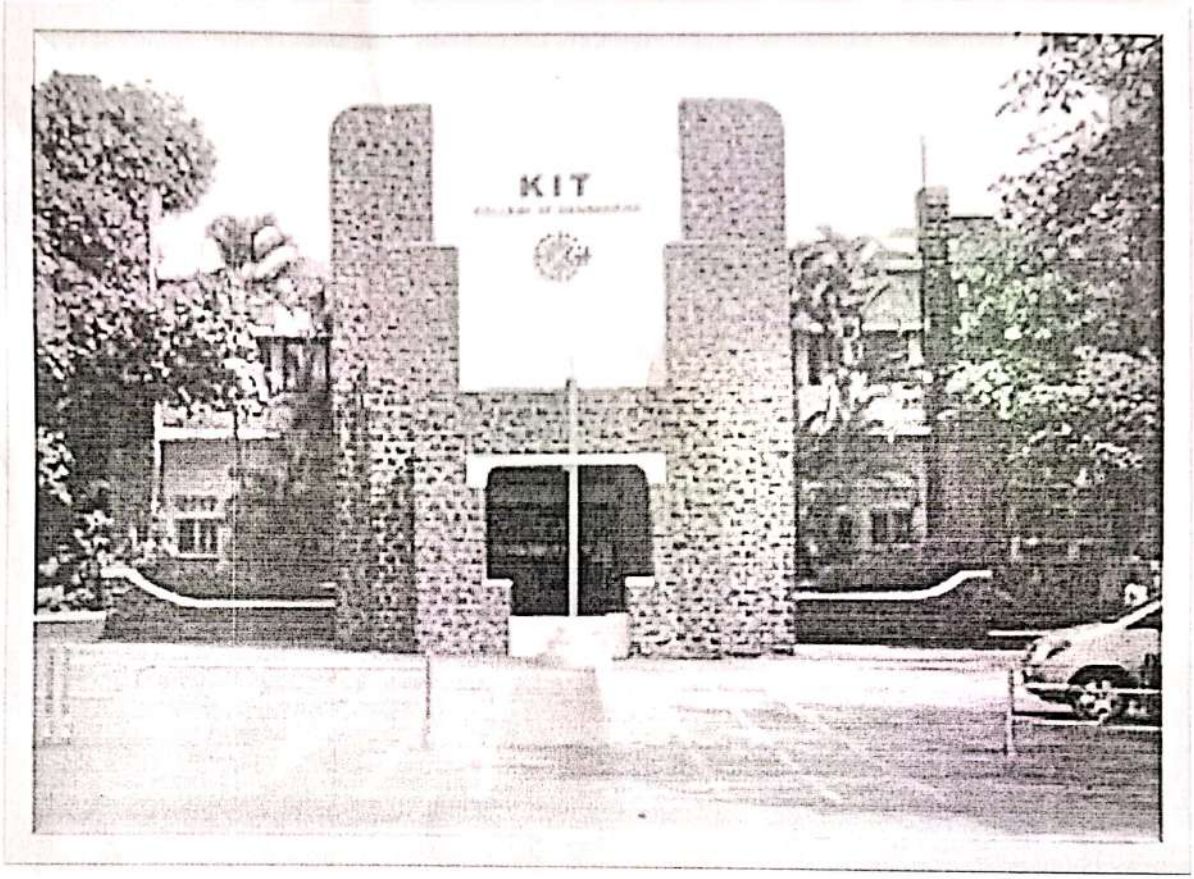
Kolhapur Institute of Technology's
College of Engineering (Autonomous),
Kolhapur



Department of Mechanical Engineering

Curriculum and Syllabus for

T.Y. B. Tech. Mechanical Engineering

With Effect from: 2025-26 (As Per NEP)

Mechanical Engineering Department

Dr. U. S. Bhapkar
Head
Department of Mechanical Engg.
Kolhapur Institute of Technology's
College of Engineering (Autonomous,
Kolhapur

SEMESTER V

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme			
									Component	Marks		
										Max	Min	
1	PC	UMEPC0501	Design of Machine Elements	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2	PC	UMEPC0502	Mechanical Vibrations	2	0	0	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3	PC	UMEPC0503	Heat Transfer	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
4	PEC	UMEPE051*	Program Elective-I	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
5	OE	UMEOE052*	Open Elective-I	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
6	HSSM	UMEEM0504	Supply Chain Management	2	0	0	2	2	ESE	50	20	
7	PC	UMEPC0531	Heat Transfer Laboratory	0	0	2	2	1	ISE	25	10	
									ESE(POE)	25	10	
8	PC	UMEPC0532	Mechanical Vibrations Laboratory	0	0	2	2	1	ISE	25	10	
									ESE(POE)	25	10	
9	VSEC	UMEVS0533	Advanced Automobile Engineering Laboratory	0	0	2	2	1	ISE	25	10	
10	FP	UMEIL0571	Community Engagement Project	0	0	2	2	1	ISE	25	10	
11	MM	UMEMM054*	Multi Disciplinary Minor	3	0	0	3	3	ESE	100	40	
						Total:	**27**	**23**	**Total Marks: 800** **Total Credit: 23**			

SEMESTER VI

Sr. No.	Category	Course Code	Course Name	L	T	P	Hrs. / Week	Credits	Evaluation Scheme			
									Component	Marks		
										Max	Min	
1	PC	UMEPC0601	Power Plant Engineering	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
2	PC	UMEPC0602	Finite Element Analysis	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
3	PC	UMEPC0603	Mechatronics	2	0	0	2	2	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
4	PEC	UMEPE061*	Program Elective-II	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
5	OE	UMEOE062*	Open Elective- II	3	0	0	3	3	ISE1	10		40
									MSE	30		
									ISE2	10		
									ESE	50	20	
6	AEC	UMEAE0604	Business Communication and Value Science	0	0	2	2	1	ISE	50	20	
7	PC	UMEPC0631	Power Plant Engineering Laboratory	0	0	2	2	1	ISE	25	10	
									ESE(POE)	25	10	
8	PC	UMEPC0632	Finite Element Analysis Laboratory	0	0	2	2	1	ISE	25	10	
9	PC	UMEPC0633	Mechatronics Laboratory	0	0	2	2	1	ISE	25	10	
									ESE(POE)	25	10	
10	FP	UMEIL1071	CAD/CAM/CAE Laboratory	0	0	2	2	1	ISE	25	10	
11	CC	UMECC0634	Co-Curricular Activities-III	0	0	2	2	1	ISE	50	20	
12	MM	UMEMM064*	Multi Disciplinary Minor	3	0	0	3	3	ESE	100	40	
Total:							**29**	**23**	**Total Marks:850 Total Credit: 23**			

Program Electives:

PROGRAM ELECTIVE -1							
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**
1	UMEPE0511	Automobile and EV Technology	3	0	0	3	3
2	UMEPE0512	Tribology	3	0	0	3	3
3	UMEPE0513	Machine Tool Design	3	0	0	3	3
4	UMEPE0514	Design Thinking	3	0	0	3	3
					Total:	**3**	**3**

PROGRAM ELECTIVE-II							
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**
1	UMEPE0611	Fault Diagnosis and Condition Monitoring	3	0	0	3	3
2	UMEPE0612	Metal Forming and Joining Technology	3	0	0	3	3
3	UMEPE0613	Advanced Automobile Design*(Tata Tech)	3	0	0	3	3
4	UMEPE0614	Introduction to CFD	3	0	0	3	3
					Total:	**3**	**3**

Multi Disciplinary Minor Courses Track: Major in Mechanical Engineering with Minor in Artificial Intelligence and Machine Learning							
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**
1	UMEMM0541	Python for Machine Learning and Data Science	3	0	0	3	3
2	UMEMM0641	Data Visualization and Analysis	3	0	0	3	3
					Total:	**14**	**14**

Multi Disciplinary Minor Courses Track :Major in Mechanical Engineering with Minor in Electrical and Electronics Technology							
Sr. No.	**Course Code**	**Course Name**	**L**	**T**	**P**	**Hrs. / Week**	**Credits**
1	UMEMM0542	Signal and Image Processing	3	0	0	3	3
2	UMEMM0642	Micro Electro Mechanical Systems	3	0	0	3	3
					Total:	**14**	**14**

Multi Disciplinary Minor Courses

Track :Major in Mechanical Engineering with Minor in Automotive Technology

Sr. No.	Course Code	Course Name	L	T	P	Hrs. / Week	Credits
1	UMEMM0543	Electrical and Hybrid Vehicles	3	0	0	3	3
2	UMEMM0643	Energy Storage Devices	3	0	0	3	3
					Total:	**14**	**14**

Emerging Minor Courses

Track: Emerging Minor in Green Technology

Sr. No.	Course Code	Course Name	L	T	P	Hrs. / Week	Credits
1	UMEMN0561	Energy Conservation and Management	3	1	0	4	4
2	UMEMN0661	Sustainable Engineering	3	1	0	4	4
					Total:	**20**	**18**

B Tech Honors(Core Engineering Domain) (Robotics)

Sr. No.	Course Code	Course Name	L	T	P	Hrs. / Week	Credits
1	UMEHN0551	Programming and Simulation for Robotics	3	1	0	4	4
2	UMEHN0651	Robot Kinematics and Dynamics	3	1	0	4	4
					Total:	**8**	**8**

OPEN ELECTIVE-I

Sr. No.	Course Code	Course Name	L	T	P	Hrs. / Week	Credits
1	UMEOE0521	Product Design and Manufacturing	3	-	-	3	3

OPEN ELECTIVE-II

Sr. No.	Course Code	Course Name	L	T	P	Hrs. / Week	Credits
1	UMEOE0621	Intellectual Property	3	-	-	3	3
2	UMEOE0622	Entrepreneurship Development	3	-	-	3	3
3	UMEOE0623	Six Sigma	3	-	-	3	3

EXIT COURSES-THIRD YEAR (B.VOC.)

Sr. No.	Course Code	Course Name	L	T	P	Hrs. / Week	Credits
1	UMEEX0691	CAD/CAM/CAE	3	0	0	3	3
2	UMEEX0692	Quality Managment	3	0	0	3	3
3	UMEEX0693	Vocational Training	0	0	4	4	2
					Total:	**10**	**8**

Title of the Course: Design of Machine Elements Course Code: UMEPC0501	L	T	P	Credit
	3	--	---	3

Course Pre-Requisite:
1. Analysis of Mechanical Elements, 2. Kinematics of Mechanics, 3. Engineering Mathematics

Course Description: Design of Machine Elements course aims to design the mechanical elements as per the requirement to accomplish the objective of task. The design Engineer requires selecting standard components such as rolling contact bearings and sliding contact bearings. The knowledge of Machine design will enable students to understand the procedures of selection of bearings, design the mechanical components against fluctuating load. By applying the basic principles of machine design students should be able to design the Machine Elements like Shaft, Gears, Couplings, Welded and Bolted joints.

Course Objectives:
1. To study fundamental principles in design of machine elements.
2. To learn to use of design data book for design of machine elements.
3. To learn to select machine elements from manufacturer's catalogue.
4. To design of components subjected to dynamic load and static loading.
5. To analyze the gears with respect to strength point of view.
6. To measure design parameters of mechanical systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain fundamental principles of fatigue and stress concentration in design of components	2	Understanding
CO2	Identify parameters required for design of mechanical Components.	3	Applying
CO3	Determine the design parameters of mechanical components.	4	Evaluating
CO4	Design of power transmission elements	5	Creating

CO-PO Mapping:

Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	2	2	3	3								2	2	
CO2	2	2	3	3								2	2	
CO3	2	2	3	3								2	2	
CO4	2	3	2	2				1		1		2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE

Course Contents:	
Unit 1:- Theories of failure and Design against fluctuating load. Introduction on material designation as per standards, Theories of failure, Stress concentration, fluctuating stresses, S-N Diagram under fatigue load, endurance limit, notch sensitivity, endurance strength- modifying factors, design for finite and infinite life under reversed stresses, Soderberg and Goodman diagrams, modified Goodman diagram.	08 **Hrs.**
Unit 2:--- Design of Shafts, Keys and Couplings Design of shafts on the basis of strength, Torsional rigidity and A.S.M.E. code, Design of keys and Splines, Design of Muff and Flange Couplings.	07 **Hrs.**
Unit 3:--- Design of Bolted and Welded Joints Design of bolted joints subjected to Eccentric Loading- 1) In a plane containing bolts, 2) Perpendicular to the axis of bolt. Welding symbols, Stresses in butt and fillet welds, Strength of butt, parallel and transverse fillet welds, Eccentric load in plane of welds, Welded joints subjected to bending moment.	07 **Hrs.**
Unit 4: Design of bearings Classification of bearings, static and dynamic load capacities, Stribeck's equation, equivalent bearing load, load- life relationship, Bearing life, Selection of bearing from manufactures catalogue. Ball and Roller bearing, Design for variable load and speed, Bearings with probability of survival other than 90%. Lubrication and mountings, dismounting and preloading of bearings, Introduction on Sliding contact bearing.	07 **Hrs.**
Unit 5: Design of Spur Gear and Helical Gear Spur Gear: Gear tooth loads, No. of teeth, face width, strength of gear teeth, static beam strength (Lewis equation), dynamic tooth load, wear strength (Buckingham's equation), Estimation of module based on beam strength and wear strength. Methods of gear lubrication. Terminology, Formative number of teeth in helical gears, force analysis, beam & wear strength of helical gears, effective load & design of helical gear.	10 **Hrs.**
Unit 6: Design of Worm and worm wheel Gear Terminology and geometrical relations. Standard dimensions and recommendation of worm gearing, Force analysis, Friction, Efficiency of worm gear drive, Design of worm drive as per IS 7443-1974 based on beam strength and wear strength rating, Thermal consideration in worm drive.	06 **Hrs.**
Textbooks: 1. Design of Machine Elements, Bhandari V. B Tata McGraw Hill New edition 2. Mechanical Engineering Design, Shigley J.E. and Mischke C.R. – McGraw Hill Publ. Co. Ltd. 3. Machine Design, R.K.Jain, Khanna Publication. 4. Machine Design, Pandya Shah, Charotar Publication. 5. Machine Design, U.C.Jindal, Pearson Education. 6. Introduction to Machine design, V.B. Bhandari, Tata McGraw Hill Publication, 2 nd Edition	
Reference Books: 1. Machine Design – Black P.H. and O. Eugene Adams – McGraw Hill Book Co. Ltd. 2. Mechanical Design of Machine‖, Maleev V.L., Hartman J.B, CBS Pub. & Distributors, 3. Design Data Handbook – P.S.G. College of Technology, Coimbatore. 4. Hall A.S.; Holowenko A.R. and Laughlin H.G. – ―Theory and Problems of Machine Design‖ Schaum's outline series. 5. Machine Design, Hall, Holowenko Laughlin, Tata McGraw Hill Pub. Schaums Outline Series. 6. Design of Machine Element, M.F.Spotts, Pearson Education Publication, 6 th Edition.	

7. Machine Component Design, Robert C. Juvniall, Willey Ltd, 5th Edition.
8. Mechanical Design of Machine Elements and Machines, Jack A Collis Henry Busby, George StaabWiley ltd., 2nd Edition.
9. Machine Design, P. Kannaiah, Scitech Publication, 2 nd Edition.
10. Design Data Book, Mahadevan, CBS Publishers and Distributors Pvt Ltd, 4 th Edition.

Title of the Course: MECHANICAL VIBRATIONS CourseCode:UMEPC0502	L	T	P	Credit
	02	-	-	02

CoursePre-Requisite: Basicsof mathematics, Physics, Analysis of Mechanical Elements, DynamicsofMachines

Course Description: Many practical applications need investigation of Vibration such asmachines, engines, turbines, structures, etc. Study of causes and effects of vibrations and analysis which is necessary toimprove performance of system and to optimize the system at both design stage and application stage. The subject contains - Introduction to vibrations, Single Degree of freedom Free and Forced Vibrations, Vibration Measurement along with its Applications.

CourseObjectives:

1. To carry out study of causes and effects of unbalance on Vibrations.
2. To take overviewofbasic conceptsofvibration analysis.
3. To studyvibrationanalysisofSingle degreeoffreedomsystems.
4. To acquaint students withtheprinciplesofvibration measuringinstruments.

CourseLearningOutcomes:

CO	Afterthecompletion ofthecoursethestudentshouldbeableto	Bloom's Cognitive level	Descriptor
CO1	Explainfundamentalsof Balancing and Vibration of Mechanical systems.	II	Understanding
CO2	Solvenumericalofnaturalfrequencyofmechanical system.	III	Applying
CO3	Analyzeand test the vibratoryresponseofmechanicalsystem.	IV	Analyze
CO4	Developmathematicalmodeltorepresentdynamicsystem.	V	Design

CO-POMapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	0	0	0	0	0	0	0	0	1	1	0	0
CO2	3	2	1	1	1	0	0	0	1	0	2	0	0	0
CO3	1	2	1	3	3	0	0	0	1	1	2	2	2	1
CO4	2	2	2	2	1	2	1	0	2	1	2	2	2	1

1:low, 2:medium,3:high

Assessments:

TeacherAssessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE)andoneEndSemester Examination(ESE)having20%,30%and50% weightsrespectively.

Assessment	Marks
ISE1	10
MSE	30
ISE2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.MSE:Assessment isbased on 50%of coursecontent (Normally firstthree Units) ESE:Assessmentisbased on100%course contentwith60-70%weightageforcoursecontent(normallylast three units)covered after MSE.	
Course Contents:	
Unit 1:--- Balancing Static and Dynamic balancing of rotary and reciprocating masses. Primary and Secondary forces and couples. Balancing of Single cylinder, Multi cylinder-Inline Engines. Function of flywheel and Study of turning moment diagram.	08**Hrs.**
Unit 2:---Free Vibrations (SDOF) Basic concepts and definitions, vibration measuring parameters- Displacement, Velocity and acceleration, Free and forced vibrations, Equivalent Springs. Types of damping. Free vibrations with and without damping (Rectilinear, Torsional & Transverse), Degree of damping. Logarithmic decrement, equivalent viscous damping, Coulomb damping.	08**Hrs.**
Unit 3:---Forced Vibrations (SDOF) Forced vibrations with viscous damping, magnification factor, frequency response curves, vibration isolation and transmissibility, forced vibrations due to support excitation. Critical speed of shafts.	07**Hrs.**
Unit 4:- Vibration Measurement and Applications : Instruments formeasurementofdisplacement,velocity,accelerationandfrequencyofvibration,Sensors and Actuators, signal conditioners, Time and frequency domain plot,Spectral analyzers, Exciters, FFT analyzer.	07 **Hrs.**
Textbooks: 1. Ratan S.S, "Theory of Machines", Tata McGraw Hill, New Delhi, 3rd Edition, 2011. 2. Sadhu Singh,"Theory of Machines", Pearson Education, 2nd Edition, 2009 3. H. G. Phakatkar,"Theory of Machines I", Edition 2009.Nirali Publication,5th Edition 2009. 4. Mechanical Vibrations by Grover G.K., Nemchand Publications.	

References:

1. Hamilton H Mabie and Charles F Reinholtz, (1987), "Mechanisms and Dynamics of Machinery", Fourth Edition, John-Wiley and Sons, Inc., New York.
2. Ghosh A. and Mallick A.K., (1988), "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
3. William T Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, (2004), "Theory of Vibration with applications", Fifth Edition, Pearson Education Publishers.
4. Theory of Machines by Dr. V.P.Singh, Dhanpat Rai Publications.
5. Theory of Machines by Ballaney, Khanna Publications.
6. Mechanical Vibrations by S.S.Rao, Pearson Education Publications
7. Theory of vibrations with applications by W.T. Thomson (CBS Publications)
8. Kinematics, Dynamics and Design of Machinery by Walidron, Wiley India Publi.
9. Theory of Vibration with applications by W.T.Thomson M.D. Dahleh, C.Padmanabhan Pearson Education

Unit wise Measurable students Learning Outcomes:

1. Apply Balancing principles to the Reciprocating and Rotary machines.
2. Understand the fundamental concepts of vibrations.
3. Apply analytical formulae to solve vibratory problems.
4. Select Suitable Vibration measuring instrument for specific applications

Title of the Course: HEAT TRANSFER Course Code: UMEPC0503	L	T		P	Credit
	3	-		-	3

Course Pre-Requisite: Differential calculus, integral calculus, Fluid mechanics.

Course Description: The course deals with fundamentals aspects of heat transfer. The knowledge of heat transfer in necessary for design of thermal equipments in the industry and simulation using Computational Fluid dynamics and Heat transfer.

