T. Y. B. Tech. Curriculum
w.e.f. 2022-2023

D. Y. Patil College of Engineering and Technology

Kasaba Bawada, Kolhapur

(An Autonomous Institute)

Accredited by NAAC with 'A' Grade

B. Tech Programme Structure

T. Y. B. Tech.

(Mechanical Engineering)

(To be implemented from academic year **2022-23**)

D. Y. PATIL
COLLEGE of ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering

T. Y. B. Tech. Curriculum
w.e.f. 2022-2023

Sr. No	Course Code	Course Type	Name of the Course	Teaching Scheme Per Week			Credits	Total Marks	Evaluation scheme			
				Lecture	Tutorial	Practical			Type	Max. Marks	Min. Marks for Passing	
1	201MEL301	HSMC	Operation Research and Project Management	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
2	201MEL302	PCC	Metallurgy	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
3	201MEL303	PCC	Tool Engineering @	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
4	201MEL304	PCC	Design of Machine Elements	3	1	-	4	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
5	201MEL305	PCC	Heat Transfer	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
6	201MEP302	LC	Metallurgy lab	-	-	2	1	50	ISE	25	10	10
									ESE (OE)	25	10	10
7	201MEP303	LC	Tool Engineering Lab	-	-	2	1	25	ISE	25	10	10
8	201MEP305	LC	Heat Transfer lab	-	-	2	1	50	ISE	25	10	10
									ESE (POE)	25	10	10
9	201MEP306	LC	3D Modeling lab	-	-	2	1	50	ISE	25	10	10
									ESE (POE)	25	10	10
10	201MEP307	ESC	Machining Technology Lab	-	-	2	1	25	ISE	25	10	10
11	201MEMC 308	MC	Material Handling Systems	2	-	-	0	50	ESE	50	20	20
			Total	**17**	**1**	**10**	**21**	**750**	**Total Credits: 21**			
									Total Contact Hrs.: 28			

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Course Code	Definition
BSC	Basic Science Course
ESC	Engineering Science Course
HSMC	Humanity and Social Science including Management Course
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
LC	Laboratory Course
MC	Mandatory Course
PROJ	Project

Abbreviations:

ISE: In Semester Evaluation,
MSE:-Mid semester Examination,
ESE: End Semester Examination

Note:
ESE will be conducted for 100 marks and converted to 50 marks
@ indicates 4 hour duration ESE

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Sr. No	Course Code	Course Type	Name of the Course	Teaching Scheme Per Week			Credits	Total Marks	Evaluation scheme			
				Lecture Hours	Tutorial Hours	Practical Hours			Type	Max. Marks	Min. Marks for Passing	
12	201MEL309	PCC	Internal Combustion Engines	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
13	201MEL310	PCC	Machine Design	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
14	201MEL311	PCC	Metrology and Quality Control	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
15	201MEL312	PCC	Industrial Hydraulics & Pneumatics	3	-	-	3	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
16	201MEL3OX	OEC	Open Elective-I	3	1	-	4	100	ISE	20	20	40
									MSE	30		
									ESE	50	20	
17	201MEP309	LC	Internal Combustion Engines Lab	-	-	2	1	50	ISE	25	10	10
									ESE (POE)	25	10	10
18	201MEP310	LC	Machine Design Lab	-	-	2	1	50	ISE	25	10	10
									ESE (OE)	25	10	10
19	201MEP311	LC	Metrology and Quality Control Lab	-	-	2	1	50	ISE	25	10	10
									ESE (POE)	25	10	10
20	201MEP312	LC	Industrial Hydraulics & Pneumatics Lab	-	-	2	1	25	ISE	25	10	10
21	201MEP315	LC	Computer aided manufacturing lab	-	-	2	1	25	ISE	25	10	10
22	21MEP 316	MC	Essentials of Electrical and Electronics Tech.	2	-	-	0	50	ESE	50	20	20
			Total	**17**	**1**	**10**	**21**	**750**	**Total Credits: 21**			
									Total Contact Hrs.: 28			

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Open Elective Course-I

Sr. No	Course Code	Course No.	Open Elective Course-I
1	OEC	201MEL313	Human Resource Management
2	OEC	201MEL314	Electric Vehicle

Course Code	Definition
BSC	Basic Science Course
ESC	Engineering Science Course
HSMC	Humanity and Social Science including Management Course
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
LC	Laboratory Course
MC	Mandatory Course

Abbreviations:

ISE: In Semester Evaluation,
MSE:-Mid semester Examination,
ESE: End Semester Examination

Note:
ESE will be conducted for 100 marks and converted to 50 marks

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Open Elective:

Open elective courses are offered to gain the knowledge of multidisciplinary areas. Students must choose one open elective course from the list of courses offered by other departments (excluding open elective courses offered by their department). Following is the list of open elective courses. The detailed syllabus is available on to the college website under academic tab.

Sr. No.	Department	Course Code	Open Elective-I Course
1	Chemical	201CHL318	Industrial Safety and Act
		201CHL319	Energy Conservation and Audit
2	Civil	201CEL330	Disaster Management
		201CEL331	Green Building
3	Architecture	201ARL318	Residential Gardening
		201ARL319	Role of Art & Technology in Interior Design
4	Electronics and Telecommunication	201ETL318	Sensor Technology
		201ETL319	Electronic Instrumentation
5	Computer Science & Engineering	201CSL319	E- Commerce & Digital Marketing
		201CSL320	Python Programming
6	Computer Science & Engineering (Artificial Intelligent & Machine Learning)	201AIML320	Applications of AI ML
		201AIML321	Augmented Reality and Virtual Reality
7	Computer Science & Engineering (Data Science)	201DSL319	Basics of Data Science
		201DSL320	Basics of Database

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Course Plan

Course Title : **Operation Research and Project Management**	
Course Code : **201MEL301**	**Semester :V**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Mathematics, probability distributions and statistics

Course Description:

This course will teach operational researchers to use their analytical and creative skills to develop better systems and operational procedures to solve manufacturing problem.

Course Objectives:

1. To analyze different situations in the industrial scenario involving limited resources and finding the optimal solution within constraints.
2. To understand the quantitative techniques in management decision-making and its applications by using Linear Programming Model, Assignment Model, Transportation Model, Network Model and Sequencing Model to solve manufacturing problem.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO301.1	**Understand** the formulation of Linear programming problems	L2
CO301.2	**Solve** Linear programming problems by using Operations Research techniques	L3
CO301.3	**Solve** Transportation and Assignment problems	L3
CO301.4	**Solve** Sequencing and replacement problems	L3
CO301.5	**Apply** the various techniques of Project Management such as CPM/PERT networks	L3
CO301.6	**Sketch** the shortest path model for Decision making	L3

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO301.1	2	2	-	-	-	-	-	-	-	-	-	-	-	1
CO301.2	2	2	-	-	-	-	-	-	-	-	-	-	-	1
CO301.3	2	2	-	-	-	-	-	-	-	-	-	-	-	1
CO301.4	2	2	-	-	-	-	-	-	-	-	-	-	-	1
CO301.5	2	2	-	-	-	-	-	-	-	-	2	-	-	1
CO301.6	2	2	-	-	-	-	-	-	-	-	-	-	-	1

***Note: PO11 (Justification):** To manage Probability of completing project by given date are defined in unit 5 to achieve PO11

Course Content

Content	Hours
Unit 1: Introduction to O.R and Linear Programming Birth of O.R., Methodology, Scope and Limitations. Types of O.R. Models, Applications in Production Management, Use of computers in O.R, Linear Programming: Formulation, graphical method.	05
Unit 2: Linear Programming Problems Introduction, Simplex algorithm, Solution for maximization and minimization problems, Basic feasible solution, Duality theory in Linear Programming	06
Unit 3: Transportation and Assignment Model **Transportation model**- Mathematical formulation, methods to obtain initial basic feasible solution (IBFS)- NWCR,LCM and VAM, Conditions for testing optimality, MODI method for testing optimality of solution of balanced problems and unbalanced problems **Assignment Model-** Mathematical statement, Methods to solve balanced assignment problems, unbalanced assignment problems, Maximization problems.	08
Unit 4: Sequencing ,Replacement Analysis and Queuing Theory **Sequencing-** Sequencing of n jobs & 2 machines, Sequencing of n jobs & 3 machines **Replacement Analysis-** With and without time value of money, single item and group replacement. **Queuing Theory:** Introduction, Elements of Queuing System, Service Discipline, Service Mechanisms	07

Unit 5: Project Management **Fundamentals of CPM / PERT networks:** **CPM** – Gantt Chart, Construction of networks, critical path, forward and backward pass, floats & their significance, resource allocation and leveling **PERT –** Time Estimates, Construction of Networks, Probability of completing projects by given date.	08
Unit 6: Decision Theory and Network Techniques: **Decision Theory:** pay off and regret tables, decision rules, decisions under uncertainty and risk, decision tree. **Network Techniques:** Shortest path model- Dijkstra's Algorithm	06

List of Assignments

Sr. No.	Name of Assignments	Type
1	Formulation of LPP and Graphical Solution.	S
2	Maximization and Minimization problems using Simplex Method.	S
3	Assignment on Transportation Problems	S
4	Assignment on Assignment Problems	S
5	Assignment on Sequencing Problems.	S
6	Assignment on Replacement Analysis and Queuing theory	S
7	Assignment on CPM Problems	S
8	Assignment on PERT Problems	S
9	Assignment on Decision Theory.	S
10	Assignment on Shortest Path Models	S

S-STUDY, O-OPERATIONAL

Textbook:

1. "Operations Research", Hira and Gupta, S.Chand and Co. New Delhi.
2. "Operations Research", Mandhar Mahajan, Dhanpat Rai & Co.

Reference Books:

1. "Operation Research an Introduction", Hamdy A. Taha, Pearson,10 th Edition
2. "Introduction to Operation Research", Paneer-Selvam, Prentice Hall of India publication,

2nd Edition.

3. "Operation Research", Pradeep J. Jha, Tata McGraw Hill Publication.
4. "Operation Research", Mariappan, Pearson Education.
5. "Operation Research – Principle and Applications", G. Shriniwasan, Prentice Hall of India Publication, 3rd Edition.

Online sources:

1. https://nptel.ac.in/courses/110/106/110106062/
2. https://nptel.ac.in/courses/110/106/110106059/
3. https://nptel.ac.in/courses/112/106/112106134/

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Course Plan

Course Title : **Metallurgy**	
Course Code : **201MEL302**	**Semester : V**
Teaching Scheme : L-T-P : **3-0-0**	Credits : 3
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Engineering Physics, Engineering Chemistry & Manufacturing Processes

Course Description:

Metallurgy plays an important role in today's world of science and technology. This course is to provide a physical basis that links the structure of materials with their properties, focusing on ferrous and nonferrous metals. The concepts of micro structural changes during cooling are also discussed, Heat treating is a group of industrial and metalworking processes as hardening, normalizing and annealing etc. are used to alter the physical properties of a material.

Course Objectives:

1. To acquaint students with the basic concepts of Metals and alloy systems
2. To understand fundamental knowledge of Steel & its alloys along with its applications.
3. To understand fundamental knowledge of Cast Iron & its alloys along with its applications.
4. To understand basic concepts of non-ferrous alloys and advanced materials
5. To understand basic concepts and its application of Heat treatment processes

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO302.1	**Classify** basic concept of metals and alloy systems.	L2
CO302.2	**Select** different grades of steel for engineering application using fundamental knowledge of Steel & its alloys	L3
CO302.3	**Describe** fundamental knowledge of Cast Iron.	L2
CO302.4	**Explain** basic concepts of non-ferrous alloys and advanced materials	L2
CO302.5	**Understand** basic concepts and its application of heat treatment processes	L2
CO302.6	**Select** appropriate heat & surface treatment processes for industrial applications	L3

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO302.1	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO302.2	2	2	2	-	-	-	-	2	-	-	-	2	2	-
CO302.3	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO302.4	2	-	-	-	-	-	-	-	-	-	-	2	2	-
CO302.5	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO302.6	2	2	2	-	-	-	-	-	-	-	-	2	2	2

Course Content

Content	Hours
Unit 1: Introduction to Metals and alloy systems Introduction to Metallic and Non-metallic materials and its classification (metals/alloys, polymers and composites) a) Imperfections in crystals, Defects- Point, Line, Planar, Volume- Slip planes and slip systems b) Alloy formation by crystallization, Nucleation and growth, Cooling curves, Dendritic structure and coring. c) Solid solutions and intermediate phases d) Phases and Gibbs phase rule e) Construction of equilibrium diagrams from cooling curves, Isomorphous (Solid Solution), Eutectic, Partial solubility Peritectic and Intermetallic Compounds Lever arm principles	08
Unit 2: Steel and its Alloys With respect to typical compositions, Properties and Applications for the following alloys.) a) Fe- Fe3C equilibrium diagram - b) Alloy steels- Free cutting steels, HSLA high carbon low alloy steels, maraging steels. creep resisting steels, Stainless steels- different types. Tool steels- types, c) Selection of materials and Specifications based on -IS, BS, SAE, AISI, DIN, JIS) Miscellaneous alloys such as super alloys, Heating element alloys. Study of low expansion and controlled expansion alloys	07

Unit 3: Cast Iron and Types of Cast Iron Classification of Cast irons Gray cast irons, nodular cast irons, white cast irons, malleable cast irons, chilled. Effect of various parameters on structure and properties of cast irons. Applications of cast irons for different components of machine tools, automobiles, pumps, etc.	05
Unit 4: Non Ferrous Alloys and Advances in Materials I. Copper based alloys brasses Cu- Zn, Bronzes Cu- Sn, Cu- Be, Cu-Ni. b) Aluminum based alloys Al-Cu (Duralumin), Precipitation Hardening, Al-Si (Modification), c) Lead Alloys-Pb-Sn (Solders and fusible alloys), g) Tin Alloys- Sn-Sb alloys (Babbits) ,h) Ti and its alloys d) Criteria for selection of materials for auto Industry aerospace, marine applications machine tools, refrigeration and air conditioning II. Polymers, Ceramics, Composites, Smart Materials, Nano-Materials & Biomaterials	08
Unit 5: Principles of Heat & Surface treatment a) Transformation of Pearlite into austenite upon heating, b) Transformation of austenite into Pearlite, Bainite and Martensite on cooling. c) TTT –Diagram and CCT - Diagrams - significance, Effect of alloying elements on TTT diagram and its significance. d) Heat treatment furnaces and equipments, controlled atmosphere. b) Surface Treatment: Electrolytic Polishing, Electroplating, Enamles & glazes, Etching, Galvanizing, Metalizing, All types of surface hardening processes	05
Unit 6: Heat Treatment Processes a) Heat Treatment of Steels I. Annealing – Types-Full, Partial and Sub critical annealing (Various types) and purposes II. Normalising- Purposes III. Hardening (Hardening types), Purposes, Austempering and Martempering, Mechanism of quenching and Quenching media, Hardenability- Concept and methods of determination of hardenability- Grossmans critical diameter method and Jominy end quench test. IV. Tempering Types, Structural transformations during tempering, purposes subzero treatment V Heat treatment defects and remedies	07

Textbook:

1. "Material Science and Metallurgy for Engineers", V.D.Kodgire, Everest Publishers Pune, 39th Edition, 2017.
2. "Heat Treatments Principles and Practices", T.V. Rajan , C.P. Sharma and Ashok Sharma Prentice Hall of India Pvt Ltd, New Delhi, 2nd Edition 2011.

Reference Books:

1. "Material Science and Engineering", V.Raghwan. Prentice Hall of India Pvt. Ltd., New Delhi ,3rd Edition, 1995.
2. "Introduction to Physical Metallurgy", S.H.Avner, Mcgraw Hill Book Company Inc, Edition, 2nd , 1974
3. "Material Science and Engineering", W.D Callister, Wiley India Pvt.Ltd., 5th Edition 2013.

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_mm05/preview
2. https://archive.nptel.ac.in/courses/113/102/113102080/

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T. Y. B. Tech. Curriculum
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Course Plan

Course Title : **Tool Engineering**	
Course Code : **201MEL303**	**Semester : V**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **4**
Evaluation Scheme : ISE + MSE Marks: **20+30**	ESE Marks : **50**

Prerequisite: Manufacturing processes, Production Drawing,

Course Description:

Tool Engineering is mainly focused on metal cutting principles and tool design. It includes machinability aspects, cutting tool geometries and other aspects of machining like surface finish, heat generation and cutting forces . Design of jigs, fixtures and dies is main focus of the course, wherein student will design and prepare manufacturing drawings of jigs and fixtures. Design of progressive and drawing die are also included to study sheet metal operations in details.

