COEP Technological University [COEP Tech]
(A Unitary Public University of Government of Maharashtra)
(Formerly College of Engineering Pune [COEP])

Department of Manufacturing Engineering and Industrial Management

NEP Compliant Curriculum Structure (UG Program)

S.Y. B. Tech. (Manufacturing Science and Engineering)
(Effective from: A.Y. 2024-25)

UG Program Structure of B. Tech. (Manufacturing Science and Engineering)

List of Abbreviations:

Abbreviation	Title	No of courses	Credits	% of Credits
BSC	Basic Science Course	**5**	**14**	**8.75**
ESC	Engineering Science Course	**6**	**16**	**10**
PCC	Programme Core Course	**19**	**54**	**33.75**
PEC	Programme Elective Course	**6**	**20**	**12.5**
OE/SE	Open/School Elective (other than particular program)	**3**	**6**	**3.75**
MDM	Multidisciplinary Minor	**5**	**14**	**8.75**
VSEC	Vocational and Skill Enhancement Course	**5**	**6**	**3.75**
AEC-01	Ability Enhancement Course	**1**	**2**	**1.25**
AEC	Indian Language	**1**	**2**	**1.25**
HSSM	Entrepreneurship/Economics/ Management Courses	**2**	**4**	**2.5**
IKS	Indian Knowledge System	**1**	**2**	**1.25**
VEC	Value Education Course	**2**	**2**	**1.25**
RM	Research Methodology	**1**	**2**	**1.25**
CEA	Community Engagement Activity /Field Project	**1**	**2**	**1.25**
CCA	Co-curricular & Extracurricular Activities	**2**	**2**	**1.25**
INT	Internship	**3**	**12**	**7.5**
	Total	**63**	**160**	**100**

F.Y. B. Tech

Manufacturing Science and Engineering

[Level 4.5, UG Certificate] Semester -I (Effective from: A.Y. 2023-24)

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	BSC	<tbd>	Matrix Algebra Univariate Calculus and Probability	2	1	0	1	3	30	10	60	--	--
2	BSC	<tbd>	Engineering Physics	2	0	2	1	3	30	20	50	CIE: 100	
3	ESC	<tbd>	Basics of Electrical & Electronics Engineering	2	0	2	1	3	30	20	50	CIE: 100	
4	ESC	<tbd>	Engineering Drawing and Graphics	1	0	4	1	3	CIE: 100			CIE: 100	
5	ESC	<tbd>	Engineering Mechanics	3	0	2	1	4	30	10	60	CIE: 100	
6	AEC	<tbd>	Communication Skills	1	0	2	0	2	CIE: 100			CIE: 100	
7	CCA	<tbd>	Liberal Learning Course	0	0	2	2	1	--	--	--	CIE: 100	
8	VSEC	<tbd>	Manufacturing Practices and Fab Lab - I	0	0	2	1	1	--	--	--	CIE: 100	
			Total	**11**	**1**	**16**	**6**	**20**					

[Level 4.5, UG Certificate] Semester -II

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	BSC	<tbd>	Engineering Chemistry #	2	0	2#	1	3	30	20	50	CIE: 100	
2	BSC	<tbd>	Ordinary Differential Equations and Multivariate Calculus	2	1	0	1	3	30	10	60	--	--
3	BSC	<tbd>	Biology for Engineers	2	0	0	1	2	30	20	50	--	--
4	ESC	<tbd>	Systems in Mechanical Engineering	2	0	2	1	3	30	20	50	CIE: 100	
5	ESC	<tbd>	Programming for Problem solving	1	0	2	2	2	CIE: 100			CIE: 100	
6	ESC	<tbd>	Design Thinking and Idea Lab	0	0	2	1	1	--	--	--	CIE: 100	
7	PCC	<tbd>	Materials Science	2	0	0	1	2	30	20	50	--	--
8	VSEC	<tbd>	Manufacturing Practices and Fab Lab - II	0	0	2	0	1	--	--	--	CIE: 100	
9	IKS	<tbd>	Indian Knowledge System	2	0	0	1	2	CIE: 100			--	--
10	CCA	<tbd>	Office Automation	0	0	2	0	1	--	--	--	CIE: 100	
			Total	**13**	**1**	**12**	**8**	**20**					

Combined lab for Engineering Chemistry and Material Science

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits ISE-In-Semester-Evaluation, ESE-End-Semester-Evaluation, MSE-Mid-Semester-Evaluation, TA-Teachers' Assessment, CIE-Continuous-Internal-Evaluation

Exit Course options to qualify for certification of School of Engineering & Technology

Any Two (02) Skill based Courses of 8 credits:

1. Computer aided Geometric modelling (4 Credits)
2. Additive Manufacturing (4 Credits)
3. Metallurgical Lab Practice - I (4 Credits)
4. Basics of CNC Programming (4 Credits)
5. Basics of Robotics and AI (4 Credits)

[Level 5, UG Diploma] Semester III

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC	MFG-24003	Strength of Material	2	0	0	1	2	30	20	50	--	--
2	PCC	MFG-24004	Theory of Machines	3	0	0	1	3	30	20	50	--	--
3	PCC	MFG-24001	Manufacturing Processes	3	0	2	1	4	30	20	50	50	50
4	PCC	MFG-24002	Product & Systems Graphics	0	0	2	1	1	--	--	--	CIE: 100	
5	OE	<tbd>	Open Elective-I	2	0	0	1	2	30	20	50	--	--
6	HSMC	HS-24003	Indian language: Sanskrit / Pali	2	0	0	0	2	30	20	50	--	--
7	HSMC	AS-24003	Constitution of India & Universal Human Values	2	0	0	0	1	30	20	50	--	--
8	HSMC	HS-24004	Principles of Economics	2	0	0	1	2	30	20	50	---	
9	CEA	AS-24004	Field Project*	0	0	4	1	2	--	--	--	CIE: 100	
			Total	**16**	**0**	**8**	**7**	**19**					

- **Field Project (Social) after semester-II during summer vacation, and evaluation will be done at the start of the III semester.**

[Level 5, UG Diploma] Semester IV

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC	MFG-24005	Engineering Thermodynamics and Heat Transfer	2	0	2	1	3	30	20	50	50	50
2	PCC	MFG-24006	Fluid Power	2	0	2	1	3	30	20	50	50	50
3	PCC	MFG-24007	Design of Machine Elements	2	0	0	1	2	30	20	50	--	--
4	PCC	MFG-24008	Machining Science and Technology	3	0	2	1	4	30	20	50	50	50
5	OE	<tbd>	Open Elective-II	2	0	0	0	2	30	20	50	--	--
6	MDM	<tbd>	Multidisciplinary Minor-I	3	0	0	0	3	30	20	50	--	--
7	VSEC	MFG-24009	CNC Programming & Machining	0	0	4	1	2	--	--	--	CIE: 100	
8	HSMC	HS-24001	Entrepreneurship	2	0	0	1	2	30	20	50	---	
9	HSMC	AS-24001	Environmental Studies	0	0	2	0	1	--	--	--	CIE: 100	
			Total	**16**	**0**	**12**	**6**	**22**					

[Level 5, UG Diploma] Semester III (wef 2024-25) [Lateral Entry]

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC	MFG-24003	Strength of Material	2	0	0	1	2	30	20	50	--	--
2	PCC	MFG-24004	Theory of Machines	3	0	0	1	3	30	20	50	--	--
3	PCC	MFG-24001	Manufacturing Processes	3	0	2	1	4	30	20	50	50	50
4	PCC	MFG-24002	Product & Systems Graphics	0	0	2	1	1	--	--	--	CIE: 100	
5	OE	<tbd>	Open Elective-I	2	0	0	1	2	30	20	50	--	--
6	HSMC	HS-24003	Indian language: Sanskrit / Pali	2	0	0	0	2	30	20	50	--	--
7	HSMC	AS-24003	Constitution of India & Universal Human Values	2	0	0	0	1	30	20	50	--	--
8	HSMC	HS-24004	Principles of Economics	2	0	0	1	2	30	20	50	--	
9	BSC	MA-24001	Mathematics	3	0	0	1	3	30	20	50	--	--
			Total	**19**	**0**	**4**	**7**	**20**					

[Level 5, UG Diploma] Semester IV [Lateral Entry]