Course Objectives:

1. To prepare students of Mechanical Engineering to excel in heat transfer problems related to thermal Engineering so as to succeed in careers in industry, technical professions or entrepreneurship.
2. To provide students with a solid foundation in mathematics, science and engineering fundamentals required to solve engineering problems in heat and also to pursue higher studies.
3. To train students with good scientific and engineering breadth in the areas of heat transfer so as to comprehend, analyze, design and create novel products and solutions for the real life problems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to		Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain fundamentals of Heat and Mass Transfer mechanisms.		2	Understanding
CO2	Develop differential equations for Heat Transfer mechanisms.		3	Applying
CO3	Analyze the performance of heat transfer devices		4	Analyzing
CO4	Estimate the rate of heat transfer at specified temperature difference.		5	Evaluating

CO-PO,PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	-	-	-		-	-		-	-	-	2	-	1
CO2	-	3	-	-		-	-	-	-	-	-	-	-	-
CO3	-	3	-	-	-	-	2	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	1	-	-	-	2	-

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment		Marks
ISE 1		10

MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

UNIT 1: BASICS OF HEAT TRANSFER AND ONE DIMENSIONAL STEADY STATE HEAT CONDUCTION **Basics of Heat Transfer:** Thermodynamics and Heat Transfer, Heat Transfer Mechanisms and Basic Laws Simultaneous Heat Transfer Mechanisms. Problem Solving Techniques in Heat Transfer. **Heat Conduction Equation:** General Heat Conduction Equation: Rectangular Coordinates, Cylindrical Coordinates and Spherical Coordinates. **One Dimensional Steady State Heat Conduction Without Heat Generation:** Plane Wall, Cylinder, Sphere. Boundary and Initial Conditions. Variable Thermal Conductivity. Concept of Thermal Resistance Thermal Contact Resistance, Overall Heat Transfer Coefficient. Critical Radius of Insulation. **One Dimensional Steady State Heat Conduction With Heat Generation:** Plane Wall, Cylinder and Sphere.	09**Hrs.**
UNIT 2: ONE DIMENSIONAL UNSTEADY STATE HEAT CONDUCTION AND EXTENDED SURFACES **Transient Heat Conduction:** Lumped System Analysis, Significance of Biot and Fourier Number. Transient Heat Conduction in Large Plane Walls, Long Cylinders, and Spheres With Spatial Effects Transient Heat Conduction in Semi-Infinite Solids. **Extended Surfaces (Finned Surfaces):** Types of fins, applications, Expression for Heat Transfer, Temperature Distribution, fin efficiency and Fin effectiveness basedfin tip condition, Error estimation in Thermowell.	07 **Hrs.**
UNIT 3: CONVECTION **Fundamentals of Convection:** Physical Mechanism of Convection, Velocity and Thermal Boundary Layer, Differential Convection Equations (Mass, Momentum and Energy Equations), Solution of Convection Equations for a Flat Plate. Reynolds and Chilton-Colburn Analogy. Buckingham's Pi Theorem applied to Forced and Free Convection, Physical Significance of dimensionless numbers. **External Forced Convection:** Local and Average Heat Transfer Coefficient,Parallel Flow over Flat Plates, Flow Across Cylinders and Spheres, Flow Across Tube Banks. **Internal Forced Convection:** Mean Velocity and Mean Temperature, Laminar Flow in tubes, Turbulent Flow in Tubes. **Natural Convection:** Physical Mechanism of natural Convection, Natural Convection Over surfaces. Natural Convection inside enclosures. Combined Natural Convection and Radiation. Combined Natural and Forced Convection.	07 **Hrs.**
UNIT 4: THERMAL RADIATION **4.1 Fundamentals of Thermal Radiation:** Nature of radiation, electromagnetic wave spectrum, Black Body Radiation, Laws of Radiation, Radiation Intensity, Irradiation,	09 **Hrs.**

Radiosity, Spectral Quantities, Radiative Properties, The Greenhouse Effect. **4.2 Radiation Heat Transfer:** View Factor, Radiation Heat Transfer Between Black Surfaces, Radiation Heat Transfer Between Non-Black Surfaces, Radiation Shields, Problem Solving using Electrical Analogy, Radiation Effect on Temperature Measurements.	
UNIT 5: HEAT EXCHANGERS Types of Heat Exchangers, Overall Heat Transfer Coefficient, Effect of Fouling, Analysis of Heat Exchangers (Parallel and Counter Flow); LMTD and Effectiveness NTU Methods, Multi pass and Cross Flow Heat Exchangers. Selection of Heat Exchangers.	08 **Hrs.**
UNIT 6: COOLING OF ELECTRONIC EQUIPEMENT Introduction and History, Importance of Heat Transfer in Electronics, Cooling Load of Electronic Equipment, Conduction Cooling, Air Cooling, Liquid Cooling, Immersion Cooling, Heat Pipes, Thermoelectric Coolers, Electrohydrodyanmic Flow, Synthetic Jet, Microchannel Cooling, Cooling by nano fluids.	05**Hrs.**

Textbooks:

1. Heat Transfer: A Practical Approach**,** Yunus A. Cengel , McGraw-Hill Higher Education; 2 edition

2. Fundamentals of Heat & Mass Transfer ,7th Edition, Frank P. Incropera, Wiley.

3. A Course in Heat and Mass Transfer,: S. C. Arora (Author), S. Domkundwar (Author), Anand V. Domkundwar

4 Heat and Mass transfer**:** J Holman (Author), Souvik Bhattacharyya , McGraw Hill Education; 10 edition

5. Heat Transfer- Thermal Management of Electronics, Younes Shabany, CRC Press, Indian Edition.

Reference Books:

1. Fundamentals of Engineering Heat and mass trasnfer, R C Sachdeva, NEW AGE; Fourthedition
2. Heat And Mass Transfer, Data Book, C.P. Kothandaraman, New Age International PrivateLimited; Ninth edition.
3. Heat Transfer 10Ed (Sie) (Pb 2020) Paperback – 1 July 2017 by J Holman (Author), Souvik Bhattacharyya

Title of the Course: Automobile & EV Technology Course Code: UMEPE0511	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite: Basic Mechanical Engineering, I. C Engine, Basic knowledge about electric motors.

Course Description: This course discusses the fundamental concepts, principles and analysis of hybrid and electric vehicles. This course discusses the various EV subsystems such as electric motors, motor controllers, energy storage devices, battery management system, charging technology etc.

Course Objectives: To impart the knowledge about electric vehicles and hybrid vehicles. To expose the students to various drive technology and energy storage technology required in electric and hybrid vehicles.

Course Learning Objectives:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Learn the ability to understand different automobile systems and components.	II	Understanding
CO2	Recall the impact of EV on environment and sustainability.	II	Understanding
CO3	Recall the structure of electric vehicle.	II	Understanding
CO4	Compute design parameters of Electric vehicles for a given requirement.	III	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1		1					1				
CO2	2	1	1		1	2	1					1		
CO3	2	1	1			2	1					2	1	2
CO4	3	1	2	1	1	2	1				2	2	1	2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1:- **Introduction to Electric Vehicles** History of electric vehicles, Development towards 21st century, Automobile history and development, Classification, vehicle layouts- engine location and drive arrangement, specifications of vehicles, Type of vehicle bodies, Environmental impact, Social and environmental importance of hybrid and electric vehicles, Fuel Cell EV.	**6 Hrs.**
Unit 2:--- **Transmission System** Clutch – Function and requirements, Classification, Construction and working of Single-plate, Multi-plate, Diaphragm spring and centrifugal clutches, Fluid flywheel. Gear Box – Necessity, classification, construction of manual gear boxes like Sliding mesh, constant mesh, Synchromesh, Epicyclic gear train, Automatic transmission, Overdrive. Propeller shaft, Differential and final drive.	**8 Hrs.**
Unit 3:- **Vehicle Systems** Steering system - function, principle of steering, Types of steering gearbox, power steering. Suspension system - Functions, Types of suspension systems, types of springs. Braking system - Need, principle, types, Mechanical, hydraulic and pneumatic brakes, disc and drum types, air brakes, Anti-lock braking system. Electrical Systems - Automotive batteries, battery charging system, alternators, lighting and electrical accessories, automobile air conditioning	**8 Hrs.**
Unit 4:--- **Vehicle Performance** Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Gradeability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio. (Numerical)	**9 Hrs.**
Unit 5:--- **Electric vehicles – technology and design** Configuration of EVs, Electric motor characteristics, design process and issue, modelling and performance estimation, energy consumption, regenerative breaking.	**7 Hrs.**
Unit 6:--- **Hybrid electric vehicle technology** Concepts, modes and operation patterns, architectures of hybrid drive trains, series hybrid drive train, parallel hybrid drive train.	**7 Hrs.**

Textbooks:

1. "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011
2. "Hybrid Electric Vehicles: Energy Management Strategies", S. Onori, L. Serrao and G. Rizzoni , Springer, 2015
3. Kripal Singh, Automobile Engineering Vol II, Standard Publishers Distributors, Tenth Edition , 2007
4. P S Gill, Automobile Engineering II, S K Kataria and Sons, Second Edition, 2012
5. R K Rajput, Automobile Engineering, Laxmi Publications, First Edition, 2007
6. Automobile Engineering", G.B.S. Narang., Khanna Publication,3rdEdition.

Reference Books:

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explaned", John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
3. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.
4. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
5. William Crouse, "Automobile Engineering"
6. Newton, Steeds and Garrett, The Motor Vehicle, Butterworths International Edition, 11th Edition, 1989
7. Crouse and Anglin, Automotive Mechanics, McGrawhill Publication, Tenth Edition, 2007

Title of the Course: Tribology Course Code: UMEPE0512	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite: Engineering Mathematics, Fluid Mechanics, Machine Design, Manufacturing Process

Course Description: Tribology is the study of friction, wear and lubrication, and design of Tribological Components, science of interacting surfaces in relative motion.

Course Objectives: After successful completion of this course, students will be able-

1. To Apply the basic theories of friction, wear and lubrications about frictional behavior commonly encountered sliding surfaces
2. To Select suitable/proper grade lubricant for specific application.
3. To know about properties of lubricants, modes of lubrication, additives etc.
4. To select suitable material combination for tribological contact.
5. To suggest an explanation to the cause of tribological failures.
6. To design bearing, friction, wear test rig for laboratory purposes.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain industrial and practical objectives of tribology Considering parameters of tribology triangle.	2	Understanding
CO2	Explain mechanisms of friction and wear for metals, alloys, Ceramics and polymers.	2	Understanding
CO3	Illustrate different types of lubrication system and methods.	2	Understanding
CO4	Apply friction/lubrication mechanism to the practical engineering problem.	3	Applying

CO-PO Mapping:

Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	2	1									2	2	
CO2	2	2										2	2	
CO3	3	2	2	3								2	2	
CO4	2	1	2	2								2	2	

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:---INTRODUCTION OF TRIBOLOGY — 08 **Hrs.**

Tribology definition, Need of Tribology, Tribology in design, Tribology in industry (Maintenance), Lubrication- Definition, Lubricant properties, Viscosity, its measurements- Numerical, basic modes of lubrication, types of lubricants, Standard Grades of lubricants, selection of lubricants, commonly used lubricants and Hazards, Recycling of used oil, Disposal of used oil, bearing materials, Fundamentals of surface engineering, Green Tribology, Bearing Terminology-Types of Sliding contact, rolling contact bearings.

Unit 2:---FRICTION Introduction, Laws of friction, kinds of friction, causes of friction, area of contact, friction measurement, theories of friction.	07 **Hrs.**
Unit 3:---WEAR Types of wear, various factors affecting wear, measurement of wear, theories of wear, Wear debris analysis; Wear reduction methods.	07**Hrs.**
Unit 4:-- HYDRODYNAMIC LUBRICATION Theory of hydrodynamic lubrication, mechanism of pressure development in an oil film. Two dimensional Reynolds equation, Petroff's equation, pressure distribution in journal bearings - long & short, Load Carrying capacity, Somerfield number and its importance- Numerical. Introduction to Hydrodynamic Thrust Bearing	08 **Hrs.**
Unit 5:-- HYDROSTATIC LUBRICATION Introduction to hydrostatic lubrication, hydrostatic step bearing, load carrying capacity and oil flow through the hydrostatic step bearing- Numerical. Hydrostatic squeeze film : basic concept, circular and rectangular plate approaching a plane-Numerical	07 **Hrs.**
Unit 6:--- DIAGNOSTIC MAINTENANCE AND CONDITION MONITORING Types of maintenance; Preventive and corrective Maintenance; Condition Based Maintenance and Condition Monitoring; Cost effectiveness. Different condition monitoring Techniques; Visual, performance, fluid and vibration monitoring. Fluid condition and particle monitoring; Fluid degradation and its identification methods. Chemical tests, infrared spectroscopy, calorimeter. Wear debris analysis; SOAP, Ferrography and other spectrometric analysis techniques for wear rate evaluation and interpretation. Vibration monitoring methods; Vibration data collection; Techniques; Instruments; Transducers; Commonly witnessed machinery faults diagnosed by vibration analysis.	08 **Hrs.**

Teaching assessment of Tutorials will be based on the completion of following assignments

Assignment on Introduction of Tribology.
Assignment on Friction.
Assignment on Wear.
Assignment on Hydrodynamic Lubrication.
Assignment on Hydrostatic Lubrication.
Assignment on condition monitoring Techniques.

Textbooks:

1. Engineering Tribology– Prasanta Sahoo – Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
2. Fundamentals of Tribology – S.K. Basu, S.N. Sengupta, B.B. Ahuja – PHI Learning Pvt. Ltd.,2010.
3. Tribology in Industries – S.K. Shrivastava – S. Chand & Company Ltd., New Delhi, 2001
4. Bearing Design in Machinery, Engineering Tribology and Lubrication - A. Harnoy- Marcel Dekker Inc., 2003

Reference Books:

1. Cameron A., Basic Lubrication Theory, Wiley Eastern Ltd.
2. Bharat Bhushan, Principles and Applications of Tribology 2nd Edition, Wiley India
3. Mujumdar B. C.,Introduction to Tribology and Bearings, S. Chand and Company Ltd. New Delhi.
4. Fuller D. D.,Theory and Practice of Lubrication for Engineers, John Wiley and Sons.
5. Halling J.,Principles of Tribology‖, McMillan Press Ltd.
6. Bhushan B. and Gupta B. K.,Handbook of Tribology: Material, Coatings and Surface Treatments, McGraw Hill Ltd.
7. Davis J.,Surface Engineering for Corrosion and Wear Resistance, Woodhead Publishing, 2001.
8. Tadausz Burakowski,Surface Engineering of Metals: Principles, Equipments and Technologies, Taylor and Francis.
9.Tribology in machine design- By -T. A. Stolarski
10.Tribology & design-edited by M. Hadfield, C. A. Brebbia, J. Seabra
11.Tribological Design of Machine Elements by D. Dowson , C.M. Taylor, M. Godet, D. Berthe

Title of the Course: Machine Tool Design	**L**	**T**	**P**	**Credit**
Course Code: UMEPE0513	**3**	**--**	**--**	**3**

Course Pre-Requisite: Knowledge of basic mechanical engineering, Machine design and Manufacturing processes.

Course Description: This course aims to impart knowledge of machine tools and various operations performed on to it, using different cutting tools.Design of machine tool structures and drives, Design and analysis of systems for specified speeds and feeds and selection of subsystems for achieving high accuracy in machining.

Course Objectives:

1) To understand all the traditional and basic machine tools used on these machines for varied applications.
2) To make the students understand the concepts & broad principles of machine tool design, regulation of speed and speed regulation, design of machine tool structure, dynamics of machine tools.
3) To study design procedure of guide ways, hoists, power screws and spindles.
4) To understand design procedure of gear boxes for stepped drives.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	**Descriptor**
CO1	Explain the fundamentals & basic concepts of metal removal process tools.	2	Understanding
CO2	Describe the basic needs of machine tool components.	3	Applying
CO3	Calculate design parameters of guide ways, power screws and spindles.	4	Analyzing
CO4	Design the gear boxes for stepped drives.	5	Evaluating

CO-PO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2												
CO2	3	2	2		2									
CO3	3	3	3	2	2								2	1
CO4	3	3	3	2	1			1					2	1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	
Unit 1:Principles of Machine Tool Design Introduction to machine tool, General requirements of machine tooldesign, Specifications and layout of machine tools, Machining rangediagram, Interference diagram, Parameter defining working motions ofa machine tool. Working and auxiliary motion in machine, Machinetool drives, Hydraulic transmission, Mechanical transmission.	**7 Hrs.**
Unit 2: Design of Machine Tool Structure Fundamentals of machine tool structures and their requirements,Design criteria of machine tool structure, Materials for machine toolstructure, Static and dynamic stiffness, Structure profiles, Design ofbeds and columns, Design of housing models, bases and tables, Designof saddle, carriages and rams.	**8 Hrs.**
Unit 3: Stepped Drives of Machine Tools Gear drive, gear box design, graphical representation of gear box operationwith raydiagram, structure diagram and deviation diagram. Gear Teeth Calculations.Basic introduction of any component of the gearbox on suitable analysis software.	**8 Hrs.**
Unit 4: Design of Guide-Ways And Power Screws Function and type of guide-ways, design of slide-ways, Protectingdevices for slide-ways, Design of power screws.	**8 Hrs.**
Unit 5:Design of Spindles And Spindle Supports Materials for spindles, Design principles of spindles, selection antifrictionbearings, Sliding bearings for machines like lathe, CNC, VMC etc.	**7 Hrs.**
Unit 6: Design of Hoists Drives for hoisting, components, and hoisting mechanisms; railtraveling components and mechanisms; hoisting gear operation duringtransient motion; selecting the motor rating and determining breakingtorque for hoisting mechanisms.	**7 Hrs.**

Text books:

1. Machine Tool Design- N.K. Mehta Tata McGraw Hill.
2. Design Principles of Metal Cutting Machine tool- F. Koenigsberger - Pergamon press
3. Machine Tool design Handbook CMTI Bangalore, McGraw-Hill
4. Sen and Bhattacharya,, “Principles of Machine Tools”, New Central Book Agencies.
5. Boothroyd, G., “Fundamentals of Metal Machining and Machine Tools”, McGraw hill.
6. Acherkan, “Machine Tool Design”, Vol 2 & 3, MIR Pub, Russia.
7. Machine Tool Design, S.K. Basu, Oxford and IBH Publishing.
8. Machine Tool Design: Sen and Bhattacharya , CBS Publications

Reference books:

1. Manufacturing Science – Amit abha Ghosh and Mallik, Affiliated East West press, 2010, 2nd edition.
2. Modern machining Process – Pandey and Shah, Tata McGraw Hill – 2009.
3. Manufacturing processes for Engineering Materials by Seropekalpakijian and Steven R.Schimidpearson education 2009, 5th edition.
4. Materials and Processes in Manufacturing by E. Paul De Garmo, J T Black, Ronald A Kohser, 8th Edition, Prentice Hall of India Private limited, 2004.

Title of the Course: Design Thinking Course Code:UMEPE0514	L 3	T -	P -	Credit 3

Course Pre-Requisites: Innovative and Creative Mindset, Genuine interest towards Entrepreneurship Development and Product design and Development.

Course Objectives:

1. To understand the Design Thinking process and its applications.
2. To develop creative and critical thinking skills.
3. To apply Design Thinking methodologies to solve complex problems.
4. To enhance team collaboration and communication skills.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	**Identify** the principles of Design Thinking and its application in engineering contexts.	1	Remembering
CO2	**Explain** the Design Thinking process, including empathizing, defining, ideating, prototyping, and testing.	2	Understanding
CO3	**Create** prototypes and conduct user testing to iterate and improve design solutions.	4	Applying
CO4	**Evaluate** the effectiveness of design solutions based on user feedback and sustainability considerations.	4	Evaluating

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2			2		2				3		
CO2	2	3	3			2		2	2				3	
CO3	2	2	3		3	2				3	2		3	
CO4	2	1	3			3	1			2	3			3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1: Introduction to Design Thinking Design Thinking Process: Empathize, Define, Ideate, Prototype, Test Historical Evolution and Importance Case Studies in Design Thinking	6 Hrs.
Unit 2: Empathizing and Problem Definition Techniques for User Research and Empathy Mapping Defining Problem Statements Framing Design Challenges	6 Hrs.
Unit 3: Ideation Techniques Brainstorming, Mind Mapping, and SCAMPER. Encouraging Creativity and Breaking Assumptions. Idea Evaluation and Selection	8 Hrs.

Unit 4: Prototyping and Testing Types of Prototypes: Low-Fidelity to High-Fidelity. User Testing and Feedback Collection. Iterative Design and Improvements	8 Hrs
Unit 5: Design Tools and Methodologies Introduction to Tools like Canva, Figma, Miro. Methodologies: Design Sprints, Lean Design. Applying Tools to Develop Prototypes	8 Hrs.
Unit 6: Design Thinking in Practice Real-Life Applications in Engineering, Business, and Social Impact Group Project: End-to-End Design Thinking Project Presentation and Reflection	8 Hrs.

Textbooks:

1. Change by Design by Tim Brown
2. Design Thinking for Startups – Praveen Gupta
3. The Design Thinking Playbook by Michael Lewrick
4. Creative Confidence: Unleashing the Creative Potential Within Us All – Tom Kelley & David Kelley
5. Design Thinking: A Guide to Creative Problem Solving for Everyone – Pavan Soni
6. Design Thinking: Process and Methods Manual – Robert A. Curedale
7. Designing for Growth: A Design Thinking Toolkit for Managers – Jeanne Liedtka & Tim Ogilvie

Reference Books :

1. Design Thinking for Strategic Innovation by Idris Mootee
2. Sprint: How to Solve Big Problems and Test New Ideas in Just Five Days by Jake Knapp
3. The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm – Tom Kelley
4. Design Thinking for Innovation – Prasad Kaipa
5. Thinking Design – S. Balaram
6. Design Thinking and Innovation in Business – M.P. Ranjan
7. Design Thinking: The Handbook – Amit Deshmukh

Title of the Course: Supply Chain Management	L	T	P	Credit
Course Code: UMEEM0504	2	0	--	2

Course Pre-Requisite: Nil

Course Description: This course will outline various key concepts of supply chain management in a manufacturing or distribution firm. The course focuses on key concepts of Supply Chain Management, specifically Forecasting, Inventory, and Logistics Management.

Course Objectives:

- Introduce students to the basic principles and terminology of supply chain management.
- Help students understand the role of supply chain management in mechanical engineering.
- Provide an overview of key supply chain processes such as procurement, production, and distribution.
- Familiarize students with basic tools and techniques used in supply chain analysis and optimization.

Course Outcomes:

CO	After the completion of the course, the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Summarize** the fundamental concepts, objectives, and decision phases of supply chain management.	2	Understanding
CO2	**Explain** the role of integration and key drivers in achieving strategic fit and enhancing supply chain performance.	2	Understanding
CO3	**Apply** forecasting and inventory control techniques to manage demand and optimize stock levels.	3	Applying
CO4	**Explain** the role of logistics and transportation in supply chain operations.	2	Understanding

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1									1		1
CO2	1	1	1	1									1		1
CO3	2	2	2	2									1	2	2
CO4	1	1	1	1									1		1

Assessments:

Assessment	Marks
ESE	50

Course Contents:

Unit-1:--- Supply Chain Concepts Introduction to Supply Chain Management, Objectives of a Supply Chain, Decision Phases in Supply Chain, Value Chain Process, Importance of Supply Chain Management, Cycle view of Supply Chain Process. Examples of Supply Chains.	**7 Hrs.**
Unit -2:--- Supply Chain Integration and Drivers Understanding the importance of integration in supply chain processes: Competitive and Supply Chain Strategies Achieving Strategic Fit. SCM drivers: Framework for Structuring Drivers Facilities, Inventory, Transportation Information, Sourcing, and Pricing, Supply Chain Performance: Bullwhip effect and reduction, Obstacles to Coordination in a supply chain, Performance measurement: Dimension, Tools of performance measurement.	**8 Hrs.**
Unit -3: Forecasting and Inventory Management **Inventory Management:** Basics of inventory management, Inventory control models (e.g., EOQ, safety stock), Estimating Cycle inventory costs, ABC analysis and inventory classification, Vendor-managed inventory (VMI), and Just-in-Time (JIT) inventory systems. **Demand Forecasting in Supply Chain**: Role of forecasting in the supply chain, components of forecast and forecasting methods, estimating forecasted demand using various methods, Measures of forecast errors. (Numerical Treatment is expected based on forecasting models and inventory management models)	**8 Hrs.**
Unit 4: Logistics Management: Logistics and transportation overview, the role of logistics/transportation in the supply chain, Warehouse design and management, Modes of transportation, and selection criteria for appropriate mode	**7 Hrs.**

Text Books

1. **Sunil Chopra** & **Peter Meindl** – *Supply Chain Management: Strategy, Planning, and Operation*, Pearson Education.
2. **R. Dan Reid** & **Nada R. Sanders** – *Operations Management: An Integrated Approach*, Wiley.
3. **R.P. Mohanty** & **S.G. Deshmukh** – *Supply Chain Management*, Biztantra, New Delhi.
4. **Ronald H. Ballou** – *Supply Chain Management*, Pearson Education.