Course Objectives:

1. To study metal cutting technology
2. To understand the locating principles of locating devices
3. To understand the principles of clamping devices
4. To understand the principles of designing locating and clamping devices
5. To understand the function of Jigs, fixtures and dies
6. To understand the design practices of Jigs, fixtures and dies

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO303.1	**Understand** metal cutting principles.	L2
CO303.2	**Discuss** machinability and tool life aspects for various machining processes.	L2
CO303.3	**Understand** important elements of Jigs, Fixtures	L3
CO303.4	**Design** drilling jig and milling fixture	L4
CO303.5	**Design** drawing die for cylindrical components.	L4
CO303.6	**Design** Progressive die.	L4

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Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO303.1	3	2	-	-	-	-	-	1	-	-	-	-	-	-
CO303.2	3	2	-		-	-	-	-	-	-	-	-	-	-
CO303.3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO303.4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO303.5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO303.6	3	2	-	-	-	-	-	-	-	-	-	-	2	-

Course Content

Content	Hours
Unit 1: Theory of Metal Cutting Wedge action, Concept of speed, Feed and depth of cut, orthogonal and oblique cutting. Mechanics of metal cutting-Chip formation, Types of chips, cutting ratio, shear plane and shear angle, velocity relationships, force measurement by tool dynamometers.,	06
Unit 2: Tool Life and Machinability Cutting tool materials and their properties, Advanced cutting tools. ISO specification of turning tool holders, **Machinability of Metals**- Factors affecting, improvement and machinability index. **Tool life -** Types of wear, relationship with cutting parameters, Taylor's equation, improvement measures. **Surface finish-** various factors affecting, effect of cutting parameters, improvements. Heat generation in machining, its effect on cutting force, tool life and surface finish, types and selection criteria of cutting fluids,	06

Unit 3: Introduction to Jigs and Fixtures: Necessity, applications and types, basic concept of jigs and fixtures for different manufacturing processes, Process planning and dependency of jig and fixture design on operation sequence. **Location -** Principles, Location by nesting and sighting, locating pins, pads, diamond pin, post locator, adjustable supports, Vee locators, **Clamping -** Principle, types of clamps like screw clamp, strap, lever, hinge type, cam operated, toggle clamps, centralizer and equalizer clamp, multiple clamping, quick acting clamps, pneumatically operated clamps	08
Unit 4: Design of Jigs and Fixture .**A) Design of jigs:** Principles of Jig design, types of jigs- plate, template, box, channel, sandwich, latch, turn-over, tumble jig etc., types of bushes, selection of bushes and liners, construction of Jig and fixture bodies, use of fasteners and standard parts for assembling different elements **B) Design of fixtures:** Principles of fixture design, types of fixtures- gang, straddle, string milling fixture etc, selection of the suitable cutting tool and machine tool for different milling operations, design of different elements of milling fixtures like setting block, tenon, T-bolt and T nut etc, Introduction to different fixtures like turning/lathe fixture, welding fixture, Inspection fixture Indexing device for jigs and fixtures, Concept of Modular Fixtures.	08
Unit 5: Introduction to press tools: Dies, punches, Theory of metal cutting, types of presses, types of dies, simple, compound, combination and progressive dies, press tools for operations like blanking, piercing, drawing, shaving, trimming, etc., (theoretical treatment only) **Design of drawing die:** Blank size determination, no. of draws, stage wise achievement of drawn component, stage wise component drawings, drawing radii and clearance, drawing forces, defects in drawing (Numerical treatment)	08
Unit 6: Design of progressive die for cutting operations A) **Introduction -** Dies, punches, types of presses, types of dies, simple, compound, combination and progressive dies, press tools for operations like blanking, piercing, drawing, shaving, trimming, etc., Theory of metal cutting Miscellaneous dies like- cut off dies, trimming, shaving, bulging, rubber,	08

lancing, slitting, horn type, side cam dies, bending, forming, curling dies etc. (theoretical treatment only) **B) Design of progressive die** Fourteen steps of die design - cutting force and blank holding force estimation, punch and die clearance, scrap strip layout, design of punches, design of dies, pilots, strippers, stock stops, finger stops, auto stops, center of pressure, selection of die set etc	

Textbooks:

1. Manufacturing Technology, Volume-2, P.N. Rao, TMH
2. Jigs and Fixture, P. H. Joshi, Tata Mc-Graw Hill Pub. Co
3. A Text Book of Prod. Engineering, P. C. Sharma, S. Chand

Reference Books:

1. Metal cutting theory and cutting tool design, V. Arshinov, G. Alekseev, MIR Publisher
2. Tool Design, Donaldson, TMH
3. An Introduction to Jig & Tool Design, M.H.A. Kempster, ELBS
4. Jigs and Fixture Design Manual, Henrikson, Industrial Press, NY
5. Fundamentals of Tool Design, Ed. Frank Wilson, ASTME, TMH
6. Techniques of Press Working of Metals by Eary and Reed
7. CMTI Machine Tool Design Handbook, TMH

Online Resources:

1. https://nptel.ac.in/courses/112105127
2. https://archive.nptel.ac.in/courses/112/105/112105306/
3. https://archive.nptel.ac.in/courses/112/105/112105233/

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Course Plan

Course Title : **Design of Machine Elements**	
Course Code : **PCC201MEL304**	**Semester : V**
Teaching Scheme : L-T-P : **3-1-0**	Credits : **4**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Machine Drawing and Computer Aided Drafting, Strength of Materials, Kinematics mechanism and machines and Theory of Machines

Course Description:

Design of Machine Elements is the application of mathematics, kinematics, statics, dynamics, mechanics of materials, engineering materials, manufacturing process and engineering drawing. It deals with understanding of basic concepts of machine design, phases of design. It involves designing of various machine elements and creative combining of these elements into a component or assembly that satisfy need.

Course Objectives:

1. **To study** basic concepts of machine design and design procedure of machine element.
2. **To study** the design of various mechanical elements against static loading such as Knuckle joint couplings, screws, springs and bolted and welded joints
3. **To study** use of design data book for design of machine elements
4. **To study** selection of machine elements from manufacturer's catalogue

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO304.1	**Understand** basic concepts of machine design and design procedure of machine elemen**t.**	L2
CO304.2	**Apply** the principles of static loading to design the mechanical elements such as Knuckle joint, levers and screws.	L3
CO304.3	**Implement** the design procedure for finding the parameters of the mechanical elements such as shaft, key and couplings.	L3
CO304.4	**Execute** the principles of static loading to design of springs, bolted and welded joints.	L3
CO304.5	**Use** of design data book for design of machine elements.	L3
CO304.6	**Select** the flat belt and V-belt from manufacturing catalogue**.**	L2

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO304.1	2	2	2	1	-	1	-	1	1	1	-	-	1	-
CO304.2	2	2	2	1	1	1	-	1	1	1	-	-	1	-
CO304.3	2	2	2	1	1	1	-	1	1	1	-	-	1	-
CO304.4	2	2	2	1	-	1	-	1	-	-	-	-	1	-
CO304.5	2	2	2	1	-	1	-	1	1	1	-	-	1	-
CO304.6	2	2	2	1	-	1	-	1	1	1	-	-	1	-

Course Content

Content	Hours
Unit 1: Introduction to Machine Design Concept of Machine design, Types of loads, Factor of safety, Theories of failures, Phases of design, Review and selection of various engineering material properties and I.S. coding for ferrous materials, standardization, preferred series, use of design data book.	07
Unit 2: Design of machine elements under static loading **i)** Knuckle joint, Turn buckle and bell crank Lever. **ii) Design of Power screw** Forms of threads, Terminology of threads, Friction in threads, multiple start screws, Torque analysis for lifting and lowering load, Design of power screws and nut with square, trapezoidal threads, Self-locking & Overhauling of screw, Stresses in power screws,	07
Unit 3: Design of shafts, keys and coupling Design of solid and hollow shafts, splined shafts, ASME code for shaft design, Types and design of Keys, Types of Couplings, Design of Rigid Coupling, flexible bushed pin type flanged coupling	06

Unit 4: Design of Joints **i) Design of bolted joints subjected to Eccentric Loading** 1) In a plane containing bolts, 2) Parallel to axis of bolt, 3) Perpendicular to the axis of bolt. **ii) Design of welded joints** 1) Strength of transverse and parallel fillet welds 2) Eccentric load in the plane of weld3) Welded joint subjected to bending moment	08
Unit 5: Design of springs Types of springs, materials and their applications, Styles of end, Stress and deflection equations for helical compression Springs, Design of Helical Compression Spring subjected to static loading.	06
Unit 6: Design of power transmission systems Design of Pulley- flat and V belt pulley, Selection of flat belt, V belt as per the standard manufacturer's catalogue.	06

List of Assignments/Experiments

Sr. No.	Name of Assignments/Experiments	Type	Hrs.
1	Prepare a detail report of design procedure showing calculations and sketches of Knuckle joint /Lever.	O	2.00
2	Draw a details and assembly drawing of Knuckle joint /Lever on A2 size drawing sheet.	O	2.00
3	Prepare a detail report of design procedure showing calculations and sketches of flexible bushed pin type flanged coupling.	O	2.00
4	Draw a details and assembly drawing of flexible bushed pin type flanged coupling on A2 size drawing sheet.	O	2.00
5	Case study of components (include selection of materials for various components showing their IS codes, composition and properties).	S	1.00
6	Problems on design of helical compression spring subjected to static load	S	1.00
7	Problems on design of Power Screw subjected to static load	S	1.00

8	Selection of Flat belts as per the manufacturer's catalogue	S	1.00
9	Selection of V- belts as per the manufacturer's catalogue	S	1.00
10	Cad drawing of Knuckle joint/flexible bushed pin type flanged coupling using any modeling software.	O	1.00

❖ **S-STUDY, O-OPERATIONAL**

Text Books:

1. "Design of Machine Elements", V.B.Bhandari ,Tata McGraw Hill Publication, 3rd Edition.
2. "Machine Design",Pandya Shah., Charotar Publishing House Pvt. Ltd ,20th Edition, 2015.
3. "Machine Design" Black P.H. and O. Eugene Adams, McGraw Hill Book Co. Ltd

Reference Books:

1. "Design of Machine Element", J.F. Shigley, Tata McGraw Hill Publication. 11th edition.
2. "Design of Machine Element" M.F.Spotts, Pearson Education Publication, 6th Edition..
3. "Machine Component Design",Robert C. Juvniall, Willey Ltd, 5th Edition.
4. "Design Data" – P.S.G. College of Technology, Coimbatore
5. "Machine Design", R.K.Jain, Khanna Publication
6. "Machine Design A Basic Approach", Dr. S.S.wadhwa S S Jolly Dhanapat Rai and Sons.

Online Resources:

1. https://onlinecourses.swayam2.ac.in/aic20_ed02/preview
2. https://onlinecourses.nptel.ac.in/noc22_de10/preview
3. https://onlinecourses.swayam2.ac.in/aic19_de04/preview
4. https://onlinecourses.nptel.ac.in/noc22_me133/preview

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Course Plan

Course Title : **Heat Transfer**	
Course Code : **201MEL305**	**Semester : V**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Applied thermodynamics, Fluid Mechanics

Course Description:

This course deals with study of working principles of different modes of heat transfer, laws of heat transfer. Analogy between heat, mass and momentum transfer. One dimensional steady state heat conduction without heat generation and with heat generation, unsteady State heat conduction. Study of extended surfaces. Understand the working principles & concept of Convection & Radiation and its applications.

Course Objectives:

1. To understand modes & basic laws of heat transfer & mass transfer, also understand Generalized differential equation of heat conduction equation
2. To analyze heat transfer problems in conduction, convection, radiation & combined modes.
3. To make the students familiarize with concept of Extended Surfaces
4. To introduce dimensional analysis', physical significance of dimensionless numbers.
5. To introduce the fundamentals of radiation and its applications.
6. To make the students familiarize with Heat Exchangers & Phase change phenomenon

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO305.1	**Understand** the basic principles & laws of heat and mass transfer	L2
CO305.2	**Analysis** of heat transfer problems for conduction, convection, radiation and combined modes.	L3
CO305.3	**Apply** the basic principles of Extended surface.	L2
CO305.4	**Apply** the basic Convection, Dimensional analysis, Physical significance of dimensionless numbers	L3
CO305.5	**Apply** the principles of Radiation	L3
CO305.6	**Apply** the fundamentals of Heat Exchangers & Phase change phenomenon	L3

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Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO305.1	3	1	-	-	-	-	-	-	-	-	-	-	-	2
CO305.2	3	3	-	2	-	-	-	-	-	-	-	-	-	2
CO305.3	3	2	-	-	-	-	-	-	-	-	-	-	-	3
CO305.4	3	2	-	-	-	-	-	-	-	-	-	-	-	3
CO305.5	3	2	-	-	-	-	-	-	-	-	-	-	-	3
CO305.6	3	2	-	-	-	-	-	1	-	-	-	-	-	3

Course Content

Content	Hours
Unit 1 : Fundamental of Heat and Mass Transfer Introduction to heat transfer, difference between thermodynamics & heat transfer, Modes of heat transfer, laws of heat transfer, Introduction to combined modes of heat transfer, Thermal conductivity and its variation with temperature for various Engg. Materials. Introduction to mass transfer, Modes of mass transfer, Analogy between heat, mass and momentum transfer, Fick's law of diffusion, Derivation of Generalized differential equation of heat conduction in Cartesian co-ordinates, its reduction to Fourier, Laplace and Poisson's equations, Generalized Heat conduction equation in cylindrical and spherical coordinates (no derivation). Heat conduction through plane wall; cylinder; sphere, electrical analogy, concept of thermal resistance and conductance, composite slab, composite cylinder and composite sphere, critical radius of insulation for cylinder and sphere.	07
Unit 2: Heat Conduction with Heat Generation and Unsteady State Heat Conduction One dimensional steady state heat conduction with heat generation: One dimensional steady state heat conduction with uniform heat generation for plane wall; cylinder; and sphere (with numerical on plane wall and cylinder & sphere) One dimensional unsteady state heat conduction: Lumped Heat capacity Analysis, Biot and Fourier number and their significance.	07

Unit 3: Extended Surfaces Temperature boundary conditions, heat flux boundary condition, convection boundary condition and radiation boundary condition. Types and applications of fins, Heat transfer from rectangular and pin fins. Fin effectiveness and efficiency, Analysis of fin with insulated end and infinite long fin, Error estimation in temperature measurement in thermo well.	06
Unit 4: Convection Mechanism of natural and forced convection. Concept of Hydrodynamic and thermal boundary layer, Local and average convective coefficient for laminar and turbulent flow for flat plate and pipe. Natural convection: Dimensional analysis, Physical significance of dimensionless numbers, correlations for natural convection over vertical plate, cylinder, & sphere and flow patterns. **Forced convection**: External Flow: Thermal analysis of flow over flat plate, cylinder, sphere, flow across tubes. Internal Flow: thermal analysis of convection correlations for circular & non circular tubes. Dimensional analysis, Physical significance of dimensionless numbers, Reynolds analogy for laminar flow.	07
Unit 5: Radiation Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power total emissive power & emissivity, concept of black body, gray body, and white body Kirchhoff's law, Wein's law and Planck's law, deduction of Stefan Boltzmann law. Lambert cosine rule, Intensity of radiation. Energy exchange by radiation between two black surfaces with non absorbing medium in between and in absence of reradiating surfaces. Geometric shape factor and its characteristics. Energy exchange by radiation between two gray surfaces without absorbing medium, concept of radiosity and irradiation. Radiation network method, network for two surfaces, radiation shields.	07
Unit 6: Heat Exchangers & Phase change phenomenon Heat Exchangers: Classification and types of heat exchangers, Fouling factor, and	06

Overall heat transfer coefficient, Heat Exchanger analysis using LMTD and NTU methods for parallel and counter flow, the effectiveness by NTU Method. Design consideration of Heat exchangers and introduction to design standards like TEMA. Heat pipe (elementary treatment only) Boiling & Condensation: Types of boiling, Pool boiling and forced convection boiling, Film wise and drop wise condensation.	

Textbook:

1. "Heat Transfer", J.P. Holman, Tata McGraw Hill Book Company, New York, 2nd Edition.
2. "Fundamentals of Heat and Mass Transfer", R.C. Sachdeva, Willey Eastern Ltd.,
3. "Heat and Mass Transfer", S .C. Arrora and S. Dokoundwar, Dhanpat Rai and Sons, Delhi.

Reference Books:

1. "Heat Transfer – A Practical approach",Yunus. A . Cengel, Tata McGraw Hill.
2. "Heat Transfer" Chapman A.J., Tata McGraw Hill Book Company, New York.
3. "Fundamentals of Heat and Mass Transfer", Frank P. Incropera, David P.Dewitt, Wisley India. 5th Edition.
4. "Heat and Mass Transfer", R. K. Rajput, S. Chand and Company Ltd., New Delhi.,5th Edition.
5. "Heat and Mass Transfer", Dr. D.S. Kumar, S. K. Kataria and Sons, Delhi.
6. "Heat Transfer", P. K. Nag, Tata McGraw hill Publishing Company Ltd., New Delhi.

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Course Plan

Course Title : **Metallurgy Lab**	
Course Code : **201MEP302**	**Semester : V**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	ESE (OE) Marks : 25

Prerequisite: Engineering Physics, Engineering Chemistry & Manufacturing Proc

Course Description:
This course student will able to understand various mechanical properties by conducting mechanical testing. Students will get acquaint with microstructure and composition of metals and its alloys.