Sr. No.	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Weightages in %)				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC	MFG-24005	Engineering Thermodynamics and Heat Transfer	2	0	2	1	3	30	20	50	50	50
2	PCC	MFG-24006	Fluid Power	2	0	2	1	3	30	20	50	50	50
3	PCC	MFG-24007	Design of Machine Elements	2	0	0	1	2	30	20	50	--	--
4	PCC	MFG-24008	Machining Science and Technology	3	0	2	1	4	30	20	50	50	50
5	OE	<tbd>	Open Elective-II	2	0	0	0	2	30	20	50	--	--
6	MDM	<tbd>	Multidisciplinary Minor-I	3	0	0	0	3	30	20	50	--	--
7	VSEC	MFG-24009	CNC Programming & Machining	0	0	4	1	2	--	--	--	CIE: 100	
8	HSMC	HS-24001	Entrepreneurship	2	0	0	1	2	30	20	50	--	
9	HSMC	AS-24001	Environmental Studies	0	0	2	0	1	--	--	--	CIE: 100	
10	HSMC	HS-24007	Communication Skills	1	0	2	1	2	30	20	50	--	
			Total	**17**	**0**	**14**	**7**	**24**					

Legends: **L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits ISE-In-Semester-Evaluation, ESE-End-Semester-Evaluation, MSE-Mid-Semester-Evaluation, TA-Teachers' Assessment, CIE-Continuous-Internal-Evaluation**

Exit Course options for Diploma in Manufacturing Science

Two (02) Skill-based Courses:

1. Geometric Dimensioning and Tolerancing and Product Inspection (4 credits)
2. Modern Prototyping Practice (4 credits)

Department of Manufacturing & Industrial Management
Open Elective Courses

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	OE-1	Production Process & Metrology	2	0	0	1	2	2
2	OE-2	Product Design for Manufacturing	2	0	0	0	2	2
		Production Planning and Control	2	0	0	0		
3	OE-3	Operations Research	2	0	0	0	2	2
		Reliability Engineering	2	0	0	0		
Total Academic Engagement and Credits			**6**	**0**	**0**	**1**	**6**	**6**

Multidisciplinary Minor
Enterprise Resource Planning

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	MDM-I (SEM IV)	Introduction to ERP and ERP Implementation Methodology	3	0	0	1	3	3
2	MDM-II (SEM V)	SAP Sales and Distribution	4	0	0	1	4	4
3	MDM-III (SEM VI)	SAP Materials Management	4	0	0	1	4	4
4	MDM-IV (SEM VII)	SAP Production Planning	3	0	0	1	3	3
Total Academic Engagement and Credits			**14**	**0**	**0**	**4**	**14**	**14**

Exit Course options to qualify for certification in the School of Engineering & Technology

Any Two (02) Skill-based Courses of 8 credits:

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	SEC	Computer-aided Geometric modeling	0	0	8	0	8	4
2	SEC	Additive Manufacturing	0	0	8	0	8	4
3	SEC	Metallurgical Lab Practice - I	0	0	8	0	8	4
4	SEC	Basics of CNC Programming	0	0	8	0	8	4
5	SEC	Basics of Robotics and AI	0	0	8	0	8	4

THIRD SEMESTER REGULAR

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Course: STRENGTH OF MATERIALS

Course Code	MFG-24003	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	2-0-0-1 = 2	**MSE-30**	**TA-20**
Credits	2	**ESE-50**	

Course Outcomes:
At the end of this course, students will be able to
Course outcomes:

- Describe properties of engineering material, their behavior, and applications.
- Explain the types of stresses and the effects of stresses in engineering applications due to different actions.
- Analyze simple problems in strength of materials and their applications in general.
- Analyze actions produced in torsion, principal stresses, thin cylinders, and long columns, and understand their applications in Manufacturing Engineering.

Unit	Contents	Lecture
01.	**Simple stresses and strains:** **a) Concept of stress and strain** (linear, lateral, shear, and volumetric), Hooke's law. Elastic constants and their relationship, Generalized Hooke's law. **b) Axial force diagram**, stresses, strains and deformation in determinate and indeterminate homogeneous and composite bars under concentrated loads, self-weight and temperature changes	**8 hrs**
02.	**a) Shear force and bending moment diagrams** Concept and definition of shear force and Bending Moment in beams due to concentrated load, UDL, uniformly varying loads, and couples in determinate beams. Relation between SF, BM, and intensity of loading, SF, and BM diagrams for cantilevers, simple beams. **b) Stresses due to bending:** Theory of simple bending, concept and assumptions, Derivation of Flexure formula. Bending stress distribution diagram. Moment of resistance, section modulus, and design (only cross-sections, loading) of beams calculations	**7 hrs**
03.	a) **Shear stress, distribution in beams**, Shear stresses concept, derivation of shear stress distribution formula, shear stress distribution diagram for common symmetrical sections, maximum and average shear stress, and design of beams (only cross-sections, loading). b) **Torsion of circular shafts**, Theory of torsion of circular, cross-sectioned shafts. Assumptions, Derivation of torsion formula, stresses, strains, and deformation in determinate and indeterminate shafts of hollow, solid,	**7 hrs**

	homogeneous circular cross-sections subjected to twisting moments.	
04.	a) **Principal stresses and Pressure Vessels,** Principal, Normal and Shear stresses on any oblique planes, their locations. **Pressure Vessels,** Stresses, strains, deformations, and volume change in thin-walled seamless cylindrical vessels due to internal fluid pressure. b) **Axially loaded columns,** Concept of critical load and buckling, slenderness ratio, derivation of Euler's formula for buckling load with hinged ends, concept of equivalent length for various end conditions.	**7 hrs**

Textbooks:

- "Mechanics of Structure" by S. B. Junnarkar and Advi, Charotar publication.
- "Fundamentals of Solid Mechanics", by ML Gambhir, PHI Publications
- "Strength of Materials", by R.S. Khurmi, S. Chand Publication

Reference Books

- "Mechanics of Materials" by Beer and Johnston, McGraw-Hill publication.
- "Mechanics of Materials" by RC Hibbeler, Pearson Publications.
- "Mechanics of Materials" by James M. Gere (5th Edition), Brooks/Cole Thomson Learning.
- "Strength of Materials" by F. L. Singer and Pytel, Harper and Row publication.

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Course: THEORY OF MACHINES

Course Code	MFG-24004	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	3-0-0-1 = 3	**MSE - 30**	**TA- 20**
Credits	3	**ESE - 50**	

Course Outcomes:

1) To make the students conversant with commonly used mechanisms for industrial applications.
2) To develop competency in drawing velocity and acceleration diagrams for simple and complex mechanisms.
3) To develop competency in graphical and analytical methods for solving problems in static and dynamic force analysis.
4) Analyze various types of belt drives and the effect of tensions on the power transmission of the drive.
5) Evaluate the characteristics of the Governor and analyze its effect on the Governor's effort and the Governor's power.
6) Evaluate gear teeth parameters as per the law of gearing and analyze various gear trains.

Syllabus:

Unit	Contents	Lecture
01.	**Fundamentals of Kinematics and Mechanisms.** Kinematic Link, Kinematic Pair, Kinematic chain, Structure, mechanism, machine, Types of Constrained Motions, Degrees of Freedom, Equivalent linkage Mechanism, Inversions of Four-Bar Chain, Single Slider Crank Chain.	**07 L**
02.	**Velocity and Acceleration Analysis in Mechanisms.** Relative Velocity and Relative Acceleration Polygon method for Kinematic link. Coriolis's component of Acceleration, Angular Velocity Ratio Theorem, Instantaneous Centre of Rotation (ICR), Methods of Locating ICR in a Mechanism.	**08 L**
03.	**Static and Dynamic Force Analysis** Introduction, Static Equilibrium, D'Alembert's Principle, Equivalent Dynamic System, Compound Pendulum, Correction couple, Static and Dynamic Analysis of Inertia Forces of Slider-Crank Mechanism by Analytical and Graphical Methods.	**07 L**
04.	**Belt Drives** Introduction, Selection of a Belt Drive, Types of Belt Drives, Materials used for Belts, Velocity Ratio of Belt Drive, Limiting Tension Ratio, Slip of Belt, Creep of Belt, Length of Flat Belts, Angle of Contact, Power Transmitted by a Belt, Different Tensions in Belt, Design of Belt.	**07 L**

05.	**Governors** Introduction, Types of governors, Terms used in Governor, Sensitiveness, Stability and Hunting of Governor, Isochronous Governor, Governor effort and Governor power.	**07 L**
06	**Gears and gear trains** Gears, Types of gears, Terms used in gears - spur gear terminology, law of gearing, involute and cycloidal profile, minimum number of teeth, interference, and undercutting. Introduction to gear trains, Types of gear trains, simple, compound, and epicyclic gear trains.	**07 L**

Textbooks

1. R. S. Khurmi and J. K. Gupta: A Text Book of Theory of Machines: S. Chand and Company Ltd.
2. S.S. Ratan: Theory of Machines, Tata McGraw-Hill.

