - W Bolton – 2nd Edition Pearson Education Ltd.
3. Mechatronics- Prof. C.R.Venkataramana, Sapna book house, First Edition , 7th reprint Oct 20022
5. Mechatronics - Electronics in Product & Process - D.A. Bradley, D.Dawson, N C Burd and A J Loader Nelson Thomes Ltd, First Indian Reprint 2004

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
Industrial Automation
(Core-II) (ME702)

L	T	P	C
3	0	0	3

ME702	INDUSTRIAL AUTOMATION					
(Core-II)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To understand the importance of automation in industry and various industrial standard sensors and process parameters to control the production process.
- To learn PLC hardware, and practice the PLC programming and simulation in real systems.
- To get knowledge on industrial standard data communication protocols, SCADA, centralized and de-centralized control.
- To get introduced to factory layout, Total Integrated Automation on factory and Industry 4.0.
- To get exposure on building automation using sensors, controllers and actuators

COs	Description	Blooms Level
CO1	Understand the need of process parameter measurement and control.	L2
CO2	Select, configure and program the PLC by interfacing the sensors and actuators and other input and output devices for automation	L4
CO3	Understand and compare various data communication protocols. Able to compare centralized, decentralized and smart control system.	L3
CO4	Select and apply suitable sensor, control and actuation for factory automation. Also, they can simulate the same using software.	L3
CO5	Select appropriate sensor, controller and actuation.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	2	-	-	3	3
CO2	2	-	-	3	3
CO3	2	-	-	3	3
CO4	1	-	-	3	3
CO 5	3	-	-	3	3

UNIT I :
Introduction and need for automation-Instrumentation system for measurement of process parameters – overview on flow, level, pressure, temperature, speed, current and voltage measurements – proximity and vision based inspection systems – process control systems – continuous and batch process – feedback control system overview.

UNIT II:
Fundamentals of programmable logic controller - functions of PLCs - features of PLC - selection of PLC - architecture – Basics of PLC programming - logic ladder diagrams – communication in PLCs – Programming Timers and counters – Data Handling - PLC modules - Advanced PLCs.

UNIT III
Industrial data communications - fiber optics – Modbus – HART – Device Net – Profibus – Fieldbus – Introduction to supervisory control systems – SCADA - Distributed control system (DCS) – Safety systems – man-machine interfaces.

UNIT IV:
Factory layout - Tools and software based factory modeling -case study on automated manufacturing units, assembly unit, inspection systems and PLC based automated systems- Introduction to factory automation monitoring software

UNIT V:
Building layout and its 3D model-Power Distribution System in Buildings- HVAC systems- Systems Design & Operation- PLC in Building Services- Building Automation Systems – control panel- Introduction to building automation software.

REFERENCES:
1. Clarke, G., Reynders, D. and Wright, E., "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes, 1st Edition, 2004.
2. D.Patranabis, "Principles of Industrial Instrumentation", Tata McGraw-Hill Publishing Ltd., New Delhi, 2010.
3. Frank D. Petruzella, "Programmable Logic Controller" McGraw – Hill Publications, 2016.
4. Frank Lamb, "Hands on Industrial Automation", McGraw-Hill Profession, 2013.
5. Hughes, T., "Programmable Logic Controllers", ISA Press, 2000.
6. Lucas, M.P., "Distributed Control System", Van Nastrand Reinhold Company, New York, 1986.
7. Shengwei Wang, "Intelligent Buildings and Building Automation", Routledge Publishers, 2009.

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
HYDRAULIC AND PNEUMATIC SYSTEMS
(Core-III) (ME406)

L	T	P	C
3	0	0	3

ME406	HYDRAULIC AND PNEUMATIC SYSTEMS					
(Core-III)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To understand the types fluid power, advantages of fluid power, application of fluid power system.
- To know the basics of hydraulics and properties of hydraulic fluids.
- To design of simple hydraulic, pneumatic circuits and servo systems.

COs	Description	Blooms Level
CO1	Understand fluid power systems	L2
CO2	Gain knowledge on pumps and compressors	L4
CO3	Exhibit the knowledge on selection of components of fluid power systems	L3
CO4	Design pneumatic and hydraulic circuits	L3
CO5	Operate LCA and FMS	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:
Introduction to fluid power, Advantages of fluid power, Application of fluid power system. Types of fluid power systems, Compressibility and incompressibility of fluids–Stagnation states, Mach waves and Mach cone–Effect of Mach number on compressibility–Isentropic flow through variable ducts–Nozzle and Diffusers. Ideal Gas equations-Applications of Pascal‘s Law– Laminar and Turbulent flow–Reynolds number–Darcy‘s equation–Losses in fluid power system.

UNIT-II:
Basics of Hydraulics –Properties of hydraulic fluids –Sources of Hydraulic Power-Pump classifications– Construction and working of Pumps– Pump performance– comparison of pumps. An overview of Basic hydraulic system. Basics of Pneumatics -Properties of compressed air-Sources of Pneumatic Power-Types of compressor-Construction and working of compressor-Performance of compressor-An overview of Basic pneumatic system-Comparison of pump and compressor–Need for compressed air conditioning –pneumatic dryer–Filter, regulator and lubricator –fluid power accumulators–purpose and types. Distribution of Fluid power and safety measures

UNIT-III:
Fluid power actuators-selection of actuators –pneumatic and hydraulic actuators –types and ISO symbols– linear and rotary. Construction and working of double acting cylinder– special actuators–rodless, tandem, impact, duplex and telescopic cylinders.–types of actuating mechanism. sensors–limit switches, reed switches and pressure switches Cushioning mechanism in pneumatic and hydraulic cylinders. Control valves–types of valves. Construction and working of control valves -3/2, 4/2, 5/3 and 4/3 Direction control valve, flow control valve, classification and working of pressure control valves, sequencing and relief valve.

UNIT-IV:
Design of simple hydraulic and pneumatic circuits-Speed and force calculation of linear actuator. Design considerations of pneumatic and hydraulic circuits. meter in, meter out and counter balancing circuits. Design of multi cylinder pneumatic and hydraulic sequencing circuit. Fluidics–Introduction to fluidic devices, simple circuits. Design of simple Electro pneumatic and Electro hydraulic circuits. Design of Multi cylinder electro pneumatic and electro hydraulic circuits–Ladder diagram. conflict signals–identification of conflict signal. Cascading method–step counter method, Karnaugh-Veitch method and combinational circuit design.

UNIT-V:
Servo systems– Hydro Mechanical servo systems, Electro hydraulic servo systems and proportional valves. Pneumatic PID circuits. PLC applications in fluid power control, ladder diagrams, Timers and counters. Low Cost Automation using pneumatics and Flexible manufacturing system. Fluid power circuits; failure and troubleshooting FIELD WORK Case study on applications using1. PLC2.FMS3. Servo system

REFERENCES:
1. Anthony Esposito, Fluid Power with application,PrenticeHall,2013.
2. Majumdar S.R., OilHydraulics, Tata McGraw-Hill, New Delhi2009
3. Anderson,J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill,2003
4. A textbook of Basic Pneumatics, SMC Pneumatics, 2012.
5. A textbook of Electro Pneumatics, SMC Pneumatics, 2012.
6. Harry Stevart D.B, Practical guide to fluid power, Taraoealasons and Port Ltd. Broadey,1976.
7. MichaelJ, Prinches and Ashby J . G, Power Hydraulics, Prentice Hall,1989

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
INSTRUMENTATION & SENSOR TECHNOLOGY
(Programme Elective -I) (ME714)

L	T	P	C
3	0	0	3

ME714	**INSTRUMENTATION & SENSOR TECHNOLOGY**					
(Programme Elective -I)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:

- To explain the concept of intelligent instrumentation and impart knowledge on automation.
- To develop an ability to model and analyze a real time system.
- To develop an ability to evaluate the performance of a real time system.
- To develop an ability to design an intelligent system for industrial automation.
- To discuss the latest technology in automation

COs	Description	Blooms Level
CO1	Demonstrate on the understanding of automation and functioning of various elements in a real time system.	L2
CO2	Have an ability to identify and analyze various components of a real time system.	L4
CO3	Have an ability to evaluate the performance of a real time system.	L3
CO4	Have an ability to evaluate a larger for industrial automation	L3
CO5	Update on the recent trends in automation technologies.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:

Measurement and Characteristics: Elements of a Measurement System; Classification of Instruments; Static Performance Parameters; Loading and Impedance Matching; Errors and Uncertainties in Measurement; Process and Standards of Calibration; Dynamic Characteristics- Transfer Function Representation of a Measurement System, Impulse and Step Responses of First and Second Order Systems, Frequency Response of First and Second Order Systems.

UNIT-II:

Mechanical Transducers: Temperature- Bimetallic Element and Fluid Expansion type Thermometers; Pressure- Manometers and Bourdon Gauges; Force- Balances, Helical Spiral Springs, Load Cells and Elastic Force Devices; Torque- Torsion Bars and Flat Spiral Springs; Liquid Level- Float Systems and Level to Pressure Converters; Flow- Pitot Static Tubes and Turbine type Flow Meters. Hot Wire Anemometer

Proximity Sensors- Reed Sensors, Inductive proximity sensor, capacitive proximity sensor, Optical sensor with through beam, Ultrasonic sensors.

UNIT-III:

Electrical Transducers: Resistance Thermometers; Interfacing Resistive Transducers to Electronic Circuits; Thermistors- Measurement of Temperature and Thermal Conductivity, Temperature Control; Resistance Strain Gauges- Gauge Factor, Bonded and Un-bonded Strain Gauges; Self Generating and Non Self Generating Inductive Transducers; Linear Variable Differential Transformers; Capacitive Transducers - Potentiometric Transducers; Thermoelectric Transducers and Sources of Errors in Thermocouples; Piezoelectric Transducers;

UNIT-IV:

Basic Signal Conditioning Elements: Amplifiers- Non Electrical and Electrical types; Op Amps- Inverting, Non Inverting, Summing, Differential, and Charge Amplifiers; Differentiating and Integrating Elements; Filters; Data Transmission Elements- Electrical, Pneumatic, Position and Radio Frequency Transmission types; Compensation Elements for First and Second Order Systems - Basic Indicating, Recording, and Display Elements.

UNIT-V:

Feedback in Instruments- Principles of Feedback and Advantages & Disadvantages of Feedback; Digital Voltmeters-Ramp and Dual Slope types; Servo type Potentiometric and Magnetic Tape Recorders; Digital Recorders of Memory type; Data Displays-Analog and Digital types.

REFERENCES:

1. Electronic Measurements and Instrumentation, K. Lal Kishore, Pearson Education Publications
2. Electronic Instrumentation, H. S. Kalsi-TMH Publications
3. Albert D Helfrick and William D Cooper; Modern Electronic Instrumentation and Measurement Techniques; 2004, PHI
4. BC Nakra, and Chaudhry; Instrumentation, Measurement and Analysis; 2004, Tata McGraw-Hill.
5. DVS Murthy; Transducers and Instrumentation; 2003, PHI.
6. CS Rangan, GR Sarma, and VSV Mani; Instrumentation Devices and Systems; Tata McGraw-Hill

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD

M.E.– I Year – I Sem. (Mechatronics)

PRINCIPLES OF PRODUCT DESIGN

(Program Elective - I) (ME721)

L	T	P	C
3	0	0	3

ME721	PRINCIPLES OF PRODUCT DESIGN					
(Program Elective - I)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- Competence with a set of tools and methods for product design and development.
- Confidence in own abilities to create a new product.
- Awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production).
- Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective.
- Reinforcement of specific knowledge from other courses through practice and reflection in an action-oriented setting.
- Enhanced team working skills.