Course Objectives:

1. To acquaint students with the basic concepts of Metallurgical Microscope and study microstructure of Ferrous and Non- Ferrous alloys.
2. To understand fundamental knowledge of Destructive and Non Destructive testing
3. To understand basic concepts of Hardenability and Heat treatment processes
4. To understand basic concepts spectrometry for Ferrous and Non Ferrous alloy

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO302.1	**Classify** phases in microstructure of ferrous and Non -ferrous alloys.	L2
CO302.2	**Analyze** result obtained from Destructive and Non Destructive testing.	L3
CO302.3	**Select** appropriate heat treatment processes for industrial applications.	L3
CO302.4	**Choose** appropriate metal based of composition obtained by spectrometry.	L2

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Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO302.1	2	2	-	-	-	-	-	-	2	2	-	2	2	-
CO302.2	2	2	-	-	-	-	-	-	2	2	-	2	2	-
CO302.3	2	2	2	-	-	-	-	-	2	2	-	2	2	2
CO302.4	2	2	2	-	2	-	-	-	2	2	-	2	2	-

List of Assignments/Experiments			
Sr. No.	Name of Assignments/Experiment	Type	Hrs.
1	Introduction to Metallurgical Microscope	S	2
2	Destructive Testing: -. Introduction to Tensile, Compressive, Impact, Hardness (Rockwell, Brinell and Vickers Hardness testing (Rockwell and Brinell)	S &O	4
3	Destructive Testing: -. Impact testing (Izod and Charpy) of M.S, Brass and Al Alloy.	S &O	2
4	Non- Destructive Testing: (Demonstrate Any two) Introduction to Non destructive testing Dye Penetrant, Magnetic, Ultrasonic, Radiography, Eddy Current testing.	S	4
5	Macroscopic Examinations Spark Test.	S	2
6	Sample preparation and study of microstructure of ferrous Alloy (Steel and Cast Iron)	O	2
7	Sample preparation and study of microstructure of ferrous Alloy (copper, Brass and aluminum)	O	2
8	Heat treatment of steels ((Annealing, Normalizing, Hardening on medium/ high carbon steels)	O	2
9	Jominy end - quench test for hardenability	S	2
10	Spectroscopy for Ferrous and Non-Ferrous	O	2

❖ **S-STUDY, O-OPERATIONAL**

Textbook:

1. "Material science and Engineering",W.D Callister, Wiley India Pvt.Ltd., 5th Edition.
2. "Testing of Materials" Vernon John Springer Link 1992

Reference Books:

1. ASM Handbook Volume 9: Metallographic and Microstructures
2. ASM Handbook Volume 8: Mechanical Testing and Evaluation
3. ASM Handbook Volumes 4A, 4B, 4C, 4D, 4E Heat Treating Set

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc22_mm05/preview
2. https://archive.nptel.ac.in/courses/113/102/113102080/

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Course Plan

Course Title : **Tool Engineering Lab**	
Course Code : **201MEP303**	**Semester : V**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	ESE Marks :

Prerequisite: Manufacturing processes, Production Drawing, Limits and Fits, Metallurgy,

Course Description:

Tool Engineering is mainly focused on metal cutting principles and tool design. It includes machinability aspects, cutting tool geometries and other aspects of machining like surface finish, heat generation and cutting forces . Design of jigs, fixtures and dies is main focus of the course, wherein student will design and prepare manufacturing drawings of jigs and fixtures. Design of progressive and drawing die are also included to study sheet metal operations in details.

Course Objectives:

1. To study metal cutting technology
2. To understand the locating principles of locating devices
3. To understand the principles of clamping devices
4. To understand the principles of designing locating and clamping devices
5. To understand the function of Jigs, fixtures and dies
6. To understand the design practices of Jigs, fixtures and dies

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO303.1	**Discuss** machinability and tool life aspects for various machining processes	L2
CO303.2	**Understand** important elements of Jigs, Fixtures	L2
CO303.3	**Design** drilling jig and milling fixture	L4
CO303.4	**Prepare** 3D model of Jigs and Fixtures.	L4

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Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO303.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO303.2	3	2	-		-	-	-	-	-	-	-	-	-	-
CO303.3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO303.4	3	2	-	-	2	-	-	-	-	-	-	-	2	-

List of Assignments/Experiments			
Sr. No.	**Name of Assignments**	**Type**	**Hrs.**
1	Selection of turning tool holders with ISO specification	S	2
2	Demonstration and measurement of effect of speed, feed data on surface finish (Tuning/milling operation)	O	2
3	Force measurement by tool dynamometers for lathe/drilling/milling operation	O	2
4	Study and design of various elements of jigs and fixture with standard fasteners	S	2
5	Design and drawing of jig for drilling / reaming/ tapping operation. (Assembly & Details on A2 size sheet showing manufacturing drawing with tolerances, material specification and heat treatments, standard components like screw, nut, bolt, pins etc)	S	4
6	Design and drawing of jig for drilling / reaming/ tapping operation (Only assembly drawing on A2 size sheet mentioning the fits)	S	2
7	Design and drawing of milling fixtures. (Assembly and Details on A2 size sheet showing manufacturing drawing with tolerances, material specification and heat treatments, standard components like screw, nut, bolt, pins etc.)	S	2
8	Demonstration of drilling jig/milling fixture setting on actual machine table	O	2
9	Design and drawing of milling fixtures. (Only assembly drawing on A2 size sheet mentioning the fits)	S	2
10	Design and drafting using any CAD software for above any one Jig, fixture or die showing assembly	O	4
11	Industrial visit to study the actual use of Jigs, Fixture and dies	S	-

❖ **S-STUDY, O-OPERATIONAL**

Textbooks:

1. Manufacturing Technology, Volume-2, P.N. Rao, TMH
2. Jigs and Fixture, P. H. Joshi, Tata Mc-Graw Hill Pub. Co
3. A Text Book of Prod. Engineering, P. C. Sharma, S. Chand

Reference Books:

1. Metal cutting theory and cutting tool design, V. Arshinov, G. Alekseev, MIR Publisher
2. Tool Design, Donaldson, TMH
3. An Introduction to Jig & Tool Design, M.H.A. Kempster, ELBS
4. Jigs and Fixture Design Manual, Henrikson, Industrial Press, NY
5. Fundamentals of Tool Design, Ed. Frank Wilson, ASTME, TMH
6. Techniques of Press Working of Metals by Eary and Reed
7. CMTI Machine Tool Design Handbook, TMH

Online Resources:

1. https://nptel.ac.in/courses/112105127
2. https://archive.nptel.ac.in/courses/112/105/112105306/
3. https://archive.nptel.ac.in/courses/112/105/112105233/

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Course Plan

Course Title : **Heat Transfer Lab**	
Course Code : **201MEP305**	**Semester : V**
Teaching Scheme : L-T-P : 0**-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	ESE(POE)Marks :**25**

Prerequisite: Fluid Mechanics, Applied thermodynamics.

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:

1. To provide the students the fundamentals of conduction, convection and radiation.

2. 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 Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO305.1	**Explain** fundamentals of Heat and Mass Transfer mechanisms	L2
CO305.2	**Evaluate** heat transfer coefficients for natural convection, for forced convection inside ducts, for forced convection over exterior surfaces..	L3
CO305.3	**Analyze** the performance of heat exchangers	L4
CO305.4	**Estimate** the rate of heat transfer at specified temperature difference	L5
CO305.5	**Evaluate** radiation heat transfer between black body surfaces and heat exchange between gray body surfaces.	L3

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Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO305.1	3	1	-	-	-	-	-	-	2	-	-	-	-	2
CO305.2	3	3	-	2	-	-	-	-	2	-	-	-	-	2
CO305.3	3	2	-	-	-	-	-	-	2	-	-	-	-	2
CO305.4	3	2	-	-	-	-	-	-	2	-	-	-	-	2
CO305.5	3	2	-	-	-	-	-	1	2	-	-	-	-	2
CO305.6	3	1	-	-	-	-	-	-	2	-	-	-	-	2

List of Assignments/Experiments

Sr. No.	Details	Type	Hrs.
1	Determination of thermal conductivity of Insulating powder.	O	2
2	Determination of thermal conductivity of a Metal rod	O	2
3	Determination of thermal resistance and temperature distribution in a Composite wall	O	2
4	Determination of thermal conductivity of insulating material in Lagged pipe.	O	2
5	Determination of local and average heat transfer coefficient in Natural convection heat transfer from a vertical cylinder.	O	2
6	Determination of Heat Transfer Coefficient under forced convection to air from a Heated pipe.	O	2
7	Determination of emissivity of a Nonblack surface.	O	2
8	Determination of Stefan Boltzmann Constant.	O	2
9	Determination of Critical Heat Flux	O	2
10	Determination of overall heat transfer coefficient and effectiveness in a Parallel flow and Counter flow Heat Exchanger.	O	2
11	Determination of heat transfer coefficient in drop wise and film wise condensation	O	2
12	Heat Pipe Demonstration	O	2

❖ **S-STUDY, O-OPERATIONAL**

Textbook:

1. "Heat Transfer", J.P. Holman, Tata McGraw Hill Book Company, New York, 2nd Edition.
2. "Fundamentals of Heat and Mass Transfer", R.C. Sachdeva, Willey Eastern Ltd.,
3. "Heat and Mass Transfer", S .C. Arrora and S. Dokoundwar, Dhanpat Rai and Sons, Delhi.

Reference Books:

1. "Heat Transfer – A Practical approach",Yunus. A . Cengel, Tata McGraw Hill.
2. "Heat Transfer" Chapman A.J., Tata McGraw Hill Book Company, New York.
3. "Fundamentals of Heat and Mass Transfer", Frank P. Incropera, David P.Dewitt, Wisley India. 5th Edition.
4. "Heat and Mass Transfer", R. K. Rajput, S. Chand and Company Ltd., New Delhi.,5th Edition.
5. "Heat and Mass Transfer", Dr. D.S. Kumar, S. K. Kataria and Sons, Delhi.
6. "Heat Transfer", P. K. Nag, Tata McGraw hill Publishing Company Ltd., New Delhi.

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Course Plan

Course Title : **3D Modeling lab**	
Course Code : **201MEP306**	Semester :**V**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	ESE(POE) Marks : **25**

Pre-requisites: Engineering Graphics , Fundamentals of drawings, Machine Drawing, Auto CAD

Course Description:

The student will emphasize the use of CAD on computer workstations as a major graphical analysis and design tool. Students will develop design skills, and practice applying these skills. Hands-on creativity, teamwork, and effective communication are emphasized.

Course Objectives:

1. Understand Parametric Modeling Fundamentals and Procedure
2. Develop an ability to create constrained 2-D Sketches.
3. Create 3 D Models of machine components.
4. Create surface models using surfacing tools
5. Create assembly model with drafting.
6. Create detailed drawings using suitable 3 D modeling software

Course Outcomes:

At the end of the course student should be able to:

CO	Statement	BTL
CO306.1	**Understand** Parametric Modeling Fundamentals and Procedure	L2
CO306.2	**Develop** an ability to create constrained 2-D Sketches.	L3
CO306.3	**Prepare** 3 D Models of machine components.	L3
CO306.4	**Prepare** surface models using surfacing tools	L3
CO306.5	**Prepare** assembly model with drafting.	L3
CO306.6	**Prepare** detailed drawings using suitable 3 D modeling software	L3

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO306.1	2	2	-	-	2	-	-	-	-	-	-	-	1	-
CO306.2	2	2	-	-	2	-	-	-	-	-	-	-	1	-
CO306.3	2	2	-	-	2	-	-	-	-	-	-	-	1	-
CO306.4	2	2	-	-	2	-	-	-	-	-	-	-	1	-
CO306.5	2	2	-	-	2	-	-	-	-	-	-	-	1	-
CO306.6	2	2	-	-	2	-	-	-	-	-	-	-	1	-

***Note: PO5 (Justification):** Prepare models by using 3 D modeling software like NX, CATIA to achieve PO5.

Course Content

Content	Hours
Unit 1: Introduction to CAD Introduction to CAD, Introduction to different CAD software, Introduction to graphical user interface (GUI), Application and modification of contents and dimensions, Concept of feature based and parametric modeling	2
Unit 2: Sketching 2D sketching of elements like line, circle, arc, spline etc Geometrical constraints like parallel, perpendicular, co-incident, vertical, horizontal, tangent, symmetric etc.	4
Unit 3: Part Modeling Conversions of 2D into 3D modeling, creating base features, creating dress up and hole features, Editing features and transformation features, Introduction to import and export of 3D models, Physical properties like volume, surface area, center of gravity etc of 3 D model.	6
Unit 4: Introduction to Surfacing Introduction to surface models using various commands	4
Unit 5: Assembly Modeling Introduction to the assembly environment, Types of assembly design approach-bottom-up and top-down assembly. Creating assembly and sub-assemblies, Editing and modifying assembly relationships, Creating exploded view of the assembly	4
Unit 6: Drafting Generation of Orthographic views [working drawings] from 3D model. Generation of title block in sheet. Orthographic views of assembly drawings, generation of Bill of Materials (BOM). Plotting of drawings.	4

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List of Assignments			
Sr. No.	**Name of Assignments**	**Type**	**Hrs.**
1	Prepare two 2 D drawings in Sketcher environment	D	2
2	Prepare 3 D models using 3 D modeling features (Model 1)	D	2
3	Prepare 3 D models using 3 D modeling features (Model 2)	D	2
4	Prepare 3 D models using 3 D modeling features (Model 3)	D	2
5	Prepare two surface models using various commands	D	2
6	Prepare two assembly models	D	4
7	Drafting of above 3D models and surface models	D	2
8	Drafting of above assemblies along with exploded view	D	4
9	Retrieving physical properties for different component materials.	D	2
10	Plotting of above drawings on A2/A3/A4 sheet	D	2

❖ **S-STUDY, O-OPERATIONAL, D-DRAWING SHEET**

Note: Latest 3D modeling software like NX, CATIA and any advance software are to be used.

Textbook:

1. N. D. Bhatt, "Machine Drawing", Charotor Publication House, Bombay, 46th Edition.
2. CAD / CAM, Theory and Practice by Zeid, (TMH)
3. CAD / CAM, Principles & Applications by P. N. Rao (TMH)

Reference Books:

1. K. L. Narayana, "Machine Drawing", New Age Publication
2. K. Venugopal, "Engineering Drawing and Graphics", New Age Publication
3. R. K. Dhawan, "A text book of Engineering Drawing", S. Chand and Co.
4. W. J. Luzadder, "Fundamentals of Engineering Drawing", Prentice Hall of India.
5. N. B. Shaha and B. C. Rana, "Engineering Drawing", Pearson Education, 2nd Edition.
6. Various 3D modeling Software Manuals.

Online Resources:

1. https://archive.nptel.ac.in/courses/112/102/112102304/

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Course Plan

Course Title : **Machining Technology Lab**	
Course Code : **201MEP307**	**Semester : V**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	ESE Marks :

Prerequisite: Workshop Practice-III, Manufacturing Processes, Machine Tools

Course Description:

This course is designed to provide students hands on demonstrations on various Machines along with the operations carried out on the same. Also, it provides fundamental information regarding CNC, G & M Code processes.

Course Objectives:

1. To provide an insight to different machine tool, accessories and attachments.
2. To inculcate team qualities and expose students to shop floor activities.
3. To train students into machining operation to enrich their practical skills.
4. To educate students about ethical, environmental and safety standards.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO307.1	Understand various type machine material and their EN codes	L2
CO307.2	Understand precautions and safety norms followed in Machine Shop	L2
CO307.3	Prepare process sheet to manufacture a component and implement the same	L3
CO307.4	Perform different operations like drilling, internal taper turning, milling, die threading, tapping	L6
CO307.5	Understand basics of CNC Programming.	L2

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO307.1	3	2	-	-	-	-	-	-	1	-	-	-	2	-
CO307.2	2	2	-		-	-	2	-	1	-	-	-	2	-
CO307.3	3	2	-	-	-	-	-	-	2	-	-	-	2	-
CO307.4	3	2	-	-	-	-	-	-	2	-	-	-	2	-
CO307.5	3	2	-	-	2	-	-	-	-	-	-	-	-	-

List of Assignments/Experiments			
Sr. No.	**Name of Assignments/Experiments**	**Type**	**Hrs.**
1	Study of various materials for machining, grades of materials	S	2
2	Study precautions and safety norms followed in Machine shop	S	2
3	Demonstration of basic measuring instruments to carry out Inspection of job	O	2
4	Prepare process sheets with working drawings for all components.	O	2
5	Performing drilling and boring operations on lathe machine.	O	2
6	Performing internal taper turning operation on lathe machine.	O	2
7	Performing die threading and tapping operations.	O	2
8	Demonstration of various operation of milling machine.	O	2
9	Study of Non convention Machining Methods (Theoretical).	S	2
10	Demonstration of CNC & Learning G & M code	O	2
11	Industrial Visit to study the following machining operations: a. Grinding b. Broaching c. Gear manufacturing d. Non-conventional machining e Special purpose machines	O	2
12	Submission of a. Industrial Visit Report	O	2

	b. Workshop Diary c. Process Sheets d. Job along with Internal Oral		

❖ **S-STUDY, O-OPERATIONAL**

Note:

1. The load of Workshop Practice IV will be allotted to the Teaching Faculty.
2. Assessment of Journal based on above Term Work and Industrial Visit Report.
3. Term work will consist of Job Carrying 15 Marks, Journal Assessment along with internal oral 10 marks.

Textbook:

1. Workshop Technology Vol 1 & 11 by Hajra Chaudhary, (Media Promoters & PublishersPvt. Ltd.)
2. Workshop Technology Vol. 1. I and III by W A.J. Chapman, (ELBS)
3. A Course on Workshop Technology-Vol 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co)

Reference Books:

1. Workshop Technology Vol. III-Chapman (ELBS)
2. Workshop Technology Vol. II by Bawa 11. S. (TMH)

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Course Plan

Course Title : **Material Handling Systems**	
Course Code : **201MEMC308**	Semester : **V**
Teaching Scheme : L-T-P : 2**-0-0**	Credits : 0
Evaluation Scheme : ISE Marks :	ESE(POE) Marks :**- 50**

Prerequisite: Manufacturing processes and Machine Tools and Processes.

Course Description:

The Course Material Handling System mainly focuses on study of various machines/equipment used in industries for effectively handling the materials. The course includes study and selection of most efficient, safe and appropriate material handling equipment, which can fulfil material handling requirement at minimum cost.

