DEPARTMENT OF MECHANICAL ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR

B.Tech. (Mechanical Engineering) Programme

VII- Semester

Sr. No.	Category	Course Code		Course Title	Hours per week			Course Credits		
		Theory	Practical		L	T	P	Theory	Practical	Total
1.	Open Elective Courses	OE (refer to list)###	--	Open Elective-III	3	0	0	3.0	--	3.0
2.	Professional Elective Courses	PEC (refer to list)**	--	Professional Elective -II	3	0	0	3.0	--	3.0
3	Professional Elective Courses	PEC (refer to list)***	--	Professional Elective -III	3	0	0	3.0	--	3.0
4.	Professional Core Courses	PCC-ME401-T	PCC-ME401-P	Refrigeration and Air-Conditioning	3	1	2	4.0	1.0	5.0
5.	Project work, Seminar and Internship in Industry	--	PROJ-ME401-P	Minor project	0	0	6	--	3.0	3.0
6.	Project work, Seminar and Internship in Industry	--	PROJ-ME402-P	Industrial Training Presentation-II	0	0	2	--	1.0	1.0
7.	Mandatory Courses	--	MC-ME401-P	General Proficiency	0	0	2	--	0.0	0.0
					12	1	12			
Total credits										18.0

###Open Elective –III	
Course Code	**Course Name**
OE-PTG491-T	Fundamentals of Packaging
OE-CSE491-T	Statistical Computing
OE-ECE491-T	Introduction to MATLAB and Simulink
OE-FT491-T	Instrumental Analysis of Foods
OE-CE491-T	Environmental Engineering
OE-EE491-T	Energy Management and Audit

**Professional Elective -II	
Course Code	**Course Name**
PEC-ME451-T	Automation in Manufacturing
PEC-ME452-T	Advanced Welding
PEC-ME453-T	Tool Engineering
PEC-ME454-T	Modern Manufacturing Processes

***Professional Elective -III	
Course Code	**Course Name**
PEC-ME455-T	Introduction to Tribology
PEC-ME456-T	CNC Technology
PEC-ME457-T	Reverse Engineering
PEC-ME458-T	Product Design and Development

7th Semester

REFRIGERATION AND AIR-CONDITIONING (THEORY)

General Course Information

Course Code: PEC-ME401-T Course Category: Professional Core Course Course Credits: 4.0 Contact Hours: 4 hours/week (L: 3; T: 1) Mode: Lectures and Tutorial Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to describe about the refrigeration, air-conditioning, refrigerant and applications of refrigeration systems.	L1
CO2	Student will be able to identify the main components, accessories and controls of refrigeration and air-conditioning systems.	L2
CO3	Student will be able to solve the air-conditioning problem using the principles of psychrometry.	L3
CO4	Student will be able to analyze the performance of vapour compression and other refrigeration system.	L4
CO5	Student will be able to select a refrigeration/air-conditioning according to the comfort conditions.	L5
CO6	Student will be able to design transmission of air in air conditioning system through various types of ducts and design methods	L6

Course Contents

Unit – I

Introduction: Definition of refrigeration & air conditioning; Necessity; Methods of refrigeration; Unit of refrigeration; Coefficient of performance (COP), Fundamentals of air-conditioning system; Refrigerants- Definition, Classification, Nomenclature, Desirable properties, secondary refrigerants, Introduction to eco-friendly Refrigerants; Introduction to Cryogenics.

Air Refrigeration System: Carnot refrigeration cycle, Brayton refrigeration or the Bell Coleman air refrigeration cycle; Air craft refrigeration systems, Simple cooling and Simple evaporative types, Boot strap and Boot strap evaporative types, Regenerative type and Reduced Ambient type system, Comparison of different systems, problems.

Unit – II

Vapour Compression (VC) Refrigeration Systems:(A) Simple Vapour Compression (VC) Refrigeration Systems, Limitations of Reversed Carnot cycle; Analysis of VC cycle considering degrees of sub cooling and superheating; VC cycle on p-v, t-s and p-h diagrams; Effects of operating conditions on COP; Comparison of VC cycle with Air Refrigeration cycle.

(B) Multistage Refrigeration Systems- Necessity of compound compression, Compound VC cycle, Inter-cooling with liquid sub –cooling and / or water inter cooler: Multistage compression with flash inter-cooling and / or water inter-cooling; systems with individual or multiple expansion valves; Individual compression system with individual or multiple expansion valves; Individual compression systems with individual or multiple expansion valves but with and without intercoolers.

Other Refrigeration Systems:(A) Vapour Absorption Refrigeration Systems – Basic Systems, Actual COP of the System, Performance, Relative merits and demerits; Properties of aqua ammonia; Electrolux Refrigeration; Problems.
(B) Steam Jet Refrigerating System- Introduction, Analysis, Relative merits and demerits, Performance Applications, Problems.