COs	Description	Blooms Level
CO1	To understand the need of Industrial Product & Development, customer needs & Design aspects of new products.	L2
CO2	Able to involve customer into the development of new products and managing requirements.	L4
CO3	Able to understand the design of experiments and technical analysis.	L3
CO4	Know product architecture.	L3
CO5	Investigate the customer requirement and survey of problems & Design for manufacture and do prototyping.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:
Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and behavior analysis, understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

UNIT-II:
Activity of concept generation – Structured approaches – Five step Method: clarify – Search-Externally and internally – explore systematically – reflect on the solutions and processes – Concept selection – Integral part of PDD process-methodology – benefits.

UNIT-III:
Product architecture: Implications – Product change – variety – component standardization – product performance – manufacturability.

Industrial design: Assessing the need for industrial design, impact – design process
Integrate design process – assessing the quality of industrial design.
ROBUST DESIGN-introduction, various steps in robust design.

UNIT-IV:
Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT-V:
Design for manufacturing: Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs –cost of supporting production. Minimizing System complexity.
Prototyping: Prototype basics – Principles of prototyping – planning for prototypes – Economic analysis. Understanding and representing tasks – baseline project planning – accelerating the project execution.

REFERENCES:
1. Product Design and Development by Kari T. Ulrich and Steven D. Eppinger, McGraw Hill International Edns. 1999.
2. Effective Product Design and Development by Stephen Rosenthal, Business One Orwin, Homewood, 1992.
3. Concurrent Engineering and integrated Product development by Kemnneth Crow, DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274 (310) 377-569, Workshop Book.
4. Tool Design – Integrated Methods for Successful Product Engineering by Staurt Pugh, Addison Wesley Publishing, Neyourk, NY, 1991.

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
FUZZY LOGIC AND NEURAL NETWORKS
(Programme Elective-I) (ME501)

L	T	P	C
3	0	0	3

ME501	FUZZY LOGIC AND NEURAL NETWORKS					
(Programme Elective-I)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To understand the fundamental theory and concepts of neural networks, neuro-modeling, several neural
- To understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic control and other machine intelligence applications of fuzzy logic.
- To understand the basics of an evolutionary computing paradigm known as genetic algorithms and its application to engineering optimization problems.

COs	Description	Blooms Level
CO1	Comprehend the concepts of feed forward neural networks.	L2
CO2	Analyse the various feedback network.	L4
CO3	Understand the concept of fuzziness involved in various systems and fuzzy set theory	L3
CO4	Comprehend the fuzzy logic control and adaptive fuzzy logic and to design the fuzzy control using genetic algorithm.	L3
CO5	Analyse the application of fuzzy logic control to real time systems.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:
Classical & Fuzzy Sets: Introduction to classical sets – properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions. Fuzzy Logic System Components: Fuzzification, Membership value assignment, development of rule base and decision-making system, Defuzzification to crisp sets, De—fuzzification methods.

UNIT-II:
Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability Theorem. Architecture of Hoptield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network Summary and Discussion of Instance/Memory Based Learning Algorithms, Applications.

UNIT-III:
Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN, McCullochPiUs Model, Historical Developments, Potential Applications of ANN. Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN — Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application.

UNIT-IV:
Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training.
Algorithms:
Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications. Credit Assignment Problem, Generalized Delta Rule, and Derivation of Back-propagation (BP) Training, Summary of Back-propagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.

UNIT-V:
Neural network applications: Process identification, control, fault diagnosis and load forecasting.

REFERENCES:
1. Artificial Neural Networks, B. Yegnanarayana, PHI.
2. Artificial Neural Networks, Zaruda, PHI.
3. Neural Networks and Fuzzy Logic System, Bail Kosko, PHI.
4. Fuzzy Logic and Neural Networks, M. Amirthavalli, Scitech Publications India Pvt. Ltd.
5. Neural Networks, James A Freeman and Davis Skapura, Pearson Education.
6. Neural networks by satish Kumar, TIVIH, 2004
7. Neural Networks, Simon Hakins , Pearson Education.
8. Neural Engineering, C.Eliasmith and CH.Anderson, PHI.

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
(Programme Elective-II) (ME712)

L	T	P	C
3	0	0	3

ME712	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING					
(Programme Elective-II)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- Study about uninformed and heuristic search techniques.
- Learn techniques for reasoning under uncertainty
- Introduce Machine Learning and supervised learning algorithms
- Study about ensemble and unsupervised learning algorithms
- Learn the basics of deep learning using neural networks

COs	Description	Blooms Level
CO1	Use appropriate search algorithms for problem solving	L2
CO2	Apply reasoning under uncertainty	L4
CO3	Build supervised learning models	L3
CO4	Build ensemble and unsupervised models	L3
CO5	Build deep learning neural network models	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:
Introduction to AI - AI Applications - Problem solving agents – search algorithms –uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP).

UNIT-II:
Acting under uncertainty –Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.

UNIT-III:
Introduction to machine learning – Linear Regression Models: Least squares, single &multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminate function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bays, Maximum margin classifier– Support vector machine, Decision Tree, Random forests.

UNIT-IV:
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.

UNIT-V:
Perception - Multilayer perception, activation functions, network training – gradient descent optimization – stochastic gradient descent, error back propagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – Re LU, hyper parameter tuning, batch normalization, regularization, dropout.

REFERENCES:

1. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, Pearson Education,2007
2. Kevin Night, Elaine Rich, and Nair B., “Artificial Intelligence”, McGraw Hill, 2008
3. Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 20064. Deepak Khemani, “Artificial Intelligence”, Tata McGraw Hill Education, 2013

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
POWER ELECTRONICS & DRIVES
(Programme Elective-II) (ME713)

L	T	P	C
3	0	0	3

ME713	POWER ELECTRONICS & DRIVES					
(Programme Elective-II)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To comprehend the concept of converters.
- Students will be able to relate to the applications of phase controlled rectifiers.
- Students will be able to describe the importance of AC voltage controllers and cyclo converters for various industrial applications.
- Students will be able to analyze and design switch mode power electronic converters for various applications including microprocessor power supplies, renewable energy systems, and motor drives.
- Students will be able to analyze pulse width modulated inverters which are used in variable speed drives.

COs	Description	Blooms Level
CO1	Understand the basic principles of switch mode power converters.	L2
CO2	Understand the operating principles and models of different types of power electronic converters AC-AC, AC-DC, DC-AC and DC-DC converter systems.	L4
CO3	Select appropriate power converter topologies and design the power stage with controllers for various applications.	L3
CO4	Apply advanced modulation techniques for analyzing and designing power converters.	L3

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:

Introduction to Power electronics- Power electronics versus linear electronics- Review of thyristors- Power FETS – Turn on and off circuits- Microprocessor based firing circuits- Series and Parallel operation –protection circuits- Design of snubber circuits- rating and protection.

UNIT-II:

Analysis of half controlled and fully controlled converters- Dual converters- Analysis of voltage source and current source- Current source and series converters.

UNIT-III:

Methods of controlling speed – Introduction and DC Motor controls- use of Microcontroller for speed control- Feedback and Feed forward control- Step-Up and Step- Down Choppers- use of Choppers- Frequency converters and cycloconverters.

UNIT-IV:

Standard Eigen value problems- properties of Eigen values and Eigen Vectors- Generalized Eigenvalue problems- Strum sequence- Jacobi, Givens and Householders transformations.

UNIT-V:

Elements of process control- Process Characteristics- ON/OFF control- Proportional and Derivative control- electronic controllers – Pneumatic controller- Temperature, flow and pressure control- voltage regulations- principle of digital control.

REFERENCES:

1. P.C Sen, “Principles of Electric Machines and Power Electronics”, John Wiley & Sons Inc 2nd edition, 1997
2. Harrott. P “ Process Control”- Tata McGraw Hill 1991
3. Joseph Vithayathil, “Power Electronics”: Principle and Application McGraw Hill 1st edition 1995

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
COMMUNICATION PROTOCOLS
(Programme Elective-II) (ME714)

L	T	P	C
3	0	0	3

ME714	COMMUNICATION PROTOCOLS					
(Programme Elective-II)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To study the various types wired protocols for electronic system
- To know the various types wireless protocols for electronic system.
- To aware the various industrial wired protocols in automation
- To study the various types wireless protocols for industrial automation.
- To develop the wired and wireless functions of various protocols

CO's	Description	Blooms Level
CO1	Design wired protocols for electronic system.	L2
CO2	Use wireless protocols for electronic system.	L4
CO3	Practice industrial wired protocols in automation.	L3
CO4	Select wireless protocols for industrial automation.	L3
CO5	Demonstrate the wired and wireless functions of various protocols in application development.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	1	-	-	3	3
CO2	1	-	-	3	3
CO3	1	-	-	3	3
CO4	1	-	-	3	3
CO 5	1	-	-	3	3

UNIT-I

Wireless - Wired Networks Comparison - Serial Communication Protocols - RS232-UART-SPI - I2C –UNI/O Bus -1 Wire - Camara Link - Parallel Communication - PPI - Wishbone Bus – AMBA – JTAG - Fireware IEEE 1394 Bus - Ethernet Overview - RS485.

UNIT-II

Antenna Technology- Network Topologies - Wireless Local Area Networks (WLAN) - Wireless Personal Area Networks (WPAN) - Wimedia – Wimax - RF – Bluetooth- Wi-Fi – Zigbee – Wireless Industrial Automation Protocols.

UNIT-III:

Overview of Industrial Wired Networks – Terminal Bus- Modbus - HART Network Mechatrolink-II – Ether CAT- Sercos II/III – CAN- Canopen - Modbus IDA-PROFINETPROFIBUS-Ethernet/IP-Ethernet Powerlink- AG Automation and Drives (AS-I) - Device Net.

UNIT-IV:

Overview of Industrial Wireless Networks - IWLAN - ISA100 Standards – Remote Networks-Controller-Based Networks - Wireless HART Technology - 3G/4G for Automation – RFID Data Tags.

UNIT-V:

Wired Machine Networking of Sub-elements and Machines - Wireless Machine Networking of Sub-elements and Machines – Networking of Industry - Communication Network Layout Design - Networking for TIA- Cloud Computing – IOT - Case Studies in Automation Applications.

REFERENCES:

1. Bolton W., “Mechatronics”, Pearson; 5th edition, 2015.
2. Bradley D.A., and Dawson, Burd and Loader, “Mechatronics”, Thomson Press India Ltd., 2004.
3. Ernest O. Doeblin, “Measurement system, Application and Design”, Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004.
4. Renganathan S., “Transducer Engineering”, Allied Publishers (P) Ltd., 2003.
5. Antony Esposito, “Fluid Power Systems and Control”, Prentice-Hall, 2006.
6. Austin Hughes, “Electric Motors and Drives Fundamentals, Types and Applications”, Fourth Edition, Elsevier, 2013.

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
EMBEDDED SYSTEMS WITH C
(Programme Elective-III) (ME718)

L	T	P	C
3	0	0	3

ME718	EMBEDDED SYSTEMS WITH C					
(Programme Elective-III)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To introduce the Building Blocks of Embedded System
- To Educate in Various Embedded Development Strategies
- To Introduce Bus Communication in processors, Input/output interfacing.
- To impart knowledge in various processor scheduling algorithms.
- To introduce Basics of Real time operating system and example tutorials to discuss on one real time operating system tool.

COs	Description	Blooms Level
CO1	Understand the concept of embedded system, microcontroller, different components of microcontroller and their interactions.	L2
CO2	Get familiarized with programming environment to develop embedded solutions	L4
CO3	Explain the role and features of RT operating system, that makes multitask execution possible by processors.	L3
CO4	Understand the key concepts of embedded systems such as I/O, timers, interrupts and interaction with peripheral devices.	L3
CO5	Acquire knowledge about Life cycle of embedded design.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:

Introduction to Embedded Systems –built in features for embedded Target Architecture - selection of Embedded processor – DMA- memory devices – Memory management methods-memory mapping, cache replacement policies- Timer and Counting devices, Watchdog Timer, Real Time Clock- Software Development tools-IDE, assembler, compiler, linker, simulator, debugger, In circuit emulator, Target Hardware Debugging- Overview of functional safety standards for embedded systems.