Course Objectives:

7. To provide knowledge on materials handling equipment.
8. To provide knowledge on conveyor equipment.
9. To provide knowledge on Industrial trucks
10. To provide knowledge on Auxiliary Equipment.
11. To provide knowledge on hoisting appliances
12. To provide knowledge on cranes.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO308.1	**Learn** the basic concepts of material handling equipment.	L2
CO308.2	**Understand** the basic working principles of various conveyors.	L2
CO308.3	**Understand** the basic working principles of various industrial trucks.	L2
CO308.4	**Understand** the basic working principles of various cranes.	L2
CO308.5	**Select** of conveyer and electric hoist.	L2
CO308.6	**Discuss** Automated Material Handling and safety precautions for material handling equipments.	L2

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO308.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO308.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO308.3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO308.4	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO308.5	3	2	-	-	-	-	-	1	-	-	-	-	-	-
CO308.6	3	2	-	-	-	2	-	-	-	-	-	-	-	-

Course Content

Content	Hours
Unit 1: Introduction: Definition, scope, basic concepts, principles of material handling, economics of handling, Concepts of unit load, containerization and palletization. Facilities Design Function: Scope, objectives and types; relationship of plant layouts with material handling, factors to be considered for plant layout design; Space planning for various activities like office, storage, and production etc., factors - area allocation, location, relative positions, future expansion.	04
Unit 2: Material Flow: Operation sequence, material flow pattern, Part flow analysis in group technology, stages of material flow - at receiving, in process and at shipping, flow planning criteria and design of flow pattern.	04
Unit 3: Warehousing: Concept, Types, Storage and design considerations for in-house warehouses.	03
Unit-4: Equipment for Material Handling Systems for Various Materials: **Storing equipment's** like pallets, bins, racks, decking, order picking, positioning equipment's.	05

Hoisting equipment like jacks, pulleys, hand trolleys, hoists, power hoist, various types of cranes and elevators. **Equipment for Material Movement:** Conveying equipment's like belt, chain, roller, wheel, trolley, tray conveyors, gravity and vibratory type conveyors, screw conveyors. **Mobile equipment** like hand trucks, fork lift trucks, powered industrial trucks and tractors, powered stackers, reach trucks, order pickers.	
Unit 5: Design and Selection of M. H. Equipment: Factors affecting, procedure for selection, design of conveyor, electric hoist, case studies.	04
Unit 6: Automated Material Handling: Need, Comparison with conventional systems, equipment's like industrial robots and automatically guided vehicles, ASRS, use of simulation software for design of m. h. system. Safety and Training: Need, environmental and human factors in material handling.	04

Textbooks:

1. Introduction to Material handling -Siddhartha Ray,(New Age International Publishers)
2. Plant Layout and Material Handling-R.B.Choudary, G.R.N.Tagore (Khanna Publishers)

Reference Books:

1. Material Handling - Immer J. R. (McGraw Hill)
2. Plant Layout & Material Handling - James Apple (John Wiley)
3. Material Handling System Design - James Apple ((John Wiley)
4. Material Handling Principles & Practice - Theodore H. Allegre Sr. (CBS Publishers & Distributors)
5. Facilities Planning – 3/e, Tompkins, White, Bozer, Tanchoco (John Wiley & Sons)
6. Material Handling Handbooks 7. Work Study - O. P. Khanna (Dhanpatrai & Sons)

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Course Plan

Course Title : **Internal Combustion Engines**	
Course Code : **201MEL309**	**Semester :VI**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Fundamentals of Mechanical Engineering, Applied Thermodynamics

Course Description:

This course studies the construction details of SI and CI engines, fundamentals of the design and operation of internal combustion engines, affect their performance, efficiency, fuel requirements, and environmental impact of IC engines and methods of controlling emissions.

Course Objectives:

1. To make the students familiar with the different parts and working of IC engines
2. To make students understand Engine thermodynamics
3. To make the students understand about the Fuel system for SI and CI engines
4. To make the students understand about the combustion phenomenon of SI and CI engines
5. To teach students performance calculation of SI and CI engines.
6. To make the aware about engine pollutants and pollution control methods Indian pollution norms

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO309.1	**Understand** fundamentals of IC engines	L2
CO309.2	**Understand** fuel system used in SI and CI engines	L2
CO309.3	**Describe** the combustion phenomenon in SI	L2
CO309.4	**Describe the** combustion phenomenon in CI engines	L2
CO309.5	**Calculate** the engine performance parameters	L3
CO309.6	**Understand** emission control technologies for SI and CI engines	L2

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Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO309.1	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO309.2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO309.3	3	2	-	-	-	-	-	-	-	-	-	-	-	1
CO309.4	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO309.5	3	2	3	-	-	-	-	-	-	-	-	2	-	2
CO309.6	3	-	-	-	-	2	2	-	-	-	-	2	-	2

Course Content

Content	Hours
Unit 1: Introduction to IC engine Introduction of I. C. Engines, Types of engines, working of engine, Nomenclature of engine, Otto cycle, Diesel cycle Fuel air cycles Characteristics of fuel - air mixtures Actual cycles, Valve timing diagram for high and low speed engine, Port timing diagram	06
Unit 2: Fuel Systems **Fuel Systems for S.I. Engines:** Engine fuel requirements, Simple carburetor, Complete Carburetor , Solex carburettor, A/F ratio, Electronic Petrol injection system (MPFI) like DMPFI, LMPFI– components such as sensors, ECU etc. **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, Electronic diesel injection system.	07
Unit 3: Combustion in SI Stages of combustion, Ignition lag, Flame propagation, Factors affecting flame speed, Abnormal combustion, Influence of engine design and operating variables on detonation, Fuel rating, Octane number, Fuel additives, HUCR, Requirements of combustion chambers of S.I. Engines and its types.	07

Unit 4: Combustion in CI Stages of combustion, Delay period, Factors affecting delay period, Abnormal combustion- Diesel knock, Influence of engine design and operating variables on diesel knock, Comparison of abnormal combustion in S.I. and C.I. Engines, Cetane number, Additives. Requirements of combustion chambers for C.I. Engines and its types	06
Unit 5: Engine Performance: Performance parameters, Measurement of Performance Parameters Like Torque, Power, and Volumetric Efficiency, Mechanical Efficiency, BSFC, Brake and Indicated Thermal efficiencies. Numerical on Heat Balance Sheet and engine performance.	08
Unit 6: Engine Emissions and Controls Introduction to Supercharging and Turbo-charging, 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, Driving Cycles, Standard pollution Norms like EURO, Bharat, Introduction to alternative fuels for I.C. engines.	06

Textbook:

1. "Internal Combustion Engines", Ganesan. V. , Tata McGraw Hill
2. "A Course in Internal Combustion Engines", Mathur & Sharma, R. P. Dhanapat Rai, Publications.
3. "Internal Combustion Engines", Domkundwar, Dhanpat RaiPublication.

Reference Books:

1. "Internal Combustion Engines", Maleev, CBS Publication andDistributors.
2. "Internal Combustion Engines", J. B. Heywood,Tata McGraw Hill Publication.
3. "Internal Combustion Engines",Gills and Smith , Oxford and IBH PublishingCompany
4. "Diesel and High Compression Gas Engines", P. M.Kates.
5. "Internal Combustion Engines Fundamentals", E. F. Obert, Harper and Row Publication ,New York
6. "Engineering Fundamentals of the I.C.Engines", W.W.Pulkrabek , PearsonEducation

Online Resources:

1. https://archive.nptel.ac.in/courses/112/103/112103262/
2. https://nptel.ac.in/courses/112104033
3. https://archive.nptel.ac.in/noc/courses/noc19/SEM1/noc19-me10/

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Course Plan

Course Title : **Machine Design**	
Course Code : **PCC201MEL310**	**Semester : VI**
Teaching Scheme : L-T-P : **3-0-2**	Credits : **4**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Strength of Material, Theory of Machine, Design of Machine Elements

Course Description:

This course is in continuation with design of Machine element. The Machine design course deals with design of the mechanical components against fluctuating load. It aims to acquire knowledge of designing procedures of transmission elements such as gears, rolling contact bearings and sliding contact bearings and pressure vessels. This course is also concerned with consideration involved in selection various elements of all machine tools.

Course Objectives:

1. **To study** machine elements subjected to fluctuating loading
2. **To study** rolling contact bearings used and hydrodynamic bearing for mechanical systems
3. **To understand** theories and principles used in design of pressure vessels.
4. **To design** various types of gears using strength and wear considerations
5. **To study** the concept of machine tool structures design.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO310.1	**Apply** fundamental principles of fatigue and stress concentration while designing various components subjected to fluctuating loading.	L3
CO310.2	**Select** rolling contact bearings from manufacturer's catalogue and solve the problems on hydrodynamic bearing.	L3
CO310.3	**Apply** theories and principles used in design of pressure vessels.	L3
CO310.4	**Execute** design procedure for spur and helical gears	L3
CO310.5	**Execute** design procedure for bevel and worm gears	L3
CO310.6	**Understand** the concept of machine tool structures design	L2

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO310.1	2	2	2	1	-	1	-	1	-	-	-	1	1	-
CO310.2	2	2	2	1	-	1	-	1	-	-	-	1	1	1
CO310.3	2	2	2	1	-	1	-	1	-	-	-	1	1	-
CO310.4	2	2	2	1	-	1	-	1	-	-	-	1	1	-
CO310.5	2	2	2	1	-	1	-	1	-	-	-	1	1	1
CO310.6	2	2	2	1	-	1	-	1	-	-	-	1	1	-

Course Content

Content	Hours
Unit 1: Design for Fluctuating Loads Stress concentration - causes and remedies, 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, Cumulative damage in fatigue failure, Goodman diagram, Modified Goodman diagram, Fatigue design for components under combined stresses	06
Unit 2: Design of Bearings **i) Introduction to Tribological consideration in design** Friction, Wear, Lubrication **ii) Rolling Contact Bearing** Types, Static and dynamic load capacities, Steinbeck's equation, Equivalent bearing load, Load-life relationship, Bearing life, Load factor, Selection of bearing from manufactures catalogue, Design for variable load and speed, Bearings with probability of survival other than 90 %. Mountings, Dismounting and preloading of bearings. **iii) Sliding contact bearing** Types of sliding contact bearing, Basic theory, thick and thin film lubrication, Reynolds's equation(No equation), Raimondi and Boyd method relating bearing variables, Somerfield Number, Design consideration in hydrodynamic bearings, Temperature rise, Introduction to hydrostatic bearings	08

Unit 3: Pressure Vessel Design Types of pressure vessels, Thin and thick cylinders; Failure criteria of vessels; Lame's equation; Clavarino's and Birnie's equation; Autofrettage and compound cylinders; Classification of pressure vessel as per IS2825, 1969, Shell and end closures, Types of pressure vessel support	06
Unit 4: Design of Spur Gear and Helical Gear Introduction to Gears: Material selection, Types of gear failure. Methods of gear lubrication. **i) Spur Gear**: Force analysis, Static beam strength (Lewis equation) Barth equation, Dynamic tooth load (spot's equation and Buckingham equation), Wear strength (Buckingham's equation), design of spur gear. **ii) Helical Gears:** Formative number of teeth, Force analysis, Beam and wear strength, Effective load and design of helical gear**.**	08
Unit 5: Design of Bevel Gear and Worm Gear **i) Bevel Gear:** Straight tooth bevel gear terminology, Force analysis, Beam and wear strength, Dynamic tooth load, Design of straight tooth bevel gears based on beam and wear strength. **ii) Worm Gears:** Terminology, 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
Unit 6: Design of Machine Structures Introduction, Functions of Machine Tool Structure, Design Criteria for Machine Tool Structure, Design of Beds, Design of Columns, Design of Housing, Design of Spindle	06

Text Books :

1. "Design of Machine Elements", V.B.Bhandari., Tata McGraw Hill Publication, 3rd Edition.
2. "Mechanical Engineering Design" Shigley J.E. and MischkeC.R,McGraw Hill Publication. Co. Ltd
3. "Machine tool design", N K Mehta, Tata McGraw Hill Publication, 3rd Edition.

Reference Books:

1. "Design of Machine Element" M.F.Spotts, Prentice Hall Publication, 6th Edition.
2. "Machine Component Design",Robert C. Juvniall, Willey Ltd, 5th Edition.
3. "Machine Design", BlackP.H.andO.EugeneAdams, Tata McGraw Hill International.
4. "Design Data" – P.S.G. College of Technology, Coimbatore
5. "Bearing Manufacturers Catalogue".
6. "Machine Design" U.C.Jindal, Pearson Publication
7. "Machine Tool Design Handbook", CMTI publication

Online Resources:

1. https://onlinecourses.swayam2.ac.in/aic20_ed02/preview
2. https://onlinecourses.nptel.ac.in/noc22_de10/preview
3. https://onlinecourses.nptel.ac.in/noc22_de14/preview
4. https://onlinecourses.nptel.ac.in/noc22_me134/preview
5. https://onlinecourses.swayam2.ac.in/aic19_de04/preview
6. https://onlinecourses.nptel.ac.in/noc22_me133/preview

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Course Plan

Course Title : **Metrology and Quality Control**	
Course Code : **201MEL311**	**Semester : VI**
Teaching Scheme : L-T-P : **3-0-0**	Credits : **3**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Engineering Physics, Machine Drawing, Manufacturing Processes, Machine tools and Processes

Course Description:

The course Metrology and Quality Control is designed to impart the knowledge to develop measurement procedures, conduct metrological experiments, and obtain and interpret the results. The different methods and instruments which can be used for linear and angular measurements, geometrical parameters (like surface finish, Squareness, Parallelism, Roundness etc.) and the use of gauges and system of limits, Fits, Tolerances etc. are often required to be studied and used by Mechanical Engineer on the shop floor. He/she is also required to analyze, Interpret and present the data collected, graphically & statistically for ensuring the quality. The knowledge of the subject also forms the basis for the design of mechanical measurements systems, design & drawing of mechanical components. The course would be useful in many areas in the traditional and modern high technology viz. manufacturing, industrial, scientific research and many others.

Course Objectives:

1. Understand the principle/s, construction, working and use of linear, angle measuring instruments and comparator.
2. Understand the use of standards in measurement, limits, fits and tolerances.
3. Study the methods used for the measurement of screw threads and gears
4. Study the measurement of geometrical forms and surface roughness and Advances in metrology.
5. Understand the concept of quality and various SQC techniques.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO311.1	**Understand** use of measuring tools for linear and angular measurements.	L2
CO311.2	**Discuss** the basics of Limits, fits, tolerances and their role and importance in manufacturing.	L1
CO311.3	**Select** proper measuring instrument for screw thread and gear measurement.	L2
CO311.4	**Learn** advanced techniques of metrology in various industrial applications.	L2
CO311.5	**Understand** Quality Control and Quality assurance concepts.	L2
CO311.6	**Analyze** use of control charts and sampling plans.	L4

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO311.1	2	2	-	-	-	-	-	1	-	-	-	-	-	-
CO311.2	2	2	-	-	-	-	-	1	-	-	-	-	1	-
CO311.3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO311.4	2	2	-	-	2	-	-	-	-	-	-	-	-	-
CO311.5	2	2	-	-	-	-	-	-	-	-	-	-	-	1
CO311.6	2	2	-	1	-	-	-	-	-	-	-	-	-	-

Course Content

Content	Hours
Unit 1:Introduction to Metrology, study of Linear and Angular measurements Need of Metrology, Precision, accuracy, methods and errors in measurement, Introduction to calibration process. **Linear Measurements** International standards of length, line standard and end standard measurements, wavelength standard characteristics of measuring instruments for linear measurement, slip gauges. **Angular Measurements** Bevel Protractor, spirit level, angle gauges, sine bar, sin center, angle dekkor, auto collimator etc.	08
Unit 2: Study of Limits, Fits, Tolerance and Comparators **Limits, Fits and Tolerances** Importance of limits system in mass production, IS specifications of limits, unilateral and bilateral tolerances, types of fits (including Numerical) **Limit Gauges** Importance of limit gauges, Types, Taylors principle, design of plug and ring limit gauges (Including numerical) **Comparators** Need of comparators, Principle of operation, its uses in inspection and characteristics of I. Mechanical (dial indicator, bore dial gauge, Johnsons Mickrokator, Sigma Comparator. II. Optical (Optical profile projector, Tool makers microscope) III. Electrical and Electronic Comparator	07

IV. Pneumatics Comparator (Solex comparator)	
Unit 3: Measurement of Screw thread and Gear Screw thread terminology, thread form error, measurement of minor, major and effective diameter (two-three wire method), pitch measurement, floating carriage micrometer, screw thread micrometer. **Gear measurement** Measurement of tooth thickness, run-out checking, pitch checking, profile checking, alignment checking, Parkinson gear tester, errors in measurement.	07
Unit 4: Surface finish measurement and Advances in Metrology **Surface finish measurement** Types of textures obtained during machining operations, CLA, Ra, RMS, Rz values and their interpretation, direction of lays, texture symbols, symbols for designating surface finish, straightness, flatness, square, roundness on drawing, various instruments used in surface roughness assessment **Advances in Metrology** Principle of Coordinate measuring Machine(CMM), Types of CMM, Laser in Metrology, Machine Vision for inspection, Robotics inspection.	07
Unit 5: Introduction to Quality Control and Quality Assurance Concept of quality and Quality Control, role of Quality, dimension of quality, quality control and quality assurance. Quality of design and conformance, Cost of quality and value of quality, balance between cost and value of quality. **Quality Assurance** 7 QC tools (new), Quality Circles, Introduction to 6 Sigma and 5S system.	05
Unit 6: Statistical Quality control and Acceptance Sampling Importance of statistical method in quality control, ND curve, types of control charts (numerical treatments on X bar, R,P and C charts)their construction and applications, process capability. **Acceptance Sampling** Basic concept of sampling inspection, Single sampling and double sampling plan, Operating characteristics curves.	06

Textbook:

1. "Engineering Metrology", I.C. Gupta, Dhanpat Rai Publications.
2. "Engineering Metrology", R.K.Jain, Khanna Publisher.