Unit – III

Psychrometry of Air & Air Conditioning Processes: Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temp., Thermodynamics wet bulb temp., Psychrometric chart; Psychrometry of air-conditioning processes, Mixing Process, Basic processes in conditioning of air; Psychrometric processes in air washer, Problems.

Air- Conditioning Load Calculations: Outside and inside design conditions; Sources of heating load; Sources of cooling load; Heat transfer through structure, Solar radiation, Electrical applications, Infiltration and ventilation, Heat generation inside conditioned space; Apparatus selection; Comfort chart, Problems.

Unit – IV

Air Conditioning Systems with Controls & Accessories: Classifications, Layout of plants; Equipment selection; Air distribution system; Duct systems Design; Filters; Refrigerant piping; Design of summer air-conditioning and Winter air conditioning systems; Temperature sensors, Pressure sensors, Humidity sensors, Actuators, Safety controls; Accessories; Problems.

Refrigeration and Air Conditioning Equipments: Type of compressors and their performance curves; Types of Condensers, Heat transfer in condensers; Types of expansion devices; types of evaporators, Cooling and Dehumidifying coils, Problems.

Text and Reference Books

1. Refrigeration & Air conditioning –R.C. Jordan and G.B. Priester, Prentice Hall of India.
2. Refrigeration & Air conditioning –C.P. Arora, TMH, New Delhi.
3. A course in Refrigeration & Air Conditioning – Arora & Domkundwar, Dhanpat Rai & Sons.
4. Refrigeration & Air conditioning –W.F. Stocker and J.W. Jones, TMH, New Delhi.
5. Refrigeration & Air conditioning- Manohar Prasad Wiley Estern limited, New Delhi.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	2	1	--	--	2	1	3	3	2	1
CO2	3	1	1	1	--	2	1	--	1	2	1	3	3	2	1
CO3	3	2	2	3	2	3	3	2	2	2	2	3	3	3	2
CO4	3	3	2	3	3	3	3	2	2	2	3	3	3	3	3
CO5	3	1	2	3	2	3	3	2	3	2	3	3	3	3	3
CO6	3	2	3	3	3	3	3	2	3	2	3	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

REFRIGERATION AND AIR-CONDITIONING (LAB)

General Course Information

Course Code: PCC-ME401-P Course Category: Professional Core Course Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to describe the components of the Refrigeration and air-conditioning systems.	L1
CO2	Student will be able to compare the performance of refrigeration system at different load conditions	L2
CO3	Student will be able to apply the knowledge of refrigeration and air conditioning principles to conduct experiments.	L3
CO4	Student will be able to analyze and evaluate the performance of refrigeration and air conditioning systems	L4

Lab Contents

1. To study the vapour compression Refrigeration System and determine its C.O.P. and draw P-h and T-S diagrams.
2. To study the Mechanical heat pump and find its C.O.P.
3. To study the Air and Water heat pump and find its C.O.P.
4. To study the cut- sectional models of Reciprocating and Rotary Refrigerant compressor.
5. To study the various controls used in Refrigerating & Air Conditioning systems.
6. To study the Ice- plant, its working cycle and determine its C.O.P and capacity.
7. To study the humidification, heating, cooling and dehumidification processes and plot them on Psychrometric charts.
8. To determine the By-pass factor of Heating & Cooling coils and plot them on Psychrometric charts on different inlet conditions.
9. To determine sensible heat factor of Air on re-circulated air-conditioning set up.
10. To study the chilling plant and its working cycle.

NOTE: *The list is indicative. The teacher can alter/add more number of experiments as per the requirement.*

Course Articulation Matrix (CO to PO/POS Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	--	1	1	--	1	1	--	--	2	--	3	3	2	1
CO2	3	--	1	2	2	1	1	2	1	2	--	3	3	2	1
CO3	3	1	2	3	2	2	2	2	2	2	2	3	3	3	2
CO4	3	2	2	3	3	2	2	2	2	2	2	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MINOR PROJECT

General Course Information

Course Code: PROJ-ME401-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 3.0 Mode: Practical Contact Hours: 6 hours per week	**Course Assessment Methods (internal: 30; external: 70):** Internal practical evaluation is to be done by the course coordinator. The end semester practical examination will be conducted jointly by external and internal examiners.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to trace out the problem using literature survey/ industry survey to draw an outline for the development or improvement in the existing system of mechanical engineering field.	L1
CO2	Students will be able to summarise various interdisciplinary ideas and technologies which could be used to achieve the desired solution.	L2
CO3	Students will be able to demonstrate an innovative working mechanical system or product which could be the requirement of new generation.	L3
CO4	Students will be able to compare various techniques which could be used to solve the identified problem.	L4
CO5	Students will be able to select the most optimum solution for the identified problem.	L5