5. **Daniel Stanton** – *Supply Chain Management For Dummies*, Wiley.

Reference Books:

1. Ronald H. Ballou – Business Logistics Management, Prentice-Hall Inc.
2. David Simchi-Levi, Philip Kaminsky, & Edith Simchi-Levi – Designing and Managing the Supply Chain, McGraw-Hill.
3. Martin Christopher – Logistics and Supply Chain Management, Pearson Education.
4. John T. Mentzer – Supply Chain Management, Sage Publications.
5. Chandra Mohan – Production and Operations Management, Himalaya Publishing House.

Title of the Course: HEAT TRANSFER LABORATORY	L	T	P	Credit
Course Code: UMEPC0531	-	-	2	1

Course Pre-Requisite: Differential calculus, Integral calculus, Fluid mechanics

Course Description: The course deals with various experiments related to conduction, convection and radiation mode of heat transfer so as to understand the fundamentals and application of governing equations used in heat transfer.

Course Objectives:

- CLO1: To provide the students the fundamentals of conduction, convection and radiation.
- CLO2:To train students with good scientific and engineering breadth in the areas of heat transfer, so as to comprehend, analyze, design and create novel products and solutions for thereal life problems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain fundamentals of Heat Transfer mechanisms.	2	Understanding
CO2	Develop differential equations for Heat Transfer mechanisms.	3	Applying
CO3	Analyze the performance of heat transfer devices	4	Analyzing
CO4	Estimate the rate of heat transfer at specified temperature difference.	5	Evaluating

CO-PO, PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	0	0	0	0	0	0	0	0	0	0	2	0	1
CO2	0	3	0	0	0	0	0	0	0	0	0	0	0	0
CO3	0	3	0	0	0	0	2	0	0	0	0	0	0	0
CO4	0	3	0	0	0	0	0	0	1	0	0	0	2	0

1-Low, 2- Medium, 3-High

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE)having 50%, and 50% weights respectively

Assessment	Marks
ISE	25

ESE (POE)	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination.

Course Contents:
Note: Experiment No. 1 to 10 shall be selected for the POE examination and All should be included in Journal.

Experiment No. 1: Heat transfer through composite wall	02 Hrs.
Experiment No. 2: Thermal conductivity of metal rod	02 Hrs.
Experiment No. 3 : Heat transfer through lagged pipe	
Experiment No. 4 : Thermal conductivity of insulating powder	02 Hrs.
Experiment No. 5: Heat transfer by natural convection	02 Hrs.
Experiment No. 6 : Heat transfer by forced convection	02 Hrs.
Experiment No. 7 : Stefan -Boltzmann apparatus	02 Hrs.
Experiment No. 8 : Emissivity measurement apparatus	02 Hrs.
Experiment No. 9 : Heat transfer through pin fin	02 Hrs.
Experiment No.10: Parallel and counter flow heat exchanger	02 Hrs.
Experiment No. 11: Heat pipe demonstration	02 Hrs.

Textbooks:

1. Heat Transfer: A Practical Approach, Yunus A. Cengel , McGraw-Hill Higher Education; 2 edition
2. Fundamentals of Heat & Mass Transfer ,7th Edition, Frank P. Incropera, Wiley.
3. A Course in Heat and Mass Transfer,: S. C. Arora (Author), S. Domkundwar (Author), Anand V. Domkundwar
4 Heat and Mass transfer: J Holman (Author), Souvik Bhattacharyya , McGraw Hill Education; 10 edition
5. Heat Transfer- Thermal Management of Electronics, Younes Shabany, CRC Press, Indian Edition.

Reference Books:

1 Fundamentals of Engineering Heat and mass trasnfer, R C Sachdeva, NEW AGE; Fourth edition
2. Heat And Mass Transfer, Data Book, C.P. Kothandaraman, New Age International Private Limited; Ninth edition.
3. Heat Transfer Laboratory Manual, Prof. Abdul Matheen, Firewall Media, 2007.

Title of the Course: Mechanical Vibrations Laboratory CourseCode:UMEPC0532	L	T	P	Credit
	-	-	02	01

Course Pre-Requisite: Basics of mathematics, physics, Dynamics of Machines

Course Description: Many practical applications need investigation of Vibration such as machines, engines, turbines, structures, etc. Study of causes and effects of vibrations and analysis which is necessary to improve performance of system and to optimize the system at both design stage and application stage. The subject contains - Introduction to vibrations, Single Degree of freedom Free and Forced Vibrations, Vibration Measurement along with its Applications.

Course Objectives:

1. To carry out study of causes and effects of unbalance on Vibrations.
2. To take overview of basic concepts of vibration analysis.
3. To study vibration analysis of Single degree of freedom systems.
4. To acquaint students with the principles of vibration measuring instruments.

CourseLearningOutcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain fundamentals of Balancing and Vibration of Mechanical systems.	II	Understanding
CO2	Solve numerical of natural frequency of mechanical system.	III	Applying
CO3	Analyze vibratory response of mechanical system.	IV	Analyze
CO4	Develop mathematical model to represent dynamic system.	V	Design

CO-POMapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PSO1	PSO2	PSO3
CO1	2	1	0	0	0	0	0	0	0	0	1	1	0	0
CO2	3	2	1	1	1	0	0	0	1	0	2	0	0	0
CO3	1	2	1	3	3	0	0	0	1	1	2	2	2	1
CO4	2	2	2	2	1	2	1	0	2	1	2	2	2	1

1:low, 2:medium,3:high

Assessments:

TeacherAssessment:

One component of In Semester Evaluation (ISE) having 100% weightage.

Assessment	Marks
ISE	25
POE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

LABORATORY CONTENT

Experiment No. 1:-Experiment on Balancing of rotary masses (Static and Dynamic).

Aim & Objectives: To observe the principles of static and dynamic balancing .

Outcomes: Able to analyze rotary system for static and dynamic balancing.

Experimentation: To arrange the given masses in Angular and linear positions for complete static and Dynamic balance.

Results and Discussions: To find Angular and linear positions of masses analytically and to verify the results.

Experiment No. 2:- Experiment on equivalent spring mass system.

Aim & Objectives: To determine Natural Frequency of equivalent spring mass system.

Outcomes: Able to determine Natural frequency experimentally.

Experimentation: Determination of time period and natural frequency.

Results and Discussions: Comparison between Analytical and Experimental natural Frequency.

Experiment No.3 :-Determination of logarithmic decrement for single DOF damped system

Aim & Objectives: To determine logarithmic decrement for Torsionally vibratory system.

Outcomes: Able to analyze effect of damping on vibratory system

Experimentation: Plotting the logarithmic decrement of Torsionally vibratory system.

Results and Discussions: Calculation of damping coefficient for vibrating systems.

Experiment No. 4:- Experiment on study of forced vibration characteristics

Aim & Objectives: To study effect of exciting force on characteristics of vibrations

Outcomes: Able to determine forced vibration characteristics like Amplitude and Frequency.

Experimentation: To plot the graph Amplitude vs Time for forced vibrations

Results and Discussions: Determination of Maximum Amplitude and Natural Frequency for the Systems subjected to forced vibrations.

Experiment No. 5:- Experiment on Whirling of Shaft

Aim & Objectives: To study whirling of shafts

Outcomes: Able to measure speed of shaft at which whirling takes place

Experimentation: To measure speed of rotating shaft which is whirling.

Results and Discussions: To measure critical speed of whirling.

ExperimentNo. 6:Study and demonstration of vibration measuring instruments.

Aim & Objectives: To study various Vibration measuring instruments.

Outcomes: Able to select suitable vibration measuring instrument for specific application.

Experimentation: To measure vibration parameters of machineries.

Results and Discussions: To measure vibration parameters and its significance.

Experiment No.7: Study of signal analysis, filtering and data acquisition.
Aim & Objectives: To study techniques of signal analysis, filtering and data acquisition.
Outcomes: Able to select suitable techniques of signal analysis, filtering and data acquisition for suitable application.
Experimentation: Able to select suitable techniques of signal analysis, filtering and data acquisition.
Results and Discussions: To process the signal analysis, filtering and data acquisition for mechanical systems.

Experiment No.8: Case study of Bearing fault analysis using vibration measurement.
Aim & Objectives: To analyze various bearing faults and its signals.
Outcomes: To identify bearing faults with vibration signals .

Experiment No.9 : Case study of Gear box fault analysis using vibration measurement.
Aim & Objectives: To analyze various gear faults and its signals.
Outcomes: To identify gear faults with vibration signals.

Experiment No 10:- Industrial visit based on above syllabus.
Aim & Objectives : To make students acquainted to balancing of components like Gears, Pulleys used in Industry.
Outcomes: Able to understand industrial procedure for Static and Dynamic Balancing.
Experimentation: Demonstration of Measurement and removal of unbalance of Pulley using Balancing Machine.

MINIMUM EIGHT (08) EXPERIMEMTS ARE TO BE PERFORMED

Textbooks:

1. Ratan S.S, "Theory of Machines", Tata McGraw Hill, New Delhi, 3rd Edition, 2011.
2. Sadhu Singh,"Theory of Machines", Pearson Education, 2nd Edition, 2009
3. H. G. Phakatkar,"Theory of Machines I", Edition 2009.Nirali Publication,5th Edition 2009.
4. Mechanical Vibrations by Grover G.K., Nemchand Publications.

References:

1. Hamilton H Mabie and Charles F Reinholtz, (1987), "Mechanisms and Dynamics ofMachinery", Fourth Edition, John-Wiley and Sons, Inc., New York.
2. Ghosh A. and Mallick A.K., (1988), "Theory of Mechanisms and Machines", Affiliated East-West Press Pvt. Ltd., New Delhi.
3. William T Thomson, Marie Dillon Dahleh and Chandramouli Padmanabhan, (2004), "Theory of Vibration with applications", Fifth Edition, Pearson Education Publishers.
4. Theory of Machines by Dr. V.P.Singh, Dhanpat Rai Publications.
5. Theory of Machines by Ballaney, Khanna Publications.
6. Mechanical Vibrations by S.S.Rao, Pearson Education Publications
7. Theory of vibrations with applications by W.T. Thomson (CBS Publications)
8. Kinematics, Dynamics and Design of Machinery by Walidron, Wiley India Publi.
9. Theory of Vibration with applications by W.T.Thomson M.D. Dahleh, C.Padmanabhan Pearson Education

Title of the Course: Advance Automobile Engineering Lab Course Code: UMEVS0533	L	T	P	Credit
	0	0	2	1

Course Pre-Requisite: Basic Mechanical Engineering, I. C Engine, Basic knowledge about electric motors.

Course Description: This course discusses the fundamental concepts, principles and analysis of hybrid and electric vehicles. This course discusses the various EV subsystems such as electric motors, motor controllers, energy storage devices, battery management system, charging technology etc.

Course Objectives: To impart the knowledge about electric vehicles and hybrid vehicles. To expose the students to various drive technology and energy storage technology required in electric and hybrid vehicles.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Understand basic concepts of electric vehicles.	II	Understanding
CO2	Learn the ability to understand different systems and components.	II	Understanding
CO3	Identify electric vehicle troubleshooting and remedies.	III	Applying

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1								1				
CO2	2	1				2	1					1		
CO3	2	1				2	1					2	1	2

Assessments :
Teacher Assessment:

Assessment	Marks
ISE	25

Course Contents:

Experiment No. 1:--- Study and demonstration of four-wheeler chassis layout and vehicle body parts and its materials.	2 **Hrs.**
Experiment No. 2:--- Study and Demonstration of working of single plate automobile clutch and synchromesh gearbox.	2 **Hrs.**
Experiment No. 3:--- Study and demonstration of final drive and differential.	2 **Hrs.**

Experiment No. 4:--- Study and Demonstration of Control systems – Braking system, steering system.	2 **Hrs.**
Experiment No. 5:--- Study and Demonstration of automobile systems –Suspension system, Electrical System.	2 **Hrs.**
Experiment No. 6:--- Demonstration of typical hybrid vehicle construction and operation.	2 **Hrs.**
Experiment No. 7:--- Regenerative braking with BLDC motor using bidirectional converter.	2 **Hrs.**
Experiment No. 8:--- Study of AC charger for electric vehicle.	2 **Hrs.**
Experiment No. 9:-- Experiment on wheel balancing and front wheel alignment.	2 **Hrs.**
Experiment No. 10:-- Visit to EV servicing station for study of vehicle maintenance, repairs and report.	2 **Hrs.**

Textbooks:

1. Kripal Singh, Automobile Engineering Vol II, Standard Publishers Distributors, Tenth Edition , 2007
2. "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons, 2011
3. "Hybrid Electric Vehicles: Energy Management Strategies", S. Onori, L. Serrao and G. Rizzoni , Springer, 2015
4. P S Gill, Automobile Engineering II, S K Kataria and Sons, Second Edition, 2012
5. R K Rajput, Automobile Engineering, Laxmi Publications, First Edition, 2007
6. Automobile Engineering", G.B.S. Narang., Khanna Publication,3rdEdition.

Reference Books:

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explaned", John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
3. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies",Springer, 2015.
4. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003.
5. Newton, Steeds and Garrett, The Motor Vehicle, Butterworths International Edition, 11th Edition, 1989

Title of the Course: Community Engagement Project	L	T	P	Credit
Course Code: UMEIL0571	0	0	2	1

Course Pre-Requisite: Basic sciences, mechanical engineering science

Course Description: New generation of students are increasingly unaware of local rural and peri-urban realities surrounding their HEIs, as rapid urbanization has been occurring in India. A large percentage of Indian population continues to live and work in rural and peri-urban areas of the country. While various schemes and programs of community service have been undertaken by HEIs, there is no singular provision of a well- designed community engagement course that provides opportunities for immersion in rural realities. Such a course will enable students to learn about challenges faced by vulnerable households and develop an understanding of local wisdom and lifestyle in a respectful manner.

Course Objectives:

1. To make students more aware of the living conditions of those in their immediate vicinity and to assist them in realizing the harsh truths of society.
2. To help the students transform their mindset and cultivate societal awareness, sensitivity, accountability, and responsibility.
3. To help students to initiate developmental activities in the community in coordination with public and government authorities.
4. To enable students to apply their knowledge to the betterment of their local communities.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to
CO1	**IDENTIFY** the real-world problems and **PROPOSE** a suitable solution based on the fundamentals of mechanical engineering
CO2	**ANALYZ**E the results and arrive at valid conclusions
CO3	**USE** of technology in proposed work and demonstrate learning in oral and written form.
CO4	**DEVELOP** ability to work as an individual and as a team member.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	P011	PSO1	PSO2	PSO3
CO1	2	2	2	1	2	2						2	1	2
CO2	3	2	2	3	2					1	2	2	2	2
CO3					3	2	3		3			1	1	1
CO4								3						

Assessments :

Teacher Assessment:

Assessment	Marks
In Semester Evaluation (ISE)	25

ISE are based on Field Project assigned/Models preparation/ Presentation/ Group Discussion/ etc.

Course Contents:

Preamble: To achieve the objectives of the socio-economic development of New India, HEIs can play an important role through active community engagement. This approach will also contribute to improve the quality of both teaching and research in HEIs in India. India is a

signatory to the global commitment for achieving Sustainable Development Goals (SDGs) by 2030. Achieving these 17 SDG goals requires generating locally appropriate solutions. Community engagement should not be limited to a few social science disciplines alone. It should be practiced across all disciplines and faculties of HEIs. These can take the forms of enumerations, surveys, awareness camps and campaigns, training, learning manuals/films, maps, study reports, public hearings, policy briefs, cleanliness and hygiene teachings, legal aid clinics, etc. For example, students of chemistry can conduct water and soil testing in local areas and share the results with the local community. Students of science and engineering can undertake research in partnership with the community on solid and liquid waste disposal Therefore, students are being encouraged to foster social responsibility and community engagement in their teaching and research.

The Community Engagement Project is an experiential learning approach that combines education, learning, community development, and meaningful community service.

• The Community Engagement Project involves students in community development and service activities and applies the experience to personal and academic development.

• The purpose of the Community Engagement Project is to establish a mutually beneficial relationship between the college and the community. The targeted contribution of college students to the village/local development will benefit the community. The college has an opportunity to help students become more socially conscious and responsible while simultaneously becoming a socially conscious organization.

Group Structure:

Working in supervisor/mentor –monitored groups. The students plan, manage and complete a task/project/activity which addresses the stated problem.

1. Create groups of 4-6 students in each class.
2. A supervisor/mentor teacher is assigned to 4-6 groups or one batch.

Procedure to implement community engagement project:

• A group of students or a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.

• If required, students of the department will be divided into groups and each group is allotted to a faculty member of the department.

• The group of students will be associated with a government official / village authorities /NGOs etc. concerned, allotted by the district administration, during the duration of the project.

• The Community Engagement Project is a two-fold one –First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area.

Recommended field-based project activities (Tentative):

Community engagement field projects for mechanical engineering could include:

- Developing sustainable energy solutions like solar water pumps or wind turbine systems for rural communities,
- Designing accessible assistive devices for people with disabilities,
- Creating energy-efficient cooling systems for schools or public buildings,
- Building water filtration systems, or
- Developing educational workshops on basic mechanical concepts for local youth

Specific project ideas based on different mechanical engineering focuses:

- **Renewable Energy:**
- Solar-powered water pumping system:
- Design and build a solar-powered water pump for villages with limited access to clean water.

- Small-scale wind turbine:
- Develop a small-scale wind turbine to generate electricity for community centers or homes in windy areas.
- **Solar cooker design:**
- Create efficient solar cookers to reduce reliance on firewood in rural communities.
- Accessibility and Assistive Technology:
- Wheelchair accessible ramps: Design and build ramps for public buildings to improve accessibility.
- Prosthetic limb modifications: Collaborate with local clinics to design and fabricate customized prosthetic limbs.
- Adaptive tools for people with disabilities: Develop customized tools for individuals with physical limitations.
- **Energy Efficiency:**
- Building energy audit:
- Conduct energy audits in schools or community centers to identify areas for improvement and suggest retrofitting solutions.
- Passive cooling systems:
- Design and implement passive cooling systems (like natural ventilation) in buildings to reduce energy consumption.
- Efficient water heating systems:
- Develop and install more efficient water heating systems in community facilities.
- Waste Management and Recycling:
- Waste sorting and recycling system: Design a waste sorting and recycling system for schools or community centers.
- Composting systems: Develop and implement community-scale composting systems to reduce organic waste.
- Upcycling projects: Design and build useful items from recycled materials.
- Education and Outreach:
- **STEM workshops for youth:**
- Conduct hands-on mechanical engineering workshops for local students to spark interest in STEM fields.
- **Community awareness campaigns:**
- Educate the community about energy conservation and sustainable practices through presentations and informational materials.
- **Technical skills training:**
- Provide basic mechanical skills training to community members to enable self-repair of appliances or equipment.
- Product market awareness program
- Services market awareness program
- Road safety awareness program

Evaluation & Continuous Assessment

The comprehensive and ongoing monitoring and evaluation of student achievement is key to the project concept's effectiveness. It is recommended that regular reporting of all actions be

mandated. Students must maintain a project log book at the department with regular evaluations of their project work. The following should be recorded in the project log book:
1. Student guidance and information
2. The project guide's weekly oversight,
3. Evaluation form for the project guide to review the project work

Recommended parameters for assessment, evaluation and weightage:

1. Idea Inception (kind of survey). (10%)
2. Documentation (Gathering requirements, design & modeling, implementation/execution, use of technology and final report, other documents). (15%)
3. Attended reviews, poster presentation and model exhibition. (10%)
4. Demonstration (Poster Presentation, Model Exhibition etc). (10%).
5. Awareness /Consideration of - Environment/ Social /Ethics/ Safety measures/Legal aspects. (5%)
6. Outcome (physical model/prototype/ virtual model/ product development/ assembly & disassembly and analysis of standard mechanism or system, design and development of small application, design of control systems, development of various systems/ /Hackathon/ application development and similar activities/ System performance and analysis) (40%)
7. Participation in various competitions/ publication/ copyright/ patent) (10%)

The review/ progress monitoring committee shall be constituted by head of departments of each institute.

The progress of project to be evaluated on continuous basis, minimum two reviews in each semester.

• In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Project shall be assessed based on following points;

- ✓ Quality of problem and Clarity
- ✓ Innovativeness in solutions
- ✓ Cost effectiveness and Societal impact
- ✓ Full functioning of working model as per stated requirements
- ✓ Effective use of skill sets
- ✓ Effective use of standard engineering norms
- ✓ Contribution of an individual's as member or leader
- ✓ Clarity in written and oral communication

Report Format

1. **Project introduction:** Introduce the project and its objectives
2. **Project details:** Include the where, when, and how of the project
3. **Participants:** Describe who participated in the project
4. **Outcomes:** Share the outcomes of the project
5. **Next steps:** Provide recommendations and next steps for the project

Project Evaluation:

1. Activity book: 5 marks
2. Project implementation working model: 10 marks
3. Presentation: 5 marks
4. Report: 5 marks

Title of the Course: Python for Machine Learning and Data Science Course Code: UMEMM0541	L	T	P	Credit
	3	0	0	3

Course Pre-Requisite:

This course requires the basic knowledge of the following:

1. Basics of Python Programming
2. Basics of Mathematics and Statistics

Course Description:

Students need to develop the skills required for Machine Learning Technologies with use of Python to analyze data, create beautiful visualizations, and problem solving using powerful machine learning algorithms. Machine learning heavily relies on mathematics, statistics, and programming expertise to develop and fine-tune algorithms. Data science requires a multidisciplinary skill set that includes knowledge of statistics, programming, data manipulation, and subject matter expertise.