Reference Books:

1. "Practical Engineering Metrology", Sharp K.W.B. Pitman, London.
2. "Statistical Quality Control", A.L. Grant, Tata McGraw Hill International, New York. 6th Edition.
3. "Statistical Quality Control", R.C. Gupta,9th Edition.
4. "Engineering Metrology", Hume K.G., MC Donald, Technical and Scientific, London ,2nd Edition.
5. "Quality Control and Indl Statistics", Duncon A.J., D.B. Taraporevela and Co. Bombay.
6. "Fundamentals of Quality Control and Improvement", Amitva Mitra, 3rd Edition.
7. "Statistical Quality Control", Douglas Montgomery, Wiley India Pvt. Ltd., 6th Edition.

Online Resources:

1. https://www.digimat.in/nptel/courses/video/112106179/L01.html
2. https://www.digimat.in/nptel/courses/video/112104250/L19.html
3. https://nptel.ac.in/courses/112/104/112104250
4. https://nptel.ac.in/courses/110/105/110105088/
5. https://nptel.ac.in/courses/112/107/112107259/

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T. Y. B. Tech. Curriculum
w.e.f. 2022-2023
Course Plan

Course Title: **Industrial Hydraulics and Pneumatics**	
Course Code: **201MEL312**	Semester: **VI**
Teaching Scheme: L-T-P: **3-0-0**	Credits: **3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks: **50**

Prerequisite: Basic Mechanical Engineering, Fluid Mechanics, Manufacturing Processes.

Course Description:

Fluid power systems are now extensively used in machine tools, material handling devices, transports and other mobile equipment. This course will provide the students the knowledge of fundamentals of fluid systems, working principles of various fluid system components and its applications in industry.

Course Objectives:

1. To study fundamentals of hydraulic and pneumatic system
2. To study construction and working principle of various elements of hydraulic system.
3. To study construction and working principle of control elements of hydraulic system.
4. To study construction and working principle of various elements of pneumatic system.
5. To understand working of hydraulic and pneumatic circuits.
6. To understand selection and sizing of fluid system elements.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO312.1	**Understand** fundamentals of hydraulic and pneumatic systems.	L2
CO312.2	**Explain** construction and working principle of various elements of hydraulic system.	L2
CO312.3	**Understand** construction and working principle of various control valves of hydraulic system.	L2
CO312.4	**Discuss** construction and working principle of various elements of pneumatic system.	L2
CO312.5	**Illustrate** the working hydraulic and pneumatic circuits.	L3
CO312.6	**Apply** knowledge of hydraulic and pneumatic system to select and design various fluid system components.	L3

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO312.1	3	-	-	-	-	-	-	-	1	1	-	-	-	-
CO312.2	2	2	-	-	-	-	-	-	1	1	-	-	-	-
CO312.3	2	2	-	-	-	-	-	-	1	1	-	-	-	-
CO312.4	2	2	-	-	-	-	-	-	1	1	-	-	-	-
CO312.5	2	2	-	-	-	-	-	-	1	1	-	-	-	-
CO312.6	2	2	2	2	-	-	-	-	-	-	-	-	1	-

Note: PO9, PO10 (Justification): A group of 4 to 5 students will be formed to prepare and present seminar on given topic.

Course Content

Content	Hours
Unit 1: Introduction to Fluid Power a) Classification, general features, applications in various fields of engineering,varioushydraulicandpneumaticISO/JICSymbols,transmissionofpowerat staticanddynamicstates,advantagesanddisadvantages b) Principle of hydraulic system, Types of hydraulic fluids and their properties, selection of fluid, effect of temperature on fluids. c) Introduction and Application of pneumatics, Physical properties, Principles, basic requirement of pneumatic system, comparison with hydraulic system.	08
Unit 2: Hydraulic System Elements a) Classification, types of seals, sealing material, pipes, hoses, compatibility of seal with fluid, sources of contamination and its control, strainer, filter, heat-exchanger, reservoir. b) Pumps-types, selection of pumps from Gear, vane, piston, screw, ball pump etc. for various applications. c) Actuators-linear and rotary, hydraulic motors, types of hydraulic cylinders and their mountings. Accumulators, intensifier and their applications.	08

Unit 3: Control of Fluid Power Elements a) Requirements of Pressure control, direction control and flow control valves. b) Principle of pressure control valves directly operated and pilot operated pressure relief valve, pressure reducing valve, sequence valves, counter balance valve. c) Principles and types of direction control valves-2/2, 3/2, 4/2, 4/3, 5/2. Open center, close center, tandem center, manual operated, mechanical operated solenoid, pilot operated direction control valves, check valves. d)Principles of flow control valves, temperature compensated, pressure compensated, temperature and pressure compensated flow control valve. e) Hydraulic servo system for linear and rotary motion.	08
Unit 4: Elements of Pneumatic System a) Air compressor- Types, selection criteria, capacity control, piping layout, fitting and connectors, Pneumatic controls, Direction control valves (two-way, three way, four way), check valves, flow control valves, pressure control valves, speed regulators, quick exhaust valves, time delay valve, shuttle valve and twin pressure valve. Solenoid operated, pilot operated valves, Pneumatic actuators, Rotary and reciprocating cylinders–types and their mountings, Air motor – types, Comparison with hydraulic and electric motor. b) Serving of compressed air–types of filters, regulators, lubricators (FRL unit), mufflers, and dryers. Maintenance, trouble shooting and safety of hydraulic and pneumatic system.	06
Unit 5: Hydraulic and Pneumatic Circuits and its Application a) Hydraulic Circuits i. Speed control circuits– Meter-in, Meter-out, Bleed off, Regenerative, Fast approach and slow traverse ii. Sequence circuits– Travel dependent and Pressure dependent iii. Synchronizing circuit. iv. Regenerative circuit. b) Pneumatic circuits i. Speed control circuits ii. Impulse operation circuit. iii. Sequence circuits.	06

iv. Time delay circuit. Note:5 circuits will be taught in practical session	
Unit 6: Selecting and Sizing of Fluid System Elements a) Power and pump efficiencies of hydraulic pump b) cylinder force and losses c) Oil flow velocity d) Cylinder efficiency e) Sizing of cylinder tubes f) Piston rod design	05

Text Books:

1. "Oil hydraulics Systems", S. R. Mujumdar, Tata McGraw Hill Publication.
2. "Pneumatic Systems", S. R. Mujumdar-Tata McGraw Hill Publication.
3. "Hydraulics and Pneumatics", Shaikh and Khan, R. K. Publication

Reference Books:

1. "Hydraulic and Pneumatic", H. L. Stewart, Industrial Press.
2. "Industrial Hydraulic", J. J. Pipenger, Tata McGrawHill.
3. "Power Hydraulics", Goodwin 1st Edition.
4. "Introduction to Hydraulic and Pneumatic", S. Ilangoand, V. Soundararajan, Prentice Hall of India, 2nd Edition.

Online Resources:

1. https://nptel.ac.in/courses/112106300
2. https://nptel.ac.in/courses/112105047

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T. Y. B. Tech. Curriculum
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Course Plan

Course Title : **Internal Combustion Engines Lab**	
Course Code : **201MEP309**	**Semester :VI**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE : **25**	ESE (POE) : **25**

Course Description:

This course will provide the student understanding various engine systems as well as testing procedure of various engine parameters

Course Objectives:

1. To make the students familiar with the basis of IC engines types and selection of engines.
2. To make the students familiar with different engine systems
3. To teach students about Carburetors and its various systems
4. To give students hands on experience on Engine testing procedures
5. To make students aware about emission testing procedure.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO309.1	**Understand** cconstructional detail of IC engines and selection of engines.	L2
CO309.2	**Explain** various Engine systems like Air intake, Exhaust, Cooling, Lubrication systems.	L2
CO309.3	**Interpret** Ignition systems and starting systems	L2
CO309.4	**Demonstrate** engine testing and performance parameters	L3
CO309.5	**Report** heat balance sheet on engine performance	L2
CO309.6	**Discuss** Pollution norms	L2

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO309.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO309.2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO309.3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO309.4	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO309.5	3	2	2	-	-	-	-	-	-	-	-	2	-	2
CO309.6	3	-	-	-	-	3	3	-	-	-	-	-	-	

List of Assignments/Experiments			
Sr. No.	**Name of Assignments/Experiments**	**Type**	**Hrs**
1	Constructional detail of I.C. engines and Selection and Specification of Engines.	S	2
2	Study and Demonstration of Engine systems: Air intake, Exhaust, Cooling, Lubrication systems	S	2
3	Study and Demonstration of Ignition systems, starting systems	S	2
4	Study and Demonstration of Carburetor and Petrol injection system	S	2
5	Study and Demonstration of fuel injection system of diesel engine	S	2
6	Test on four stroke Diesel Engine (variable compression).	O	2
7	Test on four stroke Diesel Engine (variable load).	O	2
8	Test on single cylinder four stroke Petrol Engine (Electrical Dynamometer).	O	2
9	Test on single cylinder two stroke Petrol Engine. (Rope Brake Dynamometer)	O	2
10	Morse Test on Multi Cylinder Engine	O	2
11	Test on computer controlled I.C. Engine	O	2
12	Industrial Visit to IC engine Manufacturing Unit	O	-
13	Visit to PUC center to understand exhaust emission testing procedure.	O	2

❖ **S-STUDY, O-OPERATIONAL**

Textbook:

1 "Internal Combustion Engines", Ganesan. V. , Tata McGraw Hill

2. "A Course in Internal Combustion Engines", Mathur & Sharma, R. P. Dhanapat Rai , Publications.

3. "Internal Combustion Engines", Domkundwar, Dhanpat RaiPublication.

Reference Books:

1. "Internal Combustion Engines",Maleev, CBS Publication andDistributors.
2. "Internal Combustion Engines", J. B. Heywood,Tata McGraw Hill Publication.
3. "Internal Combustion Engines",Gills and Smith , Oxford and IBH PublishingCompany
4. "Diesel and High Compression Gas Engines", P. M.Kates.
5. "Internal Combustion Engines Fundamentals", E. F. Obert, Harper and Row Publication ,New York
6. "Engineering Fundamentals of the I.C.Engines", W.W.Pulkrabek , PearsonEducation

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T. Y. B. Tech. Curriculum
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Course Plan

Course Title : **Machine Design Lab**	
Course Code : **201MEP310**	**Semester : VI**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	ESE(POE)Marks :**25**

Prerequisite: Strength of Material, Theory of Machine, Design of Machine Elements.

Course Description:

This course is in continuation with design of Machine element. The Machine design course deals with design of the mechanical components against fluctuating load. It aims to acquire knowledge of designing procedures of transmission elements such as gears, rolling contact bearings and sliding contact bearings and pressure vessels. This course is also concerned with consideration involved in selection various elements of all machine tools.

Course Objectives:

1. **To study** design of power transmission system involving spur and helical gears or bevel and worm and worm wheel.
2. **To select** rolling contact bearings from manufacturer's catalogue used for mechanical systems.
3. **To implement** design of pressure vessel with use of I.S. codes.
4. **To demonstrate** the various manufacturing process during industrial visit.
5. **To study** the concept of machine tool structures design.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO310.1	**Design** and draw detail and assembly drawing of power transmission involving i) Spur/helical gears **or** ii) Bevel gears/Worm and worm wheel.	L3
CO310.2	**Select** rolling contact bearings used for mechanical systems from manufacturer's catalogue.	L3
CO310.3	**Design** and draw detail and assembly drawing of pressure vessel.	L3
CO310.4	**Understand** the various manufacturing process during industrial visit.	L3
CO310.5	**Use** of design criteria for machine tool structures	L2
CO310.6	**Draw** CAD drawing of assembly of any one of the followings: Spur gear/ Helical gear or Bevel gear/ Worm and Worm wheel **or** pressure vessel.	L3

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T. Y. B. Tech. Curriculum
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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO310.1	2	2	2	1	-	1	-	1	1	1	-	1	1	1
CO310.2	2	2	2	1	-	1	-	1	1	-	-	1	1	1
CO310.3	2	2	2	1	-	1	-	1	1	1	-	1	1	-
CO310.4	2	2	2	1	-	1	-	1	1	1	-	1	1	-
CO310.5	2	2	2	1	-	1	-	1	1	-	-	1	-	-
CO310.6	2	2	2	1	1	1	-	1	1	-	-	1	-	-

List of Assignments/Experiments			
Sr. No.	**Name of Assignments/Experiments**	**Type**	**Hrs.**
1	Prepare a detail report of design procedure showing calculations and sketches of i) Spur gear/ Helical gear box or ii) Bevel gear/ Worm and Worm wheel box.	O	2.00
2	Draw a details and assembly drawing of i) Spur gear/ Helical gear box or ii) Bevel gear/ Worm and Worm wheel box on A2 size drawing sheet.	O	4.00
3	Assignments based on Study of Ball bearing mountings and its selection of bearings	S	2.00
4	Assignments on selection of bearings using Manufactures catalogue	S	2.00
5	Prepare a detail report of design procedure showing calculations and sketches of pressure vessel.	O	4.00
6	Draw a details and assembly drawing of pressure vessel	O	2.00
7	Industrial visit based on above syllabus	S	2.00
8	Design criteria for machine tool structures	S	2.00
9	Design of Machine tool components such as spindle, bed, column and housing	S	2.00
10	**Draw** cad drawing of assembly of any one of the followings: Spur gear/ Helical gear or Bevel gear/ Worm and Worm wheel or pressure vessel.	O	2.00

❖ **S-STUDY, O-OPERATIONAL**

Text Books:

1. "Design of Machine Elements", V.B. Bhandari., Tata McGraw Hill Publication, 3rd edition.
2. "Mechanical Engineering Design" Shigley J.E. and Mischke C.R , McGraw Hill Publication. Co. Ltd
3. "Machine tool design", N K Mehta, Tata McGraw Hill Publication, 3rd Edition.

Reference Books:

1. "Design of Machine Element" M.F.Spotts, Prentice Hall Publication, 6th Edition.
2. "Design Data" – P.S.G. College of Technology, Coimbatore
3. "Machine Component Design",Robert C. Juvniall, Willey Ltd, 5th Edition.
4. "Machine Design", Black P.H. and O.EugeneAdams, Tata McGraw Hill International.
5. "Bearing Manufacturers Catalogue".
6. "Machine Design" U.C.Jindal, Pearson Publication
7. "Machine Tool Desdign Data Book", CMTI Publication.

Online Resources:

1. https://onlinecourses.swayam2.ac.in/aic20_ed02/preview
2. https://onlinecourses.nptel.ac.in/noc22_de10/preview
3. https://onlinecourses.nptel.ac.in/noc22_de14/preview
4. https://onlinecourses.nptel.ac.in/noc22_me134/preview
5. https://onlinecourses.swayam2.ac.in/aic19_de04/preview
6. https://onlinecourses.nptel.ac.in/noc22_me133/preview

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T. Y. B. Tech. Curriculum
w.e.f. 2022-2023
Course Plan

Course Title : **Metrology and Quality Control Lab**	
Course Code : **201MEP311**	**Semester : VI**
Teaching Scheme : L-T-P : **0-0-2**	Credits : **1**
Evaluation Scheme : ISE Marks : **25**	ESE(POE)Marks :**25**

Prerequisite: Engineering Physics, Machine Drawing, Manufacturing Processes, Machine tools and Processes

Course Description:

This course deals with the study, use, demonstration and hands on practice of different types of measuring instruments, equipment's and machines used for measurement of various features/measurands of industrial parts and also apply knowledge of measuring instruments in actual industry practice.

Course Objectives:

1. To elaborate basic concepts of metrology, various standards and methods of dimensional measurement.
2. To explain importance of measurement of various parameters of screw threads, gears and surface quality by using different tools.
3. To make the students to identify quality aspects at various stages of product development.
4. To train the students to apply knowledge of statistical tools for analysis of quality.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO311.1	Select and use an appropriate linear, angular measuring instrument and comparator for inspection.	L3
CO311.2	Measure surface roughness, screw thread parameter and gear tooth parameter using appropriate instrument.	L3
CO311.3	Demonstration on CMM for dimensional and geometrical features.	L3
CO311.4	Plot normal distribution curve and control charts for a given manufacturing process.	L4

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO311.1	2	2	-	-	-	-	-	-	1	1	-	-	-	-
CO311.2	2	2	-	-	-	-	-	-	1	1	-	-	-	-
CO311.3	2	2	-	-	1	-	-	-	-	1	-	-	-	-
CO311.4	2	2	-	-	1	-	-	-	-	-	-	-	-	-

List of Assignments/Experiments			
Term work should consist of any 8 experiments from the following			
Sr. No.	**Name of Assignments/Experiments**	**Type**	**Hrs.**
1.	Perform linear measurement experiment using Vernier caliper, Vernier height gauge, and vernier depth gauge.	O	6
2.	Perform linear measurement experiment using Outside Micrometer, Inside Micrometer and Depth Micrometer.	O	2
3.	To check the bore diameter using Bore Dial Gauge.	O	2
4.	Perform angle measurement using Bevel protractor.	O	4
5.	Perform angle measurement using Sine bar.	O	2
6.	Use of comparators to inspect various dimensional and geometrical features.	O	2
7.	Use of optical profile projector for Screw thread measurement and gear tooth profile inspection.	O	2
8.	Use of Tool maker's microscope for profile inspection of various industrial parts.	O	2
9.	Use of gear tooth vernier caliper for measuring Chordal thickness of gear tooth.	S	4
10.	Measurement of surface roughness with portable surface roughness tester	S	-
11.	Screw thread measurement (major, minor and effective diameter) with the help of floating carriage Micrometer.	O	-
12.	Study and use of variable (Xbar and R chart) and attribute(P) chart using Mini tab.	O	-
Group Activity	A group of 5 students can select any one group activity given below- Students should collect drawing of a component from industry and suggest a measuring instrument / method to measure various dimension and geometric parameters in it.	S	-
Industrial Visits for studying Coordinate measuring machine (CMM), different comparators, various special measuring instruments and calibration process.			