Course Contents

Project involving design/ fabrication/ testing computer simulation/ case studies etc. which is commenced in VIIth Semester, will be completed in VIIIth Semester. The student will be required to submit his ideas/objectives in the form of a synopsis to project coordinator and to project guide. Group of 5-6 students choose a project guide and works on the development of any new ideas in the field of Mechanical Engineering

Note:

- ***The design work should also be practiced through latest tools such as ANSYS, solid modeling CAD packages (e.g. AutoCAD, Solidworks, Pro-E, CATIA etc.)***

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	1	2	3	3	3	3	3	3	3
CO2	3	3	3	2	2	2	1	2	3	3	3	3	3	3	3
CO3	3	3	3	2	2	3	1	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

INDUSTRIAL TRAINING PRESENTATION-II

General Course Information

Course Code: PROJ-ME402-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 1.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods (internal:100)** Internal continuous assessment of 100 marks on the basis of report writing, presentation and viva voce in practical classes by the team of panel of faculty members.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to get the exposure of 'real' working environment and get acquainted with the organization structure, business operations and administrative functions.	L1
CO2	Students will be able to demonstrate competency in relevant engineering fields through problem identification, formulation and solution.	L2
CO3	Students will be able to develop the ability to work as an individual and in group with the capacity to be a leader as well as an effective team member.	L3
CO4	Students will be able to generate a report based on the experiences with the ability to apply knowledge of Engineering fundamentals	L4
CO5	Students will be master in his profession and perform ethical responsibilities of an engineer	L5

Course Contents

As a part of the B. Tech. Mechanical Engineering Curriculum Industrial Training-II is a Practical course, which the students of Mechanical Engineering should undergo in reputed Private / Public Sector / Government organization / companies as industrial training of four-six weeks in the summer vacation after the VIth semester.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	--	--	--	--	--	2	2	--	--	--	2	3	3	3	3
CO2	3	3	3	3	3	--	--	--	--	2	--	2	2	2	2
CO3	--	--	--	--	--	--	--	2	3	--	--	--	--	--	2
CO4	3	--	--	--	--	--	--	--	--	3	--	2	--	--	2
CO5	--	--	--	--	--	1	--	3	--	2	2	2	2	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

GENERAL PROFICIENCY

General Course Information

Course Code: MC-ME401-P Course Category: Mandatory Course Course Credits: 0.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods(internal: 100):** This is a **non-credit course of qualifying nature**. Internal practical evaluation is to be done by the course coordinator.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to state the importance of extra-curricular activities along with academics.	L1
CO2	Students will be able to discuss the role of social activities in career/professional development of an individual.	L2
CO3	Students will be able to choose most feasible solution to tackle the problem in a team.	L3
CO4	Students will be able to criticize the on-going topic in a group discussion.	L4
CO5	Students will be able to argue for the most preferred solution for a project work.	L5

Course Contents

At the end of semester students will be evaluated on the basis of their performance in various fields. The evaluation will be made by the course coordinator. A specimen performa indicating the weightage to each component/ activity is given below :-

Name : _____
Roll No. _____
Branch _____
Year of Admission _____

I. Academic Performance (15 Marks) :

(a) Performance in University Examination :-

Sem.	Result (%age of marks obtained)	Number of Attempt in which the Semester exam has been cleared
I		
II		
III		
IV		
V		
VI		
VII		

II. Extra Curricular Activities (10 Marks) :

Item	Level of Participation	(Position Obtained)	Remarks
Indoor Games (Specify the Games	_____ _____ _____	_____ _____	
Outdoor Games (Specify the Games)	_____ _____ _____	_____ _____ _____	

Essay Competition _____
_____
_____

Scientific Technical Exhibitions _____
_____
_____

Debate _____
_____
_____
_____

Drama _____
_____
_____
_____

Dance _____
_____
_____
_____

Music _____
_____
_____
_____

Fine Arts _____
_____
_____
_____

Painting _____
_____
_____
_____

Hobby Club _____
_____
_____
_____

N.S.S. _____
_____
_____
_____

Hostel Management Activities _____
_____
_____
_____

Any other activity (Please Specify) _____
_____
_____

III. Educational tours/visits/Membership of Professional Societies (5 Marks)

1. _____
2. _____
3. _____
4. _____

IV. Contribution in NSS Social Welfare Floor Relief/draught relief/Adult Literacy mission/Literacy Mission/Blood Donation/Any other Social Service (5 Marks)