UNIT-II:

Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

UNIT-III:

General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

UNIT-IV:

Introduction to basic concepts of RTOS- Need, Task, process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking, Preemptive and non-preemptive scheduling.

UNIT-V:

Task communication- context switching, interrupt latency and deadline shared memory, message passing-, Interprocess Communication – synchronization between processes-semaphores, Mailbox, pipes, priority inversion, priority inheritance, comparison of Real time Operating systems: VxWorks, uC/OS-II, RT Linux

REFERENCES:

1. Wayne Wolf, “Computers as Components-principles of Embedded Computer system Design”, 1st edition, Elseveir, 2009.
2. Labrosse, “Embedding system building blocks”, 2rd edition, CMP Publishers, 2007.
3. Kenneth J. Ayala and Thomson, “The 8051 Microcontroller”, 3rd edition, Thompson Delmar, Learning, 2008.
4. Frank Vahid, Tony Givargis and John Wiley, “Embedded System Design, Microcontrollers”, 3rd edition, Pearson Education, 2008.
5. Michael J. Pont, “Embedded C”, Addison Wesley, 2002

With effect from academic year 2024-2025

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
MICRO ELCTRO MECHANICAL SYSTEMS & APPLICATIONS
(Program Elective-III) (ME717)

L	T	P	C
3	0	0	3

ME717	MICRO ELCTRO MECHANICAL SYSTEMS & APPLICATIONS					
(Program Elective-III)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- Have a concept on the scope and recent development of the science and technology of micro- and nano-systems
- Gain the physical knowledge underlying the operation principles and design of microand nano- systems
- Learn some typical or potentially applicable micro- and nano-systems at the frontier of the development of the field.

COs	Description	Blooms Level
CO1	Fundamental basis of MEMS/NEMS.	L2
CO2	Overview of basic microfabrication processes.	L4
CO3	Bulk and Surface micromachining.	L3
CO4	Polymer and Carbon MEMS.	L3
CO5	MEMS design, modeling and simulation & 3D Integration.	L4

Program Articulation Matrix

Course Outcome	Program Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

UNIT-I:
MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics

UNIT-II:
Atomic structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.

UNIT-III:
Static Bending of Thin plates, Mechanical Vibration, Thermo mechanics, Fracture Mechanics, Thin-Film Mechanics, Overview of Finite Element Stress Analysis.

UNIT-IV:
Overview of Basics of Fluid Mechanics in Macro and Mesoscales, Basic equations in Continum Fluid Dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid flow in Sub micrometer and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor.

UNIT-V:
Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, Chemical and Physical vapor deposition, etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process.

REFERENCES:
1. Tia-Ran Hsu, MEMS & Microsystems. Design & Manufacturing, TMH 2002
2. Maluf, M., "An Introduction to Microelectromechanical Systems Engineering". Artech House, Boston 2000
3. Trimmer , W.S.N., "Micro robots and Micromechanical Systems", Sensors & Actuators, Vol 19, 1989
4. Trim, D. W., "Applied Partial Differential Equations"., PWS-Kent Publishing, Boston, 1990
5. Stephen D. Senturia, Microsystem Design, Springer Publishers

UNIVERSITY COLLEGE OF ENGINEERING, OU, HYDERABAD
M. E. – I Year – I Sem. (Mechatronics)
MECHATRONICS LAB
(Lab-I) (ME751)

L	T	P	C
0	0	2	1

ME406	MECHATRONICS LAB				
(Lab-I)					
Pre-requisites		L	T	P	C
		0	0	2	1

Evaluation	**SEE**	60 Marks	**CIE**	40 Marks

Course Objectives:

- To understand Hydraulic and Pneumatic fluid power applications
- To design, simulate and experiment Hydraulic and Pneumatic circuits.
- To understand the use of different types of sensors and transducers
- How to install the softwares required for programming
- To understand the basic programming in Embedded C

COs	**Description**	**Blooms Level**
CO1	Gain Knowledge on Hydraulic powerpack elements	L2
CO2	Gain Knowledge on Airline installation and FRL Unit with Pneumatic circuits	L4
CO3	Posses the ability to analyze the characteristics of sensors and transducers	L3
CO4	Gain the knowledge in Programming concepts for micro controllers.	L3
CO5	Able to write programming in Embedded C	L4

Program Articulation Matrix

Course Outcome	**Program Outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	1	-
CO2	3	3	1	1	-
CO3	3	2	1	1	-
CO4	3	3	2	1	-
CO 5	3	2	1	1	-

SECTION-I:

1. Study of Pneumatic components.
   a. Airline installation
   b. FRL Unit
   c. Control Valves
2. Draw the circuit diagram to operate single acting Pneumatic cylinder with Meter-in control system
3. Draw the circuit diagram to operate double acting Pneumatic cylinder with Meter-out control system
4. Draw the circuit diagram to operate the double acting cylinders for sequencing $A^+ B^+ A^- B^-$
5. Draw the circuit diagram to operate the double acting cylinders for sequencing $A^+ B^- A^- B^+$

6. Draw the circuit diagram to operate double acting Pneumatic cylinder with re generative circuits
7. Study the Hydraulic powerpack and its elements.
8. Draw the circuit diagram to operate double acting Hydraulic cylinder with Meter-in control system.
9. Draw the circuit diagram to operate double acting Hydraulic cylinder with Meter-out control system.
10. Draw the circuit diagram to operate double acting Hydraulic cylinder with counter balancer circuit.

SECTION-II:

1. Study of Thermocouple and its characteristics.
2. Study of RTD and characteristics of RTD.
3. Temperature sensing using LM35 and AD590 as temperature sensor
4. Study and calibration of LVDT for displacement measurement.
5. Finding error in the given pressure gauge with respect to Digital Gauge.
6. Measurement of Speed

a) Contact type (Tachometer) b) Non- Contact Type (Proximity Sensor & Stroboscope).

7. Study about IR, PIR, Ultrasonic, RTD, REED sensors.
8. Familiarization of Inductive Proximity, Capacitive Proximity, IR and REED Switch.

SECTION-III:

1. Downloading and installation of KEIL µ vision software.
2. Programming arithmetical operations using Embedded C.
3. Programming Logical operations using Embedded C.
4. Programming on I/O Ports.
5. Programming on simple LED blinking using Embedded C.
6. Programming on Timers/Counters
7. Programming on Seven segment display.
8. Programming on LCD using Embedded C.

SECTION-IV:

1. Basic Programming
2. Digital Programming
3. Familiarization of different Timers
4. Familiarization of different Counters
5. Familiarization of analog and jump function
6. One Real time application project
7. Familiarization of different programmable controller

ME 761	**SEMINAR**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**	25		

Course Objectives:

The course is taught with the objectives of enabling the student to:

1 *Understand the purpose of seminar*
2 *Learn the resources available at the college and outside for pursuing project*
3 *Importance of literature review*
4 *Learn to document results and arrive at required conclusions*

Course Outcomes :

On completion of this course, the student will be able to do :

CO-1 *Identify engineering problems reviewing available literature.*
CO-2 *Study the different techniques adopted to solve the problem.*
CO-3 *Understand the usage of related techniques and software's*
CO-4 *Investigate the procedure adopted and Interpret the results and conclusions obtained*
CO-5 *Document the findings as a technical report with proper references.*

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	1		
CO2	3	3	1	1	
CO3	2	3	3	2	
CO4	2	2	2	2	

The seminar must be clearly structured and Power point presentation should include the following:

1. Introduction
2. Literature survey
3. Consolidation of available information
4. Objectives and Methodology
5. Results and Discussions
6. Conclusions
7. References

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Objectives and Methodology
5. Results and Discussions & Summary
6. Conclusions
7. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of few research papers from Peer-reviewed or UGC recognized journals.
2. The seminar report should be in the following order: Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and references
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory.

SEMESTER II

ME703	INDUSTRIAL ROBOTICS					
(CORE - IV)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To demonstrate knowledge of different types of actuators used in robotic systems.
- To analyze the position and velocity kinematics of a robot arm, implement in 2D.
- To analyze the dynamics of a robot arm, implement in 2D.
- To analyze sensor signals to implement real-time control algorithms.
- To demonstrate knowledge of error propagation in electrical, mechanical & computational systems.
- To construct, program, and test the operation of a robotic system to perform a specified task.

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

COs	Description	Blooms Level
CO1	Understand the evolution, classification, structures and drives for robots.	L2
CO2	Teach the students about the kinematic arrangement of robots and its applications in the area of manufacturing sectors.	L4
CO3	Expose the students to build a robot for any type of application.	L4
CO4	Students shall understand the robotic programming and robotic languages	L3
CO5	Exposure to students on Robot Cell Design and Control and its applications	L4

Program Articulation Matrix

Course outcome	Program outcome				
	PO1	PO2	PO3	PO4	PO5
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

UNIT-I:
Automation and Robotics, Robot anatomy configuration, motions joint motion and notation, work volume, robot drive system, control system and dynamic performance, precision of movement, basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal & External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics, Power Transmission Systems.

UNIT-II:
Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward & Inverse transformations, problems on planar & spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, Manipulator Path Control: Slew, Joint Interpolated &Straight line motions, trajectory planning: Joint space scheme, Cartesian space scheme, Cubic Polynomial fit without and with via point, blending.

UNIT-III:
Robot Dynamics: Lagrange – Euler & Newton - Euler formulations, problems on two link planar manipulators, configuration of robot controller.
End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.
Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT-IV:
Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations.
Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions.

UNIT-V:
Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection, and Work cell controller.
Robot Applications: Material transfer, Machine loading/unloading. Processing operations, Assembly and Inspection, Future Applications.

REFERENCES:

1. Introduction to Robotics Mechanics & Control by John J.Craig, Pearson.
2. Industrial robotics by Mikell P.Groover, McGraw Hill.
3. Robotics by K.S. Fu, McGraw Hill.
4. Robot Analysis by Lung Wen Tsai, John Wiley & Sons.
5. Robot Analysis and Control by Asada H. and J. E. Slotin, Wiley, New York.

ME704	**CONTROL OF DYNAMIC SYSTEMS**					
(CORE - V)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To introduce the concepts of control systems and develop the ability of formulating mathematical models and designing feedback control systems.
- To provide students with the necessary tools to analyze feedback (linear) controls systems
- An ability to analyze, design, simulate, and experimentally validate linear and nonlinear control systems while taking into account practical limitations of operations.
- Anunderstandingofnegativeandpositivefeedbacksystemsandtheirapplicationtocircuitanalysis and control system design
- Anunderstandingoffrequencycompensationanditsapplicationtolinearandnonlinearcontrol system design.

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

CO's	**Description**	**Blooms Level**
CO1	Apply mathematical modeling for different physical systems	L2
CO2	Analyze the poles and zeros	L4
CO3	Determine the state space methods	L4
CO4	Analyze the non linear systems	L3
CO5	Understand the stability of the various systems	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

UNIT-I

Mathematical Modeling of physical systems, 1st, 2nd order and higher order systems, transient, steady state analysis, steady state errors, Performance Indices.

UNIT-II

Poles, zeros, zero and pole placements, Routh‟s criteria, Root locus Technique, Bode plots, Nyquist criterion, Compensation circuits

UNIT-III

State space method, state transition matrix, canonical forms, Diagonalisation, solutions of homogeneous and non homogenous equations, zero and pole placement using state space techniques, controllability and
observability, state controllability matrix, state observability matrix.

UNIT-IV

Non-Linear Systems Phase plane analysis: Phase portraits, Singular points characterization. Analysis of nonlinear.systems using phase plane techniques, Existence of limit cycles.