Course Objectives:

1. To revise the basics of Python programming and learn the installation of various Python Libraries.
2. To explain the basics of machine Learning and Data Science.
3. To explain the basics of NumPy and Pandas.
4. To explain the applications of Machine Learning and Data Science using Python programming.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Demonstrate** the installation of various Python libraries.	II	Understanding
CO2	**Demonstrate** the use of NumPy and Pandas for data handling.	II	Understanding
CO3	**Apply** the Data Cleaning and Regression techniques to various practical problems.	III	Applying
CO4	**Illustrate the** Machine learning process and its applications	II	Understanding

CO-PO-PSO Mapping:

Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	1	0	0	0	0	0	0	0	0	0	0	1	0	3
CO2	1	1	1	2	1	0	0	0	0	0	0	3	0	3
CO3	1	1	1	2	3	0	0	0	0	0	0	3	0	3
CO4	1	1	1	2	3	0	0	0	0	0	3	3	0	3

Assessments :

ESE: Assessment is based on 100% course content equal weightage for all units.

Course Contents:	
Unit 1: --- Introduction Python for Data Analysis, essential python libraries, Installation and setup of different operating systems, important development environments (IDEs) and text editors, brief background of python, decision structures and Boolean logic, looping, built-in data types, and functions	7 **Hrs.**
Unit 2: --- Introduction to NumPy and Pandas Introduction to NumPy,What is NumPy, Key Features of NumPy, Array Operations, Random Number Generation Introduction to Pandas, what is Pandas, Overview of Pandas for data manipulation and analysis, Key Features of Pandas, Pandas Series, Pandas Data Frame, Data Manipulation with Pandas: Sorting, filtering, and grouping data.	8 **Hrs.**
Unit 3: --- Data Cleaning and Preparation Handling missing data-filtering out missing data, filling in missing data, data transformation-removing duplicates, transforming data using a function or mapping, replacing values, string manipulation Matplotlib and libraries, figures and subplots, colors, markers and line styles, ticks, labels, and legends, Annotations and drawing on a subplot, saving plots to file, plotting with pandas-line plot, bar plot, histogram and density plots, scatter and point plots.	8 **Hrs.**
Unit 4: --- Introduction to Machine Learning Introduction to machine learning – definition, terminology. Types of machine learning – supervised learning, unsupervised learning, semi-supervised learning, reinforcement learning. Machine learning process. Performance metric in machine learning. Tools and frameworks.	7 **Hrs.**
Unit 5: --- Regression and Classification Regression –simple linear regression, multiple linear regression, Assumptions in regression analysis, other regression techniques, improving accuracy of the linear regression model, polynomial regression model, logistic regression. Support Vector Machines Decision trees – definition, terminology, the need, advantages, and limitations. Constructing and understanding decision trees. Common problems with decision trees. Decision tree algorithms – ID3 , random forest, examples, cross-validation, confusion matrix, precision-recall.	9 **Hrs.**
Unit 6: --- Applications of Machine Learning Predictive Maintenance , Quality Control and Defect Detection, Design Optimization, Robotics and Automation, Research papers and journals on specific applications in Mechanical Engineering	6 **Hrs.**
Textbooks: 1.Wes McKinney, "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", O'Reilly, 2nd Edition,2018. 2. WesLey J. Chun, "Core Python Programming", Second Edition, Pearson Education, 2010. 3.Machine Learning with Python - an approach to applied ML, by Abhishek Vijayvargia, BPB publications 4.Practical Machine Learning by Sunila Gollapudi Packt Publishing Ltd 5.Machine Learning by Tom M. Mitchell, McGraw Hill Education; First edition	
Reference Books: 1. Aurelien Geron , " Hands on Machine Learning with Scikit -learning , Keras & Tensorflow ",Concepts , Tools & Techniques to build Intelligent systems 2. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", 1st Edition, O'Reilly Media, 2017. 3. Rajiv Chopra, Machine Learning, Khanna Book Publishing 2021	

Assessment	Marks
ESE	50

Title of the Course: Signal and Image Processing	L	T	P	Credit
Course Code: UMEMM0542	3	-	-	3

Course Pre-Requisite: Knowledge of basic Electronic Devices and Signal.

Course Description: Signal Image Processing deals with the processing of Digitized images. In image processing, there are two major categories of processing; the first is enhancing the quality of the image so that human beings will better visualize the image. The other applications associated with detecting and extracting information by machine may be to assist human decisions. In this course, we will introduce various image processing techniques, algorithms, and their applications for improvement in the visual quality of the image. Also, the curriculum includes an introduction to segmentation and object representation.

Course Learning Outcomes:

CO	After successful completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Explain** basic concepts of signal conditioning components and Image Formation.	II	Understanding
CO2	**Make Use of** the fundamentals of image enhancement and restoration techniques in both spatial and frequency domains.	III	Applying
CO3	**Demonstrate** various image segmentation techniques and morphological operations used in image analysis.	II	Understanding
CO4	**Summarize** key image compression techniques and their role in reducing redundancy and improving efficiency.	II	Understanding

CO-PO, PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	1	1									1	1	1
CO2	1	1	1	2									1	1	2
CO3	1	1	1	1									1	1	2
CO4	1	1		1									1	1	1

1: Low 2: Medium 3: High

Assessments:

Components	Marks
ESE	100

ESE: Assessment is based on 100% course content

Course Contents:	Hours
Unit 1: - Signal Conditioning Signal conditioning process, Operational amplifier (inverting amplifier, non-inverting amplifier, summing, subtractor), Filtering, Data acquisition, Multiplexer, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC).	07
Unit 2: - Digital Image Fundamentals & Image Transforms: Digital Image fundamentals, Sampling and quantization, Relationship between pixels.	08

Image Transforms: 2-D FFT, Properties. Walsh transforms, Hadamard Transform, Discrete cosine Transform, Discrete Wavelet Transform.	
Unit 3: - Image Enhancement: **Image enhancement (spatial domain):** Introduction, Image Enhancement in Spatial Domain, Enhancement Through Point Operation, Types of Point Operation, Histogram Manipulation, gray level Transformation, local or neighborhood operation, median filter, spatial domain high- pass filtering. **Image enhancement (Frequency domain):** Filtering in Frequency Domain, Obtaining Frequency Domain Filters from Spatial Filters, Generating Filters Directly in the Frequency Domain, Low Pass (smoothing) and High Pass (sharpening) filters in Frequency Domain.	**08**
Unit 4: - Image Restoration: Degradation Model, Algebraic Approach to Restoration, Inverse Filtering, Least Mean Square Filters, Constrained Least Squares Restoration.	**07**
Unit 5: - Image Segmentation and Processing: Detection of discontinuities. Edge linking and boundary detection, Thresholding, Region oriented segmentation**.** **Morphological Image Processing:** Dilation and Erosion, Dilation, Structuring Element Decomposition, Erosion, Combining Dilation and Erosion, Opening and Closing, the Hit or Miss Transformation.	**08**
Unit 6: - Image Compression: Redundancies and their Removal Methods, Fidelity Criteria, Image Compression Models, Huffman and Arithmetic Coding, Error Free Compression, Lossy Compression, Lossy and Lossless Predictive Coding, Transform Based Compression, JPEG 2000 Standards.	**07**

Text books:

1. Digital Image Processing- Rafeal C. Gonzalez, Richard E. Woods, 3rd Edition, Pearson, 2008.
2. Digital Image Processing- S Jayaraman, S. Essakkirajan, T. Veerakumar-TMH,2010.
3. Pratt, William K., "Digital Image Processing", John Wiley & Sons, New

References:

1. Digital Image Processing and analysis-human and computer vision application with using CVIP Tools – Scotte Umbaugh,2ndEd, CRC Press,2011.
2. Introduction to Digital Image Processing with Matlab, Alasdair McAndrew,Thomson Course Technology.
3. Fundamentals of Digital Image Processing-A.K. Jain,PHI,1989.
4. Introduction to Image Processing & Analysis-JohnC.Russ, J.ChristianRuss, CRCPress, 2010.
5. Digital Image Processing with MATLAB & Labview - Vipula Singh Elsevier

Title of the Course: Electric & hybrid vehicle. Course Code:UMEMM0543	L 3	T -	P -	Credit 3

Course Pre-Requisite: Basic knowledge about electric motor, Applied Thermodynamic, Basic Mechanical Engineering.

Course Description:

This course discusses the fundamental concepts and analysis of hybrid and electric vehicles. This course discusses the various EV subsystems such as electric motors, energy storage devices, charging technology etc. Analytical exercises in vehicle dynamics, battery parameters and charging technology are included as a preparatory base for designing an EV.

Course Objectives:

To impart the knowledge about electric vehicles and hybrid vehicles. To expose the Electrical Engineering students to various interdisciplinary areas related to electric and hybrid vehicles.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Understand the concept of EV & HEV.	II	Understanding
CO2	Explain the correlation between HEV, EV and environment, infrastructure and policies of a nation.	II	Understanding
CO3	Illustrate various subsystems and components in EV and HEV.	IV	Applying
CO4	Solve the performance parameters of EV subsystems.	IV	Applying

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1		1					1				
CO2	2	1	1		1	2	1					1		
CO3	2	1	1			2	1					2	1	2
CO4	3	1	2		1	2	1				2	2	1	2

Assessments :

Teacher Assessment:

Assessment	Marks
ESE	100

Course Contents:	
Unit 1:--- Introduction to Electric Vehicle History of electric vehicles, Development towards 21st century, Environment impact, Types of electric vehicles in use today – Battery Electric Vehicle, Hybrid, Fuel Cell EV, Solar powered Vehicle, Conventional drive train.	**07 Hrs.**
Unit 2: Vehicle Dynamics Calculation/modeling of traction power and energy consumption. Resistance to vehicle motion, Air, Rolling and Gradient resistance, Acceleration, Gradeability and draw bar pull, Traction and Tractive effort, Distribution of weight, Power required for vehicle propulsion, Selection of gear ratio, Rear axle ratio. (Numerical)	**09 Hrs.**
Unit 3:--- Electrical Vehicles – Technology and design Configuration of EV's, electric motor characteristics, design process and issues, modelling and performance estimation, electric motors used for EVs and HEVs, energy consumption, Regenerative brakes.	**07 Hrs.**
Unit 4:--- Hybrid electric vehicle technology Concept, Modes and operation patterns, Architectures of hybrid drive trains, series hybrid drive train, parallel hybrid drive train with torque coupling and speed coupling, Sizing of components, Introduction to electric components used in hybrid and electric vehicle.	**08 Hrs.**
Unit 5:--- Energy sources and storage system Introduction to energy storage requirements in Hybrid and electric vehicles, Battery based energy storage, Fuel Cell based energy storage, super capacitor based energy storage, flywheel based energy storage. Battery Management System (BSM)	**07 Hrs.**
Unit 6:--- Energy Management Strategies Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematics of charging stations.	**07 Hrs.**
Text books: 1."Electric and Hybrid Vehicles" by Tom Denton, Routledge, 2016. 2. Modern Electric Vehicle Technology, by C.C.Chau and K.T. Chau, OXJORD Unv. 3. Advanced Electric Drive Vehicles by Ali Emadi, CRC press, 2014. 4. P S Gill, Automobile Engineering II, S K Kataria and Sons, Second Edition, 2012 5. R K Rajput, Automobile Engineering, Laxmi Publications, First Edition, 2007 6.Automobile Engineering", G.B.S. Narang., Khanna Publication,3rdEdition.	
Reference Books: 1. "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design" by M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, CRC Press, 2004 2. "Hybrid Electric Vehicles: Energy Management Strategies" by S. Onori, L. Serrao and G. Rizzoni, Springer, 2015 3. Funda& Appl of Li- ion Bat in Electric Drive Vehicles, JiuchungJuaing, CaipingZhang, Wiley publications, 2015	

Title of the Course: Energy Conversion and Management Course Code: UMEM0561	L	T	P	Credit
	3			3

Course Pre-Requisite:

Course Description: This course examines how energy is transformed and used, covering both traditional and renewable sources. Students will learn to analyze energy systems, apply management techniques to improve efficiency, and evaluate sustainable energy solutions for a cleaner future.

Course Objectives:

1. To enable students to analyze diverse energy resources and environmental impact of various energy conversion technologies.
2. To equip students with the ability to apply energy management principles and design sustainable energy systems for practical applications.
3. To foster an understanding of the relationship between energy, environment, and sustainable development, and integrate renewable energy solutions.
4. To develop students' skills in assessing energy consumption, identifying areas for improvement, and recommending effective energy conservation and management strategies.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain need of different energy sources and their importance	II	Understanding
CO2	Understand different energy resources and its implementation.	II	Understanding
CO3	Identify and implement different energy conservation and management techniques.	III	Applying
CO4	To analyze energy system impacts and recommend sustainable solutions that adhere to global environmental standards.	IV	Analyzing

CO-PO Mapping

CO - PO Mapping														
Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	0	0	0	0	2	0	0	0	1	0	0	0	0
CO2	2	2	0	0	0	2	0	0	0	0	2	0	0	0
CO3	0	2	0	0	0	0	0	1	2	0	1	1	2	2
CO4	0	0	2	2	0	2	2	1	0	0	0	0	0	2

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

Course Contents:	
Unit 1: **Energy Scenario and fundamentals:** Global and national energy scenario: Current energy demand and supply, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), Energy resources, energy conservation and its importance, energy strategy for the future.	**7Hrs**
Unit 2: **Organizing for energy conservation programme**, The energy audit and energy information system, technology for energy conservation, co-generation of process, steam & electricity, computer integrated energy management, commercial options in waste heat recovery equipment, cases of energy studies, energy conservation opportunity. **Economics of Power Plant**- Load Curves and Load duration curves (Numerical treatments), Performance and operational characteristics of power plants, Peak load, Intermediate	**8 Hrs**
Unit 3: Renewable Energy Resources and Conversion Solar energy: Photovoltaic and thermal conversion, Wind energy: Horizontal and vertical axis wind turbines, Biomass energy: Combustion, gasification, and anaerobic digestion, Geothermal energy: Geothermal power plants and heat pumps, Ocean energy: Tidal, wave, and ocean thermal energy conversion, Small hydro power plants.	**7Hrs**
Unit 4: Energy Management and Efficiency Energy auditing and analysis, Energy conservation techniques in industries and buildings., Demand-side management, Cogeneration and trigeneration, Topping cycle and bottoming cycle.	**8 Hrs.**
Unit 5: Waste Utilization and Energy Storage Waste-to-energy technologies: Incineration, pyrolysis, and gasification, Landfill gas utilization, Energy storage systems: Batteries, pumped hydro, compressed air, and thermal storage, Hydrogen energy storage, Flywheel energy storage, Super capacitors.	**7Hrs.**
Unit 6: Sustainable Energy and Environmental Considerations Sustainable energy development and policies, Environmental impact of energy generation and utilization. **Pollution control technologies:** Emission standards and regulations., Climate change and its impact on the energy sector, Carbon capture and storage, Sustainable Development Goals (SDGs) related to energy, Recent developments in sustainable energy technologies.	**8 Hrs.**
Text books: 1. Fundamentals of Renewable Energy Resources, G. N.Tiwari and M. K. Ghosal, Narosa Publishing House. 2. Non-Conventional Energy Recourses, G D Roy, Khanna Publication, 2020. 3. Energy Management Handbook by Wayne C. Turner. 4. Solar Energy, Sukhatme, 3rd Edition, Tata McGraw-Hill Education, 2008 5. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi Publications, New Delhi.	

Reference Books:

1) Renewable Energy Resources, John Twidell & Anthony D. Weir, 2nd Edition, Taylor & Francis, 2006.
2) Handbook of Energy Engineering by Albert Thumann and D. Paul Mehta.
3) Thermal Energy, Mahesh Rathore, Tata McGraw-Hill Education, 2010
4) Power Plant Engineering, P.K.Nag, 2nd Edition, Tata McGraw-Hill Education, 2002
5) An Introduction to Power Plant Technology, G.D. Rai, 3rd Edition, Khanna publications.

Kolhapur Institute of Technology's College of Engineering, Kolhapur

Curriculum (Structure)

for

B.TECH
Robotics (Hons.) Programme
(Under Graduate Programme)
From Academic Year 2021-2022

Kolhapur Institute of Technology's College of Engineering,(Autonomous) Kolhapur.

Department of Mechanical Engineering

Teaching and Credit scheme for

Propose B.Tech. Robotics (Hons.) Programme in Mechanical Engineering

Course No.	Course Name	Semester	No. of Hours /Week			
			L	**T**	**P**	**Credits**
UMEHN0351	FUNDAMENTALS OF ROBOTICS	III	3	1	--	**4**
UMEHN0451	FUNDAMENTALS OF MICROCONTROLLERS	IV	3	1	--	**4**
UMEHN0551	PROGRAMMING & SIMULATIONS FOR ROBOTICS	V	3	1	--	**4**
UMEHN0651	ROBOT KINEMATICS AND DYNAMICS	VI	3	1	----	**4**
UMEHN0751	MINI PROJECT	VII	-	-	4	**2**
			12	**4**	**4**	**18**

Total Credits - 18, Total Contact hours – 20

UMEHN0351 As per NEP Structure **AY2425 onwards**

Title of the Course: Programming and Simulations for Robotics **Course Code:** UMEHN0551	**L**	**T**	**P**	**Credit**
	3	**1**	**-**	**4**

Course Pre-Requisite: Basics of programming**,** Basic electronics & electrical, Basic Sciences, sensors

Course Description: This course gives knowledge about the Robotics programming. It also describes the emerging trends in robotics programming in different languages

Course Objectives

1. To understand basic terminologies and concepts associated with Robotics and **its** programming.
2. To study various peripheral devices and interfacing them with robots.
3. To study motor control using PWM and communication between two robots.
4. To study the various different platforms for robot programming.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	Descriptor
CO1	To **Apply** knowledge of automation tools and other equipment's by taking into account the fundamental principles robot programming	I	Cognitive (Knowledge)
CO2	To **identify** various task related to robot programming	I	Cognitive (Knowledge)
CO3	To **Acquire** knowledge various new tool usage for robot programming	I	Cognitive (Knowledge)
CO4	To **Analyzing** the problem logically and Demonstrate, & apply knowledge for robot programming.	II	Psychomotor (Skill)

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**	
CO1	2							2				3		2	
CO2	3			3				2				3	2	2	
CO3					3			2				3	2	2	
CO4		3			3			2			3	3		2	

Assessments:

Teacher Assessment:

Assessment	Marks
ESE	100

No ISE 1 and ISE II and MSE:

ESE: Fianl ESE Assessment is based on 100% course content for 100 marks.

Course Contents:

Unit 1:- Introduction to Robot Programming Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.	**(07)Hrs.**
Unit 2:-Robot Programming Languages Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications,	**(07)Hrs.**

palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications. VAL-II programming-basic commands, applications-Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot.	
Unit 3:-Introduction to Firebird V and ROS Introduction to Firebird V,Avatars of Fire Bird V Robot, Block diagram, Pin Connections. Introduction to an architectural overview of the Robot Operating System Framework and setup with ROS environment using suitable Workspace	**(08)Hrs.**
Unit 4: -Motion Control & Robot communication Basic movements of Robots, Understanding L293DIC, Motion interfacing with Firebird-V, Pin Connections, Logic tables, writing c code. Serial Communication using UART, Registers involved in the serial communication, Interrupts, Sources of Interrupts, Position encoder,	**(08) Hrs.**
Unit 5: -Velocity control using PWM&LCD Interfacing Introduction, PWM, Duty cycle, PWM generation in AVR, Timers in AVR, Timers in Firebird V, Servo motor control using PWM.LCD definition, Pin configuration, control pins, Data pin, LCD Interfacing, LCD Commands.	**(08) Hrs.**
Unit6: -Artificial Intelligence: - Foundations of AI, AI techniques, Need and application of AI, Turing test, acting and thinking humanly, acting and thinking rationally. History of AI. Intelligent Agents of AI.	**(07) Hrs.**

Text Books:

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 2004
2. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
3. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
4. Industrial Automation: W.P. David, John Wiley and Sons.
5. Programming Robots with ROS: A Practical Introduction to the Robot Operating System 1st Edition, by Morgan Quigley (Author), Brian Gerkey (Author), William D.
6. Smart, O'Reilly Media; 1st edition (16 November 2015)

Reference Books:

1. Robot Programming A Guide to Controlling Autonomous Robots by Cameron Hughes, Tracey Hughes, Que Publishing.
2. Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy by Lentin Joseph ISBN 1484234049, 978-1484234044

Title of the Course: Power Plant Engineering Course Code:UMEPC0601	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite: Basic Mechanical Engineering, Applied Thermodynamic, Heat Mass Transfer.

Course Description:

The aim of this course is to provide students with a working knowledge and application of the fundamentals of how the operation of power plant affect their working, performance, fuel requirements and environmental impact.

The focus is on explaining engine performance in terms of power, energy utilization and exhaust emissions, its relation to internal processes like combustion and gas exchange at varying engine-operating condition.