1. _____
2. _____
3. _____
4. _____
5. _____

V. Briefly evaluate your academic & other performance & achievements in the Institution (5 Marks)

_____
_____
_____
_____

VI. Performance in Viva voce before the committee (10 Marks)

_____
_____
_____
_____
_____

*Marks obtained 1.( )+II( )+III( )+IV( )+V( )+VI( ) =

**Total Marks :

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	--	--	--	--	--	3	2	3	3	3	2	1	1	1	3
CO2	--	--	--	--	--	3	3	3	2	3	1	2	1	1	3
CO3	--	--	--	--	--	1	1	2	3	3	3	3	1	1	3
CO4	--	--	--	--	--	1	1	1	2	3	2	3	1	1	3
CO5	--	--	--	--	--	1	1	1	3	3	3	2	1	1	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

Professional Elective -II

Course Code	Course Name	L	T	P	Credits
PEC-ME451-T	Automation in Manufacturing	3	-	-	3.0
PEC-ME452-T	Advanced Welding	3	-	-	3.0
PEC-ME453-T	Tool Engineering	3	-	-	3.0
PEC-ME454-T	Modern Manufacturing Processes	3	-	-	3.0

AUTOMATION IN MANUFACTURING (THEORY)

General Course Information

Course Code: PEC-ME451-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to memorize the concepts of automation theory and its applications in various fields of manufacturing.	L1
CO2	Students will be able to describe principles, methods, and hardware/software tools used in Hydraulics/Pneumatics Electro-pneumatic controls and devices.	L2
CO3	Students will be able to illustrate the principles of Rapid Prototyping, classifications of different RP techniques along with their applications.	L3
CO4	Students will be able to develop the concepts of Automatic transfer machines with assembly automation.	L4

Course Contents

UNIT-I

Introduction to Factory Automation and Integration: Basic Concepts, Types of automation, Modern developments in automation in manufacturing and its effect on global competitiveness, Need and implications of automation in Manufacturing.

UNIT-II

Introduction to Hydraulics/Pneumatics Electro-pneumatic controls and devices, Basic elements hydraulics/pneumatics, Electro-pneumatic systems, Fluid power control elements and standard graphical symbols for them, Construction and performance of fluid power generators, Hydraulic & pneumatic cylinders - construction, design and mounting, Hydraulic & pneumatic valves for pressure, Flow & direction control, Servo valves and simple servo systems with mechanical feedback, Solenoid, Different sensors for electro-pneumatic system, hydraulic, pneumatic & electro-pneumatic circuits.

UNIT-III

Introduction to rapid prototyping (RP), Basic Principles of RP, Steps Classifications of Different RP Techniques. Materials for RP: Plastics, Ceramics, Resins, Metals, Selection criterions processes, the advantages and limitations of different types of materials.

UNIT-IV

Automatic transfer machines: Classifications, Analysis of automated transfer lines, without and with buffer storage, Group technology and flexible manufacturing system.

Assembly automation: Types of assembly systems, Assembly line balancing, Performance and economics of assembly system.

Text and Reference Books

1. Groover, M. P., "Automation, Production systems and Computer Integrated Manufacturing", 2nd Ed., Prentice Hall, 2005.
2. Boothroyd, G., "Assembly Automation and Product Design", 2nd Ed., Marcel Dekker, 1992.
3. Boothroyd, G., Dewhurst, P. and Knight, W., "Product Design for Manufacture and Assembly", 2nd Ed., Taylor & Francis, 2002.
4. Boothroyd, G., Poli, C. and Murch, L. E., "Automatic Assembly", Marcel Dekker, 1982.
5. Tergan, V., Andreev, I. and Lieberman, B., "Fundamentals of Industrial Automation", Mir Publishers,

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1
CO2	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1
CO3	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1
CO4	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

ADVANCED WELDING (THEORY)

General Course Information

Course Code: PEC-ME452-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define welding, its mechanism, welding processes and welding defects	L1
CO2	Students will be able to describe principles, methods, welding defects and their maintenance	L2
CO3	Students will be able to examine and compare different welding process	L3
CO4	Students will be able to select the welding process for different materials	L4

Course Contents

UNIT-I

Introduction- Classification of welding processes, physics of welding arc, arc stability, arc blow, polarity, welding symbols, safety and hazards in welding. Metal Transfer: Mechanism and types of metal transfer in various arc welding processes.Welding consumables: Classification and selection of welding electrodes and filler rods, welding fluxes, characteristics and manufacturing of the welding fluxes, characteristics of different shielding gases.