UNIT-V

Stability Analysis Concept of stability, Stability in the sense of Lyapunov and absolute stability, autonomous systems, the invariance principle, linear systems and linearization, non autonomous systems, linear time varying systems and linearization.

REFERENCES:

1. K. Ogata, “Modern Control Engineering”, Pearson India, 3rd Edition.
2. Norman Nise,”Control System Engineering”, Prentice Hall India, Fourth Edition.
3. Anand Kumar, “Control System Theory”, Prentice Hall India.
4. M.Vidyasagar, "Nonlinear systems analysis", Second Edition, Prentice Hall, 1993.
5. H.Khalil, "Nonlinear Systems", Macmillan Publishing Company, NY, 1992.
6. A.Isidori, “Nonlinear Control Systems” 3rd edition, Springer Verlag, London, 1995.
7. B.Brogliato, R. Lozano, B. Maschke, O. Egeland, "Dissipative Systems Analysis and Control",SpringerVerlag, London, 2nd edition, 2007.

ME717	**MICRO-CONTROLLER & APPLICATIONS**					
(CORE - VI)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To relate the basic architecture and addressing modes of a stored-program computer.
- To summarize the principles of top down design to microcontroller software development.
- To demonstrate assembly language programs for the advanced Microcontroller , assembly language code for high-level language structures such as IF-THEN-ELSE and DO-WHILE.
- To analyze a typical I/O interface and to discuss timing issues.
- To identify different types of memory used in microcontroller systems.

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

CO's	**Description**	**Blooms Level**
CO1	Distinguish Types of computers & microcontrollers.	L2
CO2	Construct Real time Applications of Microcontrollers	L4
CO3	Demonstrate 8051 for Microcontrollers.	L4
CO4	Translate Hardware applications using Microcontrollers.	L3
CO5	Students shall understand the different types of memory used in microcontroller systems	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

UNIT – I:
Overview of 8 bit Microcontrollers- Intel, Motorola, and overview of the 8051 family- 8051 Architecture.

UNIT – II:
8051 Assembly languages programming – addressing modes Instruction set- Jump, Loop+ CALL instructions & programs- Arithmetic instructions, Logic Instructions & Programs – Single bit instructions & Programming- I/o- Port programming.

UNIT – III:
Timer/ Counter, programming of 8051 serial communication, interrupts.

UNIT – IV:
Interfacing 8051 to external memory- semiconductor memory-Memory address decoding- Interfacing with external ROM-data memory space- Interfacing to 8255 Architecture of PIC micro controllers features, interfacing of I/O devices with PIC Controllers. PIC16c6x, 16c7x. 18x, 24x PIC memory organization.

UNIT – V:
Applications – Interfacing of LCD to 8051- Interfacing ADC, Sensors- Interfacing steeper motor- Interfacing keyboard- Interfacing DAC to 8051.ARM Controllers Introduction to ARM controllers. Comparison between RISC & CISC processor. Versions & variants of ARM processor. Register model of ARM processor. Modes of Operation. Applications of ARM processor.

REFERENCES:

1. Muhammad Ali Mazzid, JancieGillispeMazid "The Microcontroller & Embedded Systems", Pearson Education, 2000.
2. Julio Sanchez and Maria P. Canton, Microcontroller Programming-The Microchip PIC, CRC Press
3. MykePredko" Programming& Customizing the 8051", Tata McGraw Hill, 1999
4. Raj Kamal "Embedded systems, Architecture, Programming and Design, "Tata McGraw Hill, 2003.
5. Kenneth J. Ayala, The 8051 Microcontroller, CENGAGE Publisher
6. Fernando E. Valdes-Perez and Ramon Pallas-Areny, Microcontrollers-Fundamentals and Applications with PIC, CRC Press
7. KVK Prasad, Embedded Real Time Systems, DearmTech Publishers.

ME715	**INTELLIGENT MANUFACTURING SYSTEMS**					
(Program Elective-IV)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- Planning manufacturing systems.
- Computer integrated manufacturing and enterprise integration.
- Group Technology .

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

CO's	**Description**	**Blooms Level**
CO1	Assess the performance of manufacturing systems.	L2
CO2	Develop a systematic approach for design and implementation of manufacturing systems.	L4
CO3	Suggest new procedures to improve the productivity of existing manufacturing systems.	L4
CO4	Utilize online collaboration tools to work in complex teams.	L3
CO5	Students understands the different types of Algorithm	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

UNIT - I:

Computer Integrated Manufacturing Systems – Structure and functional areas of CIM system - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM.

Manufacturing Communication Systems – MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing – System Components, System Architecture and Data Flow, System Operation.

UNIT - II:

Components of Knowledge Based Systems – Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

UNIT - III:

Machine Learning – Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

UNIT - IV:

Automated Process Planning – Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning.

UNIT - V:

Group Technology: Models and Algorithms – Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation – Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System, Structure of Knowledge based system for group technology (KBSGT) – Data Baswe, Knowledge Base, Clustering Algorithm.

REFERENCES:

1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4. Neural networks: A comprehensive foundation/ Simon Haykin/ PHI.
5. Artificial neural networks/ B. Vegnanarayana/PHI
6. Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
7. Neural networks/ James A Freeman David M S kapura/ Pearson education/2004
8. Introduction to Artificial Neural Systems/Jacek M. Zurada/JAICO Publishing House Ed. 2006.

ME716	**ENTREPRENEURSHIP**					
(Program Elective-IV)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To enable student learn about entrepreneurship, entrepreneurial behavior, functional areas of business and their interrelationship with each other.
- To acquaint the student with the knowledge to understand the risks and rewards of a new venture and the steps required to start a new venture.
- To develop an entrepreneurial mind-set by learning key skills such as design, personal selling, and communication.
- To understand the role of entrepreneurship in economic development.
- To comprehend various methods of financing new business ventures.
- To study the requirements of patents, trademarks and copyrights.

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

CO's	**Description**	**Blooms Level**
CO1	Understand the fundamentals of Entrepreneurship.	L2
CO2	Apply the techniques of environmental analysis, opportunity assessment, feasibility study and generating business ideas.	L4
CO3	Construct a business plan by including all the necessary elements of the business plan.	L4
CO4	Analyse working of these enterprises and to measure and evaluate their performance and efficiency.	L3
CO5	Build an understanding about business situations in which entrepreneurs act.	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

UNITI:

Entrepreneurship: meaning – role – Strengths and weaknesses – Defining an entrepreneur – entrepreneurial traits - Developing entrepreneurs – New ventures and Business Plan : Need for a Business plan – steps in the preparation of business plan – Need for marketing research – Operating plans and financial plans – Dynamics of small business environment – Causes for small business failure – Success factors for small business.

UNIT II:

Feasibility Planning: Planning paradigm for new ventures – Stages of growth model – Fundamental of a good feasibility plan – Relevance of marketing concept to new ventures – Marketing research of pre-start-up planning – Sources of marketing research information – Implication of market research**.**

UNIT III:

Financing a new venture: Financing and its effects on effective asset management – alternate methods of financing – Venture capital and new venture financing – working out working capital requirement – Government agencies assisting in financing the project. Marketing functions that new ventures must address – Establishing marketing and sales promotion infrastructure – Concept of pricing – Growth strategies – Marketing plan.

UNIT IV:

Acquiring an Established venture: Advantages and disadvantages of acquiring established business – considerations for evaluation business opportunities – Methods of valuing a business – Franchising and franchisee's perspective.

UNIT V:

Life cycle of an entrepreneurial venture – Role of entrepreneur during various transition stages – growth – Requirements for successful patent grants – steps in obtaining a patent – Registration of trademark – copy right and the concept of fair use – Protection of intellectual property.

REFERENCES:

1. Innovation and Entrepreneurship, Peter Drucker, Harper Collings, 2015.
2. Entrepreneurship, Bruce Baringer, Pearson, 2015.
3. Projects: Planning, Analysis, Selection, Implementation and Review, Prasanna Chandra, Tata
4. McGraw Hill, 2017.
5. Management and Entrepreneurship, NVR Naidu, IK International, 2008.
6. Entrepreneurship: Creating and leading and entrepreneurial organization, Arya Kumar, Pearson,2012.

ME125	**INDUSTRY 4.0**					
(Program Elective-IV)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

At the end of completing this course, students will have knowledge on Industry 4.0, need for digital transformation and the following Industry 4.0 tools:

- Big Data and Data Analytics
- Cyber Security
- Internet of Thing

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

CO's	**Description**	**Blooms Level**
CO1	Apply mathematical modeling for different physical systems	L2
CO2	Understand the Bigdata details, Components and applications	L4
CO3	Understand the different types of IOT devices and components	L4
CO4	Concepts of Cyber Security details	L3
CO5	Understand applications of IOT in different sectors	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

Unit I :

Industry 4.0 Need – Reason for Adopting Industry 4.0 - Definition – Goals and Design Principles - Technologies of Industry 4.0 – Big Data – Artificial Intelligence (AI) – Industrial Internet of Things - Cyber Security – Cloud – Augmented Reality.

Unit II :

Big Data: Evolution - Data Evolution - Data : Terminologies - Big Data Definitions - Essential of Big Data in Industry 4.0 - Big Data Merits and Advantages - Big Data Components : Big Data Characteristics - Big Data Processing Frameworks - Big Data Applications - Big Data Tools - Big Data Domain Stack : Big Data in Data Science - Big Data in IoT - Big Data in Machine Learning - Big Data in Databases - Big Data Usecases : Big Data in Social Causes - Big Data for Industry -Big Data Roles and Skills -Big Data Roles - Learning Platforms.

Unit III :

Internet of Things (IoT) : Introduction to IoT - Architecture of IoT - Technologies for IoT - Developing IoT Applications - Applications of IoT - Security in IoT.

Unit IV :

Cyber Security Cyber Security : Cyber Crime and Information Security – Classification of Cyber Crimes - Types of Cyber Attacks - Cyber crime and Indian IT Act 2000 – Security Methods -

Unit V :

Applications of IoT – Manufacturing – Healthcare – Education – Aerospace and Defense – Agriculture – Transportationa and Logistics – Impact of Industry 4.0 on Society: Impact on Business, Government, People. Tools for Artificial Intelligence, Big Data and Data Analytics, Virtual Reality, Augmented Reality, IoT, Robotics

REFERENCES:

1. The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics By Christoph Jan Bartodziej
2. Industry 4.0: Entrepreneurship and Structural Change in the New Digital Landscape, By Springer
3. Virtual and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping, By Bartolo, P J, Taylor and Francis
4. Rapid Manufacturing: An Industrial Revolution for a Digital Age By Hopkinson, N, Haque, R., and Dickens, P., Wiley
5. P. Kaliraj, T. Devi, Industry 4.0 and Education: Transformative Technology and Applications, 2022, CRC Press, Taylor & Francis Group.

ME756	**DESIGN THINKING**					
(Program Elective-V)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- Students shall understand the Importance of design & problem-solving technique
- Understands importance of Concept generation in the design thinking
- Importance of prototyping in product development
- Understanding the Testing prototypes

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

CO's	**Description**	**Blooms Level**
CO1	Understands design & problem-solving technique	L2
CO2	Importance of Concept generation in the design thinking	L4
CO3	Prototyping in product development	L4
CO4	Digital creation of Prototyping and importance	L3
CO5	Understanding the Testing prototypes	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

UNIT I :

Design Thinking Process: Types of the thinking process, Common methods to change the human thinking process, Design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking, Problem solving, the need of design thinking; An approach to design thinking, Design thinking Process model, Design thinking tools.

UNIT II:

Design thinking phases, how to empathize, Role of empathy in design thinking, the purpose of empathymaps, Things to be done prior to empathy mapping, Activities during and after the session, Understanding empathy tools: Customer Journey Map, Personas.