❖ **S-STUDY, O-OPERATIONAL**

Textbook:

1. "Engineering Metrology", I. C. Gupta, Dhanpat Rai Publications, 7th Edition
2. "Engineering Metrology", R. K. Jain, Khanna Publications, 17th Edition
3. "Statistical Methods", S. P. Gupta, Danpat Rai and Sons, New Delhi, 2007

Reference Books:

1. "Engineering Metrology and Measurements", N. V. Raghavendra and L. Krishnamurthy, Oxford publication,2013 Edition.
2. "Practical Engineering Metrology", Sharp K.W.B., Pitman, London, 1966
3. "Statistical Quality Control", A. L. Grant, Tata McGraw Hill International, New York, 6th Edition
4. "Statistical Quality Control", R. C. Gupta, 9th Edition
5. "Engineering Metrology", Hume K. G., M. C. Donald, Technical and Scientific, London, 2nd Edition.
6. "Quality Control and Industrial Statistics", Duncon A. J., Publisher- R. D. Irwin, 4th Edition.

Online Resources:

1. http://www.nptelvideos.in/2018/12/mechanical-measurements-and-metrology.html

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T. Y. B. Tech. Curriculum
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Course Plan

Course Title: **Industrial Hydraulics and Pneumatics Lab**	
Course Code: **201MEP312**	Semester: **VI**
Teaching Scheme: L-T-P: **0-0-2**	Credits: **1**
Evaluation Scheme: ISE Marks: **25**	

Prerequisite: Basic Mechanical Engineering, Fluid Mechanics, Manufacturing Processes.

Course Description:

Fluid power systems are now extensively used in machine tools, material handling devices, transports and other mobile equipment. This course will provide the students the knowledge of fundamentals of fluid systems, working principles of various fluid system components and its applications in industry.

Course objectives:

1. To study and demonstrate fundamentals of hydraulic and pneumatic system
2. To demonstrate construction and working principle of various components of hydraulic and pneumatic system
3. To prepare and execute hydraulic and pneumatic circuit
4. To use software to simulate hydraulic and pneumatic circuit.
5. To select fluid system components using manufacturer catalogue.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO312.1	Demonstrate fundamentals of hydraulic and pneumatic system.	L2
CO312.2	Demonstrate construction and working of various components of hydraulic and pneumatic system	L2
CO312.3	Prepare and execute hydraulic and pneumatic circuit	L2
CO312.4	Prepare and execute hydraulic and pneumatic circuit using simulation software	L2
CO312.5	Apply knowledge of hydraulic and pneumatic system to select and design various fluid system elements.	L3

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO312.1	2	-	-	-	-	-	-	-	2	2	-	-	-	-
CO312.2	2	-	-	-	-	-	-	-	2	2	-	-	-	-
CO312.3	3	-	-	-	-	-	-	-	2	2	-	-	-	-
CO312.4	2	-	-	-	2	-	-	-	2	2	-	-	-	-
CO312.5	2	2	2	-	-	-	-	2	-	-	-	-	1	-

Note: PO5 (Justification): In experiment no. 6, fluid system circuits will be prepared by using fluid system simulation software.

PO8 (Justification): In experiment student will refer manufacture catalogue for selection of fluid system component

List of assignments/experiments			
Sr. No.	**Name of assignment/experiment**	**Type**	**Hrs.**
1	Study and Demonstration of basic hydraulic and pneumatic system.	S/O	2
2	Study of ISO/JIC Symbols for hydraulic and pneumatic systems.	S	2
3	Circuit preparations on meter in and meter out on hydraulic trainer kit.	O	2
4	Circuit preparations on Sequencing circuits on hydraulic trainer kit.	O	4
5	Circuit preparations on Synchronizing circuit on hydraulic trainer kit.	O	2
6	Circuit preparations on Sequencing circuits on pneumatic trainer kit.	O	4
7	Circuit preparations on Synchronizing circuit on pneumatic trainer kit.	O	2
8	At least two Circuit preparations using Fluid Simulation Software.	O	2
9	Study of manufacturer catalogue to select fluid system components	S	2
10	Industrial visits are recommended for applications of pneumatic and hydraulic system and their reports.	S	2

- **S-STUDY, O-OPERATIONAL**

Text Books:

1. "Pneumatic Systems", S. R. Mujumdar-Tata McGraw Hill Publication.
2. "Industrial Fluid Power", D. S. Pawaskar, Nishant Prakashan.
3. "Hydraulics and Pneumatics", Shaikh and Khan, R. K. Publication

Reference books:

1. "Hydraulic and Pneumatic", H. L. Stewart, Industrial Press.
2. "Industrial Hydraulic", J. J. Pipenger, Tata McGrawHill.
3. "Power Hydraulics", Goodwin 1st Edition.
4. "Introduction to Hydraulic and Pneumatic", S. Ilangoand, V. Soundararajan, Prentice Hall of India, 2nd Edition.

Online Resources:

1. https://nptel.ac.in/courses/112106300
2. https://nptel.ac.in/courses/112105047

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T. Y. B. Tech. Curriculum
w.e.f. 2022-2023
Course Plan

Course Title: **Computer Aided Manufacturing Lab**	
Course Code: **201MEP315**	Semester: **VI**
Teaching Scheme: **L-T-P: 0-0-2**	Credits: **1**
Evaluation Scheme: **ISE Marks: 25**	

Pre-requisites: 3D modelling, basic knowledge of turning, milling and other machining processes

Course Description:
Computer Aided Manufacturing is aimed at providing basic understanding of the CNC technology with industrial practices to make them fit in industries. This course enables students to understand CNC programming and use CAM software in order to produce mechanical components.

Course Objectives:
1. To enable them to understand the use of CNC technology for efficient manufacturing.
2. To develop an ability to write a CNC part program using G & M codes.
3. To prepare CNC part programs using appropriate CAM software.
4. To carry out the machining of component as per the generated part program.

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

CO	Statement	BTL
CO315.1	Prepare a manual part program for machining operations.	L3
CO315.2	Use the CAM software and prepare CNC part programs.	L3
CO315.3	Execute the part program and manufacture the component.	L6
CO315.4	Develop a 3D printed object from CAD Model.	L6

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO315.1	2	-	-	-	-	-	-	-	2	-	-	3	3	-
CO315.2	2	-	2	-	2	-	-	-	2	-	-	2	3	-
CO315.3	-	-	-	-	-	-	-	-	2	-	-	2	3	-
CO315.4	2	-	2	-	2	-	-	-	2	-	-	2	2	-

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Course Content

Content	Hours
Unit 1: Introduction to CAM Brief Introduction to Computer-aided Manufacturing, The History of Computer Numerical Control (CNC), Applications of Computer-aided Manufacturing, Benefits of CAD-CAM in Manufacturing	04
Unit 2: Introduction to Manual Part Programming Co-ordinate system, Programming methods- Incremental method, Absolute method, Preparatory Functions (G-Code), Miscellaneous Functions (M-Code), Program format for machining (basic motion commands, tool radius compensation, canned cycles, cutter radius compensation, tool length compensation), manual part programming	06
Unit 3: Computer Assisted Part Programming Generation of part programming through CAM software package, Creation of a Blank, Setting Machining Environment, Geometry Definition, Creating Operation, Tool Creation and Selection, Tool Path Settings, Cutting Parameters, Speeds and Feeds, Program Generation, Tool Path Display, Tool Path Simulation, postprocessing, importing and exporting the different file types, execution of the program.	08
Unit 4: Rapid Prototyping Introduction to rapid prototyping, Process of rapid prototyping, techniques of rapid prototyping, Generation of CAD model, slicing of CAD model, G code generation, 3D printing of CAD model using FDM & SLA additive manufacturing techniques, postprocessing	06

List of Assignments			
Sr. No.	**Name of Assignments**	**Type**	**Hrs.**
1	Manual part programming for CNC Turning	S	2
2	Manual part programming for CNC Milling	S	2
3	Generation of Part Program using software- CNC turning – Job 1	O	2
4	Machining on CNC turning – Job 1	O	2

5	Generation of Part Program using software- CNC turning – Job 2	O	2
6	Machining on CNC turning – Job 2	O	2
7	Generation of Part Program using software- CNC Miling – Job 1	O	2
8	Machining on CNC Milling – Job 1	O	2
9	Generation of Part Program using software- CNC Miling – Job 2	O	2
10	Machining on CNC Milling – Job 2	O	2
11	3D modelling and printing of Mechanical component using FDM and SLA	O	4

❖ **S-STUDY, O-OPERATIONAL**

Text Books:

1. “CAD/CAM- Principals and Applications”, P.N. Rao, Tata McGraw Hill, 2ndEdition.

2.“CAD/CAM/CAE”, N.K. Chougule, SciTech Publication, Revised Edition.

Reference Books:

1. CAD/CAM by M.P.Grover and E.W.Zimmer, Prentice Hall of India Pvt. Ltd.

2. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Kamrani A. K., Nasr E. A., Springer

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Course Plan

Course Title : **Essentials of Electrical & Electronics Technology**	
Course Code : **201MEP316**	Semester : **VI**
Teaching Scheme : L-T-P : **2-0-0**	Credits : **0**
Evaluation Scheme : ISE Marks :	ESE(POE) Marks :**- 50**

Pre Requisite:- Fundamentals of Electrical & Electronics Engineering

Course Description:

The aim of this course is to understand construction and working principle of DC motors, Transformer and basic of Electronics technology.

Course Objectives:-

1. Produce competent Mechanical engineers with comprehensive knowledge of Electrical & Electronics Technologies to enable them to apply the relevant knowledge and technologies for the understanding and design of systems and products.
2. Prepare Mechanical Engineering students for advanced graduate studies in Mechatronics, Automation, Robotics and related field.

Course Outcomes (COs):-

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

CO	Statement	BTL
CO 316.1	Explain the construction and operation of DC motor and transformer	L2
CO316.2	Demonstrate basic electronic circuit	L3
CO316.3	Understand the importance of signal conditioning	L2

Course Content

Content	Hours
Unit 1: DC motor Construction, working, types, equivalent circuit, back emf, characteristics, power losses, applications, Need of starter, 3 point starter, 4 point starter, reversal of rotation, DC servo motor - desirable features, types and applications. Stepper motor- desirable features, types and applications, Introduction of VFD, Criteria for selection of motor for application like lathe, lift, pumps, conveyor etc.	08
Unit 2:Transformers **Single phase transformer:-** Construction ,working principle, ideal and practical	04

transformer, Transformer losses, **Three phase transformer:-** Construction ,working principle, ideal and practical transformer, Transformer losses	
Unit 3: Basic electronics Circuit Resister, Capacitors, Transistor, Printed circuit board, Diode, Switches, Circuit breaker	06
Unit 4: Signal Conditioning Signal conditioning process, Op-Amplifier, (Inverting Op-Amp, Non-Inverting Op-Amp, Summing Amplifier, Differentiating amplifier), Filters, data acquisition, logic gates, Number System, multiplexing and De-multiplexing, ADC,DAC,	06

Text Books:

1. Electrical Technology (Vol-II) - B.L.Theraja, S. Chand Publication
2. Basic Electronics- Solid state - B.L.Theraja, S. Chand Publication

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'A' Grade

B. Tech Programme Structure

T. Y. B. Tech.

(Mechanical Engineering)

(To be implemented from academic year **2022-23**)

Open Elective- I

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Open Elective:

Open elective courses are offered to gain the knowledge of multidisciplinary areas. Students must choose one open elective course from the list of courses offered by other departments (excluding open elective courses offered by their department). Following is the list of open elective courses. The detailed syllabus is available on to the college website under academic tab.

Sr. No.	Department	Course Code	Open Elective-I Course
1	Chemical	201CHL318	Industrial Safety and Act
		201CHL319	Energy Conservation and Audit
2	Civil	201CEL330	Disaster Management
		201CEL331	Green Building
3	Architecture	201ARL318	Residential Gardening
		201ARL319	Role of Art & Technology in Interior Design
4	Electronics and Telecommunication	201ETL314	Sensor Technology
		201ETL315	Electronic Instrumentation
5	Computer Science & Engineering	201CSL319	E- Commerce & Digital Marketing
		201CSL320	Python Programming
6	Computer Science & Engineering (Artificial Intelligent & Machine Learning)	201AIML320	Applications of AI ML
		201AIML321	Augmented Reality and Virtual Reality
7	Computer Science & Engineering (Data Science)	201DSL319	Basics of Data Science
		201DSL320	Basics of Database

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Course Plan

Course Title : **Human Resource Management**	
Course Code : **201MEL313**	**Semester :VI**
Teaching Scheme : L-T-P : **3-1-0**	Credits : **4**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Basic understanding of English and Human Skills

Course Description:

In this course students will learn the role of the human resource professional. Also learn about Key functions such as selection, recruitment, development, retention, appraisal, compensation and labor relationship. Best practices of employers of choice are considered.

Course Objectives:

1. Define the objectives, scope and functions of human resource management.
2. To impart knowledge about problems Job Description and Recruitment Process.
3. To impart knowledge about Training and Development in an organization.
4. To make aware with Compensation and Reward Management.
5. To introduce with concepts of HR Analytics and problem solving tools.
6. To introduce about new trends in HRM.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO313.1	Describe key human resource functions within organizations.	L2
CO313.2	Describe Job Description and Recruitment Process.	L2
CO313.3	Identify Need of Training and Development.	L2
CO313.4	Describe the Importance of Compensation and Reward Management	L2
CO313.5	Interpret HR Analytics and problem solving tools.	L2
CO313.6	Understand New Trends in HRM.	L2

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Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO313.1	2	-	-	-	-	-	-	-	-	-	2	-	-	-
CO313.2	2	-	-	-	-	-	-	-	-	-	2	-	-	2
CO313.3	2	-	-	-	-	-	-	2	-	-	2	-	-	2
CO313.4	2	-	-	-	-	-	-	2	-	-	2	-	-	2
CO313.5	2	-	-	-	-	-	-	-	-	-	2	-	-	2
CO313.6	2	-	-	-	-	-	-	-	-	-	2	-	-	2

Course Content

Content	Hours
Unit 1: Introduction to Human Resource Management Introduction, Objectives, Scope, Importance of HRM, Features of HRM, Functions, Role, Policies and Practices, Challenges of HRM.	06
Unit 2: Human Resource Procurement Definition, Objective, Need and Importance, Human Resource Planning Process, Barriers to HRP. Job Analysis Process – contents of Job Description, biodata /CV writing and Job Specification, Job Description. Recruitment - Selection Process Recruitment, Induction and Orientation. Career Planning, Transfer and Promotion. Retention of Employees.	08
Unit 3: Training and Development Framework of Training and Development of employees, Role of Training in organizations, Objectives, Process, Training Need Assessment, Types of Training, Difference between Training and Development, E-learning. Benefits of Training, CS Responsibilities.	06
Unit 4: Compensation and Reward Management Concept, Objectives, Importance of Compensation Management, Process of Compensation	06

Plan, Wage/Salary differentials, Components of Salary. Incentives and Benefits- Need, Financial and Nonfinancial Incentives, Fringe Benefits. Employee Separation- VRS, Retirement, Golden Handshake, Termination, Suspension.	
Unit 5: HR Analytics Role and Responsibilities of HR Analytics, Framework of HR Analytics – Predictive tools and applications in solving problems using HR Analytics.	07
Unit 6: Recent Trends in Human Resource Management HR Audit, Balance Score card, HRIS, HR Accounting, HR Shared Services, Issues creating HR shared services.	07

List of Assignments

Sr. No.	Name of Assignments	Type	Hrs.
1.	Introduction to Human Resource Management.	S	1
2.	Features of Human Resource Management.	S	1
3.	Job Analysis	S	1
4.	Recruitment	S	1
5.	Framework of Training and Development	S	1
6.	Role of Training in Organizations	S	1
7.	Compensation And Reward Management	S	1
8.	Incentives and Benefits	S	1
9.	HR Analytics	S	1
10.	Framework of HR Analytics	S	1
11.	Recent Trends in Human Resource Management	S	1
12.	HR Audit	S	1

- **S-STUDY, O-OPERATIONAL**

Text Book:

1. "Principles of Human Resource Management", George W. Bohladender, Scott a Snell, Cengage Learning, 2013.
2. "Human Resource Management", Pravin Durai, Pearson, 2010.

Reference Books:

1. "Human Recourse Management", Ian Breadsevace and len Holden.
2. "Human Resource Management", Michael Armstrong, kogan page 2006.
3. "Human Resource Management", Garry Dessler, Prentice Hall 2015.
4. "Human Resource Management", Biswajeet Patnayak,.
5. "Management of Human Resource", R. S. Diwivedi.
6. "Human Resource Management", Cynthia D. Fisher, Lyle F. Schoenfeldt, James B. Shaw.