UNIT-II

Welding processes: Manual Metal Arc Welding (MMAW), TIG, MIG, Plasma Arc, Submerged Arc Welding, Electrogas and Electroslag, Flux Cored Arc Welding, Resistance welding, Friction welding, Brazing, Soldering and Braze welding processes, Laser beam welding, Electron beam welding, Ultrasonic welding, Explosive welding, Friction Stir Welding, Underwater welding & Microwave welding. Weldability: Definition, different tests of weldability, weldabitity of steel, stainless steel, cast iron, aluminum and titanium.

UNIT-III

Joining of ceramics and plastics processes: Allied welding processes: brazing, soldering, metal spraying, and gas & arc cutting of steels, stainless steel and cast iron, thermal spraying, plasma cutting. heat flow welding: calculation of peak temperature; width of heat affected zone; cooling rate and solidification rates; weld thermal cycles; residual stresses and their measurement; weld distortion and its prevention.

UNIT-IV

Welding defects: Different types of welding defects, causes and remedies, testing for identifying defects. Welding distortion and residual stresses**:** Types, factors affecting the distortion and residual stresses, methods of reducing the distortion. Repair & Maintenance Welding: Hard facing, Cladding, Surfacing, Metallizing processes and Reclamation welding.

Text and Reference Books

1. Welding and Welding Technology, by- Richard L. Little, McGraw Hill Education.
2. Welding Principals and Practices, by- Edwars R. Bohnart, McGraw Hill Education.
3. Welding Engineering and Technology, by- R. S. Parmar, Khanna Publishsers.
4. Jean Cornu, Advanced welding systems, IFS.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	--	--	--	--	--	--	--	2	--	3	2	2	2
CO2	3	1	1	1	--	--	--	--	--	2	--	3	2	2	2
CO3	3	1	2	1	--	--	--	2	--	2	--	3	2	2	2
CO4	3	2	2	1	--	--	--	2	--	2	--	3	2	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

TOOL ENGINEERING (THEORY)

General Course Information

Course Code: PEC-ME453-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the different manufacturing devices viz. various cutting and gaging tools and their materials, work holding devices, jigs and fixtures, and dies.	L1
CO2	Students will be able to describe different manufacturing devices along with their principles.	L2
CO3	Students will be able to solve different kind of problems related to selection of manufacturing devices.	L3
CO4	Students will be able to compare different manufacturing devices effectively.	L4
CO5	Students will be able to select and design appropriate manufacturing device required to manufacture a particular component.	L5

Course Contents

UNIT-I

Cutting Tool Materials: Desirable Properties of Cutting Tool Materials, Different Types of Cutting Tool Materials, Cutting-Tool Reconditioning

Design of Cutting Tools: Basic Mechanics and Geometry of Chip Formation, General Considerations for Metal Cutting, Design of Single Point Cutting Tools, Design of Milling Cutters, Design of Drills

.

UNIT-II

Gages: Definition of gage, Types of Gages, Gage Tolerances, Material for Gages

Work Holding Devices: Location: Principles, Methods and Devices, Clamping: Principles, Methods and Devices

UNIT-III

Drill Jigs: Definition and Types of Drill Jigs, General Considerations in the Design of Drill Jigs, Drill Bushings

Fixtures: Fixtures and Economics, Types of Fixtures

UNIT-IV

Bending, Forming and Drawing Dies: Bending Dies, Forming Dies, Drawing Operations, Variables that Affect Metal Flow during Drawing

Tool Design for Numerically Controlled Machine Tools: Fixture Design for Numerically Controlled Machine Tools, Cutting Tools for Numerical Control, Tool-Holding Methods for Numerical Control.

Text and Reference Books

1. Mehta, N. K., "Metal Cutting and Design of Cutting Tools, Jigs & Fixtures" , McGraw Hill Education (India) Private Limited
2. Cyril Donaldson, George H LeCain, Goold V.C., JoyjeetGhose , "Tool Design", Tata-McGraw Hill.
3. Jeff Lantrip, John G. Nee, David Alkire Smith, "Fundamentals of Tool Design", Society of Manufacturing Engineers
4. Jones E.J.H., Town H.C., "Production Engineering: Jig and Tool Design", Butterworth and Co (Publishers) Ltd

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

MODERN MACHINING PROCESSES (THEORY)

General Course Information

Course Code: PEC-ME454-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the basic principles, construction and working of modern machining methods.	L1
CO2	Students will be able to explain the applications, advantages, and limitations of new machining methods.	L2
CO3	Students will be able to differentiate various non-traditional machining processes.	L3
CO4	Students will be able to select the correct non-conventional material removal process	L4

Course Contents

UNIT-I

Unconventional Machining Process: Characteristics of Modern Machining Processes, Basic Principles of New Machining Methods, Advantages and Limitations of Non-traditional Machining Processes.