UNIT III:

Challenges in idea generation, Visualize, Empathize, and Ideate method, Importance of visualizing and empathizing before ideating, Applying the method, Create Thinking, Generating Design Ideas, Lateral Thinking, Analogies, Brainstorming, Mind mapping, National Group Technique, Synectic's, Development of work, Analytical Thinking, Group Activities. Ideation Tools: How Might We? (HMW), Storyboard, Brainstorming. What is design innovation? A mindset for innovation, and asking "What if?" asking "What wows?" and "What works?"

UNIT IV:

What is a prototype? - Prototyping as a mindset, prototype examples, prototyping for products; Whywe prototype? Fidelity for prototypes, Process of prototyping- Minimum Viable prototype.

UNIT V:

Prototyping for digital products: What's unique for digital products, Preparation; Prototyping for physical products: What's unique for physical products, Preparation; Testing prototypes with users. Create a Pitch-Plan for scaling up-Road map for Implementation, Fine-tuning and Submission of the project report

REFERENCES:

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperCollins Publishers Ltd.
2. IdrisMootee, Design Thinking for Strategic Innovation,2013, John Wiley & Sons Inc.
3. Roger Martin (2009), The Design of Business, Harvard Business Review Press.
4. Pavan Soni (2020), Design Your Thinking: The Mindsets, Toolsets, and Skill Sets for Creative Problem-solving, Penguin Random House India Private Limited.
5. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve– Apply", Springer, 2011.

ME104	**ADVANCED PROCESS CONTROL**					
(Program Elective-V)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- To understand how to apply advanced control concepts to different processes.

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

CO's	**Description**	**Blooms Level**
CO1	Control relevant process modeling and identification	L2
CO2	Identification of SISO, MISO	L4
CO3	Understands the Linear multivariable control	L4
CO4	Details of Multivariable optimal constraint control algorithm	L3
CO5	Study of Nonlinear multivariable control	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

Unit I ;
Control relevant process modeling and identification: Model applications, types of models, empirical dynamic models, model structure considerations, model identification.

Unit II ;
SISO furnace parametric model identification, MISO parametric model identification, MISO non-parametric identification of a non- integrating process, MIMO identification of an integrating and non-integrating process, design of plant experiments, conversion of model structures.

Unit III :
Linear multivariable control: Interaction in multivariable systems, Dynamic matrix control, properties of commercial MPC packages.

Unit IV :
Multivariable optimal constraint control algorithm: Model formulation for systems with dead time, model formulation for multivariable processes with and without time delays, model formulation in case of a limited control horizon, Non-linear transformations.

Unit V :
Nonlinear multivariable control: Non-linear model predictive control, non-linear quadratic DMC, generic model control, GMC application to chemical engineering systems, one step reference trajectory control.

REFERENCES:

1. B. Roffel, B.H.L. Betlem, "Advanced Practical Process Control" Springer, 2004.
2. Jean Pierre Corriou, "Process Control: Theory and applications" Springer, 2004.
3. CA. Smith and A.B. Corrupio," Principles and Practice of Automotive Process Control", John Wiley, New York, 1976

ME416	**DIGITAL MANUFACTURING**					
(Program Elective-V)						
Pre-requisites			L	T	P	C
			3	-	-	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:

- Explain the architecture of digital manufacturing system.
- Discuss on design process and role of CAD.
- Summerize on three dimensional modelling schemes.
- Explain the need of reverse engineering.
- Explain on tool selection and process and parameters in computer aided manufacturing.
- discuss on classification of additive manufacturing process based on initial state of materials.
- explain the processes used in additive manufacturing for a range of materials.

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

CO's	**Description**	**Blooms Level**
CO1	Understand the fundamentals of Digital Manufacturing System	L2
CO2	Interpret the role of CAD and design process in Digital Manufacturing	L4
CO3	Appreciate the role of Reengineering (Reverse Engineering) and CAM in Digital Manufacturing	L4
CO4	A Illustrate various additive manufacturing technologies and softwares nalyze the non linear systems	L3
CO5	Understand the wide range of applications of AM and also cost estimation for various AM Technologies	L4

Program Articulation Matrix

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	3	2	2	1
CO2	3	3	2	2	1
CO3	3	3	2	3	1
CO4	3	3	2	3	1
CO 5	3	3	2	3	1

UNIT – I :

Definition of digital manufacturing, Historical perspective on industrial production and outlook, Industrial Revolutions, Industry 4.0, Cyberphysical system, Factory of the future, Operation Mode and Architecture of Digital Manufacturing System.

UNIT – II

Fundamentals of CAD - Hardware in CAD-Computer Graphics Software: CAD Software: System software, Application Software, Graphic Standards & Exchange formats, CAD database and structure, 2D Geometric Transformations, 3D Geometric Transformation, Geometric modelling: Bezier Curve, Spline curves, NURBS, Surface: Plane surface, ruled surface, Surface of revolution, Tabulated Cylinder, Bezier surface, B-spline surface and solid modelling: CSG and B-Representation.

UNIT – III

Reengineering Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.

Computer Aided Manufacturing: Introduction – Features & Elements of NC, Types of input media and NC Classification, CNC Hardware, NC and NC part programming, Machining Centers, CNC Adaptive Control systems, FMS: Definition, components of FMS and FMS layouts.

UNIT – IV

Introduction to additive manufacturing, Additive manufacturing process chain, Material selection, Manufacturing, Post processing, Additive manufacturing technologies and processes, Vat photo polymerization, Material extrusion, Material jetting, Sheet lamination, Powder bed fusion, Binder jetting, Planning and slicing additive manufacturing software. AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT – V

Application – Material Relationship, Application in Design, Engineering Analysis and Planning, Aerospace, Automotive, Jewelry, Coin, GIS, Arts, Architecture. Medical and Bioengineering Applications, Forensic Science and Anthropology, Visualization of Biomolecules.

REFERENCES:

1. Zude Zhou Shane (Shengquan) Xie Dejun Chen, "Fundamentals of Digital Manufacturing Science' 'Springer Series in Advanced Manufacturing,2012
2. Ibrahim Zeid and Sivasubramanian R, "CAD/CAM - Theory and Practice", Tata McGraw Hill Education, 2011.
3. Radhakrishnan, P. Sbramanyam, S.Raju.v, "CAD/CAM/CIM", New Age International (P) Ltd, 2nd Edition
4. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific.

OE 941 BM	**MEDICAL ASSISTIVE DEVICES**					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
2	To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
3	To develop improved lower-extremity devices

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Apply fundamental knowledge of engineering in rehabilitation
CO-2	Apply analytical skills to assess and evaluate the need of the end-user
CO-3	Develop self-learning initiatives and integrate learned knowledge for problem solving
CO-4	Understand the basics of robotics and apply their principles in developing prosthetics
CO-5	Apply the knowledge of computers in solving rehabilitation problems

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I
Introduction to Rehabilitation Engineering, Measurement and analysis of human movement, Disability associated with aging in the workplace and their solutions, clinical practice of rehabilitation engineering.

Unit – II
Assistive Technology, Seating Biomechanics and systems. Wheeled Mobility: Categories of

Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of Wheel chair propulsion. Power Wheelchair Electrical Systems. Control. Personal Transportation. Auxiliary devices and systems.

Unit – III

Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution; Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Measurement tools and processes: fundamental principles, structure, function; performance and behavior. Subjective and objective measurement methods.

Unit – IV

Rehabilitation Robotics, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

Unit – V

Augmentative and Alternative communication technology, Computer applications in Rehabilitation Engineering, telecommunications, and Web Accessibility.

Suggested Reading:

1	Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2	Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3	Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4	Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rdEd., CRC Press, Taylor & Francis Group, London, 2006.

OE 942 BM	**MEDICAL IMAGING TECHNIQUES**					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To familiarize the students with various medical imaging modalities.
2	To make learners understand the principles, detectors and operating procedures of X-ray, CT, MRI, ultrasound, PET and SPECT.
3	To make the students learn the advantages, disadvantages and hazards of various medical imaging equipment.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Interpret the working principle and operating procedure and applications of X-ray equipment.
CO-2	Understand the image reconstruction techniques and applications of CT.
CO-3	Summarize the image acquisition and reconstruction techniques in MRI.
CO-4	Comprehend the working principle, modes and medical applications of ultrasound imaging.
CO-5	Examine the operation and applications of PET, SPECT and radio nuclide instrumentation.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I

X ray Imaging: Electromagnetic spectrum, Production of X-rays, X-ray tubes- Stationary and Rotating Anode types, Block diagram of an X-Ray Machine, Collimators and Grids, Timing and Exposure controls. X-Ray Image visualization-Films, Fluorescent screens, Image Intensifiers. Dental X-Ray machines, Portable and mobile X-Ray units, Mammographic X-Ray equipment, Digital Radiography and flat panel detectors.

Radiation safety, ALARA principle, Dose units and dose limits, Radiation dosimeters and detectors.

Unit – II
Computed Tomography: Basic principles, CT number scale, CT Generations. Major sub systems- Scanning system, processing unit, viewing unit, storage unit. Need and Principle of sectional imaging, 2D image reconstruction techniques - Iteration and Fourier methods. Applications of CT - Angio, Osteo, Dental, Perfusion (Body & Neuro), Virtual Endoscopy, Coronary Angiography.

Unit – III
Magnetic Resonance Imaging: Principles of NMR imaging systems, Image reconstruction techniques-Relaxation processes, imaging/ pulse sequences. Sub systems of an NMR imaging system, NMR detection system, types of coils, biological effects and advantages of NMR imaging. Functional MRI - The BOLD effect, intra and extra vascular field offsets, source of T2* effects, Creating BOLD contrast sequence optimization sources and dependences of physiological noise in fMRI.

Unit – IV
Ultrasound Imaging: - Principles of image formation -Imaging principles and instrumentation of A-mode, B-Mode, Gating Mode, Transmission mode and M-mode. Basics of multi-element linear array scanners, Digital scan conversion. Doppler Ultrasound and Colour Doppler imaging, Image artifacts, Biological effects, Ultrasound applications in diagnosis, therapy and surgery.

Unit – V
Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation detectors, Pulse height analyzer, Rectilinear scanner, Gamma camera. Emission Computed Tomography (ECT), Principle and instrumentation of Single Photon Emission Computed Tomography(SPECT) and Positron Emission Tomography (PET). Comparison of SPECT, PET and combined PET/ X-ray CT.

Suggested Reading:

1	Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
2	S Webb, "*The Physics of Medical Imaging*", Adam Highler, Bristol Published by CRC Press, 1988.
3	A C Kak, "*Principle of Computed Tomography*", IEEE Press New York, 1988.
4	Hykes, Heorick, Starchman, *Ultrasound physics and Instrumentation* MOSBY year book, 2nd Ed. 1992.
5	Stewart C. Bushong, *Magnetic Resonance Imaging- physical and biological principles*, MOSBY, 2nd Ed., 1995.

OE 941 CE	**GREEN BUILDING TECHNOLOGY**					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Exposure to the green building technologies and their significance.
2	Understand the judicial use of energy and its management.
3	Educate about the Sun-earth relationship and its effect on climate.
4	Enhance awareness of end-use energy requirements in the society.
5	Develop suitable technologies for energy management

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the fundamentals of energy use and energy processes in building.
CO-2	Identify the energy requirement and its management.
CO-3	Know the Sun-earth relationship vis-a-vis its effect on climate.
CO-4	Be acquainted with the end-use energy requirements.
CO-5	Be familiar with the audit procedures of energy

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	3	3	2	1	2
CO-2	3	2	3	2	1	1
CO-3	3	2	3	2	1	2
CO-4	3	2	3	2	1	2
CO-5	3	2	3	2	1	1

Unit – I

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

Unit – II

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

Unit – III

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

Unit – IV

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer.

Unit – V

Nuclear Medicine–Radioisotopes in medical diagnosis, Basic instrumentation- Radiation Energy management options - Energy audit and energy targeting - Technological options for energy management.