Course Objectives:

1. To enable the students to analyze the Ideal and actual air standard cycles and valve timing diagrams.
2. To make the students to study of fuel supply system in I.C. Engine.
3. To educate the student about combustion phenomenon and emission characteristics of engines.
4. To impart knowledge about various engine performance characteristics of engine.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain fundamentals of I. C. Engine	II	Understanding
CO2	Classify different power plants.	II	Understanding
CO3	Identify different control systems in Power Plants	III	Applying
CO4	Analyze performance parameters of Power Plants.	IV	Analyzing

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2											2		
CO2	2													
CO3	2	2				2	2							
CO4	3	2									2	2		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Unit 1:--- Introduction Introduction, Classification of Power plants, applications, Engine specifications. Engine Cycles: Engine cycles, Deviation of actual cycles from air standard cycles, Valve timing diagram for high and low speed engine, Port timing diagram. Supercharging and Turbo-charging, Alternative fuel for I. C. engines (Hydrogen etc.)	**07 Hrs.**
Unit 2: Fuel Supply system for SI and CI Engine **Fuel Systems for S.I. Engines:** Engine fuel requirements, complete carburetor, Derivation for calculation of A/F ratio, Calculation of main dimensions of carburetors, Effect of altitude on Air fuel ratio. Electronic Petrol injection system (MPFI). **Fuel Systems for C.I. Engines:** Requirements of injection system, Types of injection systems – Individual pump, Common rail and Distributor systems, Unit injector, Types of fuel nozzles- single hole, multi hole, pintle, and pintaux. Governing of C.I. engines. Electronic diesel injection system.	**09 Hrs.**
Unit 3:--- Performance Testing of I. C. Engine Performance parameters, Measurement of performance parameters like torque, power, Volumetric Efficiency, Mechanical Efficiency, BSFC, Brake and Indicated Thermal efficiencies. Numerical on Heat Balance Sheet and engine performance, Performance curves.	**07 Hrs.**
Unit 4:--- Combustion & Emission control Stages of combustion in S.I. and C.I. engine, Knocking in S.I. and C.I. engine, types of combustion chamber in S.I. and C.I. engine. S.I. engine emission (HC, CO, NOx) Control methods- Evaporative (ELCD), Thermal, Catalytic converters, C.I. Engines Emission (CO, NOx, Smog, Particulate), Control methods- Chemical, EGR, Standard pollution Norms like EURO, Bharat stage. Different pollutants due to power plants and their effects on ecology, Pollution measuring and control devices, O2, CO2, CO, smoke and dust measurement.	**09 Hrs.**
Unit 5:--- Resources and development of power in India- NTPC, NHPC and their role in Power development in India, Present Power position in India. Different types of power plants – Thermal, Hydro, Gas Turbine, Nuclear and their characteristics, Comparison of Power plants with respect to various parameters, Combined Cycle, Pumped storage, Compressed Air storage power plants and their characteristics. Renewable energy sources like solar, wind, Biomass.	**07 Hrs.**
Unit 6:--- Economics of Power Plant- Load Curves and Load duration curves (Numerical treatments), Performance and operational characteristics of power plants, Peak load, Intermediate load and Base load plants and their characteristics, Input output characteristics of power plants, Economic division of between Base load plant and peak load plants, Tariff methods, Cost of electric Energy, Fixed and operating cost	**06 Hrs.**

Text books:

1. A Course in Power Plant Engineering, S.C. Arora and S. Domkundwar, Dhanpat Rai, 1988
2. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi Publications, New Delhi.
3. Internal Combustion Engines", V. Ganesan, Tata McGraw Hill Publication.
4. "Internal Combustion Engines" Mathur and Sharma, Dhanpat Rai Publication , Delhi.
5. "Internal Combustion Engines",R. K. Rajput, SciTech Publication.
6. Solar Energy, Sukhatme, 3rd Edition, Tata McGraw-Hill Education, 2008
7. Fundamentals of Renewable Energy Resources, G. N.Tiwari and M. K. Ghosal, Narosa Publishing House, 2007

Reference Book:

1. "Internal Combustion Engines", J. B. Heywood,Tata McGraw Hill Publication .
2. "Internal Combustion Engines",Maleev, CBS Publication and Distributors.
3."Internal Combustion Engines",Gills and Smith, Oxford and IBH Publishing Company
4. "Internal Combustion Engines Fundamentals", E. F. Obert, Harper and Row Publication , New York.
5. Renewable Energy Resources, John Twidell & Anthony D. Weir, 2nd Edition, Taylor & Francis, 2006
6. Power Plant Engineering, P.K.Nag, 2nd Edition, Tata McGraw-Hill Education, 2002

Title of the Course: Finite Element Analysis Course Code: UMEPC0602	L	T	P	Credit
	3	-	-	3

Course Pre-Requisite:

- Applied Mechanics
- Strength of Materials

Course Description:

This subject enables the student to understand the important concepts of FEA, its evolution and applications. Students will learn the mathematical formulation of FEA problems. The Knowledge gained through this subject will be helpful in solving the real life problems.

Course Objectives:

1. Introduce students to Finite Element Analysis fundamentals.
2. Introduce students to steps involved in FEA, domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems.
3. To enable the students to formulate the design problems into FEA.
4. Understand the practical (modeling and analysis) aspects of the FEA.
5. Apply this theory and practical knowledge to solve 1-d, 2-d structural and thermal Problems manually and with using computers.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Understand the mathematical modeling and FEA.	II	Analyze
CO2	Use of advanced software for solving the problems and interpreting the results.	III	Undertake
CO3	Develop solutions of some mechanical real time problems.	IV	Develop
CO4	Estimate the deformation, stresses, strains and reactions	V	Estimate

CO-PO Mapping:

UM - FEA: CO - PO Mapping

Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3							1		1	1			
CO2	3	3						1			2			2
CO3		3		3	3			1			1	1	1	
CO4			3	2				1			1	1		

1:low,2:medium,3:high

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE),One Mid Semester Examination(MSE)and one End Semester Examination (ESE) having 20%,30% and 50% weights respectively.

Assessment	Marks
ISE1	10
MSE	30
ISE2	10
ESE	50

ISE1 and ISE2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on100% course content with 60-70% weightage for course content (Normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- **Introduction** Introduction, An overview of engineering problems and methods for solving them, demonstration by an example – Physical system – Physical model – Mathematical model – Methods for solution – Solution. Need for using numerical method to solve engineering problems-Types of Engineering Analysis.	**7Hrs.**
Unit 2:--- **Introduction to 1D bar element problems:** Introduction to steps of FEM for the problem of finding elongation of an axially loaded bar as an example of a 1-D problem. Step- by-step development of the procedure of Galerkin weighted residual FEM for the bar problem - residual error, weighting function, discretization, elements and nodes, local variables, approximation functions (or shape functions), need for numerical integration and co-ordinate transformation, Gauss Legendre integration scheme. Process of assembly of local matrix equations into global, solution to the equations, equation solvers	**8Hrs.**
Unit 3:--- **Introduction to 2D truss element problems:** FE formulation for truss, FEM procedure followed for the truss problems. Computation of derived quantities like strains and stresses from the nodal values of the field variables, Result post processing. Finite element formulation using variational and virtual work methods, demonstration for bar and truss problems.	**8Hrs.**
Unit 4:--- **2-D Problem from structural mechanics:** Introduction to 2-dimensional problem from structural mechanics static analysis, Triangular and quadrilateral elements, Basic concepts of Plain stress and Plain strain. Constant strain triangular element Stiffness Matrix and Equation. Finite element Solution of a plane stress Problem. Higher order elements, iso-parametric elements	**8Hrs.**

Unit 5:--- **Potential field problems:** Introduction to potential field problems, examples from structural mechanics - of torsion of noncircular prismatic bars, 2-D steady state heat transfer with convection from surface. Sources of errors, error analysis, remedies to minimize the errors. Application of FEM to Axisymmetric problems, Axisymmetric solids under rotation.	**8Hrs.**
Unit 6:--- Non-linear Static elasticity, Buckling, Modal, Transient Response, Harmonic Response, Shock Spectrum Analysis. Translators, types and use, importance of translators.	**6Hrs.**

Text Books:

1. M. J. Fagan, Finite element analysis, Longman Scientific and Technical
2. D. L. Logan, A first course in finite element method, 4 ed. Cengage learning
3. J. N. Reddy, An introduction to the finite element method, 2 ed. McGraw Hill

Reference Books:

1. S. S. Rao, the finite element method in engineering, 4 ed. Elsevier Science & Technology Books, Dec2004.
2. T. A. Stolarski, Engineering analysis with ANSYS Software, Elsevier 2006
3. Erdogan Madenci, Ibrahim Guven, The Finite Element Method And Applications In Engineering Using Ansys, Springer 2017.
4. N.S. Gokhale, S.S. Deshpande, S.V. Bedekar, A.N. Thite, Practical Finite Element Analysis, Finite to Infinite Publication

Title of the Course:MECHATRONICS	L	T	P	Credit
Course Code: UMEPC0603	2	-	-	2

Course Pre-Requisite: Knowledge of basic Electronics and Electrical Engineering.

Course Description: Studying the mechatronics course is of importance due to the global demand and developments in Mechatronic systems and automated manufacturing planning and controlling activities etc. The mechanical systems are becoming smart and for designing and developing such smart systems students of mechanical engineering must understand basic elements of smart systems such as sensors, signal conditioning devices, microcontrollers, digital logic and programs for automating the processes.

Course Learning Objectives:

CLO1: To learn various concepts of automation, Mechatronics and PLC and the integration of different branches of engineering in Mechatronics.

CLO2: To prepare graduates of mechanical engineering with comprehensive knowledge of Mechatronics to enable them to apply the relevant knowledge and technologies for the design and realization of innovative systems and products.

CLO3: To prepare Mechanical Engineering students for advanced graduate studies in Mechatronics, Manufacturing engineering and related field.

Course Learning Outcomes:

CO	After successful completion of the course the student should beable to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Select** appropriate sensor for given application	I	Remembering
CO2	**Classify** different signal conditioning techniques	II	Understanding
CO3	**Explain** the various concepts related to different microcontrollers used in mechatronic systems.	II	Understanding
CO4	**Solve** scenarios of automating the processes using the PLC programming approach.	III	Applying

CO-PO,PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1									1	1	1
CO2	3	1	2									1	1	1
CO3	2	1	2	1	2							2	2	2
CO4	2	1	2	1	2							2	3	3

1:Low 2:Medium 3: High

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Components	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:	Hours
Unit 1: -Introduction a)Introduction:Definition, Mechatronics advantages and its applications, Components of Mechatronic Systems b) Sensors and Transducers: Performance terminology, Contact and non-contact type switches and proximity sensors- inductive, capacitive, optical, pneumatic, potentiometric, thermal, incremental and absolute encoders.	**08**
Unit 2: -Signal Conditioning and Actuators a)Signal Conditioning: Signal conditioning processes, voltage divider, rectification, Operational Amplifiers: inverting and non-inverting, summing, integrating, differential, analog to digital and digital to analog converters, multiplexing and de-multiplexing b)Actuators: Brushless DC servomotors, timing motors, SCR (Silicon Controlled Rectifiers) motors, Stepper motor	**07**

Unit 3: - Introduction to Microcontroller Introduction to Microcontroller, Comparison between microprocessor and microcontroller, Organization of a microcontroller system, Architecture of 8051, Pin diagram of 8051, Addressing modes Introduction to Arduino, Types of Arduinos, Arduino Pin Diagram, Basics of Programming, Sample Circuits	**07**
Unit 4: - Programmable Logic Controllers (PLC) Introduction to PLC, components of PLC Input-output module, Ladder diagram and PLC programming fundamentals: logic functions, latching, sequencing, timers (Delay On Timer, Delay OFF Timer, Cascading of Timers) counters (Up Counter, Down Counter), jumps, Internal relays, Disagreement circuit, Majority circuit.	**08**

Textbooks:

1. "Mechatronics",W. Bolton, Pearson Education, 4th Edition.
2. "Mechatronics", Mahalik, TATA McGraw Hill, (2006) Reprint,
3. "Microprocessor 8085", Gaokar Prentice Hall of India, 5th Edition.
4. "The 8051 Microcontroller -A System Approach", by Muhammad A. Mazidi, 1st Ed., PHI
5. "Programmable Logical Controller", Hackworth, Pearson Education, (2008).
6. "Programmable Logical Controller", Reis Webb, Prentice Hall of India 5th Edition.

Reference Books:

1. "Mechatronics",AppuKuttam, Oxford Publications, 1st Edition.
2. "Automated Manufacturing Systems", S. Brain Morris, Tata McGraw Hill.
3. "Mechatronics and Microprocessor", Ramchandran , Willey India, (2009).
4. "Mechatronics: Integrated Mechanical Electronic System", Ramchandran , Willey India,1st Edition.
5. "Programmable Logical Controller", Gary Dunning Cengage Learning, 3rd Edition.
6. "Programmable Logic Controllers and programming concepts", JojiParambath.
7. "Mechatronics Source Book", N C Braga, Cengage Learning.

Title of the Course: Fault Diagnosis and Condition Monitoring Course Code: UMEPE0611	L	T	P	Credit
	03	-	-	03

Course Pre-Requisite: Basics of Mathematics, Physics, Analysis of Mechanical Elements, Dynamics of Machines, Mechanical Vibrations.

Course Description: In Industry, it is necessary to monitor the condition of equipments to avoid down time of machines and hence improve productivity of plant. There are many maintenance strategies in which condition monitoring using vibrations are most important. The subject contains basics of condition monitoring and various techniques used such as vibration analysis, motor signature analysis, NDT methods etc. The subject emphasizes on practical approach of condition monitoring.

Course Objectives:

1. To take overview of basic concepts of maintenance and condition monitoring.
2. To study vibration analysis of rotating elements for condition monitoring.
3. To acquaint students with the vibration measuring instruments and condition monitoring.
4. To apply various techniques of condition monitoring to engineering applications.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain fundamentals of maintenance strategies and condition monitoring.	II	Understanding
CO2	Identify fault and state condition of rotating equipment.	III	Applying
CO3	Analyze response of mechanical system and provide corrective action.	IV	Analyze
CO4	Develop condition monitoring system for given equipment.	V	Design

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2							2	2	2
CO2	3	2	2	1	2							2	2	2
CO3	3	2	2	1	1							2	2	1
CO4	3	2	2	1	1	2	1	1				3	2	1

1:low, 2:medium,3:high

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE1	10
MSE	30
ISE2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc. MSE: Assessment is based on 50% of course content (Normally first three Units) ESE: Assessment is based on 100% course content with 60-70%weightage for course content (normally last three units) covered after MSE.	
Course Contents:	
Unit1:CONDITION MONITORING TECHNIQUES Introduction to Maintenance Strategies, Condition monitoring, definition, Types of condition monitoring, advantages and limitations of different condition monitoring techniques like wear debris monitoring, oil monitoring, vibration monitoring, and thermography.	07 **Hrs.**
Unit 2:DATA ACQUISITION Introduction, collection of vibration signal, vibration transducers, characteristics and mountings, conversion of vibrations to electrical signal.	07 **Hrs.**
Unit 3:SIGNAL PROCESSING AND ITS APPLICATIONS Time and Frequency domain Signal analysis, Data Acquisition Systems and Filtering, Fourier Series and FFT, Instrumentation, Data Recording.	08 **Hrs.**
Unit 4:MACHINERY FAULT DIAGNOSIS USING VIBRATION ANALYSIS Unbalance, bent shaft, Eccentricity, Misalignment, looseness, Belt drive problems, gear defects, bearing defects.	07 **Hrs.**
Unit 5:- FAULT DETECTIONS IN ROTATING MACHINES Signal classification, signals generated by rotating machines and Case studies on such as Fans, Blowers, and Pumps.	08 **Hrs.**
Unit 6:-:- FAULT DETECTIONS IN RECIPROCATING MACHINES Signals generated by reciprocating machines time frequency diagrams, torsional vibrations and Case studies on such as IC Engines, automobiles.	08 **Hrs.**

Textbooks:

1. Machinery vibration Analysis & Predictive Maintenance by Paresh Girdhar, Elsevier publishers.

2. Mechanical Fault diagnosis and condition monitoring by R. A .Collacott.

3. Robert Bond Randall, Vibration-Based Condition Monitoring: Industrial, Aerospace and Automotive applications, 1st Edition, John Wiley & Sons Ltd., 2011

Reference Books:

1. Vibration monitoring and diagnosis by R. A. Collacott.

2. First course on condition monitoring in the process industries, by M.J.Neale, Nov 1979, Manchester.

3. Management of Industrial Maintenance by Newman-Butterworth, March 1978.

4. Condition Monitoring Manual by National Productivity council, New Delhi.

5.John S. Mitchell, Introduction to Machinery Analysis and Monitoring, 1st Edition, Penn Well Books,1993

6. R. C. Mishra, K. Pathak, Maintenance Engineering and Management, 1st Edition, Prentice Hall of India Pvt. Ltd., 2002.

7. Amiya Ranjan Mohanty, Machinery Condition Monitoring: Principles and Practices, 1st Edition, CRC press, 2014

Title of the Course: Metal Forming and Joining Technology **Course Code:** UMEPE0612	**L**	**T**	**P**	**Credit**
	3			**3**

Course Pre-Requisite: basic manufacturing processes.

Course Description: Metal forming techniques are use create different sheet metal product for engineering and residential applications. Theories of forming processes are good application of theory of plasticity like yielding criteria, application of two- and three-dimensional problem.

Course Objectives:

1. Gain the fundamental knowledge about metal forming and plastic tech. processes
2. Understand the analysis of flow of material and its properties during the processes
3. Selection the process of metal forming as per the applications such as wire drawing, extrusion, rolling forging etc.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Select process parameter of different metal forming and joining processes.	1	Remember
CO2	Explain various basic concepts of metal forming and joining processes	1	Remember
CO3	Discuss various operations in metal forming and joining processes	4	Analyze
CO4	Analyze various processes for specific manufacturing needs.	3	Apply

CO-PO Mapping:

	PO											**PSO**		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**
1	2	1	1	1	1	0	0	0	0	1	0	2	1	1
2	1	1	1	1	1	0	0	0	0	1	0	2	1	1
3	1	1	1	1	2	0	0	0	0	1	0	2	1	1
4	1	1	1	1	2	0	0	0	0	1	2	2	1	1

Indicate mapping strength as 3 (High), 2 (Medium), 1 (Low)

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Unit 1:--- Theory of Plasticity Flow curve, Concepts of true stress and true strain, plane stress condition , stress tensor, yield criteria and their comparison., plastic stress-strain relationships. Strain tensor, strain hardening. Strain rate, Friction and Lubrication in metal forming	6 **Hrs.**
Unit 2:- Introduction to Forging and rolling **Introduction to Forging** Basic operations, types of forging, forging hammers/ presses, forging stress and force calculations, die design considerations, forging defects, applications **Introduction to Rolling:** Classification of rolling processes, rolling mill types, deformation of metal in rolling, roll bite, elongation, reduction, defects in rolling, rolling of sheets, plates, bars, sections and tubes, application--	6 **Hrs.**
Unit 3:--- Introduction to Extrusion and Drawing **Introduction to Extrusion** Equipment and principles, types of extrusion, direct, indirect, impact, hydrostatic, tube extrusion, metal flow in extrusion, defects, factors affecting extrusion load, **Introduction to Drawing:** Types of Drawing, Rod/wire drawing, equipment and principles of process, defects, Tube drawing, Seamless pipe manufacturing	6 **Hrs.**
Unit 4:- **Fundamentals of Metal Joining Technologies:** mechanisms for obtaining metallic continuity, Fusion based processes: principle of fusion welding processes, oxy-fuel has welding, common arc welding processes, laser beam welding, spot welding processes, newer variants of fusion welding processes	7 **Hrs.**
Unit 5 :- **Solid-liquid joining processes**: brazing and soldering, braze welding, Solid state joining processes: diffusion bonding, ultrasonic welding, and explosive welding and Adhesive joining	7 **Hrs.**
Unit 6 :- **Metallurgical Aspects of Welding:** weld thermal cycle, basics of residual stresses, Common issues related with joining technologies their causes and remedies: hardening and softening of heat affected zone, porosity, cracking.	6 **Hrs.**

Textbooks:

1. Manufacturing Processes – Begman, Amstead etc.(John Wiley)
2. Rowe, Principles of Industrial Metal working Processes,
3. Forging and Forging Die Design - Sharan, Prasad, Saxena.
4. Rolling of Metals: Ivankove and Chaturvedi (Yantrik Publications, Mumbai)
5. Extrusion - Pearson (McGraw Hill)
6. Manufacturing Technology: Foundry, Forming and Welding by P.N. Rao (TMH)
7. Manufacturing Engineering Technology by Kalpakjian (Addison Wesley)
8. Manufacturing Processes for Engineering Materials by Kalpakjian (Addison Wesley)
9. Injection Mold Design, R.G.W. Pye 4/e, Affiliated East West Press Pvt. Ltd. New Delhi.

References:

1] ASM Handbook on Forming
2] Mechanical Metallurgy (S.I. Units) - Dieter, McGraw Hill
3] Plastics for Industrial Use- Sasse John

Unit Learning Outcome: Metal Forming and Joining Technology By the end of this unit, students should be able to: 1. Understand the Fundamentals of plasticity 2. Identify Different forging and rolling Processes: 3. Understand the Fundamentals of extrusion and drawing 4. Apply Knowledge of Equipment in Metal Joining: 5. Understand the Fundamentals solid liquid joining processes 6. Explore Advanced Joining Considerations

Title of the Course: Advanced Automobile Design	L	T	P	Credit
Course Code: UMEPE0613	3	-	-	3

Course Pre-Requisite: -- basics Knowledge of 'Fundamentals of Automobile Design (Ready Engineer Part -I)', CAD, General Design procedure is essential.

Course Description: The course covers some of the practical & real-world design aspects for automobiles, especially for body-in-white (i.e. structures) and trims (i.e. interiors). This is one of the unique and highly advanced courses prepared by over 20 senior experts of TATA TECHNOLOGIES, PUNE working on multiple national and international projects of whole-vehicle development. The course is intended to provide an edge to the engineering students seeking career in design domain.