Reference Books

1. Ulicker Jr., J.J., Penock, G.R., and Shigley, J.E. “Theory of Machines and Mechanisms”, Tata McGraw-Hill.
2. John Hannah and Stephens, R.C. “Mechanics of Machines: Advanced Theory and Examples” Edward Arnold, London.
3. Ramamurthy, V. “Mechanics of Machines”, Narosa Publishing House.
4. Thomas Beven, “Theory of Machines”, Pearson Education Ltd.

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Course: MANUFACTURING PROCESSES

Course Code	MFG-24001	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	3-0-2-1	**MSE - 30**	**TA - 20**
Credits	4	**ESE - 50**	

Course outcomes:

1) Summarize the basics and working of various casting and foundry techniques.
2) Interpret the various basic Manufacturing Processes and Machine Tools.
3) Learn how to select a particular production process for the given component from the available conventional as well as non-conventional manufacturing processes.
4) Interpret development and application of advanced technologies, components & and processes for manufacturing.
5) Implement the knowledge of manufacturing processes in industrial environment effectively.
6) Interpret and appreciation of the breadth and depth of the field of Manufacturing Engineering.

Syllabus:

Unit	Contents	Lecture
01.	**Casting Processes:** Sand Casting, types of pattern materials, pattern making allowances, core prints, Moulding sand-properties and testing, hand and machine Moulding, core, core boxes, Melting and pouring, Study of furnaces – cupola, fuel fired, Electric arc, Induction furnaces, Investment casting, Shell moulding, Casting techniques of cast iron, Steels and nonferrous metals of alloys, Solidification, Design of casting, Gating and riser Cleaning, Finishing and heat treatment of castings, defects in casting, Centrifugal casting, Semi-centrifugal casting, Centrifuging, Continuous casting. Basics of composite manufacturing ***Self-study**:* Permanent Mould Casting Processes, Die-casting, Low-pressure permanent mould casting–hot and cold chamber processes, Plastic and Rubber Moulding processes, different types	**07 L**
02.	**Hot and cold working of metals:** Principles of rolling, Forging, Drop, Press, Upset, Roll forging, Extrusion, drawing, spinning, Effects of hot working, Cold working processes, Cold rolling, Swaging, Forging, extrusion- forward, Backward, and impact roll forming, Tube drawing, Wire drawing, ***Self-study**:* Spinning, Shot Penning, High Energy Rate Forming.	**07 L**
03.	**Introduction to Manufacturing Processes** Introduction, Classification of Different Manufacturing Processes **Turning, Boring, Related Processes:** Fundamentals of turning and boring, Lathe – construction, accessories, operations, Thread cutting, Different tools, Tool materials, Tool	**07 L**

	geometry, Concept of speed, feed, Depth of cut, Capstan and Turret Lathe- Construction, Working and Applications, **Introduction to CNC machines:** Definition, Types of NC Systems, working principle, Classification of NC machines, Elements of NC, CNC and DNC machines, ***Self-study:*** Introduction to boring machines – general arrangement and nature of work done, Comparison and advantages of CNC lathes over conventional lathe machines.	
04.	**Drilling and Milling Machines:** Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling machines, Operations performed on drilling machines, reaming process, Milling Machines, Fundamentals of Milling process, Operations performed on milling machines, Dividing head, different methods of indexing, Gear train ***Self-study****:* Types of drills, Reamer types, Geometry, Milling Cutters - types and geometry	**07 L**
05.	**Abrasive Machining Processes:** Abrasive machining, abrasives - types, size and geometry, Grinding wheels, Wheel marking, Wheel selection, Wheel mountings, Types of grinding machines, Honing, Lapping, Super Finishing, Buffing. **Surface treatment processes:** Honing, lapping, Buffing, Polishing, Honing tools, and lapping materials. Abrasive, Buffing, Polishing wheels and burnishing processes, ***Self-study:*** *Electroplating, Electroless plating, Plasma coating,* Phosphating, Galvanizing, Metal spraying, Anodizing.	**07 L**
06.	**Joining Processes:** Welding Processes: Theory, control and applications, Arc Welding – SMAW, GTAW, GMAW, FCAW, Submerged arc welding, etc, .Resistance welding – theory, Spot, Seam, Projection welding processes etc., Gas welding, Thermit welding, Friction welding, Ultrasonic welding, Electron beam and Laser welding, Defects in welding, their cause and remedy, Weldability, welding of dissimilar metals, NDT and other methods of testing welded joints, ***Self-study:*** Soldering and Brazing applications, Use of adhesives for joining, Classification of adhesives, Types of adhesives and their applications, Surface preparation and various joints.	**07 L**

Textbooks

1. S.K. Hajra Choudhary and S.K. Bose, "Elements of workshop Technology" Volume I, II, Asia Publishing House, 10th Edition 2000.
2. P.N. Rao, "Manufacturing Technology", Tata McGraw-Hill Publishing Limited, 2 nd Edition, 2002.
3. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

Reference Books

1. Degarmo, Black, and Kohser, "Materials and Processes in Manufacturing", Prentice Hall of India. 2nd Edition, 1998.
2. Milton Shaw, "Metal Cutting Principles", Oxford University Press, 4th Edition, 2001.
3. O.P. Khanna and M. Lal, "Production Technology", Vol. I and II, Dhanpatrai Publication, 5th Edition, 1999.
4. B.S. Raghuvanshi, "Workshop Technology", Dhanpatrai Publication, 9th Edition, 1999.

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Course: MANUFACTURING PROCESSES LABORATORY

Course Code	MFG-24001	**Scheme of Evaluation**	Oral & Term Work
Teaching Plan	0-0-2-0	Term Work	50
Credits	1	Oral	50

Course outcomes:

1) Explain the machine tools, mechanisms, and accessories used in various production processes.
2) Able to perform basic turning operations as well as basic Forging and grinding operations.
3) Able to perform welding using the Arc welding process.
4) Demonstrate the Sand-Casting process.

Syllabus:

Experiments	**Contents**	**Practical**
01	Study and demonstration of the Lathe machine, including plain and Taper turning.	6 hrs
02	Forging and grinding of a lathe tool with one end knife and another end vee	4 hrs
03	Making a simple, solid pattern involving wood turning	4 hrs
04	Perform a joining operation using Arc Welding (MIG/TIG)	4 hrs
05	Demonstration of the CNC machine and completion of one job using CNC programming	4 hrs
06	Simulation and Demonstration of Sand-Casting Processes	2 hrs

Journal & Demonstration:

- Demonstrations of different machine tools, briefing students about the different parts of the machine, working principle, and operations
- Assignments on machine tools will be a questionnaire that needs to be solved in a journal. These assignments include sketches and relevant descriptions.

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Course: PRODUCT & SYSTEMS GRAPHICS

Course Code	MFG-24002	**Scheme of Evaluation**	Oral & Term Work
Teaching Plan	0-0-2-1	CIE	100
Credits	1		

Course Outcomes:

1) Classify Engineering Drawing, Dimensioning. Represent machine components conventionally.
2) Classify various types of joints. Study the construction details of Screw Threads, different types of bolts, nuts, washers, and set screws.
3) Able to select the fits and tolerances for the designed components.
4) Illustrate Computer Aided Drafting to develop the 2D and 3D views using software tools.