Suggested Reading:

1	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2	Carter, W. Nick, (1991): Disaster Management, Asian Development Bank, Manila.
3	Sahni, Pardeep et.al. (eds.) (2002), Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi.
4	Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.

OE 942 CE	**COST MANAGEMENT OF ENGINEERING PROJECTS**					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduce the concepts of cost management
2	Fundamentals of cost overruns
3	Introduce the concepts of Quantitative techniques for cost management Linear Programming, PERT/CPM.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
CO-2	Ability to appreciative detailed engineering activities of the project and execution of projects
CO-3	Preparation of project report and network diagram
CO-4	Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
CO-5	Applications of various quantitative techniques for cost management

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I
Introduction and Overview of the Strategic Cost Management Process-Cost concepts in decision- making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System- Inventory valuation- Creation of a Database for operational control; Provision of data for Decision-Making.

Unit – II
Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of

technical and non- technical activities- Detailed Engineering activities.

Unit – III
Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

Unit – IV
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector- Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets- Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Unit – V
Quantitative techniques for cost management, Linear Programming, PERT/CPM,- Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Reading:

1	Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2	Charles T. Horngren and George Foster, Advanced Management Accounting
3	Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4	Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5	N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OE 941 CS	**BUSINESS ANALYTICS**					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understanding the basic concepts of business analytics and applications
2	Study various business analytics methods including predictive, prescriptive and prescriptive analytics
3	Prepare the students to model business data using various data mining, decision making methods

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To understand the basic concepts of business analytics
CO-2	Identify the application of business analytics and use tools to analyze business data
CO-3	Become familiar with various metrics, measures used in business analytics
CO-4	Illustrate various descriptive, predictive and prescriptive methods and techniques
CO-5	Model the business data using various business analytical methods and techniques

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

Unit – II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures

of variation, measures of shape-skewness, data visualization.

Unit – III
Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

Unit – IV
Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics**- Linear Programming(LP) and LP model building.

Unit – V
Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox.

Suggested Reading:

1	U Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2	Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015
3	S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1	https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2	https://nptel.ac.in/courses/110105089 /

OE 941 EC	**ELEMENTS OF EMBEDDED SYSTEMS**					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Understanding various Embedded Design strategies
2	Designing Micro controller based Embedded Systems
3	Designing FPGA Based Embedded Systems

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand Embedded Design Strategies and architecture of Arduino Board
CO-2	Program using various onboard components of Arduino
CO-3	Design real time interfacing with Arduino
CO-4	Understand Design Flow of FPGA, programming FPGA using Verilog HDL
CO-5	Implement combinational and sequential circuits using verilog HDL

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I
Embedded Systems Design Strategies: Micro Controller, DSP, FPGA, Introduction to Arduino (Micro controller Board), Components of Arduino, Architecture and Pin Configuration of ATMega328, Ports of ATMega328.

Unit – II
Interfacing: Interfacing Switches, LEDs, Analog to Digital Converter, Digital to Analog Converter, Interfacing and Programming I2C, SPI

Unit – III
Real Time Programming: Interfacing Key Pad, 7-segment display, LCD, Interfacing Sensors,

Interfacing Stepper Motor**,** USB programming

Unit – IV
FPGA Based Embedded Design: FPGA Design flow, Introduction to Verilog HDL**,** Basic building blocks, Data types of Verolog HDL, Behavioral Modelling, Data Flow Modelling, Structural Modelling, Hierarchal Structural Modelling, Case Studies on Verilog HDL descriptions of Basic Circuits

Unit – V
Modelling of Circuits: Verilog HDL Implementation of Combinational MSI Circuits, Verilog HDL Implementation of Sequential MSI Circuits, Finite Sate Machine Design, Tasks and Functions, Introduction to Test Benches

Suggested Reading:

1	Ming-Bo Lin, Digital System Designs and Practices Using Verilog HDL and FPGAs, Wiley India, 2008
2	Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Pearson Education, 2005
3	Simon Monk, Programming Arduino: Getting Started with sketches, Mc.Hill, 2016

Web Resources:

1	www.arduino.cc
2	www.learn.sparkfun.com/tutorials/arduino

OE 941 EE	**WASTE TO ENERGY**					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To know the various forms of waste
2	To understand the processes of Biomass Pyrolysis.
3	To learn the technique of Biomass Combustion.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of conservation of waste
CO-2	Identify the different forms of wastage.
CO-3	Chose the best way for conservation to produce energy from waste.
CO-4	Explore the ways and means of combustion of biomass.
CO-5	Develop a healthy environment for the mankind.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	-	3	2	3	1
CO-2	3	-	3	2	3	1
CO-3	3	-	3	2	3	1
CO-4	3	-	3	2	3	1
CO-5	3	-	3	2	3	1

Unit – I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit – II

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Unit – III

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Unit – IV

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit – V

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1	Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2	Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3	Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4	Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OE 942 EE	**POWER PLANT CONTROLAND INSTRUMENTATION**					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	The operation of different types of power plants.
2	The basic working principle of instruments for measurement of electrical and non-electrical quantities like Temperature Pressure flow level measurements.
3	The instrumentation and protection systems applied in thermal power plant.
4	The control techniques employed for the operation of modern power generation plant

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Explain the different methods of power generation. Along with Piping and Instrumentation diagram of boiler.
CO-2	Select various measurements involved in power generation for measuring electrical and non-electrical parameters.
CO-3	Identify the different types of analyzers used for scrutinizing boiler steam and water.
CO-4	Model different types of controls and control loops in boilers.
CO-5	Illustrate the methods of monitoring and control of different parameters like speed, vibration of turbines

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	3	1	-	-	-	2
CO-2	3	1	-	-	-	2
CO-3	3	1	-	-	-	2
CO-4	3	1	-	-	-	2
CO-5	3	1	-	-	-	2

Unit – I
Brief survey of methods of power generation, hydro, thermal, nuclear, solar and wind power, importance of instrumentation in power generation, thermal power plants, block diagram, details of boiler processes, Piping and Instrumentation diagram of boiler, cogeneration.

Unit – II
Electrical measurements, current, voltage, power, frequency, power factor etc, non-electrical parameters, flow of feed water, fuel, air and steam with correction factor for temperature, steam pressure and steam temperature, drum level measurement, radiation detector, smoke density measurement, dust monitor.

Unit – III
Flue gas oxygen analyzer: Analysis of impurities in feed water and steam, dissolved oxygen analyzer. Chromatography, pH meter, fuel analyzer, pollution monitoring instruments.

Unit – IV
Combustion control, air / fuel ratio control, furnace draft control, drum level control, main steam and reheat steam temperature control, super heater control, air temperature, distributed control system in power plants, interlocks in boiler operation.

Unit – V
Speed, vibration, shell temperature monitoring and control, steam pressure control, lubricant oil temperature control, cooling system.

Suggested Reading:

1	Sam G. Dukelow, The Control of Boilers, Instrument Society of America, 2nd Edition, 2010.
2	P.K. Nag, „Power Plant Engineering“, Tata McGraw-Hill, 1st Edition, 2001.
3	S.M. Elonka and A.L. Kohal, “Standard Boiler Operations”, Tata McGraw-Hill, 1st Edition, 1994.
4	R K Jain, “Mechanical and Industrial Measurements”, Khanna Publishers, 1st Edition, 1995.
5	E Al Wakil, “Power Plant Engineering”, Tata McGraw-Hill, 1st Edition, 1984.

OE 941 ME	OPERATION RESEARCH					
(OPEN ELECTIVE)						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the dynamic programming to solve problems of discrete and continuous variables
2	To apply the concept of non-linear programming and carry out sensitivity analysis
3	To understand deterministic and probabilistic inventory control models.

Course Outcomes:	
After the completion of this course, the students shall be able to:	
CO-1	To understand the basics of OR, including mathematical modeling, feasible solutions and optimization.
CO-2	Able to carry out sensitivity analysis.
CO-3	Apply PERT/CPM in project management.
CO-4	Select appropriate inventory control model.
CO-5	Able to apply dynamic programming and understand the concept of non-linear programming.

Course Outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	1	1	3	2	1	2
CO-2	3	1	2	3	2	-
CO-3	1	3	3	1	2	2
CO-4	3	2	1	3	1	1
CO-5	2	1	3	2	2	2

Unit – I

Development, Different Phases, Characteristics, Operations Research models and applications. Linear Programming Problem: Introduction, Basic Assumptions, Formulation, graphical method, simplex method: Big M and Two Phase method.

Unit – II

DUALITY: Duality theory, primal-dual relationships, Economic interpretation, Dual simplex method, Post optimal or sensitivity analysis.

Unit – III

Project Management: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.
Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

Unit – IV
Sequencing Models: Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines. **Game Theory**: Introduction, Characteristics of Game Theory, Dominance theory, Mixed strategies (2 x 2, m x 2), Algebraic and graphical methods. **Nonlinear programming problem:** - Kuhn-Tucker conditions.

Unit – V
Queuing models - Queuing systems and structures – Notation parameter – Single server and multi server models – Poisson arrivals – Exponential service times – with finite population – Infinite population. Dynamic Programming: Characteristics, principle of optimality, deterministic problems.

Suggested Reading:

1	H.A. Taha, Operations Research, An Introduction, PHI,2008
2	H.M. Wagner, Principles of Operations Research, PHI, Delhi,2010
3	J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers,Delhi, 2008.
4	Frederick S. Hillier, Gerald J. Lieberman, Operations Research, 10thEdition, McGraw Hill Pub. 2017.
5	Panner selvam, Operations Research: Prentice Hall of India, 2010.
6	Ronald L. Rardin, Optimization in Operations Research, First Indian Reprint, Pearson Education Asia. 2002,

OE 942 ME	**COMPOSITE MATERIALS**					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*Study the concepts of composite construction.*
2	*Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.*
3	*Apply the concepts for design of multi-storey composite buildings.*
4	*Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Understand the fundamentals of composite construction, and analysis and designs of composite beams.*
CO-2	*Analyse and design the composite floors*
CO-3	*Select suitable materials for composite columns,*
CO-4	*Analyse composite trusses and understand connection details.*
CO-5	*Analyse and design the multi-storey composite buildings*

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I

Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.

Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

Unit – II

Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

Unit – III
Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

Unit – IV
Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

Unit – V
Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1	R.P. Johnson, "Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings", Blackwell Publishing, Malden, USA, 2004.
2	"INSDAG Teaching Resources for Structural Steel Design", Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3	"INSDAG Handbook on Composite Construction – Multi-Storey Buildings", Institute for Steel Development and Growth Publishers, Calcutta, India.
4	"INSDAG Design of Composite Truss for Building", Institute for Steel Development and Growth Publishers, Calcutta, India.
5	"INSDAG Handbook on Composite Construction – Bridges and Flyovers", Institute for Steel Development and Growth Publishers, Calcutta, India.
6	IS: 11384-1985, "Code of Practice for Composite Construction in Structural Steel and Concrete", Bureau of Indian Standards, New Delhi, 1985.

OE 943 ME	**INDUSTRIAL SAFETY**					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Causes for industrial accidents and preventive steps to be taken.
2	Fundamental concepts of Maintenance Engineering.
3	About wear and corrosion along with preventive steps to be taken
4	The basic concepts and importance of fault tracing.
5	The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Identify the causes for industrial accidents and suggest preventive measures.
CO-2	Identify the basic tools and requirements of different maintenance procedures.
CO-3	Apply different techniques to reduce and prevent Wear and corrosion in Industry.
CO-4	Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
CO-5	Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

Unit – II
Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Unit – III
Wear and Corrosion and their Prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

Unit – IV
Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

Unit – V
Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Suggested Reading:

1	H. P. Garg, "Maintenance Engineering", S. Chand and Company
2	Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication
3	Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
4	1. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

With effect from academic year 2024-2025

OE 941 LA	INTELLECTUAL PROPERTY RIGHTS					
	(OPEN ELECTIVE)					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
2	Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
3	Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of intellectual property rights.
CO-2	Develop proficiency in trademarks and acquisition of trade mark rights.
CO-3	Understand the skill of acquiring the copy rights, ownership rights and transfer.
CO-4	Able to protect trade secrets, liability for misappropriations of trade secrets.
CO-5	Apply the patents and demonstration of case studies.