Electric Discharge Machining (EDM): Operating Principles of Spark Erosion, Construction details and components of Spark Erosion Machines (Schematic Diagrams), Applications, Advantages, and Limitations of EDM process.

UNIT-II

Electro-Chemical Machining (ECM): Principle of ECM process, ECM process Details with Chemical Reactions (Schematic Diagram), Advantages, Disadvantages and Application of ECM process.

Electron Beam Machining (EBM): Description of EBM process (Schematic Diagrams), Applications and Limitations of Electron Beam Machining, Electron Beam Welding (EBW), and Laser beam Welding (LBW).

UNIT-III

Ultrasonic Machining (USM): Basic Principle of the USM, Essential components of USM, Performance Parameters of USM, Applications, Advantages and Limitations of USM.

Abrasive Jet Machining (AJM): Features of AJM (Schematic Diagrams), Practical Applications of AJM, Advantages and Disadvantages of AJM, Water Jet Machining (WJM).

UNIT-IV

Chemical Machining (CHM): Basic Techniques of CHM, Mechanism of CHM, Process Variables in CHM, Advantages and Applications of CHM.

Comparison of Unconventional Machining Processes: Comparison on Power Consumption basis, Selection of Non-traditional Machining process, Effect of Non-conventional Material removal processes on Surface Integrity.

Text and Reference Books

1. Unconventional Machining Process – M.Adithan, Atlantic
2. Modern Machining Processes – P.C.Pandey, H.S.Shan, Tata McGraw Hill
3. Machining Science- Ghosh and Malik, Affiliated East-West Press
4. Non Traditional Manufacturing Processes- Benedict G.F, Marcel Dekker
5. Advanced Methods of Machining- Mc Geongh J.A, Chapman and Hall

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	--	--	--	--	--	--	--	2	--	2	2	2	1
CO2	3	1	--	--	--	--	--	--	--	2	--	2	2	2	1
CO3	3	--	2	--	--	2	--	--	2	2	1	3	3	2	2
CO4	3	--	2	--	--	2	2	3	2	2	2	3	3	2	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

Professional Elective -III

Course Code	Course Name	L	T	P	Credits
PEC-ME455-T	Introduction to Tribology	3	-	-	3.0
PEC-ME456-T	CNC Technology	3	-	-	3.0
PEC-ME457-T	Reverse Engineering	3	-	-	3.0
PEC-ME458-T	Product Design and Development	3	-	-	3.0

INTRODUCTION TO TRIBOLOGY (THEORY)

General Course Information

Course Code: PEC-ME455-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the interdisciplinary subject 'Tribology' and its technological significance	L1
CO2	Students will be able to examine the genesis of friction and wear	L2
CO3	Students will be able to learn about the principles of lubrication, lubrication regimes, hydrodynamic lubrication and hydrostatic lubrication.	L3
CO4	Students will be able to analyze real life problem in tribology.	L4

Course Contents

UNIT-I

Introduction: History of Tribology, Introduction to Friction, Wear and Lubrication, Characteristic features of tribological systems, Surface topography, environmental and Economic aspects of tribology.

UNIT-II

Friction: Causes of friction, Adhesion theory, Abrasive theory, Junction growth theory, Laws of rolling friction, Modeling of friction. Wear: Wear mechanisms, Adhesive wear, Abrasive wear, Corrosive war, Fretting wear, Modeling of wear.

UNIT-III

Physical Properties of Lubricants: Introduction, Oil viscosity, Viscosity temperature relationship, Viscosity index, Viscosity pressure relationship, Viscosity-shear rate relationship, Viscosity measurements, Viscosity of mixtures, Oil viscosity classification, Lubricant density and specific gravity, Thermal properties of lubricants, Temperature characteristics of lubricants, Other lubricants characteristics, Optical properties of lubricants, Additive compatibility and solubility, Lubricant impurities and contaminants, Solubility of gases in oils.

Lubricants and Their Composition: Introduction, Mineral oils, Synthetic oils, Emulsions and aqueous lubricants, Greases, Lubricant additives.

UNIT-IV

Fluid Film Lubrication: Regimes of fluid film lubrication, Hydrodynamic Lubrication; Introduction, Generalized Reynolds equation, Converging-diverging wedges, Journal bearings, Thermal effects in bearings, Limits of hydrodynamic lubrication, Hydrodynamic lubrication with non-Newtonian fluids, Reynolds equation for squeeze films, Porous bearings.Hydrostatic Lubrication; Basic concepts, Aerostatic bearings, Hybrid bearings, Stability of journal bearings.