Syllabus:

Assignment	**Contents**	**Practical**
01	Study of different types of drawings and the conventional representation of various machine elements.	4 hrs
02	Study of basic characteristics of Production Drawings	4 hrs
03	Study of Screwed Fasteners.	4 hrs
04	Study of Pipe Joints and their symbolic representation in Pipe Layouts.	4 hrs
05	Study of Limits, Tolerance, and Fits.	4 hrs
06	Study of the concept of Roughness and, effect and representation of Surface Roughness in Drawings	4 hrs
07	Study of 2D Drafting Assignment using CAD tools	6 hrs
08	Study of 3D modelling Assignment using CAD tools	6 hrs

Suggested learning resources:

1. A Textbook of Machine Drawing, Latest Edition, by R.K. Dhawan
2. Computer-aided design: a conceptual approach, Jayanta Sarkar
3. Elements of Workshop Technology Hajra & Choudhary, Media Promoters & Publisher.
4. Workshop Practice HS Bawa, Tata McGraw Hill, 2nd ed. India.

OPEN ELECTIVE-I

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Course: PRODUCTION PROCESSES AND METROLOGY (OE-I)

Course Code	OE-I	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	2-0-0-1 = 2	**MSE - 30**	**TA - 20**
Credits	2	**ESE - 50**	

Course outcomes:

1) Explain basic casting processes and their applications.
2) Aware of basic machining processes and their real-time applications
3) Select various joining processes for the practical applications.
4) Inspect linear and angular components and carry out measurements.
5) Evaluate the surface finish of the given specimen using a measuring instrument.
6) Demonstrate basic geometric parameters and their measurements.

Syllabus:

Unit	Contents	Lecture
01.	**Casting and moulding Processes**. Sand Casting, types of pattern materials, pattern making allowances, core prints, machine Moulding, core, core boxes, Melting and pouring, Investment casting, Shell moulding, Casting techniques of cast iron, Steels and nonferrous metals of alloys, Die casting, Low-pressure permanent mould casting–hot and cold chamber processes, Centrifugal casting, Semi-centrifugal casting, Centrifuging, Continuous casting. Plastic moulding processes. Basics of composite manufacturing. ***Self-Study***- *Study of furnaces – cupola, fuel-fired, Electric arc, Induction furnaces*,	**06 L**
02.	**Machining Processes** Fundamentals of turning and boring, Lathe – construction, accessories, operations, Thread cutting – single and multi-start threading, Different tools, Tool materials, Tool geometry, Concept of speed, feed, Depth of cut, Drilling and Milling Machines: Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling Operations performed on drilling machines, Reaming process, Milling Machines, Fundamentals of milling process, Cutters - types and geometry, Operations performed on milling machines. Types of grinding machines: Honing, Lapping, Super Finishing, Buffing. Basics of CNC machines and operations. ***Self-Study-*** Capstan and Turret Lathe- Construction, Working and Applications, Shaper, Planer and Slotting Machines	**06 L**
03.	**Joining Processes:** Welding Processes: Theory, control, and applications, Arc Welding – SMAW, GTAW, GMAW, FCAW, Submerged arc welding, etc.	**06 L**

	Resistance welding, Spot, Seam, Projection welding processes, etc., Gas welding, Thermit welding, Friction welding, Ultrasonic welding, Electron beam, and Laser welding Soldering and Brazing applications, Use of adhesives for joining, Classification of adhesives, Types of adhesives and their applications, Surface preparation and various joints. ***Self-Study***- Defects in welding, their cause and remedy, weldability, welding of dissimilar metals, NDT, and other methods of testing welded joints	
04.	Introduction to Metrology, Precision, Accuracy, Methods and Errors in Measurement, Calibration. Linear Measurement: Standards, Line Standards, End Standards, Wavelength Standards, Classification of Standards, Precision and Non-Precision Measuring Instruments and Their Characteristics, Slip Gauges. Angle Measurement: Sine bars, Sine centres, Uses of sine bars, angle gauges, Auto Collimator angle dekkor, Limits, Fits and Tolerances: Meaning of Limit, Fits and Tolerance, Cost–Tolerance relationship, concept of Interchangeability, Indian Standard System.	**08 L**
05.	Surface Roughness measurement method and instruments, Inspection of Geometric parameters- Straightness, Flatness, Parallelism, Concentricity, Squareness, and Circularity. Coordinate Measurement Machine working and applications.	**04 L**

Textbooks

1. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition, 2002.
2. O.P. Khanna and M. Lal, "Production Technology", Vol. I,II, Dhanpatrai Publication,5th Edition, 1999.
3. "Elements of Workshop Technology Vol-I & II" by S.K. Hajra Chaudhary, Media Promoters & Publishers.

Reference Books

1. B.S. Raghuwanshi, "Workshop Technology", Dhanpatrai Publication, 9th Edition
2. R. K. Jain, A Textbook of Engineering Metrology, Khanna Publications Pvt. Ltd.18th Edition,2002
3. I.C. Gupta, A Textbook of Engineering Metrology, Dhanpat Rai Publications Pvt. Ltd.6th Edition, 2004.

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Course: Matrices, Differential Calculus and Probability (MDCP)
Direct S.Y. B.Tech.

Course Code	MA-24001	**Scheme of Evaluation**	
Teaching Plan	3-0-0-1 = 3	**MSE-30**	**TA**-20
Credits	3	**ESE-50**	

Outcomes: Students will be able to

1. Define matrices, linear equations, and determinants, recall basics of probability theory, probability distribution, gradient, divergence, and curl, Laplace Transform, ODE, and PDE.
2. Identify types of ordinary differential equations and partial differential equations, state the formulae for Fourier coefficients, basic concepts of probability, probability distributions, and Laplace Transform.
3. Solve ODEs and PDEs, find Fourier series expansions, analyze, and calculate eigenvalues, eigen vectors, evaluate the probability of compound events, find probabilities using standard distributions, and solve ODEs using the Laplace Transform.
4. Prove theorems, solve theoretical problems.
5. Apply concepts of ODE and PDE, Matrix algebra, Calculus, and Probability to various problems, including real-life problems.

Syllabus:

Unit	**Contents**	**Lecture**
01.	**Matrix Algebra:** Properties of Matrices and Determinants, Solutions of Systems of Linear Equations using the Gauss Elimination method, Eigen Values and Eigen Vectors. **Self-study:** Properties of Matrices and Determinants	**6**
02.	**Vector Differential Calculus:** Functions of several variables (Domain and Range), Partial Derivatives, The Chain Rule, Vector differentiation, gradient, divergence, and curl. **Self-study:** Review of Vector Algebra	**6**
03.	**Ordinary Differential Equations:** First order Ordinary Differential Equations - Variable Separable, Homogeneous, Linear; Higher order linear equations with constant coefficients, non-homogeneous. Higher-order linear differential equations with constant coefficients: method of variation of parameters; Applications to Initial value problems: Simple Electrical Circuits. Definition of Laplace Transform, Laplace Transform of standard functions, basic properties to solve ODE: linearity and LT of derivatives.	**12**

	Self-study: First order Ordinary Differential Equations - Variable Separable, Homogeneous ODEs	
04.	**Partial Differential Equations:** Fourier Series; Partial differential equations. Initial and Boundary value problems by the separation of variables method, boundary value problems: Vibration of a string: one-dimensional wave equation. **Self-study:** Types of PDEs	**8**
05.	**Probability:** Mean, median, mode, standard deviation, combinatorial probability, compound, and conditional probability. Probability distributions, Binomial distribution, Poisson distribution, Normal distribution. **Self-study:** Compound and conditional probability.	**8**

Textbook:

- Advanced Engineering Mathematics (10^{th} edition) by Erwin Kreyszig, Wiley Eastern Ltd.
- Thomas's Calculus (12th edition) by Maurice D. Weir, Joel Hass, Frank R. Giordano, Pearson Education.

Reference Books:

- Calculus for Scientists and Engineers by K.D. Joshi, CRC Press.
- A course in Calculus and Real Analysis (1^{st} edition) by Sudhir Ghorpade and Balmohan Limaye, Springer-Verlag, New York.
- Applied Mathematics Vol . 1 (Reprint July 2014) by P.N. Wartikar and J.N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune.