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Course Plan

Course Title: **Electric Vehicle**	
Course Code: **201MEL314**	**Semester : VI**
Teaching Scheme : L-T-P : **3-1-0**	Credits : **4**
Evaluation Scheme : ISE + MSE Marks : **20 + 30**	ESE Marks : **50**

Prerequisite: Basic Mechanical Engineering, Basic Electronics and Electrical Engineering

Course Description:

This course will be a first level course on electric vehicle. Students will be able to understand the operation of battery driven electric vehicle. The introduction section will enable the students to understand the architect of electric vehicles and its important components. Then the course will cover vehicle dynamics, electric motors, power electronics, batteries and it's charging**.**

Course Objectives:

1. To impart the basic knowledge of Electric Vehicle.
2. To make the student conversant with power sources of today's and future EV.
3. To prepare the students for a career in the drastically changing automotive industry.
4. To acquaint the student with prerequisite for higher studies in Electric Vehicle.
5. To make the students aware with different areas of research in the field of Electric Vehicle.

Course Outcomes (COs):

At the end of the course the student should be able to:

CO	Statement	BTL
CO314.1	**Understand** the basic knowledge of electric vehicle.	L2

CO314.2	**Describe** the various types of batteries used in electric vehicles.	L2
CO314.3	**Understand** various battery charging methods for electric vehicles.	L2
CO314.4	**Determine** the various types of motors used in electric vehicles.	L3
CO314.5	**Explain** motor control technology in electric vehicles.	L3
CO314.6	**Discuss** safety, norms of electric vehicles.	L1

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Course Outcomes (COs)	Program Outcome (POs)												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO314.1	3	-	-	-	-	2	2	-	-	-	-	-	-	-
CO314.2	3	2	2	-	-	-	-	-	-	-	-	1	-	-
CO314.3	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO314.4	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO314.5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO314.6	3	-	-	-	-	-	-	-	-	-	-	2	-	-

Course Content

Content	Hours
Unit 1: Introduction Energy crises, Need of future transportation, Introduction and overview of Electric Drive layouts and its configurations, Traction power requirement for vehicle propulsion under different road and speed condition, EV – Indian policies (FAME I and FAME II), R&D and Collaboration.	06

Unit 2: Batteries for electric vehicle Electrochemical Batteries – Fundamental reactions and thermodynamics, Voltage, Specific power and Energy, Working of Pb-Acid batteries, Ni-Fe, Ni- Cd, Ni-MH Batteries, Li- Polymer, Li-ion, Battery selection for Electric Vehicle, Regenerative Braking for battery charging. Battery Storage, Battery Pack Design.	08
Unit 3: Battery charging technology for electric vehicle Types of battery charging, Normal charging, Opportunity charging, Fast charging, Constant current and constant voltage Charging, Multistage charging (MSC), Pulse Charging, Trickle Charging (TC), Wire and Wireless charging, Charging station infrastructure. Battery swapping. Battery Charging algorithms.	06
Unit 4: Motors in electric vehicles Types of Electric Motors used in electric vehicles, DC motors, Induction motors, Permanent Magnet motors, Switched Reluctance motors, BLDC motor, Torque – speed characteristics of above mentioned motors, Comparison and its layout in EV, Selection of motor for EV, Motor location and drive from motor to wheels.	06
Unit 5: Motor control in electric vehicle Power conversion required in EV, Principle of operation of power electronics devices like: SCR, TRIAC, DIAC, GTO, MOSFET, IGBT and power BJT, Battery to Motor with speed control, Regenerative Braking requirements, Bi-directional and multiple input to single output power conversion in EV. Power conversion required for DC charging and AC charging on board and off board.	09
Unit 6: Safety, Norms of Electric Vehicle Type approval procedure for electric and hybrid electric vehicles, V2X technology like V2 home, V2Grid, Self-driving from level 1 to level 5, Autonomous driving.	05

List of Assignments			
Sr. No.	**Name of Assignments**	**Type**	**Hrs.**
1	Electric vehicle drive layout and its configurations.	S	1
2	EV – Indian Government Policies (FAME I and FAME II).	S	1

3	Electrochemical Batteries – Fundamental reactions and thermodynamics (Principle of working of battery and its construction)	S	1
4	Explain construction and working of Lithium – ion , Nickel – Iron, Nickel – Metal Hydride battery.	S	1
5	Types of battery charging for electric vehicle (Fast charging and Slow charging)	S	1
6	Types of Motors used in Electric Vehicle (DC and BLDC Motor)	S	1
7	Selection of motor for EV	S	1
8	Power Conversion in EV	S	1
9	Motor Control in EV	S	1
10	Type of approval procedure required for EV and hybrid electric vehicle	S	1

❖ **S-STUDY, O-OPERATIONAL**

Textbook:

1. M. Ehsani, Y. Gao, S.E. Gay and Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press. 2005
2. Sheldon Williamsom, Energy Management Strategies for Electric and Plug-in Hybrid Vehicles, Springer 2013
3. J. Larminie and J. Lowry, Electric Vehicle Technology Explained, Wiley, 2003

Reference Books:

1. James Larmine and John Lowry, Electrical Vehicle Technology Explained,John Wiely and Sons Ltd.,2nd Edition WSE 2020.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamental. CRC Press, 2nd Edition, e-library 2017
3. C.C. Chan, K.T. Chau, Modern Electric Vehicle Technology, Oxford Publication, New York, 1st edition 2011

Online Resources:

1. Electric Vehicle Part I: https://onlinecourses.nptel.ac.in/noc22_ee53/preview
2. Fundamentals of Electric vehicles: https://nptel.ac.in/courses/108106170
3. Electric Vehicle Part I :https://nptel.ac.in/courses/108102121

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Department of Mechanical Engineering

Program Structure

Robotics and Industry 4.0 (Minor)

(To be implemented from academic year **2022-23**)

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Minor Degree details

With a view to enhance the employability skills and impart knowledge in emerging areas which are usually not being covered in Undergraduate Degree credit framework, AICTE has come up with the concept of 'Minor Degree' in emerging areas.

Minor specialization in EMERGING AREAS in Under Graduate Degree Courses is allowed where a student of another Department shall take the minimum additional Credits in the range of 18-20 and get a degree with minors in specialized area. These credits are in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline.

Knowledge of these emerging areas will help students in capturing the plethora of employment opportunities available in these domains. With the help of industry-academia experts, the institute has framed the curriculum of Minor Degrees. Following are the minor degrees offered by the various departments:

Sr. No.	Department	Minor Degree Offered
1	Architecture	Sustainable Energy Practices
2	Chemical Engineering	Food and Nutrition Technology
3	Civil Engineering	Environmental Sustainability
4	Mechanical Engineering	Robotics and Industry 4.0
5	Electronics & Telecommunication Engineering	Internet of Things (IoT)
6	Computer Science & Engineering	Cyber Security
7	Computer Science & Engineering (Artificial Intelligent & Machine Learning)	Artificial Intelligence & Machine Learning
8	Computer Science & Engineering (Data Science)	Data Science

Interested students studying in semester III can choose only one minor degree track offered by other department (excluding minors offered by their core undergraduate course). The final list of allocation will be displayed, following the eligibility criteria mentioned in the academic rules and regulations, before beginning of semester IV.

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The minor degree will be run only when the minimum students count is 30 for respective track.

Students once enrolled for any minor degree are not permitted to change the track. However, a student can withdraw at any semester.

The fee for minor degree is to be paid in addition to the college fees. There will not be any fee concession/relaxation for any category student. The fee will not be refunded when withdrawn from the minor degree.

Minor degree courses will begin from semester IV onwards as per the structure of the respective tracks.

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Sr. No	Course Code	Course Type	Name of the Course	Sem	Teaching Scheme Per Week			Credits	Total Marks	Evaluation scheme			
1	201MEMIL223	PCC	Elements of Robotic Systems	IV	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
2	201MEMIP223	LC	Elements of Robotic Systems Lab	IV	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
3	201MEMIL319	PCC	Basics of Robot Design	V	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
4	201MEMIP320	LC	Robot Simulation Lab	V	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
5	201MEMIL322	PCC	Robot Programming and Machine Vision Systems	VI	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
6	201MEMIP322	LC	Robot Programming and Machine Vision Lab	VI	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
7	201MEMIL323	PCC	Industry 4.0	VI	3	-	-	3	100	ISE	20	20	40
										MSE	30		
										ESE	50	20	
8	201MEMIP323	LC	Industry 4.0 Lab	VI	-	-	2	1	50	ISE	25	10	10
										ESE (POE)	25	10	10
										ESE (POE)	25	10	10
9	201MEMIP422	PROJ	Mini Project	VII	-	-	2	2	100	ESE	100	40	40
				Total	**12**	**-**	**10**	**18**	**700**	**Total Credits: 18**			
										Total Contact Hrs.: 5/week			

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Course Code	Definition
BSC	Basic Science Course
ESC	Engineering Science Course
HSMC	Humanity and Social Science including Management Course
PCC	Professional Core Course
PEC	Professional Elective Course
OEC	Open Elective Course
LC	Laboratory Course
MC	Mandatory Course
PROJ	Project

Abbreviations:

ISE: In Semester Evaluation,
MSE: Mid semester Examination,
ESE: End Semester Examination

Note:
ESE will be conducted for 100 marks and converted to 50 marks

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Course Plan:

Course Title: **Elements of Robotic Systems**	
Course Code: **201MEMIL223**	**Semester: IV**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Prerequisite: Fundamentals of Electrical and Electronics Engineering.

Course Description:
This course aims to familiarise students with basic terminologies of the robotics sciences and essential knowledge required to get started in the field of Robotics.

Course Objectives:

1. To provide Basic knowledge of Robots, their types and operations
2. To provide information about Sensors Used in Robotics
3. To make students aware of various types of actuators for robotics
4. To develop student knowledge about Various drives and motors used in robots
5. To provide overview of Controllers and basics of Programming Languages for Robotics
6. To provide overview of Grippers, Manipulators and Various types of accessories used in Robots

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

CO	Statement	BTL
CO223.1	**Understand** basics of Robots and its Anatomy	L2
CO223.2	**Select** Suitable Sensors for Robotics	L2
CO223.3	**Understand** Various types of Drives used in Robotics	L2
CO223.4	**Discuss** Different Control Systems and Controllers	L2
CO223.5	**Discuss** Grippers or Manipulators used in Robots	L2
CO223.6	**Explain** Allied fields related to Robotics	L2

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Course Content

Content	Hours
Unit 1: Introduction to Robotics Brief History, Basic Concepts of Robotics such as Definition, three laws, Robot anatomy, DOF, Misunderstood devices etc., Evolution of Robots, Classification of Robotic systems on the basis of various parameters such as work volume, type of drives, applications etc. etc, Industrial applications of robot.	08
Unit 2: Sensors Used in Robotics Basics of Sensors, Classification of Sensors based on sensing entity, operating parameters, output parameters etc., Applications of Sensors, Characteristics of Sensing Devices, Selection of Sensors, Need for Sensors.	07
Unit 3: Drives and Actuators used in Robotics Drive - Types of Drives, Types of transmission systems, Actuators – Hydraulic Actuators, Pneumatic Actuators, selection of Actuators while designing a robot system. Motors – DC Motors, Servo Motors, Stepper motors etc.	06
Unit 4: Control for Robotics Control Systems: introduction to Open loop and Closed loop control systems, Types of Controllers, PLC – Introduction, Types, applications, advantages, disadvantages and selection, NC Controller- Introduction, Types, applications, advantages, disadvantages and Selection	05
Unit 5: Grippers and Manipulators for Robotics: Grippers for Robotics - Types of Grippers, Guidelines for design and selection of robotic gripper. Manipulators for Robotics- Types of manipulators, Guidelines for design and selection of manipulators	06
Unit 6: Allied Topics in Robotics Socio-Economic aspect of robotization. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.	08

Textbook:

1. "Introduction to Robotics" 2nd edition, S. K. Saha, TATA McGraw Hills Education (2014)
2. "Robotics: Fundamental concepts and analysis", Asitava Ghoshal, Oxford University Press (2006

Reference Books:

1. "Fundamentals of Robotics", Dilip Kumar Pratihar, Narosa Publishing House, (2019)
2. "Robotics and Control", R. K. Mittal, I. J. Nagrath, , TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
3. "Introduction to Robotics – Analysis, Control, Applications", S. B. Niku, John Wiley & Sons Ltd., (2020)
4. "Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms", J. Angeles, Springer (1997)
5. "Industrial Robotics 2nd edition", Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, SIE, McGraw Hill Education (India) Pvt Ltd (2012)

Online sources:

1. https://nptel.ac.in/courses/107106090
2. https://nptel.ac.in/courses/108108147

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Course Plan:

Course Title: **Elements of Robotic Systems Lab**	
Course Code: **201MEMIP223**	**Semester: IV**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :**25**

Prerequisite: Fundamentals of Electrical and Electronics Engineering.

Course Description:

The course is focused on study, demonstration and hands on experience on Basic Robotic Systems, Anatomy of Robots, various sensors, actuators and drives used in Robotics.

Course Objectives:

1. To teach Basics of Robots, their types and operations
2. To demonstrate various Sensors Used in Robotics
3. To demonstrate various types of actuators for robotics
4. To demonstrate Various drives and motors used in robots

Course Outcomes:

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

CO	Statement	BTL
CO223.1	**Understand** Robot basics of Robots and its Anatomy	L2
CO223.2	**Select** Suitable Sensors for Robotics	L2
CO223.3	**Understand** Various types of Drives used in Robotics	L2
CO223.4	**Discuss** Different Control Systems and Controllers for Robots	L2
CO223.5	**Discuss** Grippers or Manipulators used in Robots	L2

List of Assignments/Experiments			
Sr. No.	**Name of Assignments/Experiment**	**Type**	**Hrs.**
1	Study of 6-axis Robotic Arm	S	2
2	Study of Robot Anatomy	S	2
3	Demonstration of Capacitive and Inductive Proximity Sensors	O	2
4	Demonstration of Optical and Laser Sensors	O	2
5	Demonstration of Pressure Sensor	O	2
6	Demonstration of Temperature Sensor.	O	2
7	Demonstration of Magnetic Sensors	O	2
8	Demonstration of Magnetic Switches	O	2
9	Demonstration of Hydraulic Actuators	O	2
10	Demonstration of Pneumatic Actuators	O	2
11	Demonstration of Various Drive Motors	O	2
12	Assignment: Study of Drive Systems used in Robotics	S	2

- S-STUDY, O-OPERATIONAL

Textbook:

1. "Introduction to Robotics" 2nd edition, S. K. Saha, TATA McGraw Hills Education (2014)
2. "Robotics: Fundamental concepts and analysis", Asitava Ghoshal, Oxford University Press (2006

Reference Books:

1. "Fundamentals of Robotics", Dilip Kumar Pratihar, Narosa Publishing House, (2019)
2. "Robotics and Control", R. K. Mittal, I. J. Nagrath, , TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)
3. "Introduction to Robotics – Analysis, Control, Applications", S. B. Niku, John Wiley & Sons Ltd., (2020)

Online sources:

1. https://nptel.ac.in/courses/107106090
2. https://nptel.ac.in/courses/108108147

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Course Plan:

Course Title: **Basics of Robot Design**	
Course Code: **201MEMIL319**	**Semester: V**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Prerequisite: Mathematics, Physics, Fundamentals of Electrical and Electronics Engineering

Course Description:
This course aims to make students able to understand various design considerations and calculations used in Robotic Systems. It also aims to make students able to Design any Robotic System and Select appropriate Control system for Robots.

Course Objectives:
1. To develop the student's knowledge in various robot structures and their workspace
2. To develop student's skills in performing spatial transformations associated with rigid body motions and robot systems
3. To make students understand Various aspects and calculations of Robot Dynamics
4. To provide development skills associated with trajectory planning and robot control.

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

CO	Statement	BTL
CO319.1	**Understand** Mathematical Requirements of Robot Design	L2
CO319.2	**Select** Suitable Control System for Robots	L2
CO319.3	**Calculate** Kinematic interpretations	L3
CO319.4	**Interpret** forces in Robots and Design Mechanical Linkages of robots	L3
CO319.5	**Interpret** Dynamic calculations in Robots	L3
CO319.6	**Develop** motion path for a Robotic System	L3

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Course Content

Content	Hours
Unit 1: Mathematical Preliminaries of Robotics Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Degree of Freedom.	07
Unit 2: Introduction to Robot Kinematics Manipulator Kinematics: Yaw, Pitch, Roll, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Forward Kinematics. Inverse Kinematics.	07
Unit 3: Velocities & Statics: Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, Jacobian Jv / Jw, Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity, Kinematics redundancy, Force balance equation.	07
Unit 4: Introduction to Robot Dynamics Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution Newton's equation, Euler's equation, Iterative Newton –Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator dynamics, dynamic simulation.	06
Unit 5: Trajectory Planning Trajectory planning: Path versus Trajectory, Joint space versus Cartesian space Descriptions, Basics of trajectory Planning, Joint space trajectory, Cartesian space Trajectories, Continuous trajectory, Workspace Design.	05
Unit 6: Basics of Robot Control Control of manipulators: open and closed loop control, Linear control schemes. Model of manipulator joint, Joint actuator, Partitioned PD control Schemes, PID control schemes, Computed Torque Control, Force control of Robotics Manipulators tasks, Force control strategy	08

Textbook:

1. "Introduction to Robotics" 2nd edition, S. K. Saha, TATA McGraw Hills Education (2014)
2. "Robotics: Fundamental concepts and analysis", Asitava Ghoshal, Oxford University Press (2006

Reference Books:

1. "Robot Modeling and Control", M. Spong, M. Vidyasagar, S. Hutchinson, Wiley & Sons, (2005).
2. "Introduction to Robotics: Mechanics and Control", 3rd edition J. J. Craig, , Addison-Wesley (2003).
3. "Introduction to Robotics: Mechanics and Control", Craig John J., Pearson

Online sources:

1. https://nptel.ac.in/courses/112105236
2. https://nptel.ac.in/courses/112107289
3. https://nptel.ac.in/courses/112104308

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Course Plan

Course Title: **Robot Simulation Lab**	
Course Code: **201MEMIP320**	**Semester: V**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :2**5**

Prerequisite: Fundamentals of Electrical and Electronics Engineering.