Course Outcomes (CO):

CO1	**Understand** the fundamental concepts and terminology related to Body-in-White (BIW) and automotive plastic trims, including their identification, necessity, and product lifecycle.	**2**	**Understand**
CO2	**Apply** design principles and material selection criteria and **Recommend** appropriate material for BIW and Trims considering factors like cost, safety, weight, manufacturing methods, and vehicle regulations.	**3, 5**	**Apply Recommend**
CO3	**Understand** concepts of GD&T, joining techniques for sheet metal and plastic components, and relevant manufacturing processes for BIW and trims.	**2**	**Understand**
CO4	**Explain** the application of DFMEA and CAE tools for the design verification and analysis of BIW and plastic trim components, including crashworthiness and durability assessments, and understand the significance of physical testing and manufacturing sequences.	**2**	**Explain**

CO-PO* Mapping:

CO	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO-10	CO-11	PSO1	PSO2	PSO2
CO1		1				2					2	1		
CO2	2	1	3		3						1	1		1
CO3	2										2	1		
CO4	2	3	2	2	3	2					3	3	2	

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Unit 1: --- Requirement Specification in the Pre-Program Stage: a) Introduction to BIW. Identification of commodities for BIW: Closures, Body Shell. BIW terminology. BIW Assembly. b.) Introduction to Plastic trims. What is trim? Necessity of trim in automobile, Identification of various trim parts and their positions in vehicle. Various commodities of interior trim like Instrument panel, Centre console, Door trims, Pillar Trims, Seating Trims, Overhead Trims, Floor Carpets & Trunk trims. c) **Product life cycle and important gateways for BIW**: PLM: Introductions, Need, Benefits, Components/Elements. Phases of Product life cycle:	7 **Hrs.**
Unit 2: BIW and TRIM Design and Materials a) **Design concepts and considerations in BIW**: BIW parts: Sheet metal, Extrusion, Cast, Moulding. Factors driving BIW Design like Package Space, Master Sections, Cost, Weight, Assembly Process, Manufacturing Methods, Vehicle regulations. Design considerations for Sheet Metal Parts b) **BIW Materials and Grades** (Steel, Aluminium, composites): Basic material selection criteria for automotive: Emissions, Safety and weight, Material Choice which is driven by Cost, Safety, Risk, Weight, Market Image, Emission. Classification of steel grade and their properties. Use of aluminium in automotive domain and its properties. Use of Composites in automotive domain and its properties. Light weight material for future automotive industry. c) **Trim Materials in Automotive**: Material Classification and Properties, Plastic Material and their applications: Polypropylene, ABS, Polycarbonate, Polyoxymethylene, Polyethylene, Polyamides, Usage and Selection Criteria, Plastic Additives: Types of additives, Impact of additives, , Application in instrument Panel Assembly.	8 **Hrs.**
Unit 3: GD & T for BIW: **b)** Concept of GD & T, Importance of GD&T. BIW Dimensional Requirement. BIW Dimensional applications. GD&T Symbols. Illustration of Feature Control Frame. **a) Sheet Metal Joining Process:** Importance. Welding, Resistant Spot welding: Advantages, Disadvantages of RSW. Concept of Tailor Welded Blanks(TWB), Types of TWB. Laser Beam Welding (LBW): Types, Advantages, Disadvantages. Self Piercing Rivets (SPR) and its advantages. Adhesive Bonding: Types, Types of joints used in it. **c) Manufacturing Processes of plastic trim:** Vacuum Forming, Injection Molding, Heat Staking, Extrusion Blow molding along with their applications characteristics and limitations.	7 **Hrs.**
Unit 4: DFMEA & CAE **DFMEA** (Design Failure Mode and Effect Analysis): Concept, Objectives of DFMEA. Over view of DFMEA process, Benefits of DFMEA, Prerequisites of DFMEA, DFMEA Flow, DFMEA team, DFMEA inputs & Outputs, DFMEA Methodology, **Design of Plastic part:** Overview, Wall thickness, Radii, Draft angle, Ribs, Bosses, Snaps, **b)** Concept of CAE, Applications of CAE, Various CAE methods for Design	8 **Hrs.**

verification of BIW viz. Structural Analysis, Fatigue life Prediction, Noise and vibration, Crash Impact analysis, Multibody Dynamics, Thermal analysis, CFD. Verification and Validation with respect to FEA. Concept of FEA, Steps of FEA, meshing, Elements: Selection and its types.	
Unit 5: CAE ANALYSIS **a) CAE Analysis of BIW: -** Concept of Load Case, NVH Analysis: Load cases for NVH analysis: Static Bending stiffness, Static torsion stiffness, Natural frequency and normal modes, , CAE Crash Analysis: 1) Full vehicle level: Frontal, Side and rear Impact, 2) Component Level: Seating and roof crush., Durability analysis: Various load cases like Front and Rear Recovery analysis, Trailed towing analysis, Floor pan fatigue, Roof and Body side oil canning, Vehicle jacking analysis, Vehicle hoisting analysis, Fatigue analysis of BIW. **CAE Analysis OF Plastic Trims:.** Types of CAE Analysis: Head Impact Analysis, Side Impact Analysis, Knee Impact Analysis, Durability Analysis, Creep Analysis, Moldflow Analysis. Applications of CAE Analysis**.** CAE Load cases for Interior Trims: Airbag deployment, Side occupant protection, Interior trims durability, Mold flow analysis. Gateway support.	8 **Hrs.**
Unit 6:- Test Validation & Assessment **:** Crashworthiness, Head Injury Criteria, Vehicle physical testing, Need of vehicle testing, Crash test requirements, Introduction to dummies, Importance of Dummies, Types of dummies. Frontal Crash test, Rear and side impact testing, Pedestrian head impact test, roll over test. Four post durability test. Wind tunnel testing. Automotive safety considering plastic components, **Manufacturing -** Sequence (after validation):, Welding & Assembly: Body shop, Paint Shop, Trim- chassis.	7 **Hrs.**

Textbooks:

1. Morello, L., Rosti Rossini, L., Pia, G., &Tonoli, A. (2010). *The Automotive Body: Volume I: Components Design (Mechanical Engineering Series)*. Retrieved from http://www.springer.com/1161---A2
2. Huang, M. (2002). *Vehicle crash mechanics*. CRC Press.-A2
3. Failure Mode and Effect Analysis: FMEA from Theory to Execution, D. H. Stamatis, ASQ Quality Press, 2003, 0873895983, 9780873895989.
4. IGETIT PORTAL OF TATA TECHNOLOGIES.

REFERENCE BOOKS:

1. Boljanovic, V. (2004). *SHEET METAL FORMING PROCESSES AND DIE DESIGN*. A1 and A2
2. Weber, J. (2009). *Automotive development processes: Processes for successful customer oriented vehicle development*. *Automotive Development Processes: Processes for Successful Customer Oriented Vehicle Development*. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-01253-2--A2
3. *An Introduction to Modern Vehicle Design*. Edited by Julian Happian-Smith,© Reed Educational and Professional Publishing Ltd 2002—A2
4. *Automotive Product Development*. A Systems Engineering Implementation, by Vivek D.

Bhise,© 2017 by Taylor & Francis Group, LLC CRC Press is an imprint of Taylor & Francis Group, an Informa business.—A2

5. Design and Manufacture of Plastic Components for Multifunctionality. (2016). In *Design and Manufacture of Plastic Components for Multifunctionality*. https://doi.org/10.1016/c2014-0-00223-7-A2
6. Effective FMEAs: Achieving Safe, Reliable, and Economical Products and Processes using Failure Mode and Effects Analysis, Carl Carlson, ISBN: 978-1-118-00743-3 June 2012.
7. Schwartz & Goodman "Plastic materials and Processing"
8. Irwin Rubin, "Handbook of plastic materials and technology"
9. Fred W. Billmeyer, "Textbook of Polymer Sciences".

Mr. S B Sangale

Course Co-ordinator

Title of the Course: INTRODUCTION TO COMPUTATIONALFLUIDDYNAMICS(CFD) CourseCode:UMEPE0614	L	T	P	C
	3	-	-	3

Course Pre-Requisite: Fluid Mechanics, Heat Transfer, Numerical Analysis.

Course Description:

Computationalfluiddynamics(**CFD**) isa branchoffluid mechanicsthatusesnumerical analysis and data structures to solve and analyze problems that involve fluid flows.

Computersareusedto performthecalculationsrequiredto simulatethe interactionofliquids and gases with surfaces defined by boundary conditions which solve the problem and produce simulated results.

Course Objectives:

- To provide students with a fundamental understanding of the principles of CFD.
- To familiarize students with different numerical methods used in CFD.
- To introduce students to the process of grid generation.
- To provide students with practical experience in using commercial CFD software.
- To enable students to interpret and analyze CFD results.

Course Learning Outcomes:

CO	After the completion of the course the student should be ableto	Bloom's Cognitive level	Descriptor
CO1	Understand the basic fundamental of the principles of CFD.	2	Understand
CO2	Implement the different numerical methods used in CFD.	2	Apply
CO3	Apply governing equations for fluid flow and Generate appropriate computational grids for numerical solutions.	3	Apply
CO4	Application of CFD software and evaluation of CFD results by comparing with available data, and evaluate the findings.	5	Evaluate

CO-PO, PSO Mapping

CO - PO Mapping														
Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	0	0	0	0	0	0	1	0	1	1	0	0	0
CO2	3	2	0	0	0	0	0	1	0	0	2	0	0	2
CO3	0	2	0	3	3	0	0	1	0	0	1	1	1	0
CO4	0	0	3	2	0	0	0	1	0	0	1	1	0	0

Assessments: TeacherAssessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE1and ISE2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

UNIT1: **Introduction to Computational Fluid Dynamics:** General introduction: Historical background and spectrum of application. History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering	07 **Hrs.**
UNIT2: **Fundamental Differential Equation:** Classification of Partial Differential Equations (PDEs): Elliptic, Parabolic, Hyperbolic. Relevance to Fluid Flow Problems. Boundary Conditions and Physical Interpretation of Boundary Conditions. **Fundamentals of Discretization:** Pre-processing, Solution, Post-processing,Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions.	08 **Hrs.**
UNIT3:Grid Generation • Importance of Grid Generation in CFD. • Structured vs. Unstructured Grids: Advantages and Disadvantages. • Grid Quality Metrics: Aspect Ratio, Skewness, Orthogonality. • Grid Generation Techniques: Algebraic Grid Generation, Elliptic Grid Generation. • Boundary Layer Meshing: Importance of Near-Wall Resolution. • Adaptive Grid Refinement (Introduction). • Common Grid Formats.	07 **Hrs.**
UNIT 4: Solution Methods for Algebraic Equations • Discretization leading to system of algebraic equations. • Direct Methods: Gaussian Elimination, LU Decomposition. • Iterative Methods: Jacobi, Gauss-Seidel, Successive Over-Relaxation (SOR). • Convergence Criteria. • Choice of Solver: Factors Affecting Solver Selection. • Pressure-Velocity Coupling: SIMPLE, SIMPLER, SIMPLEC Algorithms. • Solution of Transient Problems: Implicit and Explicit Methods. Stability Considerations.	07**Hrs.**
UNIT5:Turbulence Modeling • Introduction to Turbulence: Characteristics of Turbulent Flow. • Reynolds-Averaged Navier-Stokes (RANS) Equations. • Turbulence Models: o Zero-Equation Models, One-Equation Models and Two-Equation Models (k-epsilon, k-omega).	08 **Hrs.**

• Limitations of RANS Models. • Large Eddy Simulation (LES) • Direct Numerical Simulation (DNS)	
UNIT6: **Introduction to CFD Software and Applications** • Overview of Commercial CFD Software Packages (e.g., ANSYS Fluent). • Pre-processing: Geometry Creation, Mesh Generation using CFD software. • Setting up the Problem: Choosing appropriate solver, boundary conditions, material properties. • Running the Simulation: Monitoring convergence. • Post-processing: Visualization of Results (Contour Plots, Vector Plots, Streamlines). • Validation and Verification: Comparison with Experimental Data or Analytical Solutions. Applications of CFD:External Aerodynamics, Internal Flows (Flow in Pipes, Heat Exchangers), Heat Transfer (Conduction, Convection, Radiation), Combustion.	08**Hrs.**

Textbooks:

1. H. K.Versteeg & W.Malalasekera, An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical.
2. John D. Anderson Jr., Computational Fluid Dynamics, McGraw Hill Book Company.
3. J. Blazek, Computational Fluid Dynamics: Principles and Applications, Esevier.
4. Introduction to Computational Fluid Dynamics: The Finite Volume *Method* by H. Versteeg and W. Malalasekera

Reference Books:

1. T.J.Chung,ComputationalFluidDynamics,CambridgeUniversityPress.
2. J.H.FerzigerandM.Peric,ComputationalMethodsforFluidDynamics,Springer.
3. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis.
4. User Manuals and Tutorials for the chosen CFD software package.

Title of the Course: Business Communication and Value Science Course Code: UMEAE0604	L	T	P	Credit
	0	0	2	1

Course Pre-Requisite: 1. Awareness of common words used in daily verbal communication.
2. Basic idea of sentence formation and there by paragraph building and writing.
3. Awareness of basic communication channels and active and passive listening skills.
4. Awareness of basic social etiquettes and knowledge of group work and communication.
5. Basic idea of like skills and value system

Course Description: Being a practice – oriented course, this course focuses on Practicing various skills of communication and Life Skills.

Course Objectives:

1. To demonstrate the importance of various modes of communication and their applications in business.
2. To Improve modes of expression in written and oral communication.
3. To understand what Life skills are and their importance in leading a happy life.
4. To introduce them to key concepts of values, life skills.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptorc oi4
CO1	To Understand the importance of (Written business communication) Basic tenets of Business communication.	I	Understand
CO2	To Apply the basic communication in different types of business communication.	III	Apply
CO3	To Recognise the need for value system.	I	Understand
CO4	To Recognise the need for life skills.	I	Understand

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1							3	2	3		1			
CO2							3	2	3		1			
CO3							3	3	2		1			
CO4							3	3	2					

Assessments :
Teacher Assessment:

Assessment	Marks
ISE	50

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

Practical No.: 1 Overview of business communication significance of business communication	**2 Hrs.**

Practical No. 2: Introduction to essentials of business communication. **a) Formal and informal communication** **b) Downward upward lateral and diagonal communication**	**2Hrs.**
Practical No.3: Basics to effective communication interactive and non interactive techniques of communication.	**2Hrs.**
Practical No.4: Effective Writing Guidelines for ideas writing, References, Bibliographical research tools, use of Library and interact for collection, classification and interpretation of data and transformation.	**2Hrs.**
Practical No. 5: Business correspondence – Need and importance of business letters, office memorandum, office circulars, notices and orders.	**2 Hrs.**
Practical No.6: Technology for communication – effective IT communication tools, Conducting Self introduction.	**2Hrs.**
Practical No. 7: Spoken English – Effective Negotiation, elements, Process, general guidelines conducting and group discussion	**2Hrs.**
Practical No. 8: Oral Presentation- Making a presentation **- Content and organising features of a good presentation** **- Delivering a presentation**	**2Hrs.**
Practical No. 9: Understanding life Skills – Need for life skills and Values. Importance of critical life skills	**2Hrs.**
Practical No. 10: Values – Sadachar. **Self confidence, achievement orientation dealing with ambiguity, team work**	**2 Hrs.**
Practical No. 11: Self Exploration – SWOT Analysis and Goal setting	**2 Hrs.**
Practical No. 12:Realities of Facing life – Stress Management, Working with rhythm and balance, Embarking diversity, Motivation – Self Motivation	**2 Hrs.**
Practical No. 13: Presentation on **Case study : Business Leaders** **Social Reformers**	**2 Hrs.**

Textbooks /References:

1. Effective Technical Communication – by Rizvi and Ashraf, Mc Graw – Hill, India 2017
2. Business Communication – by K.K. Siaha, Galgetia publishing company India
3. Business Correspondence and Report Writing – by R.C. Sharma and Krishna Mohan Mc Graw – Hill, India
4. Business Communication – by Asha Kaur, Prentice Hall of India
5. Managerial Communication – by P.D. Chaturvedi and Mukesh Chaturvedi, Pearson Publication, India
6. "The Professional", Subroto Bagchi, 1st edition, Penguin Publishers
7. Business Communication: Building Critical Skills – by Locker, Kitty O., and Stephen Kyo Kaczmarek Mc Graw – Hill, India
8. Soft Skills – by Dr. Alex, Chand Publications India
9. Seven Habits of highly effective people – by Stefan convey
10. Emotional Intelligence – by Dianel Goleman, Harvard Business Review Press.
11. Law of Success – by Napoleon Hill
12. Think and Grow Rich – by Napoleon Hill
13. How to Stop Worrying and Start Living – by Dale Carnegie
14. Critical Thinking – by Bruce Walker
15. Focus – the hidden drives of Excellence - by Dianel Goleman

Experiment wise Measurable students Learning Outcomes:

1. Students should be able to Understand Basic Communication skill used in industry and Importance of Life science.
2. Students will gain knowledge of the different Communication modes which are commonly employed in the industry and will be Prepare for future leaders
3. Upon completion of this laboratory course students will be able to communicate effectively, with different modes of communication.
4. Student will be able to Improve decision-making, Enhance personal growth, Better relationships, implement more ethical policies

Title of the Course: Power Plant Engineering Lab Course Code:UMEPC0631	L 0	T 0	P 2	Credit 1	

Course Pre-Requisite: Basic Mechanical Engineering ,Applied Thermodynamic, Heat Mass Transfer.

Course Description:
This course deals with demonstration of different engine components and systems and conduct of various experiments on engine performance in terms of power, energy utilization and exhaust emissions, its relation to internal processes like combustion and gas exchange at varying engine operating conditions.

Course Objectives:
1. To demonstrate the basic engine components and systems.
2. To train the students to measure different engine performances and apply the knowledge to solve real life problems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Explain various system used in power plants.	II	Understanding
CO2	Analyze performance parameters of I. C. Engine.	IV	Analyzing
CO3	Measure the performance parameters of I. C. Engine.	V	Evaluating

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2													
CO2	2											2		
CO3	3	3			2							2		

Assessments :

Teacher Assessment:
One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

Assessment	Marks
ISE	25
ESE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

Course Contents:		
Experiment No. 1:--- Study and demonstration of different types of power plants.	2 **Hrs.**	CO1
Experiment No. 2 Study and Demonstration of components of I. C. Engine.	2 Hrs	CO1
Experiment No. 3:--- Study and Demonstration of Engine systems: Air intake, Exhaust, Cooling, Lubrication systems.	2 **Hrs.**	CO1
Experiment No. 4:--- Study and Demonstration of fuel supply system in S.I. and C.I. engine.	2 **Hrs.**	CO1
Experiment No. 5:--- Study and Demonstration of Ignition system and starting system	2 **Hrs.**	CO1
Experiment No. 6:--- Heat Balance sheet on Petrol/Diesel engine.	2 **Hrs.**	CO3
Experiment No. 7:--- Morse test on Petrol/Diesel engine	2 **Hrs.**	CO3
Experiment No. 8:--- Variable speed test on Petrol/Diesel engine	2 **Hrs.**	CO3
Experiment No. 9:--- Test on computerized Variable compression Ratio Engine.	2 **Hrs.**	CO2
Experiment No. 10:--- Industrial visit to engine manufacturing company	2 **Hrs.**	CO1
Text books: 1. A Course in Power Plant Engineering, S.C. Arora and S. Domkundwar, Dhanpat Rai, 1988 2. "Internal Combustion Engines", V. Ganesan, Tata McGraw Hill Publication. 3. "Internal Combustion Engines" Mathur and Sharma, Dhanpat Rai Publication , Delhi. 4. A Text Book of Power Plant Engineering, R. K. Rajput, Laxmi Publications, New Delhi.		
Reference Books: 1."Internal Combustion Engines", J. B. Heywood,Tata McGraw Hill Publication . 2. "Internal Combustion Engines",Maleev, CBS Publication and Distributors. 3."Internal Combustion Engines",Gills and Smith , Oxford and IBH Publishing Company. 4. "Internal Combustion Engines Fundamentals", E. F. Obert, Harper and Row Publication , New York. 5. Renewable Energy Resources, John Twidell & Anthony D. Weir, 2nd Edition, Taylor & Francis, 2006 6. Power Plant Engineering, P.K.Nag, 2nd Edition, Tata McGraw-Hill Education, 2002		

Title of the Course: FINITE ELEMENT ANALYSIS LAB. Course Code: UMEPC0632	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite:

1. Stiffness of spring
2. Material properties
3. Creation of nodes, elements
4. Global stiffness matrix

Course Description:

The course aims at solving the structural and thermal problems by FEA by hand calculations as well as by using Software.

Course Objectives:

1. To provide the students the methodology of solving FEA problems by using hand Calculations
2. To train students in using the FEA software for solving FEA problems

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Understand structural and thermal problems by hand calculations as well as by using softwares	2	Understand
CO2	Analyze structural and thermal problems using FEA software	3	Apply

CO-PO Mapping:

UM - FEA: CO - PO Mapping														
Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3											2		
CO2	2	2		3									2	2

1:low, 2:medium, 3: high

Assessments :

Teacher Assessment:

One component of In Semester Evaluation (ISE)

Assessment	Marks
ISE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/Internal oral etc

Course Contents:

Unit 1:--- 1-D Element Problems –Linear Static Analysis	**2 Hrs.**
Unit 2:--- 2-D Element Problems – Linear Static Analysis	**2 Hrs.**
Unit 3:--- 3-D Element Problems – Linear Static Analysis	**2Hrs**
Unit 4:--- Non-Linear Analysis of 1-D Element Problems Like Beams, Bars	**2Hrs**
Unit 5:--- 1-D Element Problems-Steady state And Transient Analysis	**2Hrs**
Unit 6: -- 2-D Element Problems of Homogeneous and Composite Slap in Steady State and Transient Analysis	**2Hrs**
Unit 7: -- 3-D Element Problems Steady State Analysis	**2Hrs**
Unit 8: -- Project-Creating or Importing and Map Meshing of 3-D component /Assembly of practical application and FEA Analysis of Same component /Assembly	**2Hrs**
Note- • Minimum two problems shall be solved with hand calculations. •Term work shall be assessed on the basis of completion of above assignments and submission of reports. •At least one programming assignment shall be completed based on Finite Element Analysis.	

Text books:

1. Finite Element Analysis using Ansys 11.0 by Paleti Shrinivas,Krisha Chaitnay Sambana, Rajesh Kuma Datti.
2. Finite Element Analysis Theory and Applications with ANSYS by Saeed Moaveni
3. Engineering Analysis with ANSYS Software by Y. Nakasone and S. Yoshimoto
4. The finite element method And applications in Engineering using Ansys® byErdogan Madenci, Ibrahim Guven
5. Practical Finite Element Analysis by NitinGokhale of M/S Finite to Infinite.
6. Reference Manual of Hypermesh Software
7. Online Tutorial HyperMesh Software.
8. Tutorial of Ansys Software.

Title of the Course: Mechatronics Laboratory Course Code: UMEPC0633	L	T	P	Credit
	-	-	2	1

Course Pre-Requisite: Knowledge of basic Electronics and Electrical Engineering, Sensor and Actuator lab.

Course Description: Studying the mechatronics course is of importance due to the global demand and developments in Mechatronic systems and automated manufacturing planning and controlling activities etc. The mechanical systems are becoming smart and for designing and developing such smart systems students of mechanical engineering must understand basic elements of smart systems such as sensors, signal conditioning devices, microcontrollers, digital logic and programs for automating the processes.

Course Learning Objectives:

CLO1: To provide graduates of mechanical engineering with fundamental skills in the field of mechatronics for advanced graduate studies in the area of Mechatronics, Manufacturing engineering, and related field

CLO2: To stimulate students for developing simple mechatronics applications.

CLO3: To introduce graduates of mechanical engineering with working principles and functioning of basic components, inputs, outputs and programming languages used in mechatronic systems.