FOURTH SEMESTER REGULAR

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Course: ENGINEERING THERMODYNAMICS AND HEAT TRANSFER

Course Code	MFG-24005	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	2-0-2-1	**MSE- 30**	**TA - 20**
Credits	2	**ESE - 50**	

Course outcomes:

Students who successfully complete this course will have demonstrated an ability to:

1) Apply steam tables to calculate various performance parameters of the Rankine vapour power cycle.
2) Analyze I.C. engines and their various systems.
3) Estimate the Heat flow in one-dimensional steady-state heat Conduction.
4) Quantify the Amount of Heat Conducted in Convection.
5) Calculate Heat Transfer and Evaluate Performance of Heat Exchangers.

Syllabus:

Unit	Contents	Lecture
01.	**Steam Generation and its properties.** Steam Generation and its properties, Measurement of dryness fraction, Ideal Rankine Cycle, Calculation of Thermal Efficiency, Specific Steam Consumption, Work ratio, Simple Impulse Turbine and Parsons' Reaction Turbine, Construction and Working Principle (No numerical treatment)	**06 L**
02.	**I. C. Engines** Classifications of I C Engines, 4 Stroke and 2 Stroke IC Engines (Petrol and Diesel), Air standard Otto, Diesel cycles (Elementary Numerical treatment), Systems of I.C. engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine: Indicated power, Brake power, Thermal efficiency, Specific fuel consumption (Elementary Numerical)	**06 L**
03.	**Conduction Heat Transfer** Introduction and Basic Concepts of Conduction, Application Areas of Heat Transfer in Manufacturing and Machine Tools. Modes and Fundamental Laws of Heat Transfer, Thermal Conductivity, Thermal Diffusivity, One-Dimensional Steady State Heat Conduction in Simple and Composite Slabs, Composite Cylinder, Composite Sphere, Concept of Thermal Resistance and Electrical Analogy, Overall Heat Transfer	**06 L**

	Coefficient, Critical Radius of Insulation for Cylinders and Spheres (Elementary Numerical Treatment).	
04.	**Fundamentals of Convection and Radiation** Concept of Laminar and turbulent flow, Mechanism of natural and forced convection, local and average heat transfer coefficient, concept of velocity & thermal boundary layers. Reynolds Number, Prandtl Number, Grashof Number, Nusselt Number Fundamental concepts of radiation, Different Laws of radiation	**06 L**
05.	**Heat Exchangers** Introduction to heat exchangers, classification, and applications; Heat exchanger analysis – LMTD for parallel and counter flow heat exchangers, concept of effectiveness, NTU method for parallel and counter flow heat exchangers (elementary level, no numerical).	**06 L**

Textbooks

1. R.K. Rajput, "Thermal Engineering", Laxmi Publications
2. R. S. Khurmi and Gupta, "Thermal Engineering", S. Chand Publication

Reference Books

1. Y.A. Cengel,"Thermodynamics – an Engineering approach", Tata McGraw Hill.
2. S.P. Sukhatme,"Heat Transfer", Orient Longman.
3. Eastop, A. Mc'conkey,"Applied Thermodynamics", Pearson Publishers.
4. Holman J.P.,"Heat Transfer", Tata McGraw Hill.

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Engineering Thermodynamics and Heat Transfer Laboratory

Course Code	MFG-24005	**Scheme of Evaluation**	Term Work and Oral
Teaching Plan	2 Hrs/week	**Term Work**	50
Credits	1	**Oral**	50

Course Outcomes: At the end of the laboratory work, students will demonstrate the ability to:

1) Compare and Study Various Systems of IC engines.
2) Analyze I.C. engines and determine the performance parameters.
3) Determine the thermal conductivity of the insulating material.
4) Perform various tests on a parallel and counter-flow heat exchanger.
5) Determine the Emissivity of a given plate.

List of Experiments/Assignments:

Term work consists of the following experiments.

1. Determination of dryness fraction of steam.
2. Study of various systems of IC Engine.
3. Study of High-pressure Boilers.
4. Test on Diesel/Petrol engine to determine various performance parameters.
5. Determination of thermal conductivity of insulating material.
6. Determination of Emissivity of a Test Plate.
7. Determination of thermal conductivity of a composite plate.
8. Study and Demonstration of Heat Exchangers.
9. Test on parallel & counter flow Heat Exchanger.

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Course: Fluid Power

Course Code	MFG-24006	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	2-0-2-1 = 2	**MSE - 30**	**TA - 20**
Credits	2	**ESE - 50**	

Course Outcomes:

1) Working principle of various components used for hydraulic & pneumatic systems.
2) Identify various components of hydraulic & pneumatic systems.
3) Ability to select appropriate components required for hydraulic and pneumatic systems.
4) Ability to design hydraulic and pneumatic systems for industrial applications.
5) Ability to understand industrial applications of hydraulic and pneumatic systems.
6) Troubleshooting of hydraulic & pneumatic circuits

Syllabus:

Unit	Contents	Lecture
01.	**Introduction to Hydraulics and Pneumatics** Introduction to oil hydraulics and pneumatics, their structure, advantages, and limitations. Properties of fluids, Fluids for hydraulic systems, governing laws. Distribution of fluid power, ISO symbols, and energy losses in hydraulic systems.	**08 L**
02.	**Pumps & Power Units.** Types, classification, principle of working and constructional details of vane pumps, gear pumps, radial and axial plunger pumps, screw pumps, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic Power transmission. **Power units and accessories:** Types of power units, reservoir assembly, constructional details, pressure switches, temperature switches. **Accumulators:** Types, selection/ design procedure, applications of accumulators. Types of Intensifiers, Pressure switches /sensors, Temperature switches/sensors, Level sensors.	**08 L**
03.	**Hydraulic Actuators** (i) Linear and Rotary. (ii) Hydraulic motors - Types- Vane, Gear, Piston types, radial piston. (iii)Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads. (vi) Design considerations for cylinders. Cushioning of cylinders. (Numerical treatment).	**08 L**
04.	***Industrial Circuits*** Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail-safe circuit,	**08 L**

	counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit (Numerical treatment), motor breaking circuit.	
05.	**Pneumatics** Principle of Pneumatics: (i) Laws of compression, types of compressors, selection of compressors. (ii) Comparison of Pneumatics with Hydraulic power transmissions. (iii) Types of filters, regulators, lubricators, mufflers, and dryers. (iv) Pressure regulating valves, (v) Direction control valves, two-way, three-way, four-way valves. Solenoid-operated valves, push-button, lever control valves. (vi) Speed regulating Methods used in Pneumatics. (vii) Pneumatic actuators-rotary, reciprocating. (viii) Air motors-radial piston, vane, axial piston (ix) Basic pneumatic circuit, selection of components, (x) Application of pneumatics in low-cost automation and in industrial automation. Introduction to Vacuum and Vacuum Measurement, Vacuum Pumps, Types, and Introduction to Vacuum Sensors and Valves. Industrial application of vacuum.	**08 L**
06	**System Design** Design of hydraulic/pneumatic circuits for practical applications, including the Selection of various components such as reservoirs, different valves, actuators, filters, and pumps based on the design.	**05 L**

Textbooks

1. Esposito, Fluid Power with Application, Prentice Hall
2. Majumdar S.R., Oil Hydraulic system- Principle and maintenance, Tata McGraw Hill
3. Majumdar S.R, Pneumatics Systems Principles and Maintenance, Tata McGraw-Hill
4. H.L.Stewart, Hydraulics and Pneumatics, Taraporewala Publication GMH1.

Reference Books

1. J. J. Pipenger, Industrial Hydraulics, McGraw Hill
2. Pinches, Industrial Fluid Power, Prentice Hall
3. D. A. Pease, Basic Fluid Power, Prentice Hall
4. B. Lall, Oil Hydraulics, International Literature Association
5. Yeaple, Fluid Power Design Handbook
6. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books.
7. ISO - 1219, Fluid Systems and components, Graphic Symbols
8. Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall.
9. Dr. R.K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd.
10. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics

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Course: DESIGN OF MACHINE ELEMENTS

Course Code	MFG-24007	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	2-0-0-1 = 2	**MSE - 30**	**TA - 20**
Credits	2	**ESE - 50**	

Course outcomes:

Students who successfully complete this course will be able to:

1) Outline the fundamentals of machine design to formulate the design problem and apply the appropriate procedure to get the solution.
2) Evaluate the different types of stresses induced in a machine component due to different types of static loading and design the commonly used machine elements.
3) Apply the fundamental concepts to design the shaft and keys.
4) Solve various types of bolted joint design problems.
5) Analyze various types of welded joints subjected to static loads and bending moments.