Course outcome	**Program Outcome**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	2	1	3	2	1	1
CO-2	3	2	1	1	2	-
CO-3	2	2	2	3	2	1
CO-4	1	3	1	2	1	1
CO-5	1	1	2	3	2	3

Unit – I

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Unit – III
Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer**.**

Unit – IV
Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

Unit – V
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading:

1	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2	"Mayall, "Industrial Design", McGraw Hill,1992
3	"Niebel, "Product Design", McGraw Hill,1974.
4	"Asimov, "Introduction to Design", Prentice Hall,1962.
5	"Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age",2016.
6	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand,2008

MC070	**MINI PROJECT**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	4	2
Evaluation	**SEE**	-	**CIE**	50 Marks		

Course Objectives :

The course is taught with the objectives of enabling the student to:

1. *Understand the purpose of doing mini project*
2. *Learn the resources available at the college and outside for pursuing project*
3. *Importance of literature review*
4. *Learn to select appropriate software and procedure*
5. *Learn to document results and arrive at required conclusions*

Course Outcomes :	
On completion of this course, the student will be able to do :	
CO-1	*Identify engineering problems reviewing available literature*
CO-2	*Study different techniques used to analyze complex systems.*
CO-3	*Use related techniques and software's for solving the problem*
CO-4	*Interpret the results and arrive at the relevant conclusions.*
CO-5	*Document the findings as a technical report with proper references*

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1			3	2	1
CO2			3	3	1
CO3			3	3	1
CO4			3	3	1
CO 5			3	3	1

Guidelines

1. Guide allocation will be done at the beginning of the semester. Identification of mini project work will be done with Guides consultation

2. Mini project presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

3. Evaluation of Mini project will be done by the Departmental Committee. Half of the marks are awarded by the Guide and the remaining half of the marks will be awarded by Departmental Committee.

ME 452	**COMPUTATIONAL LAB FOR MECHATRONICS**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**	50		

Course outcomes

1. Able to solve basic problems using Matlab
2. Able to install and solve basic engineering problems using python software
3. Able to implement matlab and python for real time projects
4. Use necessary tools to analyze practical systems for both static and dynamic conditions
5. Analyze, design, simulate, and experimentally validate systems while taking into account practical limitations of operations

MATLAB programs

1. Evaluate the mathematical expressions in Matlab
2. Write scripts to make the following single-index arrays
3. Basic syntax and command-line exercises, Basic array exercises, Relational and logical operations
4. Control of flow: if-blocks , Loop constructs: for and while
5. Problems on generating various kinds of 2D & 3D Plots
6. Solving ordinary differential equations
7. Solving non-linear algebraic equations
8. Applications of Curve fitting and interpolation
9. Usage of Data Analysis and statistics
10. Introduction to optimization methods like GA, Fuzzy, Neural & PSO
11. Introduction to SIMULINK
12. Matlab& Simulink applied to manufacturing processes

Python Programming

1. Running Python scripts
2. Using Python as a calculator
3. Compute the value of PI
4. Computing trigonometric functions, arrays, strings, functions, methods, conditional expressions, loops, lists, modules,
5. Working with data: lists, sorting, tuples, sets, files, comprehensions, dictionaries
6. Woking with modules, object oriented programming (state, classes, objects, inheritance, errors, exceptions, iterators, generators)
7. Working with functional programming: recursion, higher order functions, decorators, exec, eval
8. Writing code for simple manufacturing processes
9. Solving optimization methods like Genetic algorithms
10. Solving problems on statistics

ME453	**Robotics LAB**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	2	1
Evaluation	**SEE**	-	**CIE**	50		

Course outcomes: on Completion the student should be able to

1. Understand the importance and application of robots in virtual environment
2. Design the robot system for point to point operation
3. Design the robot program for drilling operation
4. Design robot programming for continuous path operation

1. Simulation of Mathematical Model of Robot.
2. Forward and Inverse Dynamic Analysis of a 2-DOF Robotic Manipulator using Software Tools.
3. Building and Programming a Simple Arduino-Based Robot for basic movement.
4. Build a robot that can navigate through a maze or an environment by using sensors to detect obstacles and avoid them.
5. Construct a robotic arm using servo motors or stepper motors and program the arm to perform various tasks, such as picking up objects, sorting the colour, or drawing shapes.
6. Build a robot that follows a black line on a contrasting surface using line-following sensors.
7. Designing a 3D Model of a Robotic Arm and Grippers Using Software
8. Implement a PID controller for a robotic arm or mobile robot and simulate its performance in tracking a desired trajectory.

SEMESTER-III

AC030 ME	**RESEARCHMETHODOLOGY IN MECHANICAL ENGINEERING**					
	AUDIT - I					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	Learn to focus on research related activities.
2	Learn methods to devise and develop the various research designs
3	Learn basic principles of data collection and analysis techniques
4	Learn the style and format of writing a report for technical papers

Course Outcomes : After completion of the course student will be able to	
CO-1	Motivate the orientation towards research related activities
CO-2	Formulate the research problem, analyze research related information
CO-3	Identify various sources for literature review and design an experimentation set-up
CO-4	Apply the basic principles of data collection and analysis techniques
CO-5	Improve the style and format of writing a report for technical / Journal articles

UNIT – I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem

UNIT – II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. **Literature Review**: Need of Review, Guidelines for Review, Record of Research Review.

UNIT – III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

UNIT – IV
Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software. **Data Analysis:** Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling

UNIT –V
Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. **Research Proposal Preparation**: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Reading:

1	C.R Kothari, Research Methodology, Methods & Technique; Revised Edition, New Age International Publishers, 2004
2	R. Ganesan, Research Methodology for Engineers, 1st Edition, MJP Publishers, 2011.
3	Ratan Khananabis and Suvasis Saha, Research Methodology, 1st Edition, Universities Press, Hyderabad, 2015
4	Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, 1st Edition, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5	Vijay Upagade and Aravind Shende, Research Methodology, 1st Edition, S. Chand & Company Ltd., New Delhi, 2009
6	G. Nageswara Rao, Research Methodology and Quantitative methods, 2nd Edition, BS Publications, Hyderabad, 2012.

AC 031	**ENGLISH FOR RESEARCH PAPER WRITING**					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*Understand that how to improve your writing skills and level of readability*
2	*Understandthenuances of language and vocabulary in writing a Research Paper.*
3	*Develop the content, structure, format of writing a research paper and produce original research papers without plagiarism*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Interpret the nuances of research paper writing.*
CO-2	*Differentiate the research paper format and citation of sources.*
CO-3	*To review the research papers and articles in a scientific manner.*
CO-4	*Avoid plagiarism and be able to develop their writing skills in presenting the research work.*
CO-5	*Create a research paper and acquire the knowledge of how and where to publish their original research papers*

Unit – I

Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.

Unit – II

Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

Unit – III

Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

Unit – IV

Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.

Unit – V

Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits

Presentation Skills: Developing Persuasive Presentations, Structure of Presentation,

Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

Suggested Reading:

1	C. R Kothari, Gaurav, Garg, "*Research Methodology Methods and Techniques*", 4/e, New Age International Publishers.
2	Day R, "*How to Write and Publish a Scientific Paper*", Cambridge University Press, 2006
3	"*MLA Hand book for writers of Research Papers*", 7/e, East West Press Pvt. Ltd, New Delhi
4	Lauri Rozakis, Schaum's, "*Quick Guide to Writing Great Research Papers"*, Tata McGraw Hills Pvt. Ltd, New Delhi.

AC 032	**DISASTER MITIGATION AND MANAGEMENT**					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*Introduction of various types of disasters and its effect on structures.*
2	*Learning of quality assurance and damage assessment of structures*
3	*Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.*
4	*Awareness about flood characteristics and flood forecasting systems*
5	*Description of Flood mitigation, adjustment, and regulation*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Understand the fundamentals of disaster and seismic performance of buildings*
CO-2	*Able to assess various damages in structures and give assurance of quality of concrete*
CO-3	*Decide the appropriate repair, strengthening, rehabilitation and technique required for a case study of building.*
CO-4	*Applications of flood routing, flood forecasting and space time characteristics of rainfall.*
CO-5	*Advanced understanding of flood plain adjustments and employment of appropriate technologies for flood mitigation.*

Unit – I
Disaster: Classifications - Causes - Impacts including social, economical, political, environmental, health, psychosocial, etc.
Seismic performance of buildings: case studies of major earthquakes in the country, damage to buildings, damage patterns, performance of non-engineered buildings- Introduction to repair and rehabilitation of structures.

Unit – II
Quality assurance for concrete – Strength, Durability and Thermal properties of concrete. Damage Assessment**:** - Condition assessment and distress, Purpose of assessment, Rapid assessment - diagnostic techniques, Investigation of damage, , Evaluation of surface and structural cracks, Damage assessment procedure, destructiv e, non-destructive and semi destructive testing systems, Procedure for evaluating damaged of structure.

Unit – III
Repair, Rehabilitation And Retrofitting Techniques : Repair materials, Common types of repairs – Repair in concrete structures – Repairs in under water structures – Guniting – Shot create –Underpinning, Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques

Unit – IV
Introduction to Disasters: Hazard, Vulnerability, Resilience, Risks.-Disaster- Different types of cold wave-heat wave- droughts- floods-Effect of climate change on Processes.
Flood characteristics and forecasting: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems.
Space-time characteristics of rainfall: Policy criteria for design flood of a major and minor reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations).

Unit – V
Flood Routing: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing.
Flood mitigation: flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.
Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards.

Suggested Reading:

1	Barry A. Richardson, "Defects and Deterioration in Buildings", E &FN Spon Press, London, 1991.
2	J. H. Bungey, "Testing of Concrete in Structures", Chapman and Hall,New York, 1989.
3	"A.R. Santakumar, "Concrete Technology", Oxford University Press,New Delhi, 2006.
4	"Pankaj Agarwal and Manish Shrihkande (2006). "Earthquake Resistance Design of Structures." Prentice Hall of India.
5	"Ravishankar.K., Krishnamoorthy.T.S, "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers, 2004. New Technological Age",2016.
6	CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008.

AC 033	**SANSKRIT FOR TECHNICAL KNOWLEDGE**					
(AUDIT COURSE - II)						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*To get a working knowledge in illustrious Sanskrit, the scientific language in the world*
2	*To make the novice Learn the Sanskrit to develop the logic in mathematics, science & other subjects*
3	*To explore the huge knowledge from ancient Indian literature*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Develop passion towards Sanskrit language*
CO-2	*Decipher the latent engineering principles from Sanskrit literature*
CO-3	*Correlates the technological concepts with the ancient Sanskrit history.*
CO-4	*Develop knowledge for the technological progress*
CO-5	*Explore the avenue for research in engineering with aid of Sanskrit*

Unit – I

Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)

Unit – II

Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series). The measurement system-time- mass- length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).

Unit – III

Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):

Building construction-soil testing- mortar-town planning-Machine definition-crucible-furnace-air blower- Generation of electricity in a cell- magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

Unit – IV

Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vediccommand words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming**.**

Unit – V
*Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering):*Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthiyanthram

Suggested Reading:

1	M Krishnamachariar, "*History of Classical Sanskrit Literature",* TTD Press, 1937.
2	M.R. Kale, "*A Higher Sanskrit Grammar: For the Use of School and College Students*", Motilal Banarsidass Publishers, 2015.
3	Kapail Kapoor, "*Language, Linguistics and Literature: The Indian Perspective",* ISBN- 10: 8171880649, 1994.
4	"*Pride of India*", Samskrita Bharati Publisher, ISBN: 81-87276 27-4, 2007.
5	Shri Rama Verma, "*Vedas the source of ultimate science",* Nag publishers, 2005.