Course Description:

This course aims to make students able to design and simulate various operations and working conditions of Robotic Systems using FANUC ROBOGUIDE software

Course Objectives:

1. Understand Robot Simulation Techniques
2. Learn FANUC ROBOGUIDE with its Basics
3. Design Robotic System for various applications
4. Simulate different applications using Robotic Systems in ROBOGUIDE

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

CO	Statement	BTL
CO320.1	**Understand** Mathematical Requirements of Robot Design	L2
CO320.2	**Understand** Dynamic calculations in Robots	L2
CO320.3	**Interpret** forces in Robots and Design Mechanical Linkages of robots	L3
CO320.4	**Calculate** Kinematic interpretations of Robotic System	L3
CO320.5	**Analyse** Motion Trajectory for Robots	L4
CO320.6	**Simulate** Robot operation	L4

List of Assignments/Experiments			
Sr. No.	**Name of Assignments/Experiment**	**Type**	**Hrs.**
1	Introduction to FANUC: ROBOGUIDE software	S	2
2	Demonstration of Basic Features of ROBOGUIDE	O	2
3	Create a new work cell	O	2
4	Edit robot properties	O	2
5	Add a part and objects to the work cell	O	2
6.	Add End-of-arm Tooling to the robot	O	2
7.	Add a pick fixture to the work cell	O	2
8.	Add a place fixture to the work cell	O	2
9	Calibrating objects to those in a real-world environment	O	2
10	Create a robot program	O	2
11	Run the programs	O	2
12	Use Task Profiler to analyse program run	O	2

- **S-STUDY, O-OPERATIONAL**

Online sources:

1. https://nptel.ac.in/courses/112105236
2. https://nptel.ac.in/courses/112107289
3. https://nptel.ac.in/courses/112104308

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Course Plan

Course Title: **Robot Programming and Machine Vision Systems**	
Course Code: **201MEMIL322**	**Semester: VI**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Course Description:

The course aims to teach students basics of different programming languages used in Robot Control. It also aims to teach Machine vision systems with its basics and make student able to perform different operations in image processing

Course Objectives:

1. To develop student knowledge about various programming methods and languages used n Robotics
2. To make students able to develop program in various programming languages
3. To develop student knowledge about machine vision systems
4. To make students able to perform various operations in image enhancement and processing

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

CO	Statement	BTL
CO322.1	**Explain** Robot Programming Methods	L2
CO322.2	**Understand** Machine Vision System Fundamentals	L2
CO322.3	**Develop** Simple Programs using VAL language	L3
CO322.4	**Develop** Simple program using RAPID language and AML	L3
CO322.5	**Develop** simple program for Image Enhancement	L3
CO322.6	**Develop** Simple programs for Image Processing	L3

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Course Content

Content	Hours
Unit 1: -Introduction to Robot Programming Robot programming-Introduction, Types- Flex Pendant, Lead through programming, Coordinate systems of Robot, Interpolation-Interlock commands Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands. Robot cycle time analysis	07
Unit 2: -VAL Language Robot Languages-Classifications, Structures **VAL language-** commands motion control, hand control, program control, pick and place applications, WAIT, SIGNAL and DELAY commands. **VAL-II programming**-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications	06
Unit 3: RAPID Language and AML **RAPID language** basic commands- Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode. **AML Language**-General description, elements and functions, Statements, constants and variables-Program control statements-Operating systems, Motion, Sensor Commands-Data processing.	07
Unit 4: Introduction to Vision System Comparison with human visual system and perception level, digital image presentation, Definitions of digital image, elements and applications of digital image processing systems, image acquisition, storage, processing, communication and display **Digital Image Fundamentals**- Elements of visual perception – brightness adaption and discrimination, light and electromagnetic spectrum, image sensing and acquisition, sampling and quantization, pixels, connectivity, adjacency, distance measures, image sensors, different types of file formats.	06
Unit 5: Basics of Image Enhancements: **Enhancement in Spatial Domain**: Point and mask Processing, Basic gray level transformations, histogram- processing, equalization, matching, statistics. Image subtraction, averaging. Basics of spatial filtering-smoothing, sharpening filters other statistical filters **Enhancement in Frequency Domain**: introduction, 2-D Fourier transform, smoothing frequency domain filters- ideal, butter worth, Gaussian low pass filter, Sharpening Filters-ideal, butter worth, Gaussian	06
Unit 6: Introduction to Image Processing **Restoration**- Model for image degradation/restoration, noise models – probability density functions of noise, periodic noise and estimation of noise parameters; Band pass and band reject filters **Compression**- Fundamentals of image compression and types of redundancy, error free and lossy compression, variable length coding – Huffman coding, arithmetic coding, LZW coding. **Image Processing:** Basic concept, Dilation and Erosion process for binary and gray image with applications, Opening & Closing for binary and gray image with applications.	08

Textbook:

1. "Programming Languages for Industrial Robots", Christian Blume, Wilfried Jakob, Springer Berlin, Heidelberg, ISBN: 978-3-642-82747-1
2 "Digital Image Processing", Refael C. Gonzalez and Richard E, Woods Addison Wesley ISBN: 9780133356724

Reference Books:

1. "Industrial Robotics, Technology programming and Applications", Mikell P Groover, Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, , McGraw Hill, 2012.
2. "Robotics control, sensing, vision and intelligence", Fu. K. S., Gonzalez. R. C. & Lee C.S.G., McGraw Hill Book co, 1987.
3. "Digital Image Processing Using MATLAB," Refael C. Gonzalez and Richard E. Woods, AddisonWesley, ISBN: 9780070702622
4. "Digital Image Processing and Analysis: Applications with MATLAB and CVIP tools" Scott E Umbaugh, , Taylor and Francis, ISBN: 1498766072

Online sources:

1. https://nptel.ac.in/courses/106105216
2. https://nptel.ac.in/courses/108103174

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Course Plan

Course Title: **Robot Programming and Machine Vision Lab**	
Course Code: **201MEMIP322**	**Semester: VI**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :2**5**

Course Description:
The course aims to teach students basics of different programming languages used in Robot Control. It also aims to teach Machine vision systems with its basics and make student able to perform different operations in image processing

Course Objectives:
1. To develop student knowledge about various programming methods and languages used n Robotics
2. To make students able to develop program in various programming languages
3. To develop student knowledge about machine vision systems
4. To make students able to perform various operations in image enhancement and processing

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

CO	Statement	BTL
CO322.1	**Explain** Robot Programming Methods	L2
CO322.2	**Understand** Machine Vision System Fundamentals	L2
CO322.3	**Develop** Simple Programs using VAL language	L3
CO322.4	**Develop** Simple program using RAPID language and AML	L3
CO322.5	**Develop** simple program for Image Enhancement	L3
CO322.6	**Develop** Simple programs for Image Processing	L3

List of Assignments/Experiments			
Sr. No.	**Name of Assignments/Experiment**	**Type**	**Hrs.**
1	Learning and implementing basic MATLAB commands	O	2
2	Forming script file and function file in MATLAB	O	2
3	Understanding different image classes	O	2
4	Use of arithmetic and logical operators on images	O	2
5	Image Segmentation	O	2
6.	Blurring the given image by spatial convolution method.	O	2
7.	Blurring and sharpening of image with built in command and performing scaling of the image	O	2
8.	Performing negative, log, power-law and contrast stretching transformations on given image	O	2
9	Implementing 1-D and 2-D Discrete Fourier Transformation of given image	O	2
10	Assignment: Programming for Pick and Place Robot Using VAL / VAL-II Language	S	2
11	Assignment 2: Programming for Pick and Place Robot Using RAPID Language	S	2
12	Assignment 3: Programming for Pick and Place Robot Using AML Language	S	2

- S-STUDY, O-OPERATIONAL

Textbook:

1. "Programming Languages for Industrial Robots", Christian Blume, Wilfried Jakob, Springer Berlin, Heidelberg, ISBN: 978-3-642-82747-1

Reference Books:

1. "Digital Image Processing", Refael C. Gonzalez and Richard E, Woods Addison Wesley ISBN: 9780133356724
2. "Digital Image Processing Using MATLAB," Refael C. Gonzalez and Richard E. Woods, AddisonWesley, ISBN: 9780070702622
3. "Digital Image Processing and Analysis: Applications with MATLAB and CVIP tools" Scott E Umbaugh, , Taylor and Francis, ISBN: 1498766072

Online sources:

1. https://nptel.ac.in/courses/106105216
2. https://nptel.ac.in/courses/108103174

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Course Plan

Course Title: **Industry 4.0**	
Course Code: **201MEMIL323**	**Semester: VI**
Teaching Scheme: L-T-P: **3-0-0**	Credits :**3**
Evaluation Scheme: ISE + MSE Marks: **20 + 30**	ESE Marks :**50**

Course Description:
This course aims to provide knowledge about Industrial Automation from its basics making students aware of various Industrial Automation Systems, its Design and selection of various components in automation system design. It also aims to make students able to understand various technologies as IoT, Big data, Industry 4.0 and SCADA.

Course Objectives:

1. To provide basic knowledge about Industrial Automation Systems,
2. To make students aware about Industry 4.0, Big Data, Artificial Intelligence, Machine Learning
3. To provide knowledge about Internet of Things for Industries
4. To make students able to understand basic concepts in SCADA and develop programs for SCADA systems.

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

CO	Statement	BTL
CO421.1	**Understand** Fundamentals of Industrial Automation	L2
CO421.2	**Understand** Various Industrial Automation Systems in detail	L2
CO421.3	**Understand** Basics of Industry 4.0	L2
CO421.4	**Understand** Basics of IoT and Industrial IoT	L2
CO421.5	**Discuss** Various applications and new technologies related to Industry 4.0	L2
CO421.6	**Explain** SCADA system architecture and Software used	L2

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Course Content

Content	Hours
Unit 1:Introduction to Industrial Automation Introduction: Definition, automation principles and strategies, scope of automation, socio-economic considerations, low cost automation, basic elements of automation system, opportunities for automation and computerization, types of automation, levels of automation, reasons for automating, automation principles and strategies, ten strategies for automation	07
Unit 2: Industrial Automation Systems continuous and discrete control systems, computer process control, common measuring devices used in automation, desirable features for selection of measuring devices, : Material handling equipment, design considerations for material handling system, material transport equipment, conventional and automated storage systems, overview of automatic identification and data capture, bar code technology, RFID	07
Unit 3: Industry 4.0 Definition, Development from Industry 1.0 to Industry 4.0, Main characteristics and advantages, Steps in implementing digital transformation, Common roadblocks in implementation, Requirements of Industry 4.0, Technologies, Processes, and Terms of Industry 4.0	05
Unit 4: Internet of Things (IoT) Internet of Things – Definition, Concept and History, IoT network, architecture and design and their comparison, Sensors in IoT, Wireless technologies for IoT – Bluetooth, Zigbee and Wi-Fi, IoT platforms – Arduino and Raspberry Pi, Benefits of IoT to organizations, Advantages and limitations of IoT, Security issues in IoT, IoT Data Management, IoT functional stack	06
Unit 5: Industry 4.0 and IoT Applications and Technologies Applications of Industry 4.0 and IoT with special reference to Smart Factory, Smart Cities, Smart Home, Smart Autonomous Cars, Smart Retail, Energy Management, IoT in Healthcare, 3 D printing **Technologies**-Big Data – Definition, Types, Characteristics, Benefits of Big data processing, Artificial Intelligence and Machine Learning – Definition, Types, Advantages and Applications, Augmented Reality – Introduction and Applications, Cloud Computing – Introduction, Types and Applications, Cyber Physical Systems – Introduction, Advantages and Applications.	07
Unit 6: Supervisory Control and Data Acquisition (SCADA) Introduction, Objectives, Functions, Advantages, Typical SCADA system hardware and software, Human Machine Interface (HMI) and Machine to Machine Interface Network Topology, Open System Interconnection, Applications of SCADA to industry with special reference to power plant, process control, foundry and forging, Introduction to Real Time Systems and Applications	08

Textbook:

1. "Industrial Automation Using PLC SCADA & DCS", R.G. Jamkar, Global Education
2. Quick Start Guide to Industry 4.0: One-stop reference guide for Industry 4.0, Kiran Kumar Pabbathi, Createspace Independent Publishing Platform (11 May 2018), ISBN-10 : 1718978618

Reference Books:

1. "Robotic Technology and Flexible Automation", S. R Deb, Tata Mc Hill
2. Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, Orient Blackswan Private Limited - New Delhi; First edition (1 January 2015), ISBN-10 : 8173719543
3. Internet of Things : Architecture and Design Principles, Rajkamal, McGraw Hill Education; First edition (10 March 2017), ISBN-10 : 9352605225

Online sources:

1. https://nptel.ac.in/courses/108105088
2. https://nptel.ac.in/courses/106105195

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Course Plan

Course Title: **Industry 4.0 Lab**	
Course Code: **201MEMIP323**	**Semester: VI**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**1**
Evaluation Scheme: ISE Marks: **25**	ESE (POE) Marks :**25**

Course Description:
This course aims to provide knowledge about Industrial Automation from its basics making students aware of various Industrial Automation Systems, its Design and selection of various components in automation system design. It also aims to make students able to understand various technologies as IoT, Big data, Industry 4.0 and SCADA.

Course Objectives:
1. To provide basic knowledge about Industrial Automation Systems,
2. To make students aware about Industry 4.0, Big Data, Artificial Intelligence, Machine Learning.
3. To provide knowledge about Internet of Things for Industries
4. To make students able to understand basic concepts in SCADA and develop programs for SCADA systems.

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

CO	Statement	BTL
CO421.1	**Understand** basic functions of Industrial Automation system	L2
CO421.2	**Understand** operation of various Industrial Automation Systems	L2
CO421.3	**Understand** Operations of Smart Factory Cell	L2
CO421.4	**Explain** SCADA system architecture and Software used	L2
CO421.5	**Develop** simple programs for HMI	L3
CO421.6	**Develop** basic programs for SCADA system	L3

List of Assignments/Experiments			
Sr. No.	**Name of Assignments/Experiment**	**Type**	**Hrs.**
1	Study of Material Handling Cell	S	2
2	Demonstration of Material Handling Workflow	O	2
3	Study of Robotic Welding Cell	S	2
4	Demonstration of Automatic Robotic Welding	O	2
5	Study and Demonstration of Smart Factory Cell	O	4
6	Basic HMI programming	O	2
7	Design of different HMI Screen layouts	O	2
8	SCADA basic Programming	O	6
9	Assignment on SCADA	S	2

- **S-STUDY, O-OPERATIONAL**

Textbook:

1. "Industrial Automation Using PLC SCADA & DCS", R.G. Jamkar, Global Education

Reference Books:

1. "Robotic Technology and Flexible Automation", S. R Deb, Tata Mc Hill
2. Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, Orient Blackswan Private Limited - New Delhi; First edition (1 January 2015), ISBN-10 : 8173719543
3. Internet of Things : Architecture and Design Principles, Rajkamal, McGraw Hill Education; First edition (10 March 2017), ISBN-10 : 9352605225
4. Quick Start Guide to Industry 4.0: One-stop reference guide for Industry 4.0, Kiran Kumar Pabbathi, Createspace Independent Publishing Platform (11 May 2018), ISBN-10 : 1718978618

Online sources:

1. https://nptel.ac.in/courses/108105088
2. https://nptel.ac.in/courses/106105195

D Y PATIL
COLLEGE of
ENGINEERING & TECHNOLOGY
(AN AUTONOMOUS INSTITUTE)
KASABA BAWADA, KOLHAPUR

T. Y. B. Tech. Curriculum
w.e.f. 2022-2023

Course Plan

Course Title: **Mini Project**	
Course Code: **201MEMIP422**	**Semester: VII**
Teaching Scheme: L-T-P: **0-0-2**	Credits :**2**
Evaluation Scheme: ESE: 100	

Course Description:
This is a project course which aims to make students apply knowledge gained during entire course to develop a system and demonstrate any Automation or Robotic System.

Course Objectives:

1. To make students able to apply knowledge gained throught the program to work independently on project of their choice under guidance of faculty
2. To engage students in development activities such as literature research, planning and execution of work plan adhering to academic calendar.

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

CO	Statement	BTL
CO423.1	**Identify** Problems in applications related to Automation and Robotics	L2
CO423.2	**Apply** theoretical concepts to provide solution for identified problem	L3
CO423.3	**Analyse** result of provided solution	L4

A detailed report to be prepared based on any one of the following topics

1. Manufacturing / Fabrication of a prototype Robotic / Automated system including selection, concept, design, material, manufacturing the components, assembly of components, testing and performance evaluation.
2. Improvement of existing Robotic / Automated system.
3. Design and fabrication of end effectors for robot
4. Computer aided design, analysis *of* components such as stress analysis.
5. Modelling and Simulation of Robotic and Automation systems
6. Robot Kinematics and Dynamic analysis
7. Low cost automation, Computer Aided Automation in Manufacturing.
8. Ergonomics and safety aspects of robotic systems
9. Management Information System.
10. Product design and development.
11. Problems related to Productivity improvements / Value Engineering / Automated Material Handling Systems

Two copies of Final Project Report shall be submitted to the college. The students shall present their Final Project report. Before the examiners. The oral examination, shall be based on the term work submitted and jointly conducted by an internal and external examiner from industry, at the end of second semester.