Syllabus:

Unit	Contents	Lecture
01.	**Fundamental aspects of design** The meaning of design, phases of design, design considerations, factor of safety, standardization, and preferred series.	**04 L**
02.	**Design against static load** Stresses due to bending and torsional load, eccentric loading, and Design for biaxial loading through theories of failure.	**06 L**
03.	**Design of shafts and keys** Shaft, Shaft subjected to bending and torsion, A.S.M.E. code for shaft design, types of keys and their design.	**06 L**
04.	**Design of threaded Joints** Threaded Joints, ISO metric screw threads profile, Coarse and fine threads, Design of bolted joints, eccentrically loaded bolted joints.	**06 L**
05.	**Design of welded joints** Types of welded joints, stresses in welded joints, eccentrically loaded welded joints, and welded joints subjected to bending moment.	**06 L**

Textbooks

1. Shigley I.E. and Mischke C.R., "Mechanical Engineering Design", McGraw-Hill Education (India) Ltd.
2. Bhandari V.B., "Design of Machine Elements", McGraw-Hill Education (India) Ltd.
3. Hall A.S., Holowenko A.R., and Laughlin H., "Theory and Practice of Machine Design", Schaum's outline series, McGraw-Hill Publication.

Reference Books

1. Spotts M. F., "Design of Machine Elements", Prentice Hall International.
2. Black P.H. and Eugene Adams, "Machine Design", McGraw-Hill Book Co., Ltd.
3. P.S.G. College of Technology, "Design Data, Coimbatore.

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MACHINING SCIENCE AND TECHNOLOGY (MST)

Course Code	MFG-24008	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	3-0-2-1 = 3	**MSE - 30**	**TA -20**
Credits	3	**ESE - 50**	

Outcomes:

1) Demonstrate understanding of metal cutting principles and mechanisms to solve the problems based on cutting force analysis and tool life.
2) Explain the design procedure of various tools and solve the problems based on the tool design.
3) Summarize the broaching machines, tools used in the process, and design methodology to solve the problems based on broach tool design.
4) Differentiate the various methods of gear manufacturing and thread manufacturing.
5) Classify the various non-conventional machining processes and learn their industrial applications.

Unit	Contents	Lecture
01.	**Unit I: Theory of Metal Cutting:** Cutting tools, tool geometry, Concept of speed, feed, depth of cut, and cutting action and effect of these on cutting forces. Types of Chips. Merchant's circle of forces. Shear angle, Shear Strain, Mechanics of metal cutting, Theories of shear angle. Velocity vector diagram, estimation of cutting forces. Empirical Relations, Tool Force dynamometers, Measurement of cutting forces and power required. Heat Generation in Metal Cutting, Cutting Fluids. **Self-Study: Cutting Fluids**	**08 L**
02.	**Unit II:** Standards and Nomenclature of cutting tools, inserts, and chip breakers. Cutting Tool Materials. Heat Treatment of Tools and Alloys. Machinability Tool Life and Tool Wear, New technology in metal cutting for higher productivity. Compliance test**.** **Self-Study: Cutting tool Materials**	**06 L**
03.	**Unit III Design of Cutting Tools:** Design Principles of cutting tools and tool holders. Single point tools, Tip tools, Drills, Reamers, Broaches, Milling cutters, Thread cutting tools, Gear cutting tools, Grinding Wheels, Form Tools.	**08 L**
04.	**Unit IV Gear Manufacturing:** Gear cutting process, forming, and generation. Gear cutting on milling. Gear hobbing. Gear shaping. Gear shaving, Lapping, and Grinding. Various machines used for gear manufacturing. **Self-Study:** Types of gears	**06L**
05.	**Unit V Thread Manufacturing:** Thread cutting internal and external, chasers, dies, thread milling, rolling, lapping, and grinding. **Self-Study:** Types of Threads	**06 L**
06	**Unit VI Non-conventional Machining Processes:** Introduction, principle, set up, operation, and applications - Chemical machining, Electrochemical machining, Electric discharge machining, Electron Beam machining, Ion Beam machining,	**08 L**

	Plasma Arc machining, Laser Beam Machining, Abrasive Jet machining, Ultrasonic Machining. **Self-Study: Chemical Machining**	

Suggested learning resources:

1. P.N. Rao, "Manufacturing Technology", Tata McGraw-Hill Publishing Limited, II Edition, 2002.
2. P.K.Mishra, "Non-Conventional Machining", Narosa Publishing House (January 15, 2001), ISBN: 978-81-7319-138-1, Reprint 2008.
3. Donaldson, Lecain and Goold,"Tool Design", Tata McGraw Hill, Edition:III.
4. "Advanced Machining Processes", Vijay K. Jain Allied Publishers Pvt. Ltd., Edition I 2007.
5. Prakash Joshi, "Cutting Tools", Wheeler Publishing, ISBN 81-85814-53-8, Edition I 1996.
6. David A Stephenson, John S Agapiou, "Metal Cutting Theory and Practice", CRC Press Edition II.

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MACHINING SCIENCE AND TECHNOLOGY (MST)- LABORATORY

Course Code	MFG-24008	**Scheme of Evaluation**	Oral & Term Work
Teaching Plan	0-0-2-1	Term Work	50
Credits	1	Oral	50

Course Outcomes:

1) At the end of the course, students should be able to:
2) Use different non-conventional processes for the given applications.
3) Know about the different types of tool force dynamometers and their applications
4) Evaluating forces acting on a single-point cutting tool, drilling tool, and milling cutter.
5) To plan and create the external threads using a CNC Lathe and a spur gear using a vertical milling machine.
6) To build the practical knowledge of the Micro EDM process for precision gear cutting using the Micro Wire EDM machine.

Term work: Each student shall be required to complete and submit the following term work

Assignment	**Contents**	**Practical**
01	To measure the cutting force, tool temperature, and shear angle during orthogonal cutting (on a Lathe)	4 hrs
02	To measure the cutting force on the drilling machine and the milling machine.	4 hrs
03	Manufacturing of external threads using CNC lathe.	4 hrs
04	Manufacturing of spur gear using vertical milling machine.	4 hrs
05	Study of Micro EDM process and Precision gear cutting using Hybrid Micro Wire EDM machine.	4 hrs
06	Tool force dynamometer, it's working principle and construction.	4 hrs
07	Study of milling machine and CNC Lathe machine.	6 hrs
08	Study of Hybrid Micro Wire EDM machine.	6 hrs

Open Elective-II

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Course: PRODUCT DESIGN AND MANUFACTURING (OE-II)

Course Code	OE-II	**Scheme of Evaluation**	MSE, TA & ESE
Teaching Plan	2-0-0-0	**MSE - 30**	**TA - 20**
Credits	2	**ESE - 50**	

Course outcomes:

At the end of the course, students will demonstrate the ability to

1) Demonstrate the basics of the product design process and the morphology of design.
2) Identify customer needs for new product development
3) Comprehend about product development process tools
4) Identify the role of the product development team
5) Illustrate design for safety, Environment, and Product cost.
6) Analyse different stages of product design.