Course Learning Outcomes:

CO	After successful completion of the course the student should beable to	Bloom's Cognitive level	Descriptor
CO1	**Make use of** Microcontrollers to **demonstrate** applications of mechatronics systems.	III	Application
CO2	**Solve** scenarios of automating the processes by **performing** PLC programming.	III	Application
CO3	**Develop** a small application of the Mechatronic system.	VI	Create

CO-PO,PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1		1						1	1		1
CO2	2	2	2		2						1	3	2	1
CO3	2	3	3	1	2		1	3	2	2	1	3	3	2

1:Low 2:Medium 3: High

Assessments:

Teacher Assessment:

One component of In Semester Evaluation (ISE)

Components	Marks
ISE	25
ESE(POE)	25

ISE is based on laboratory performance and journals.

Minimum 08 experiments to be performed and included in the journal.

ESE is based on a practical examination followed by an oral examination.

Course Contents:	Hours
Experiment No.1 -- Study Invering OPAMP	**02**
Experiment No.2 -- Study Non-Invering OPAMP	**02**
Experiment No.3: --- Addition and Subtraction of 8-bit numbers using microcontroller 8051	**02**
Experiment No. 4: --- LED interfacing with Arduino	**02**

Experiment No. 5: --- Digital Sensor interfacing with Arduino	**02**
Experiment No. 6: --- Analogue Devices interfacing with Arduino.	**02**
Experiment No. 7: --- PLC programming for demonstrating applications of Logic gates.	**02**
Experiment No. 8: --- Applications based on timers using PLC ladder programming.	**02**
Experiment No. 9: --- Applications based on counters using PLC ladder programming.	**02**
Experiment No. 10: --- Demonstration of Piece counting using rotary indexing mechanism	**02**
Experiment No. 11: ---Demonstration of temperature and flow sensor	**02**
Experiment No. 12: --- Fabrication of Simple Mechatronics working project by a group of 4/5 students using hardware like sensors, signal conditioning, actuators, and suitable software.	**02**

Textbooks:

1. "Mechatronics",W. Bolton, Pearson Education , 4th Edition,
2. "Mechatronics",Mahalik, TATA McGraw Hill, (2006) Reprint,
3. "Microprocessor 8085", Gaokar Prentice Hall of India, 5th Edition.
4. "The 8051 Microcontroller -A System Approach", by Muhammad A. Mazidi, 1st Ed., PH
5. "Programmable Logical Controller", Hackworth, Pearson Education, (2008).
6. "Programmable Logical Controller", Reis Webb, Prentice Hall of India 5th Edition.

Reference Books:

1. "Mechatronics", AppuKuttam, Oxford Publications, 1stEdition.
2. "Automated Manufacturing Systems",S. Brain Morris, Tata McGrawHill.
3. "Mechatronics and Microprocessor", Ramchandran, Willey India,(2009).
4. "Mechatronics: Integrated Mechanical Electronic System", Ramchandran, Willey India,1st Edition.
5. "Programmable Logical Controller",Gary Dunning Cengage Learning, 3rdEdition.s

Title of the Course: CAD/CAM/CAE Laboratory Course Code: UMEIL1071	L 0	T 0	P 2	Credit 1

Course Pre-Requisite: Knowledge of Machine drawing, isometric & orthographic projection and CNC machines is essential.

Course Description: Under this course the student will be introduced to the principles of parametric design using computer aided design software. Students will construct 3 models and surfaces. Topics will include sketching, constraining, solid modeling, surface modeling, Drafting and Assembly modeling and kinematics, Students will also learn Manual part programming and CAM.

Course Objectives:

1. To Construct 3D solid Models of parts using CAD software and measure its physical properties.
2. To Construct surface models of parts using CAD software
3. To build 3D assemblies using CAD software taking into consideration appropriate assembly approach
4. To Build 2D projections from 3D models and assemblies
5. To Develop the CNC part program by using manual programming and CAM software.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Construct 3D solid and surface Models of parts using CAD software and measure its physical properties.	3	Construct
CO2	Build 3D assemblies with appropriate assembly approach and 2D projections using CAD software.	3	Build
CO3	Develop the CNC manual part program for 2D Profile and understand concepts of CAE.	3,2	Develop Understand

CO-PO Mapping:

CO	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10	CO11	PS01	PS02	PS03
CO1	1		2	1	2						1	2		
CO2	1		1	1	1						1	2		
CO3	1		1		3						1	2		

Assessments :

Teacher Assessment:

Assessment	Marks
ISE	25

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

1: Introduction to CAD: Need for implementing CAD, Application and benefits of CAD, Hardware Requirements, Different Software packages used for 3D	2 **Hrs.**

Modeling.	
2: Sketching & Solid Modeling: 2D sketching of elements like line, circle, arc, spline etc. Dimensioning these elements, Geometrical constraints **Solid Modeling:** Concept of Feature based and parametric modeling Basic and advanced modeling features. Import and export of 3D solid models between two different software packages. Physical properties like volume, surface area, center of gravity etc of solid model.	8 **Hrs.**
3: Basic Surface Modeling: Concept of surface modeling. Basic modeling features. **Assembly Modeling**: Concept of Bottom up and top down approach, Building two composite assemblies of components (consisting at least five components) along with all relevant details, Exploded Views using assembly features in any suitable 3D modeling software.	**8 Hrs**
4: Generation of 2D Drawings: Generation of Orthographic views of individual components required for shop floor [working drawings] from 3D model which will include all relevant views like front, side, top, bottom views, sectional views, dimensioning, dimensional and geometrical tolerances etc. Generation of title block in sheet. Orthographic views of assembly drawings, generation of Bill of Materials (BOM). Plotting of drawings.	2 **Hrs.**
5. Computer Aided Manufacturing: **a) Part Programming:** Introduction to manual part programming, use of G and M codes to generate manual part program, Introduction to data exchange formats, Demonstration of integration of CAD/CAM software to generate tool path using suitable software. b) Introduction to CAE, Applications.	4 **Hrs.**

Text Books:

1) “CAD/CAM- Principals and Applications”, P.N. Rao, Tata McGraw Hill, 2nd Edition.
2. “CAD/CAM/CAE”,N.K. Chougule, SciTech Publication, Revised Edition.
3. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2007 4. Radhakrishnan P, SubramanyanS.andRaju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi,2000.

Reference books:

1. Various 3D modeling Software Manuals.
2. CNC Programming manual.
3. “Machine Drawing”, N. D. Bhatt and V.M. Panchal, Charoter Publications
4. “Mastering CAD CAM”,Ibrahim Zeid, Tata McGraw-Hill, Special Indian Edition, (2007).
5. “Machine Drawing”, N. Siddheshwar, P. Kannaiah, V V S Sastry, Tata McGraw Hill Publications, 2nd Edition.
6. “CAM/CAM – Theory and Practice”,Ibrahim Zeid, R. Sivasubramaniam, Tata McGraw Hill,2nd Edition.
7. “CAD/CAM – Concepts and applications”, Chennakesava R. Alavala – Prentice Hall of India

Class: T. Y. B. Tech Mechanical Engineering	**L**	**T**	**P**	**Credits**
Title of the Course: Co -Curricular Activities-III **Course Code.: UMECC0634**	---	---	02 hours per week	01

Course Pre-Requisite:

None: This course is open to all second-year engineering students interested in enhancing their personal and professional development through co-curricular activities.

Course Description:

Co-Curricular activities are an integral part of curriculum which provides educational activities to the students and thereby help in broadening their experiences. Co-Curricular activities can be defined as the activities that enhance and enrich the regular curriculum during the normal college hours. All CoCurricular activities are organized with specific purpose which may according to the nature and form of activities. This course introduces students to a variety of co-curricular activities aimed at enhancing their professional and personal development within the field of engineering and technology. Through practical projects, competitions, workshops, and community engagement, students will develop teamwork, leadership, communication, and technical skills essential for success in their careers.

Course Learning Objectives (CLOs):

1. To encourage students to showcase their intellectual and independent thinking skills.
2. To imbibe a sense of confidence and managerial capabilities among students.
3. To promote the ability to work in team, organize and analyse available resources.
4. To build responsiveness among students about the social and cultural responsibilities.

Course Outcomes (COs):

At the end of the course students will be able to:

CO	After the completion of this course the student will be able to	Bloom's Cognitive	
		Level	Descriptor
CO1:	**Demonstrate** the ability to critically analyse information and apply independent judgment in decision-making within the context of the activity.	II	Understanding
CO2:	**Apply** principles of management and organizational skills to plan, coordinate, and execute tasks related to the co-curricular activity.	III	Applying
CO3:	**Collaborate** effectively with peers to achieve common goals and objectives within the co-curricular activity.	III	Applying
CO4:	**Reflect** on their roles and responsibilities as members of a diverse community, fostering empathy and inclusivity.	IV	Analyzing

Assessments:

Assessment	**Weightage (Marks)**
ISE	50

ISE: Assessment is based on the student's participation in various Co-Curricular Activities and Guidelines given in "Rules for Assigning Activity Points: Activity – Event Grade Point Scheme" Policy Document.

Course Guidelines:

2. Students are entitled to gain academic knowledge in this fast-paced environment, but it is also necessary for them to develop their personalities in both internal and external situations.
3. Co-curricular activities help students grow and develop their personalities. These activities contribute to a student's total personality development.
4. Not every student is intellectually inclined. Similarly, not all pupils are interested in co-curricular activities. Therefore, there is a need to provide a solid balance of co-curricular and extra-curricular activities in order to achieve the course learning objectives.
5. It primarily refers to intellectual, physical, emotional, and social growth that can be attained by a careful mix of academic, co-curricular, and extra-curricular activities.
6. So, keeping the course learning objectives the "Rules for Assigning Activity Points: Activity – Event Grade Point Scheme" Policy Document is proposed.

6. Student participation is assessed and reflected in the final activity performance report in order to get most students involved in extra-curricular activities (Group A) and co-curricular activities (Group B) as shown in Table 1 in the Policy Document.
7. All undergraduate students must choose at least ONE activity/event from each group i.e. (Group A and B).
8. Students shall choose one activity/ event from Group A and One from Group B that take place oncampus or off-campus.
9. Freedom shall be given to the students to take part in more than one activity under the group.
10. Students are expected to actively participate in activities, participate in contests, and earn grade points.
11. One student in each group must earn up to 50 grades in one semester so that they can achieve up to 100 grades in one year.
12. Grades for each semester are awarded based on the points achieved by the student, as shown in Table 2 in the Policy Document.

Course Structure: ***(Refer Rules for Assigning Activity Points: Activity – Event Grade Point Scheme)***

Sr. No.	Initiatives	Criteria, Activities and Assignments
1	Introduction to Co-Curricular Activities	Orientation, Induction, Course Overview
2	National Initiatives Participation	Participation, Achievement Levels and Assigned Activity Points in NCC, NSS, Unnat Bharat/ Unnat Maharashtra Abhiyan, Ek Bharat Shreshtha Bharat (EBSB)
3	Sports and Games Participation	Participation, Achievement Levels and Assigned Activity Points in Sports and Games
4	Cultural Activities Participation	Participation, Achievement Levels and Assigned Activity Points in Music, Performing Arts, Literary Arts

Sr. No.	Initiatives	Criteria, Activities and Assignments
5	Professional Self Initiatives	Participation, Achievement Levels and Assigned Activity Points in 1.Technical Events/Quiz/Paper Contest/Project Contest / Model Making etc. 2. MOOC/ NPTEL/ SWAYAM/ Coursera etc. 3. Competitions/ Events Conducted by Professional Societies (ISTE, IEI, CSI, IEEE, IETE, SAE, ISRO-IIRS, SWE, ISHRAE, ASM, ISNT etc.) 4. Attending Full time Conference/ Seminars/ Exhibitions/ Workshop/ STTP Conducted at IITs/ NITs/ Reputed Institutes/ Universities 5. Attending Full time Conference/ Seminars/ Exhibitions/ Workshop/ STTP Conducted at KITCoEK 6. Paper Presentation in National/ International Conference of High Repute 7. Poster Presentation in National/ International Conference of High Repute 8. Paper Publication in National/ International Journal of High Repute 9. Industrial Training/ Internship (at least for 04 Weeks) 10. Participation in Institute Level Student Clubs
6	Entrepreneurship and Innovation	Participation, Achievement Levels and Assigned Activity Points in 1. Prototype Developed and Tested 2. Awards for Products Developed 3. Innovative Technologies Developed and Used by Industries 4. Got Funding from Government/ Industry for Innovative Ideas 5. Patent-Filed/ Published/ Approved/ Licensed 6. Social Innovations

Sr. No.	Initiatives	Criteria, Activities and Assignments
7	Leadership & Management of Clubs/ Activities	Participation, Achievement Levels and Assigned Activity Points in 1. Elected Student Representative of Student Council (University Representative, General Secretary, Cultural, Sports, NSS Secretary, Ladies Representative, Academic Toppers, Invitee Members) 2. Office Bearer of Professional Society Chapter (ISTE, IEI, CSI, IEEE, IETE, SAE, ISRO-IIRS, SWE, ISHRAE, ASM, ISNT etc.) 3. Office Bearer of Institute Level Student Club (Developer Student Club, Gaganvedhi, Walk With World, Team Mavericks, Cultural Club, Aura, Amateur Write Club, Rotaract Club of KIT Sunshine, Women Development and Gender Equality Cell, Shourya, Lead India etc.) 4. Office Bearer of Departmental Student Association 5. Office Bearer of ECell, Digital Content Lab etc. 6. Student Ambassador for Mayura AICTE IDEA Lab/ NIDHI iTBI etc. 7. Editorial Board Member of Annual Magazine 8. Editorial Board Member of E-Newsletter 9. Member of Governance Committee/ Statutory Committee
8	Culminating Event and Reflection	Final Presentations, Course Reflection, Documentation, Assessment and Evaluation

Participation Levels:

1. Level: I College Level Events
2. Level: II District/ Central/ Zonal Level Events
3. Level: III State Level Events
4. Level: IV National Level Events
5. Level: V International Level Events

Approval Documents:

1. Certificate
2. Letter from Authorities
3. Appreciation recognition letter
4. Documentary evidence
5. Legal Proof

Grading Scheme:

Grade Range	Grade	Academic Performance
90-100	O	Outstanding
71 to 90	A+	Excellent
68-71	A	Very Good
65-68	B+	Good
60-65	B	Average
55-60	C	Below Average
50-55	D	Marginal
< 50	F1	Fail due to Poor Performance

j

Title of the Course: Data Visualization and Analysis **Course Code:** UMEMM0641	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	3

Course Pre-Requisite: Statistics and Fundamentals of Python

Course Description: This course gives knowledge on basics of statistical analysis of data. Also provides the insights of data behavior and its properties through graph visuals.

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	Understand basics of data analytical concepts	II	Understand
CO2	Analyze the data using statistical tools on raw data	III	Analyze
CO3	Apply the data transformation methods to generate synthetic data	IV	Apply
CO4	Evaluate the model using transformed data	V	Evaluate

CO-PO Mapping:

CO	**PO1**	**PO 2**	**PO 3**	**PO4**	**PO5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO1 1**	**PO12**	**PSO1**	**PSO2**	**Pso3**
CO1	1	1										1			1
CO2	1	1										2			1
CO3	1	1			1							1			1
CO4	1	1									1	1			1

Assessments:

Teacher Assessment:

One End Semester Examination (ESE) having 100% weightage.

Assessment	Marks
ESE	100

ESE: Assessment is based on 100% course content.

Course Contents:

Unit 1: Understanding Data Science	**07 Hrs.**

Definition of data science and data analytics, Data Analytics Cycle: steps in EDA, Making sense of data: Numerical Data, Categorical Data and Measurement of Data, Getting Started with data analysis libraries: Numpy, Pandas, Scipy and Matplotlib.

Unit 2: Data Visualization	**08 Hrs.**

Data Visualization Tools : **Matplotlib**: Line Chart, Bar Chart, Scatter Chart, Area Chart, Pie Chart, Table Chart, Histogram.
Seaborn: Visualizing distributions of data, Visualizing statistical relationships

Unit 3:Data Transformation	**08 Hrs.**

Data Cleansing, loading CSV file, applying descriptive statistics, data refactoring, dropping columns, replacing values, handling missing values, renaming axis indices, discretization and binning, outlier detection and filtering, Permutation and Random Sampling.

Unit 4: Descriptive Data Analysis	**08 Hrs.**

Understanding statistics: Distributive function, descriptive statistics, Measure of Central Tenancy, Measures of Dispersion.

Grouping dataset and correlation: groupby mechanics, data aggregation, pivot tables, correlation definition , types of correlation analysis, case study of multivariate analysis using titanic dataset

Unit 5:Time Series Analysis	**07 Hrs.**

Understanding the time series dataset, data cleaning, time based indexing, visualizing time series, grouping and resampling time series data, time series forecasting and its methods, case studies of weather forecasting.

Unit 6:Model Development and Evaluation	**07 Hrs.**

Hypothesis Testing, Understanding regression, model evaluation, understanding supervised learning, unsupervised learning and reinforcement learning, understanding machine learning workflow.

Textbooks:
1. “Hands on Exploratory Data Analysis with Python” by Suresh Kumar Mukhiya and Usman Ahmed,2020 Packt Publication.
Reference books:
1. “Python: Data Analytics and Visualization”, by Phuong Vo.T. H, Martin Czygan, Ashish, Kirthi Raman, 2017 Packt Publication. 2. “Data Analytics & Visualization All in one” for Dummies A Wiley Brand,2024

Title of the Course : Micro Electro Mechanical Systems Course Code: UMEMM0642	L 3	T -	P -	Credit 3

Course Pre-Requisite: Knowledge of basic Electronic Devices and Circuits, Digital Electronics

Course Description: A MEMS (Micro-Electro Mechanical Systems) course typically covers the fundamental principles of designing and fabricating miniature mechanical devices integrated with electronic circuitry, including topics like, micro sensing and actuation mechanisms, micro-fabrication techniques, device modeling, packaging.

Course Learning Objectives:

CLO1: To study the evolution of micro fabrication.
CLO2: To learn about the Micro sensors and Micro actuators
CLO3: To study various fabrication technologies.
CL04: To study various machining processes

Course Learning Outcomes:

CO	After successful completion of the course the student should beable to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Explain** the fundamentals of Micro Electro Mechanical Systems and polymer and optical MEMS	II	Understanding
CO2	**Outline** the Polymer in MEMS and Optical MEMS	II	Understanding
CO3	**Utilize** MEMS techniques in Micro Sensor and Micro Actuators	III	Analyzing
CO4	**Explain** the various MEMS Fabrication Technologies and Micro Machining Processes	V	Evaluating

CO-PO,PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	1								1	1	1
CO2	2	1	1	1								1	1	1
CO3	2	1	1	1	1							1	1	1
CO4	2	1	1	1	1							1	1	1

1:Low 2:Medium 3: High

Assessments:

Teacher Assessment:

Components	Marks
ESE	100

ESE: Assessment is based on 100% course content

Course Contents:	Hours
UNIT 1: - INTRODUCTION TO MEMS: Basic definitions – evolution of Micro fabrication – Micro systems and Microelectronics, scaling laws: Scaling in Electrostatic force, Electromagnetic force, Rigidity of structures, Fluid mechanics and Heat transfer	**08**
UNIT 2: - MICRO SENSORS: Introduction – Micro sensors: Bio medical sensors and Biosensors – Chemical sensors – Optical sensors – Pressure sensors – Thermal sensors, Acoustic wave sensors.	**08**
UNIT 3: - MICRO ACTUATORS: Micro Actuation: Actuation using thermal Forces, Piezo electric crystals, Electro static forces. SMA based Micro actuators, Micro actuators: Micro grippers, Micro motors, Micro valves, Micro pumps, Micro accelerometers – Micro fluidics.	**07**
UNIT 4: - MEMS FABRICATION TECHNOLOGIES: Materials for MEMS: Silicon, Silicon compounds, Piezo electric crystals, Polymers Micro system Fabrication Process: Photolithography, Ion implantation, Diffusion, Oxidation, CVD, Sputtering, Etching techniques.	**07**

UNIT 5: - MICRO MACHINING: Micro Machining: Bulk micro machining, Surface micro machining, LIGA process. Packaging: Micro system packaging, Essential packaging technologies, Selection of packaging materials**.**	**07**
UNIT 6: - POLYMER AND OPTICAL MEMS: Polymers in MEMS - Polimide - SU-8 - Liquid Crystal Polymer (LCP) - PDMS - PMMA - Parylene - Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors - Optical MEMS - Lenses and Mirrors - Actuators for Active Optical MEMS. Application of MEMS - Case studies: Blood Pressure Sensor, Microphone,MEMS vibratory gyroscope	**08**

Text Books:

1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill, 2002.
2. Cheng Liu, "Foundations of MEMS", Pearson education India limited, 2006
3. S. Fatikow U. Rembold, "Microsystem Technology and Microrobotics", Springer-Verlag Berlin Heidelberg New York in 1997.
4. Stephen D Senturia, "Microsystem Design", Springer Publication, 2000.

Reference Books:

1. Marc Madou, "Fundamentals of Micro fabrication" CRC press 1997.
2. Stephen D.Senturia, "Micro system Design" Kluwer Academic publishers, 2001.
3. K.Anatha Suresh, K.J.Vinoy, S.Gopala Krishnan, K.N.Bhat, V.K.Aatre, "Micro and smart systems", Willy India.
4. Nitaigrun Premchand Mahalik, "MEMS", Tata McGraw Hill, 2007.

Title of the Course: Energy Storage Devices	L	T	P	Credit
Course Code: UMEMM0643	3	-	-	3

Course Pre-Requisite: Thermodynamics, Heat Transfer, Basic Engineering and Material Science.

Course Description:
This course provides a comprehensive overview of various energy storage technologies, focusing on their principles, applications, and performance characteristics. It covers electrical, thermal, mechanical, and chemical energy storage systems, emphasizing their role in sustainable energy systems.

Course Objectives: The course aims to

- Understand the fundamental principles and classifications of various energy storage devices.
- Analyze the performance characteristics and applications of different electrical energy storage systems.
- Evaluate the operational principles and applications of thermal and mechanical energy storage systems.
- Design and assess the integration of energy storage systems into renewable energy and smart grid applications.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Students will be able to classify and compare different energy storage technologies.	2	Understanding
CO2	Students will be able to evaluate the performance of batteries, supercapacitors, and fuel cells.	4	Analyze
CO3	Students will be able to analyze thermal energy storage systems like sensible and latent heat storage.	5	Evaluate
CO4	Students will be able to design and evaluate a hybrid energy storage system.	6	Create

O-PO-PSO Mapping:

CO - PO Mapping														
Course Outcomes	PO's											PSO's		
	1	2	3	4	5	6	7	8	9	10	11	1	2	3
CO1	3	0	0	0	0	0	0	1	0	1	0	0	0	0
CO2	2	3	0	0	0	2	0	1	0	0	0	0	0	2
CO3	0	0	2	0	0	0	0	1	0	0	1	2	2	0
CO4	0	0	2	2	2	2	0	1	0	0	0	0	0	2

Assessments : Teacher Assessment:
Two components of in Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/case study/group discussion etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content(normally last three modules) covered after MSE.