Text and Reference Books

1. Conner, J.J. and Boyd, J., "Standard Handbook of Lubrication Engineering", McGraw Hill (1968)
2. Khonsari, M. M. and Booser, E. R., "Applied Tribology: Bearing Design and Lubrication", 2nd Ed, Wiley (2008)
3. Kudish, I. I. and Covitch, M. J., "Modeling and Analytical Methods inTribology", Chapman and Hall/CRC (2010)
4. Bhushan, B., "Principles and Applications of Tribology", 2nd Ed., Wiley (2013)
5. Stachowiak, G.W. and Batchelor, A. W., "Engineering Tribology", 4th Ed,Butterworth-Heinemann (2013)
6. Wyong B., "Tribology: Engineering Applications", NY Research Press (2015)
7. Hirani H., "Fundamentals of Engineering Tribology with Applications", Cambridge University Press(2016)

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	--	--	--	--	3	2	--	--	--	--	2	3	2	3
CO2	3	2	3	2	--	2	--	--	--	--	--	2	3	1	3
CO3	3	2	3	2	3	--	--	--	--	--	--	3	3	2	3
CO4	3	2	3	3	3	--	--	--	--	--	2	3	3	2	3

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

CNC TECHNOLOGY (THEORY)

General Course Information

Course Code: PEC-ME456-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe construction, working and tooling systems in Computer Numeric Control (CNC) machines.	L1
CO2	Students will be able to demonstrate the working of CNC machines through the Manual part programming and Automatically Programmed Tool (APT) language.	L2
CO3	Students will be able to distinguish between the different features of CNC Turning Center and CNC Machining Center.	L3
CO4	Students will be able to select the different CNC process as per the machining process.	L4
CO5	Students will be able to develop CNC programs as per the ISO standards, process, machine and tooling arrangements.	L5

Course Contents

UNIT-I

Computer Numerical Control (CNC) Technology: Numerical Control (NC), Historical Development of CNC Machines, NC Coordinate Systems, NC Modes, Advantages and Limitations of CNC Machine Tools.
CNC Hardware: Structure of CNC Machine tools, Drives used in CNC machines, Actuation Systems of CNC Machines Tools, Feedback Devices used in CNC Machine.

UNIT-II

CNC Programming Fundamentals: Part Programming Steps, Axes Identification in CNC Turning and Machining Centres, Machine Zero and Home Position, ISO Standards for Coding.
Manual Part Programming: Preparatory Functions, Miscellaneous Functions, Absolute and Incremental Programming, Tool Length Compensation.

UNIT-III

Turning Centre Programming: Motion Commands, Tool Nose Radius Compensation, Cut Planning, Thread Cutting, Part Program Numericals.

Machining Centre Programming: Canned Cycles, Cutter Radius Compensation, Part Program Numericals.

UNIT-IV

Computer Aided Part Programming : APT Language, Geometry Statements, Motion Statements, Post Processor Statements, Auxiliary Statements, Part Program Numericals.

CNC Tooling: Cutting Tool Material and Characteristics, Turning Tool Geometry, Tooling System for Turning, and Milling. Tool Presetting, Automatic Tool Changers, Work Holding.

Text and Reference Books

1. Jon S. Stenerson, Kelly Curran, "Computer Numerical Control: Operation and Programming", Prentice Hall, 3rd edition 2007.
2. Mattson Mike, "CNC Programming: Principles & Applications", Cengage learning, 1st edition 2013.
3. Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Higher Education, 3rd edition 2013.
4. Michael J. Peterson, "CNC Programming: Basics & Tutorial Textbook", Create Space Independent Publishing Platform, 1st edition 2008.
5. Peter Smid, "CNC Tips and Techniques: A Reader for Programmers", Industrial Press Inc., 1st edition 2013.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1	--	1	1	2	1	1	3	3	3	1
CO2	3	3	1	1	1	--	1	1	2	2	1	3	3	3	1
CO3	3	3	1	1	1	--	1	1	2	1	1	3	3	3	1
CO4	3	3	1	1	1	--	1	1	2	2	1	3	3	3	1
CO5	3	3	1	1	1	--	1	1	2	3	1	3	3	3	1

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

REVERSE ENGINEERING (THEORY)

General Course Information

Course Code: PEC-ME457-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks. For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe phases of reverse engineering for geometric model development.	L1
CO2	Students will be able to understand methodologies and techniques used for reverse engineering.	L2
CO3	Students will be able to select a reverse engineering system	L3
CO4	Students will be able to discuss case studies for understanding relationship between reverse engineering and rapid prototyping.	L4

Course Contents

UNIT-I

Introduction: Reverse engineering fundamentals-The generic process-Three phases of reverse engineering-Phase I: Scanning, Phase II: Point processing, Phase III: Geometric model development.

UNIT-II

Methodologies and techniques of Reverse Engineering: Computer aided reverse engineering, Computer vision and reverse engineering, Structured light range imaging, Scanner pipeline.