Syllabus:

Unit	Contents	Lecture
01.	**Introduction to Product Design**: Asimow's Model: Definition of Product Design, Design by Evolution, Design by Innovation, Essential Factors of Product Design, Production-Consumption Cycle, Flow and Value Addition in the Production-Consumption Cycle, The Morphology of Design (The seven phases), Primary Design Phases and flowcharting, Role of Allowance Process Capability, and Tolerance in Detailed Design and Assembly ***Self-study–*** creative design, and the cultural design	**06 L**
02.	**Product Development Process Tools & Scoping Product Developments** Product development team: definition, composition, team roles, Myers-Briggs type indicator, team structure, team building, team evaluation; Product Development; phases of modern product development process; Reverse engineering and redesign product development process ***Self-Study***- Types of design, engineering design	**08 L**
03.	**Customer Needs Customer satisfaction:** Kano diagram, customer populations, types of customer needs, and customer need models. Customer needs gathering methods include interviews, questionnaires, and focus groups. Grouping the needs: affinity diagram method, customer sort method, cluster analysis method; ***Self-study***- determining need importance; interview data method, questionnaire method	**06 L**
04.	**Product Design Practices in Industry:** Introduction, Product Strategies, Time to Market, Analysis of the Product, The Three S's,	**06 L**

	Standardization Renard Series (Preferred Numbers), Simplification, The Designer and its Role, The Designer: Myth and Reality, The Industrial Design Organization Basic Design Considerations, Problems faced by Industrial Designer. Procedure adopted by Industrial Designers, Types of Models designed by Industrial Designers, and What the Designer contributes. **Self Study**:- Role of Aesthetics in Product Design, Functional Design Practice. Introduction to different Technology readiness levels (TRLs).	
05.	Design for Manufacture and Assembly (DfMA) Design Guidelines, Manufacturing Cost Analysis. Design for Environment objectives, Basic design for environmental methods, life cycle assessment, and techniques to reduce environmental impacts. Introduction to Safety Engineering, Design for safety, Product Architecture Design for Safety and Reliability. Cost and Price Structure, Information Need Sources, Estimating Direct and Indirect Costs, Design and Manufacturing Costs, Ways to Model Manufacturing Costs Human Engineering Considerations in Product Design	**06 L**

Suggested learning resources:

1.Geoffrey Boothroyd, Assembly Automation and Product Design, Marcel Dekker Inc., NY, 3rd Edition, 2010.
2.Geoffrey Boothroyd, Hand Book of Product Design, Marcel Dekker Inc., NY, 1992.
3.Pravin Kumar. & M Ramaswamy, Fundamentals of design and manufacturing
4. Daniel Ling, Complete Design Thinking Guide for Successful Professionals, Kindle Edition
5. Karl Ulrich, Steven Eppinger, Product Design and Development, McGraw Hill India.
6. Seider, Seader, Lewin, Widagdo, Product and Process Design Principles: Synthesis, Analysis and Evaluation, 3ed, ISV: Synthesis, Analysis and Evaluation - ISV

Course: MDM-I: Introduction to ERP and ERP Implementation Methodology

Course Code	MDM	Scheme of Evaluation	MSE, TA & ESE
Teaching Plan	3-0-0-1	--	30-20-50
Credits	3		

Unit 1

Basic Conceptual Foundations for ERP:(ERP Overview, Need of ERP) Architecture of an ERP System Navigation(Demo)

Specialized Processes (Marketing and Sales Related): Basics of CRM, Handling Marketing Functions using ERP, Leads and Campaign Management, Marketing Workflows. **Specialized Processes (Manufacturing Operations):** Manufacturing and Production Systems Procurement, Scheduling, Just in Time using ERP

Unit 2

Specialized Processes (Finance Operations) : Chart of Accounts (Country Specific), Book-Keeping with Basic Accounting System, Buying and Selling Process and Workflow from Procurement to Sales, **Best Practices:** Best Practices in the Automotive Industry, Best Practices in Industrial Machinery and Components Industry, Best Practices in the Manufacturing Industry.

Unit 3

ERP Implementation: (Selecting an ERP System, Project Planning for Implementation, Comparison for Various ERP Systems, Implementation Risks. **Configuration of a Basic Demonstration System:** Configuring a Demonstration Company, Developing a Company System on the basis of Profile Systems, Databases, and Security Tools

Unit4

Basic Concepts on ERP Implementation Methodologies: SAP Methodologies for Implementation. Preparation: Project Management, Organizational Change Management, Training Data management, Business Process Management, Technical Solution Management and Integrated Solution Management.

Unit 5

Business Blueprint: Requirement Gathering, QA & DB, Business Blueprint. Training, Baseline Configurations and Configurations, Systems Change management, Final Configurations, Custom Developments (RICEF), Final Integration Testing. Final Preparation: Training, Systems Change Management, Cut Over Planning

Unit 6

Final Preparation: Training, Systems Change Management, Cut Over Planning. Go Live Support: Role-Based Training, Go Live, System Handover and Production Support Run SAP Methodology: Governance Model for Operation Optimization, End User Support Optimization, Custom Code Optimization

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CNC PROGRAMMING & MACHINING (CPM)

Course Code	MFG-24009	**Scheme of Evaluation**	
Teaching Plan	0-0-4-1	CIE-100	
Credits	2		

Course Outcomes:

1) Program various CNC-controlled machines and centres.
2) Prepare and understand the program for various profiles
3) Identify and set parameters for various simulators and operate the CNC machines for various operations.
4) Analyze the problems with the machining operations.

Unit	Contents	Hrs
01.	**Introduction to CNC technology** Introduction to CNC technology – CNC machines controls, History and development of CNC technology, Components of CNC system, Program of instructions, Machine Control unit, Machine tools, Construction details of CNC machines, Machine structure, Slideways, Spindle, Drive units, Coordinate systems, Numerical Control Procedure	**06**
02.	**Drawing interpretation** Reading the machining sketches, Different Geometrical Tolerance symbols. Reading Dimensional Tolerances. Understanding the Views. Identifying feature from sketch and operation from feature.	**06**
03.	**CNC programming.** Introduction to CNC programming Introduction and demonstration of line programs, CNC programming or lathe & milling machine, CNC simulator, CNC programming for lathe and milling machines using different machining cycles on CNC simulator. Procedures Associated with part programming, cutting process parameter selection, Process planning issues and path planning, G and M Codes, Interpolations, Canned Cycles and Subprograms, Compensations.	**08**
04.	**CNC Turning** Plan and optimize programs for CNC turning operations. Calculate parameters like speed feed etc. and set a reference for the various operations. Prepare operation and operation sequence for the lathe operations like turning, grooving etc. Prepare and set CNC lathe operations and test run programmes, execute program and inspect simple geometrical forms on standard parts. Tooling for CNC turning	**08**
05.	**CNC Milling** Plan and optimize programs for CNC Milling operations. Calculate parameters like speed feed, depth of cut, etc., and set a reference for the	**06**

	various operations. Various methods of work process like edge finding block centre etc. Prepare and set CNC Milling operations and test run programme. Execute the program and inspect simple geometrical forms on standard parts. Tooling for CNC Milling	
06	**Modern CNC systems** Introduction to advanced CNC systems: Computer Aided Part Programming (CAPP), an application using CAM software tools. Comparison of manual part programming and CAPP for a simple component, Automatic Tool Changer, Automatic Pallet Control, and Automatic Storage and Retrieval Systems.	**08**

Text Books:

1. Programming of CNC machines, by Ken Evans
2. CNC Programming Handbook by Peter Smid
3. NC Control by Kundra Rao, Tewari
4. CNC Machines by M Adithan, B S Pabla

Exit Course option for Diploma in Manufacturing Sciences

Two (02) skill-based courses:

Course: **Geometric Dimensioning and Tolerancing & Product Inspection (GDTPI)**

Course Code		**Scheme of Evaluation**	Term work
Teaching Plan	0-0-8-0	Term Work	50
Credits	4	Oral	50

Course Outcomes (COs): At the end of this course, students will be able to

1. Differentiate between conventional and GD&T tolerance zones.
2. Demonstrate MMC, LMC and RFS concepts.
3. Assess the significance of selection of datum & datum features as well as showcase the form, orientation, profile, runout, and orientation controls.
4. Apply the GD and T concept for part manufacturing.

Course Contents:

Unit No.	**Topics**	**Teaching Hours**
1	Introduction: Geometric product definition principles; verification ofposition with open setup; geometric characteristic symbols. Geometric Dimensioning and Tolerancing: an explanation of tolerance zone conversion; surfaces, features, features of size, datum features, datum features of size, and datum's; tolerances; components common to geometrically dimensioned& toleranced drawing; fits & allowances, advantages of GD&T	10
2	MMC, LMC & RFS: Maximum Material Condition (meaning & use); Least Material Condition (meaning & use); Regardless of Feature Size How to read a Feature Control Frame	06
3	Size Control Form: The Taylor's principle; Gauging size limits. Rules, concepts, Characteristics, and untolerated dimensions: individual or related datum's, Material Conditions, and untolerated dimensions	06
4	Datums: Datum features; oddly configured & curved surfaces as datum features; equalizing datums; datum feature symbols; flexible parts; direct vs indirect tolerancing. MMC and its ramifications. Relations between individual features. Virtual Condition and Resultant Condition Boundaries: Virtual condition (MMC concept & a functional boundary). Effect of LMC: wall thickness calculation.	05
5	Datum Feature of Size Representation: Modes of datum feature representation; angular orientation. Form Controls: flatness; straightness: circularity; free state variation; circularity Orientation Controls: orientation characteristics; angularity; perpendicularity Profile; line element controls Run out: circular & total Location: concentricity; the return of symmetry;	05
6	A Logical Approach to Part Tolerancing, Dimensioning, and Tolerancing, Schemes, Steps for the Development of a Dimensional Inspection Plan: Paper Gauging, and Functional Gauging	10

List of References:

1. James D Meadows, "Geometric Dimensioning and Tolerancing", Marcel Dekker, Inc
2. James D Meadows, "Measurement of Geometric Tolerances in Manufacturing" Marcel Dekker, Inc
3. P S Gill, "Geometric Dimensioning and Tolerancing", S K Kataria & sons, 2005-6.