Course Contents:

Unit 1: Need for energy storage, classification of energy storage systems, performance parameters (energy density, power density, cycle life, efficiency), applications of energy storage. • Energy storage and the smart grid. • Environmental impacts of energy storage.	07 Hrs.
Unit 2: Electrical Energy Storage: Batteries • Fundamentals of electrochemical storage, types of batteries (lead-acid, lithium-ion, nickel-based, flow batteries), battery characteristics and modeling, battery management systems (BMS), battery safety and recycling. • Solid state batteries.	08 Hrs.
Unit 3: Electrical Energy Storage: Capacitors and Fuel Cells • Supercapacitors: principles, types, and applications. • Fuel cells: principles, types (PEMFC, SOFC), performance characteristics, and applications. • Hybrid energy storage systems (battery-supercapacitor).	07 Hrs.
Unit 4: Thermal Energy Storage • Sensible heat storage (water, solids), latent heat storage (phase change materials), thermochemical energy storage, applications in solar thermal systems and building heating/cooling. • Thermal energy storage for concentrated solar power.	08Hrs.
Unit 5: Mechanical Energy Storage Pumped hydro storage, compressed air energy storage (CAES), flywheel energy storage, principles, and applications.	07 Hrs.
Unit 6: Energy Storage System Integration and Applications. • Integration of energy storage into renewable energy systems (solar, wind), energy storage for grid stabilization, microgrids, electric vehicles, and portable electronics, economic analysis of energy storage systems. • Energy storage for off grid applications.	08 Hrs.

Text books:

- Energy Storage: A Systems Approach" by J.A. Duffie and W.A. Beckman.
- Energy Storage Systems" by Godfrey Boyle.

Reference Books:

- Battery Technology Handbook" by K. Miyazaki.
- Thermal Energy Storage: Systems and Applications" by I. Dincer and M.A. Rosen.
- Journals: Journal of Energy Storage, Applied Energy.

Title of the Course: SUSTAINABLE ENGINEERING **Course Code:** UMEMN0661	**L**	**T**	**P**	**Credit**
	3	1		4

Course Pre-Requisite: Basic knowledge of environmental science, engineering materials, and energy systems.

Course Description:

This course introduces students to sustainable engineering principles, focusing on environmental, economic, and social sustainability. It covers sustainable design, renewable energy, waste management, and green technologies.

Course Objectives:

1. To understand the principles of sustainability and their application in engineering.
2. To analyze environmental impacts and propose sustainable solutions.
3. To explore renewable energy sources and sustainable materials.
4. To integrate sustainability into engineering design and decision-making.

Course Outcomes:

CO	After the completion of the course the student should be able to
CO1	Explain the principles of sustainability and their relevance to engineering.
CO2	Analyze environmental challenges and propose sustainable solutions.
CO3	Evaluate renewable energy sources and sustainable materials.
CO4	Apply sustainability concepts in engineering design and decision-making.

CO-PO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2				3	2					3		
CO2		3				3	3						3	
CO3			3		3	3							3	
CO4			3			3					3			3

Assessment Scheme:

SN	Assessment	Marks	Remark
1	ESE	100	Written Paper

Course Contents

Unit No.	Unit Title and Contents	Hours
Unit 1	**Introduction to Sustainability** • Definition, scope, and importance of sustainability in engineering. • Triple Bottom Line: Environmental, economic, and social sustainability. • Concepts of sustainable development: Brundtland Commission & SDGs. • Environmental ethics and responsibility of engineers.	6Hrs.
Unit 2	**Environmental Challenges and Solutions** • Global environmental issues: Pollution, deforestation, climate change. • Carbon footprint, ecological footprint, and environmental impact assessment (EIA). • Waste management: Solid waste, e-waste, wastewater treatment. • Circular economy principles: Reduce, reuse, recycle.	8Hrs

Unit 3	**Renewable Energy and Sustainable Materials** • Renewable energy sources: Solar, wind, hydro, biofuels, geothermal. • Energy efficiency strategies and green building technologies. • Sustainable materials: Bamboo, bioplastics, eco-friendly concrete, recyclable metals. • Life cycle analysis (LCA) of materials and energy systems.	**8Hrs**
Unit 4	**Sustainable Engineering Design** • Principles of sustainable design and green manufacturing. • Design for Environment (DfE) & Cradle-to-Cradle concept. • Low-impact product design: Eco-labeling and environmental certifications. • Case studies on sustainable engineering projects.	**10 Hrs.**
Unit 5	**Policy, Regulations, and Global Initiatives** • Environmental policies and legal frameworks: The Water Act, The Air Act, EPA regulations. • International agreements: Kyoto Protocol, Paris Agreement, SDGs. • Corporate sustainability strategies and ESG reporting. • Role of government and industries in sustainable development.	**8 Hrs.**
Unit 6	**Case Studies and Applications:** • Sustainable transportation systems: EVs, smart grids, and urban mobility solutions. • Circular economy models in manufacturing industries. • Smart cities and sustainable urban planning. • Innovations in waste reduction and sustainable packaging.	**6Hrs**
Tutorial Contents:		
T1	Case study on sustainable cities and smart infrastructure.	
T2	Conduct a life cycle assessment (LCA) of a consumer product.	
T3	Design a renewable energy system for a community.	
T4	Comparative analysis of waste management techniques in different countries.	

Text Books:

1. Sustainable Engineering: Concepts, Design, and Case Studies – David T. Allen & David R. Shonnard
2. Introduction to Sustainability – Robert Brinkmann
3. Environmental Engineering: Fundamentals, Sustainability, Design – James R. Mihelcic & Julie B. Zimmerman
4. Handbook of Sustainable Development Through Green Engineering and Technology – Vikram Bali
5. Engineering Applications in Sustainable Design and Development – B.A. Striebig
6. Introduction to Sustainable Engineering – R.L. Rag & Lekshmi Dinachandran Remesh
7. Handbook of Sustainable Building Design and Engineering – Dejan Mumovic & Mat Santamouris

Reference Books:

1. Engineering for Sustainable Development – William M. Adams
2. Renewable Energy and Sustainable Engineering – John Twidell & Tony Weir
3. Handbook of Sustainable Engineering – Joanne Kauffman & Kun-Mo Lee
4. Sustainable Engineering: Concepts and Practices – Israel Sunday Dunmade, Michael Olawale Daramola & Samuel Ayodele Iwarere
5. Fundamentals of Sustainable Drilling Engineering – M.E. Hossain
6. Handbook of Environmental Engineering – Frank R. Spellman

Kolhapur Institute of Technology's College of Engineering, Kolhapur

Curriculum (Structure)

for

B.TECH
Robotics (Hons.) Programme
(Under Graduate Programme)
From Academic Year 2021-2022

Kolhapur Institute of Technology's College of Engineering,(Autonomous) Kolhapur.

Department of Mechanical Engineering

Teaching and Credit scheme for

Propose B.Tech. Robotics (Hons.) Programme in Mechanical Engineering

Course No.	Course Name	Semester	No. of Hours /Week			
			L	**T**	**P**	**Credits**
UMEHN0351	FUNDAMENTALS OF ROBOTICS	III	3	1	--	**4**
UMEHN0451	FUNDAMENTALS OF MICROCONTROLLERS	IV	3	1	--	**4**
UMEHN0551	PROGRAMMING & SIMULATIONS FOR ROBOTICS	V	3	1	--	**4**
UMEHN0651	ROBOT KINEMATICS AND DYNAMICS	VI	3	1	----	**4**
UMEH0701	MINI PROJECT	VII	-	-	4	**2**
			12	**4**	**4**	**18**

Total Credits - 18, Total Contact hours – 20

UMEHN0351 As per NEP Structure **AY2425 onwards**

Assessment	Marks
ESE	100

Title of the Course: Robot Kinematics and Dynamics **Course Code:** UMEHN0651	**L**	**T**	**P**	**Credit**
	3	**1**		**4**

Course Pre-Requisite: Basic electronics & electrical, Basic Sciences,

Course Description: This course gives knowledge about Robotics and its kinematics and dynamics. It also describes the fundamentals of Artificial Intelligence.

Course Objectives

1. To understand basic terminologies and concepts associated with Robotics.
2. To study various Robotic kinematics, forward and backward or inverse.
3. To study kinematics and dynamics to understand exact working pattern of robots.
4. To study the associated recent updates in Artificial Intelligence.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	**Bloom's Cognitive**	
		level	Descriptor
CO1	**Define** various robot structures and their workspace.	I	Cognitive (Knowledge)
CO2	**Interpret** spatial transformations associated with rigid body motions	II	Cognitive (Knowledge)
CO3	**Acquire** knowledge of fundamentals of Artificial Intelligence	III	Cognitive (Knowledge)
CO4	**Relate** the problem logically and demonstrate problem solving with Artificial Intelligence technique	III	Psychomotor (Skill)

CO-PO Mapping:

CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**	**PSO3**	
CO1	2														
CO2	2			3								3	2		
CO3		3			3			2					2		
CO4		2			3			0			3	3			

Assessments:

Teacher Assessment:

No ISE 1 and ISE II and MSE:

ESE: Final ESE Assessment is based on 100% course content for 100 marks.

Course Contents:

Unit 1:- Introduction **The mechanics and control of manipulators :-**The description of position and orientation, Concept of Forward kinematics of manipulators, Inverse kinematics of manipulators, Velocities, static forces, singularities, Robot joints and work volume	**(05)Hrs.**
Unit 2:- Forward Kinematics :- Description Position, orientation and frames. Transformation matrices and their arithmetic, link and joint description, Mapping: Changing descriptions to frame to frame, Operations: Translation, Rotation and transformation Denavit-Hartenberg parameters, frame assignment to links, direct	**(05)Hrs.**

kinematics,	
Unit 3:-Manipulator Kinematics:- Link Description, Link connection description, convention for affixing Frames to links, Actuator Space, Joint space, Cartesian space, Frames with standard names.	**(06)Hrs.**
Unit 4:- Inverse kinematics:- Kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators: - Jacobeans, singularities, static forces, Jacobean in force domain.	**(05) Hrs.**
Unit5:- Dynamics :- Introduction to Dynamics, Trajectory generations, Forward Dynamics and Inverse Dynamics – Importance – Spatial description and transformations – Different types of dynamic formulation schemes – Lagrangian formulation for equation of motion for robots and manipulators.	**(07) Hrs.**
Unit6:-Trajectory Planning Trajectory planning, Geometric Jacobian / Analytical Jacobian, Singularities and redundancy, Inverse kinematics algorithms, Statics and manipulability, Kinematic solutions and trajectory planning,	**(07) Hrs.**
Text Books: 1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2. 2nd Edition, 2004 3. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications,McGraw – Hill International, 1986. 4. Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, 2001. 5. Artificial Intelligence A modern approach by Stuart Russell 2 nd edition 6. Artificial Intelligence by Saroj Kaushik	
Reference Books: 1. Richard D. Klafter, Thomas A. Chemielewski, Michael Negin, 2. Robotic Engineering: An Integrated Approach, Prentice Hall India, 2002. 3. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.	

Title of the Course:CAD/CAM/CAE	L	T	P	Credit
Course Code:UMEEX0691	3	0	0	3

Course Pre-Requisite: Knowledge of Machine drawing, isometric &orthographic projection and CNC machines is essential.

Course Description: Under this course the student will be introduced to the principles of parametric design using computer aided design software. Students will construct 3 models and surfaces. Topics will include sketching, constraining, solid modeling, surface modeling, Drafting and Assembly modeling and kinematics, Students will also learn Manual part programming and CAM.

Course Objectives:

1. To Construct 3D solid Models of parts using CAD software and measure its physical properties.
2. ToConstruct surface models of parts using CAD software
3. Tobuild 3D assemblies using CAD software taking into consideration appropriate assembly approach
4. To Build 2D projections from 3D models and assemblies
5. ToDevelop the CNC part program by using manual programming and CAM software.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	Construct 3D solid and surface Models of parts using CAD software and measure its physical properties.	3	Construct
CO2	Build 3D assemblies withappropriate assembly approachand 2D projections using CAD software.	3	Build
CO3	Develop the CNC manualpart program for 2D Profile and understand concepts of CAE.	3,2	Develop Understand

CO-PO Mapping:

CO	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10	CO11	PS01	PS02	PS03
CO1	1		2	1	2						1	2		
CO2	1		1	1	1						1	2		
CO3	1		1		3						1	2		

Assessments :

Teacher Assessment:

Assessment	Marks
ISE	50

ISE are based on practical performed/ Quiz/ Mini-Projectassigned/ Presentation/ Group Discussion/ Internal oral etc.

Course Contents:

1:Introduction to CAD: Need for implementing CAD, Application and benefits of CAD, Hardware Requirements, Different Software packages used for 3D Modeling.	6 **Hrs.**
2:Sketching& Solid Modeling: 2D sketching of elements like line, circle, arc, spline etc. Dimensioning these	7**Hrs.**

elements, Geometrical constraints **Solid Modeling:** Concept of Feature based and parametric modeling Basic and advanced modeling features.Import and export of 3D solid models between two different software packages. Physical properties like volume, surface area, center of gravity etc of solid model.	
3: Basic Surface Modeling: Concept of surface modeling. Basic modeling features. **Assembly Modeling**: Concept of Bottom up and top down approach, Building two composite assemblies of components (consisting at least five components) along with all relevant details, Exploded Views using assembly features in any suitable 3D modeling software.	**7 Hrs**
4:Generation of 2D Drawings: Generation of Orthographic views of individual components required for shop floor [working drawings] from 3D model which will include all relevant views like front, side, top, bottom views, sectional views, dimensioning, dimensional and geometrical tolerances etc. Generation of title block in sheet. Orthographic views of assembly drawings, generation of Bill of Materials (BOM). Plotting of drawings.	7 **Hrs.**
5. Computer Aided Manufacturing: **a) Part Programming:**Introduction to manual part programming, use of G and M codes to generate manual part program, Introduction to data exchange formats, Demonstration of integration of CAD/CAM software to generate tool path using suitable software.	6 **Hrs.**
6 Introduction to CAE, Applications.: Concept of CAE. Concept of FEA, advantages and limitations of CAE, applications of CAE in mechanical engineering **Matlab:** advantages and limitations of MATLAB, applications of MATLAB	6 Hrs

Text Books:

1) “CAD/CAM- Principals and Applications”, P.N. Rao, Tata McGraw Hill, 2nd Edition.
2. “CAD/CAM/CAE”,N.K.Chougule, SciTech Publication, Revised Edition.
3. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill PublishingCo.2007 4. Radhakrishnan P, SubramanyanS.andRaju V., “CAD/CAM/CIM”, 2nd Edition, New Age International (P) Ltd, New Delhi,2000.

Reference books:

1. Various 3D modeling Software Manuals.
2. CNC Programming manual.
3. “Machine Drawing”, N. D. Bhatt and V.M. Panchal, Charoter Publications
4. “Mastering CAD CAM”,Ibrahim Zeid, Tata McGraw-Hill, Special Indian Edition, (2007).
5. “Machine Drawing”, N. Siddheshwar, P. Kannaiah, V V S Sastry, Tata McGraw Hill Publications, 2nd Edition.
6. “CAM/CAM – Theory and Practice”,Ibrahim Zeid, R. Sivasubramaniam, Tata McGraw Hill,2nd Edition.
7. “CAD/CAM – Concepts and applications”, Chennakesava R. Alavala – Prentice Hall of India

Title of the Course: **QUALITY MANAGEMENT** **Course Code:** UMEEX0692	**L**	**T**	**P**	**Credit**
	3	**-**	**-**	**3**

Course Pre-Requisite: Knowledge on Basic Statistics

Course Objectives:

1. Student should able to demonstrate to the core concepts and the emerging trends in Quality Management.
2. Student should able develop hands-on-skills on tools and techniques of Quality management for industrial problem-solving.
3. To student should able to demonstrate implementation and documentation requirements for Quality system.

Course Description:

The Industry Internship Program offers students the opportunity to gain practical experience and insight into the professional world within their chosen field. Throughout the internship experience, students will engage in meaningful projects, tasks, and assignments designed to develop industry-specific skills, enhance professional competencies, and foster personal growth. Under the guidance of experienced mentors and supervisors, students will have the opportunity to explore various aspects of the industry, gain exposure to industry trends and practices, and contribute to organizational goals.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		Level	Descriptor
CO1	Explain the quality.	II	Understanding
CO2	Make use of quality systems.	III	Apply
CO3	Analyse the data using statistical tools and techniques	IV	Analyse
CO4	Decide the hands on skill in problem solving, controlling and improvement of quality.	V	Evaluating

CO-PO-PSO Mapping:

CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	1	2	-	-	-	-	2	-	1	1	-
CO2	2	1	1	1	1	2	-	-	-	-	-	-	2	-
CO3	3	2	1	2	-	-	-	-	-	-	-	2	-	-
CO4	2	2	3	2	2	-	-	1	1	2	-	-	2	-

Teacher Assessment:

Assessment	Marks
ISE	50

Course Content:	
Unit -I Introduction to quality management, historical background, contribution by quality gurus.	**6**
Unit-II Quality Planning: Designing for quality, capturing voice of customer, quality function deployment, quality loss function, signal to noise ratio, parameter design and optimization, tolerance design.	**9**
Unit-III Organizing for quality:, Quality systems: ISO9001 and TS 16949, Control of Non-conforming products, certification requirements, introduction to ISO 14000.	**7**
Unit-IV Quality Control: Stages of inspection, Acceptance sampling plans, Product vs. Process control, Statistical quality control, Variable (Xbar –R) and Attribute (p, np, c and u) charts, Introduction to basic seven tools of quality control.	**8**
Unit-V Quality Improvement: Single parameter experiments, Orthogonal array, Analysis of Means, Analysis of Variance ANOVA (one - way), Statistical inferences, Variance reduction, Process capability, Correlation analysis, Linear regression models	**9**
Unit-VI Introduction to Six Sigma methodology, D-M-A-I-C approach. Reliability, availability and Maintainability (RAM) approach	**6**

TEXT BOOKS

1. Armand V. Feigenbaum, Total Quality Control, McGraw Hill Inc. New York
2. J. M. Juran, F. M. Gryna, Quality Planning and Analysis, Tata McGraw Hill Publishing Co., New Delhi
3. E. Grant, R. Leavenworth, Statistical Quality Control, McGraw Hill International Book Co.
4. John Hardesky, Total Quality Management Handbook, McGraw Hill Inc.
5. D. H. Besterfield, Total Quality Management, Pearson Education
6. Logothetis, Managing for Total Quality, PHI Publication

REFERENCE BOOKS

1. Genichi Taguchi, Quality Engineering in Production Systems, McGraw Hill
2. John M. Ryan, Total Quality Control, Tata McGraw Hill Publishing Co.
3. P. F. Wilson, L.D. Dell & L.F. Anderson, Root Cause Analysis, A Tool for Total
4. Quality Management, Tata McGraw Hill Publishing Co.
5. Montgomery D (2004). Introduction to Statistical Quality Control, 5/e, (John Wiley & Sons)

Title of the Course: Vocational Training Course Code: UMEEX0693	L	T	P	Credit
	-	-	4	2

Course Pre-Requisite: Students should be able to communicate effectively and work well in a team. She/he should be able to demonstrate professional, reliable and a strong work ethic, this includes being punctual, taking initiative and being able to manage time effectively.

Course Objectives:

1. To apply theoretical knowledge gained in the classroom to real – world industry (Hands on experience.)
2. To develop professional skills such as communication, teamwork, time management, problem-solving and adaptability (Professional Development).
3. To expose students to the operations, practices and culture of a specific industry.

Course Description:

The Industry Internship Program offers students the opportunity to gain practical experience and insight into the professional world within their chosen field. Throughout the internship experience, students will engage in meaningful projects, tasks, and assignments designed to develop industry-specific skills, enhance professional competencies, and foster personal growth. Under the guidance of experienced mentors and supervisors, students will have the opportunity to explore various aspects of the industry, gain exposure to industry trends and practices, and contribute to organizational goals.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	**Apply** theoretical concepts and academic knowledge gained in the classroom to practical.	III	Applying
CO2	**Develop** industry specific skills such as technical skills, research skills, analytical skills, or communication skills.	V I	Creating
CO3	**Interpret** effectively through various channels, such as written reports, oral presentation, emails or meetings	II	Understanding
CO4	**Demonstrate** overall growth and development as a professional integrating academic knowledge, practical skills, and personal qualities to succeed in future career endeavors within the industry	II	Understanding

CO-PO-PSO Mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2										3	2	
CO2	3	3	3										3	3	
CO3										3	2				2
CO4	2	2	2			3			2	2	2		2	2	2

Assessments :

Teacher Assessment:

Assessment	Marks
ISE	50

Course Contents:

As per the approved academic structure, students have to undergo an internships for a duration of **Two Weeks** in an Mechanical Engineering Industry. Student will have to submit a Valid Company certificate of internship completion.

The department holds the final authority to accept or reject the internship offered to students. Department will check the credibility of the organization offering the internship to students. If the department finds the internship is unworthy, then students will not be allowed to join the organization.

Guidelines for Internship

1. Orientation and company Introduction

Introduction to the host company, its mission, values, and organizational structure.
Overview of the departments relevant to mechanical engineering.
Familiarization with safety protocols, facilities, and resources.

2. Departmental Rotation

Rotations through different departments or teams within the company.
Exposure to various functions such as marketing, operations, research and development, finance, etc.
Observe daily tasks, workflows, and project management processes.

3. Project Assignments:

Assignments aligned with the intern's field of study or interests.
Real-world projects with defined objectives, deliverables, and timelines.
Opportunities to work independently or collaborate with teams on cross-functional projects.

4. Mentorship and Guidance:

Assignment of a mentor or supervisor to provide guidance, support, and feedback.
Regular check-ins and one-on-one meetings to discuss progress, challenges, and learning goals.
Opportunities for skill development, and professional networking.

5. Final Presentation and Report:

Culminating presentation and report showcasing the intern's accomplishments, projects, and key leanings.
Presentation to company executives, department heads, and/or internship college mentor.
Recommendations for improvements or insights gained during the internship.