AC 034	**VALUE EDUCATION**					
(AUDIT COURSE - II)						
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*Understand the need and importance of Values for self-development and for National development.*
2	*Imbibe good human values and Morals*
3	*Cultivate individual and National character.*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Gain necessary Knowledge for self-development*
CO-2	*Learn the importance of Human values and their application in day to day professional life.*
CO-3	*Appreciate the need and importance of interpersonal skills for successful career and social life*
CO-4	*Emphasize the role of personal and social responsibility of an individual for all-round growth.*
CO-5	*Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universal brotherhood.*

Unit – I
Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture and tradition.

Unit – II
Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

Unit – III
Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.

Unit – IV
Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

Unit – V
Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

Suggested Reading:

1	Chakroborty, S.K., *"Values & Ethics for organizations Theory and practice*", Oxford University Press, New Delhi, 1998.
2	Jaya DayalGoyandaka, "*Srimad Bhagavad Gita with Sanskrit Text*", Word Meaning and Prose Meaning‖, Gita Press, Gorakhpur, 2017.

AC 035	**STRESS MANAGEMENT BYYOGA**					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*Creating awareness about different types of stress and the role of yoga in the management of stress.*
2	*Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
3	*Prevention of stress related health problems by yoga practice.*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*To understand yoga and its benefits.*
CO-2	*Enhance Physical strength and flexibility.*
CO-3	*Learn to relax and focus.*
CO-4	*Relieve physical and mental tension through Asanas*
CO-5	*Improve work performance and efficiency.*

Unit – I
Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

Unit – II
Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

Unit – III
Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

Unit – IV
Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

Unit – V
Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.
Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1	"Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2	"Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3	Nagendra H.R nad Nagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Web resource:

1	https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2	https://freevideolectures.com/course/3539/indian-philosophy/11

AC 036	**PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS**					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*To learn to achieve the highest goal happily*
2	*To become a person with stable mind, pleasing personality and determination*
3	*To awaken wisdom in students*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Develop their personality and achieve their highest goal of life.*
CO-2	*Lead the nation and mankind to peace and prosperity.*
CO-3	*To practice emotional self regulation.*
CO-4	*Develop a positive approach to work and duties.*
CO-5	*Develop a versatile personality.*

Unit – I
Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

Unit – II
Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

Unit – III
Introduction to Bhagavad Geetha for Personality Development - Shrimad Bhagawad Geeta: Unit 2 – Verses 41, 47, 48 - Unit 3 – Verses 13,21,27,35 - Unit 6 – Verses 5,13,17,23,35 - Unit 18 – Verses 45, 46, 48 Unit – 6: Verses 5, 13, 17, 23, 35; Unit – 18: Verses 45, 46, 48.

Unit – IV
Statements of basic knowledge - Shrimad Bhagawad Geeta: Unit 2- Verses 56, 62,68 - Unit 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

Unit – V
Role of Bahgavadgeeta in the present scenario - Unit 2 – Verses 17 – Unit 3 – Verses 36, 37, 42 - Unit 4 – Verses 18, 38, 39 - Unit 18 – Verses 37, 38, 63.

Suggested Reading:

1	"Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2	Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit, Sansthanam, New Delhi.

Web resource:

1	NTPEL:http://nptel.ac.in/downloads/109104115

AC 037	**CONSTITUTION OF INDIA**					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*The history of Indian Constitution and its role in the Indian democracy.*
2	*Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
3	*Have knowledge of the various Organs of Governance and Local Administration.*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Understand the making of the Indian Constitution and its features.*
CO-2	*Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.*
CO-3	*Have an insight into various Organs of Governance - composition and functions*
CO-4	*Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.*
CO-5	*Understand Electoral Process, special provisions.*

Unit – I
History of making of the Indian constitutions: History, Drafting Committee (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features.

Unit – II
Contours of Constitutional Rights and Duties Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties

Unit – III
Organs of Governance": Parliament: Composition, Qualifications, Powers and Functions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

Unit – IV
Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of

grass root democracy.

Unit – V
Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Suggested Reading:

1	The Constitution of India", 1950 (Bare Act), Government Publication
2	Dr. S. N. Busi, Dr. B. R. Ambedkar, "Framing of Indian Constitution", 1st Edition, 2015.
3	M. P. Jain, "Indian Constitution Law", 7th Edn., Lexis Nexis, 2014
4	D.D. Basu, "Introduction to the Constitution of India", Lexis Nexis, 2015.

Web resource:

1	http://www.nptel.ac.in/courses/103107084/Script.pdf

AC 038	**PEDAGOGY STUDIES**					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	*To present the basic concepts of design and policies of pedagogy studies.*
2	*To provide understanding of the abilities and dispositions withregard to teaching techniques, curriculum design and assessment practices and familiarize various theories of learning and their connection to teaching practice.*
3	*To create awareness about the practices followed by DFID, other agencies and other researchers and provide understanding of critical evidence gaps that guides the professional development*

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	*Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informal classrooms.*
CO-2	*Examine the effectiveness of pedagogical practices.*
CO-3	*Understand the concept, characteristics and types of educational research and perspectives of research.*
CO-4	*Describe the role of classroom practices, curriculum and barriers to learning.*
CO-5	*Understand Research gaps and learn the future directions.*

Unit – I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

Unit – II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

Unit – III

*Evidence on the Effectiveness of Pedagogical Practices***:** Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

Unit – IV
Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

Unit – V
Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

Suggested Reading:

1	Ackers J, Hardman F, *"Classroom Interaction in Kenyan Primary Schools, Compare*", 31 (2): 245 – 261, 2001.
2	Agarwal M, *"Curricular Reform in Schools: The importance of evaluation*", Journal of Curriculum Studies, 36 (3): 361 – 379, 2004.
3	Akyeampong K, "*Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER)",* Country Report 1. London: DFID, 2003.
4	Akyeampong K, Lussier K, Pryor J, Westbrook J, *"Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count?"*International Journal Educational Development, 33 (3): 272- 282, 2013.
5	Alexander R J, *"Culture and Pedagogy: International Comparisons in Primary Education",* Oxford and Boston: Blackwell, 2001.
6	Chavan M, Read India: *"A mass scale, rapid, learning to read campaign",* 2003

AC 039	**E-WASTE MANAGEMENT**					
	(AUDIT COURSE - II)					
Pre-requisites			**L**	**T**	**P**	**C**
			2	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Introduction to E-Waste management
2	Understanding on resource efficiency and circular economy
3	E-waste Management rules 2016
4	RoHS compliances/directives to EEE

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Complete understanding on E-Waste management
CO-2	Understanding on effective recycling methodologies for e-waste management
CO-3	Overall understanding about E-waste Management rules 2016 and strategies for e-waste management
CO-4	Understanding on RoHS compliances for EEE products

Unit – I

Waste Electrical and Electronic Equipment (WEEE): Flows, Quantities and Management, a Global Scenario; The Importance of Waste Management; Types of Waste- Solid and Liquid; Criteria for EEE/E-Waste Classification; Multivariate Model for E-Waste Estimation; Environmental and Health Effects of Waste Management, Inventorisation of E-Waste and Emerging trends in E-waste disposal with bench marks for depollution - global scenario; Dumping, Burning and Landfill: Impact on the Environment

Unit – II

Effective Waste Management and Disposal Strategies; Legislative Influence on Electronics Recycling; Waste Management Rules and Their Amendments; Extended Producer Responsibility (EPR) in E-Waste Management; The Role of Collective versus Individual Producer Responsibility in E-Waste Management

Unit – III

Electronic Waste: Public Health Implications; Restriction of Hazardous Substances (RoHS) Directives in Electrical and Electronic Equipment; Materials Used in Manufacturing Electrical and Electronic Products

Unit – IV

Recycling and Resource Management: Ecological and Economical Valuation; Life Cycle Assessment (LCA) Approach to Waste Management System; Environmental Incentives for Recycling and Life Cycle Analysis of Materials Recycling Electronic Waste: Challenges and

Opportunities for Sustainable Management; Resource Recovery from E-waste: Efficiency and Circular Economy; Integrated Approach to E-Waste Recycling: Recycling and Recovery Technologies, Recycling and Recovery Technologies.

Unit – V
Cases studies: E-waste Generation, collection and recycling

Suggested Reading:

1	Electronic Waste Management and Treatment Technology, Editors: Majeti NarasimhaVara Prasad MeththikaVithanage
2	Electronic Waste Management, Edited by R. E. Hester, R. M. Harrison, RSC Publishing 2009
3	Solid Waste Technology & Management, Christensen, T., Ed., Wiley and Sons., 2011
4	Electronics Waste Management: An India Perspective. Front Cover. Sandip Chatterjee. Lap Lambert Academic Publishing GmbH KG, 2010 - Electronic
5	Handbook of Electronic Waste Management, International Best Practices and Case studies, Elsevier, 2019
6	E-waste: Implications, regulations, and management in India and current global best practices. Author(s): Rakesh Johri, TERI Press

ME 481	DISSERTATION PHASE-I					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	20	10
Evaluation	**SEE**	-	**CIE**	100 Marks		

Course Objectives:

The course is taught with the objectives of enabling the student to:

1. Understand the purpose of Project work
2. Learn the resources available at the college and outside for pursuing project
3. Importance of literature review
4. Learn to select appropriate software and procedure
5. Learn to document results and arrive at required conclusions

Course Outcomes :	
On completion of this course, the student will be able to do :	
CO-1	*Identify suitable engineering problems reviewing available literature.*
CO-2	*Study different techniques used to analyze complex systems.*
CO-3	*Use related techniques and software's for solving the problem*
CO-4	*Interpret the results (if available) and defend work in front of technically qualified audience*
CO-5	*Document the findings as a technical report with proper references*

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1			2	3	1
CO2			2	3	1
CO3			2	3	1
CO4			2	3	1
CO 5			2	3	1

Guidelines

1. The Major Project Phase-I Work should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M.E.
3. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the examiners panel set by Head and Faculty Advisor
6. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

With effect from academic year 2024-2025

SEMESTER – IV

ME 481	**DISSERTATION PHASE-II**					
Pre-requisites	-		**L**	**T**	**P**	**C**
			-	-	20	10
Evaluation	**SEE**	100 Marks	**CIE**	100 Marks		

Course Objectives: The course is taught with the objectives of enabling the student to:

1. Understand the purpose of doing project work
2. Learn the resources available at the college and outside for pursuing project
3. Importance of literature review
4. Learn to select appropriate software and procedure
5. Learn to document results and arrive at required conclusions

Course Outcomes : On completion of this course, the student will be able to do :	
CO-1	*Use different Simulation models /experimental techniques/ software/ computational /analytical tools.*
CO-2	*Design and develop Simulation model/Mathematical model/ experimental set up/ equipment/ test rig.*
CO-3	*Conduct tests and draw logical conclusions from the results after analyzing them.*
CO-4	*Work in either in research environment or in an industrial environment and Conversant with technical report writing.*
CO-5	*Present and defend their work to the evaluation committee*

Course outcome	**Program outcome**				
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1			2	3	1
CO2			2	3	1
CO3			2	3	1
CO4			2	3	1
CO 5			2	3	1

Guidelines

1. It is a continuation of Major Project Phase I work started in semester III.
2. The project work should be presented in standard format as provided by the department.
3. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) adopted & Result analysis.
4. The report must bring out the conclusions of the work and future scope for the study and also should be properly referenced.
5. Student has to submit the report in prescribed format and also present a seminar.
6. Student should present a Seminar in front of Internal committee consisting of Head, CBoS, Guide, Subject expert, Faculty Advisor. Further the suggestions of the committee have to be incorporated in the final Report.
7. The final work has to be presented in front of the examiners panel consisting of an approved external examiner and a guide, co-guide etc. as decided by the Head and Faculty advisor.
8. The candidate has to be in regular contact with his guide.