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Course: Modern Prototyping Practice

Course Code	SEC	**Scheme of Evaluation**	Oral & Term Work
Teaching Plan	0-0-8-0	Term Work	50
Credits	4	Oral	50

Course Outcomes:

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

1) Use different FDM 3D printing processes for the given applications.
2) Know about the different types of additive manufacturing techniques and their applications
3) Evaluating key parameters of reverse engineering processes.
4) To plan and fabricate the 2D and 3D profiles using a laser engraver and a CNC wood router machine.

Assignment	Contents	Practical
01	Study and Hands-on-Practice on FDM 3D Printing Technologies:	4 hrs
02	Study and Hands-on Practice on Liquid Resin Printing Technologies:	4 hrs
03	Demonstration of Advanced Additive Manufacturing Technologies like Metal AM.	4 hrs
04	Study and Hands-on-Practice on Reverse Engineering Equipment's	4 hrs
05	Study and hands-on-Practice on the Laser engraver	4 hrs
06	Study and hands-on practice on the CNC milling machine	4 hrs
07	Study and hands-on practice on a wood router	6 hrs

Exit Course option to qualify for certification in the School of Engineering & Technology

Any two (02) skill-based courses of 8 credits:

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Course: Computer-aided Geometric Modelling

Course Code	SEC	**Scheme of Evaluation**	Oral & Term Work
Teaching Plan	0-0-8-0	Term Work	50
Credits	4	Oral	50

Course outcomes:

At the end of the laboratory work, students will demonstrate the ability to:

1) Build Computer-Aided Design and Drafting software to produce basic concepts for 2D drafting.
2) Carry out part drawing and assembly of systems, along with preparation of the Bill of Materials
3) Draw any Mechanical drawings using computer-aided software like AutoCAD with detailing.
4) Demonstrate the 3D Modelling concepts and prepare the 3D Models using Computer-Aided software.

Syllabus:

Assignment	Contents	Practical
01	**Fundamentals Of Computer Graphics** Introduction to CAD, Product cycle-Design process, Computer-aided design, Computer graphics, coordinate systems-2D and 3D transformations, homogeneous coordinates, graphics primitives (point, Line drawing algorithms.	4 hrs
02	**Transformation and Projection techniques:** 2D and 3D transformation techniques - Translation, Rotation, Scaling, and Reflection principles. Principle of concatenated transformation. Orthographic and Perspective Projections of Geometric Models.	8 hrs
03	**Introduction to different features of the CAD Software.** Study of Capabilities of Software for Drafting & Modeling – Coordinate System, Introduction to various menus and options in software, Introduction to Dimensioning & Dimension Styles and Annotations, technical drafting practices, procedures, and processes according to current ANSI/ISO standards, Drawing of a Title Block with necessary Text and Projection Symbol	8 hrs
04	**2-D Drafting**. Drawing of entities like Line, Circle, Rectangle, parabola, spiral etc, Drawing of front view and top view of simple solids like Cylinder, Prism, Pyramid, cone, etc,	8 hrs
05	**Constructions of Mechanical Drawings using Software Packages**	8 hrs

	Drawing Projection views of a simple machine drawing using CAD software tool, drawing front view, top view and side view of objects from the given pictorial views	
06	**Introduction to 3D Modelling Using AutoCAD** Study of different options for 3D modelling, CAD of simple mechanical drawings using a CAD software tool	8 hrs

Suggested learning resources:

1. William M Neumann and Robert F.Sproul ―Principles of Computer Graphics‖, McGraw-Hill Book Co., Singapore, 1989.
2. Elements of Workshop Technology, Hajra & Choudhary, Media Promoters & Publisher.
3. Workshop Practice HS Bawa, Tata McGraw Hill 2nd ed. India
4. Computer-aided design: a conceptual approach, Jayanta Sarkar

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SEC: BASICS OF ADDITIVE MANUFACTURING

Course Code	SEC	**Scheme of Evaluation**	Term work
Teaching Plan	0-0-8-0	**----**	100
Credits	4	---	100

Course Outcomes:

- Interpret how CAD technology can be leveraged in the additive manufacturing process
- Compare and distinguish the difference between Solid model syntax with .STL file.
- Illustrate the concept like a process chain of Rapid Prototyping and its necessity in the manufacturing of real-life components
- Illustrate and classify the various additive manufacturing techniques to understand their applications in various fields like automobile, biomedical, fashion, and the food industry.
- Demonstrate the use of 3D printing software and the effect of various process parameters
- Infer the printing process on 3D printers by varying the process parameters and evaluate the quality of 3d printed components

Unit	**Contents**	Practical
01.	Introduction to CAD, Introduction to Additive Manufacturing Technology, Introduction to .STL File, Process chain of Additive Manufacturing	8
02.	Study of different processes comes under the Additive Manufacturing umbrella: Study of Liquid-based, Solid-based Based and Powder-based AM processes	5
03.	Study of pre-processing techniques and Study of 3D Printing Software to understand the role of various process parameters and their effect on printing quality, Introduction to post-processing techniques	5
04.	Printing of 3D components on an FDM printer: This experiment will give hands-on experience of using a 3D printer to build the components	10
05.	Demonstration of various technologies under Additive Manufacturing: This experiment will cover the learning of basic Additive Manufacturing techniques and their different industrial applications	10
06.	Integration of Reverse Engineering and Additive Manufacturing	4

Suggested learning resources:

- Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles and Applications”, World Scientific, 2003.
- Ian Gibson, David W Rosen, Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010
- Ali K. Kamrani, EmandAbouel Nasr, “Rapid Prototyping: Theory and Practice”, Springer, 2006.
- Paul C. Bave: CAD Principles and Applications
- Understanding of Additive Manufacturing, Andreas Gebhardt, Hnaser Publishers, 2011.
- D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 20

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BASICS OF CNC PROGRAMMING

Course Code	SEC	**Scheme of Evaluation**	Term work
Teaching Plan	0-0-8-0		
Credits	4		100 marks

Outcomes:

- Prepare programs, demonstrate, simulate, and operate CNC lathe machines for various machining operations
- Prepare programs, demonstrate, simulate and operate CNC milling machines for various machining operations.
- Demonstrate to read the part print and select the machining operations.
- Develop the programs and simulate the program.
- Work on Modern CNC systems and carry out the various operations.

Students need to carry out the following exercises:

Exercise 1	Expt 1: Identification of different parts of the CNC lathe, including data input Expt 2: Identification of different parts of the CNC mill, including data input Expt 3: Practice on the CNC controller using on-screen simulation for generating different profile	10 Hrs
Exercise 2	Expt 4: Writing simple code and test on controller for CNC lathe Expt 5: Writing simple code and test on controller for CNC mill Expt 6: programming canned cycles for simple profile	11 Hrs
Exercise 3	Expt 7: Machining of programmed exercise on CNC lathe machine. Expt 8: Machining of programmed exercise on CNC milling machine. Expt 9-11: Programming for complex shape cylindrical objects with parameter selection, machining. (at least 3 exercises)	10 Hrs
Exercise 4	Expt 12-14: Programming for complex shape prismatic objects with parameter selection, machining. (at least 3 exercises) Expt 15: comparison of manual part programming and CAPP for a simple component	11 Hrs

Text Books:

1. Programming of CNC machines, by Ken Evans
2. CNC Programming Handbook by Peter Smid
3. NC Control by Kundra Rao, Tewari