UNIT-III

Reverse engineering hardware and software: Introduction, Reverse engineering hardware, Reverse engineering software, Selection of a reverse engineering system, Case studies with implementation.

UNIT-IV

Introduction to rapid prototyping: Need & Development of RP systems, RP process chain, Impact of Rapid prototyping and Tooling on Product Development, Benefits, Digital prototyping, Virtual prototyping, Applications, Relationship between reverse engineering and rapid prototyping, Case studies with implementation.

Text and Reference Books

1. K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, 1st edition, Prentice Hall, 2001. ISBN-13: 978-0130212719.
2. V. Raja and K. Fernandes, Reverse Engineering: An Industrial Perspective, Springer- Verlag, 2008. ISBN: 978-1-84628-855-5.
3. K. A. Ingle, Reverse Engineering, McGraw-Hill, 1994. ISBN-13: 978-0070316935.
4. L. Wills and P. Newcomb, Reverse Engineering, 1st edition, Springer-Verlag, 1996. ISBN-13: 978-1475788280.
5. C. K. Chua, K. F. Leong and C. S. Lim, Rapid Prototyping: Principles and Applications, 4th edition, World Scientific, 2010. ISBN: 978-981-277-897-0.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	--	--	--	--	--	--	--	--	2	--	3	2	1	1
CO2	2	--	1	2	2	--	--	--	--	2	--	3	3	2	2
CO3	2	--	2	3	3	--	2	--	2	2	--	3	3	2	2
CO4	2	3	2	3	3	--	2	--	2	2	--	3	3	3	2

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)

PRODUCT DESIGN AND DEVELOPMENT (THEORY)

General Course Information

Course Code: PEC-ME458-T Course Category: Professional Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0) Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Two minor tests each of 20 marks, Class Performance measured through percentage of lectures attended (4 marks) Assignment and quiz (6 marks), and end semester examination of 70 marks.For the end semester examination, nine questions are to be set by the examiner. Question number one will be compulsory and based on the entire syllabus. It will contain seven short answers type questions. Rest of the eight questions is to be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt any other four questions selecting one from each of the remaining four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe design process, design models, design phases, design strategies, design planning and design specifications.	L1
CO2	Students will be able to understand the concept of design for 'X', particularly design for manufacturing processes, design for aesthetics, design for ergonomics, design for assembly, design for economics and design for environment.	L2
CO3	Students will be able to demonstrate industrial design concepts.	L3
CO4	Students will be able to make use of different tools for product design.	L4

Course Contents

UNIT-I

Product Design Philosophy: Design process, design models, design phases, product design strategies, product design planning and specification, need analysis, concept generation, concept selection, concept testing, Modern product development process, Innovative thinking, Morphology of design.

UNIT-II

Design considerations: General considerations in design for casting, forging, machining, powder metallurgy and welding, Design considerations for assembly.

Material selection processing and Design: Material Selection Process, Economics, Cost Vs Performance, Weighted property Index, Value Analysis

UNIT-III

Design for aesthetics and ergonomics: Human Factors in Design, Aesthetics considerations in design-Basic types of product forms, designing for appearance, shape, features, materials and finishes, Ergonomic considerations in design display and controls, workspace design, hand tool design, human engineering considerations-Relation between man, machine and environmental factors.

Societal consideration – Contracts, Product liability, Protecting intellectual property, Legal and ethical domains, Codes of ethics, Ethical conflicts, Environment responsible design-future trends in interaction of engineering with society.

UNIT-IV

Industrial Design concepts: human factors design, user friendly design, design for serviceability, design for environment, prototyping and testing , cost evaluation, categories of cost, overhead costs, activity based costing, methods of developing cost estimates, manufacturing cost, value analysis in costing.

Tools for product design: Concurrent Engineering, Rapid prototyping, Drafting/Modeling software CAM, Interface Reverse Engineering.

Text and Reference Books

1. Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill.
2. Product Development, by Chitale & Gupta, Tata McGraw Hill
3. The Mechanical Process Design, by David Ullman, McGrawhill Inc
4. Engineering Design Process, by Yousef Haik, T M MShahin, Cengage Learning
5. Product design & process Engineering by Niebel & deeper, McGraw hill
6. Value Management by Heller, Addison Wasley
7. Value Engineering A how to Manual S.S.Iyer, New age International Publishers
8. Value Engineering : A Systematic Approach by Arthur E. Mudge - Mc GrawHill
9. New Product Development Timjones. Butterworth Heinmann, Oxford.
10. Value Engineering A how to Manual S. S. Iyer, New age International Publishers
11. Value Engineering : A Systematic Approach by Arthur E. Mudge - Mc GrawHill
12. Assembly automation and product design – by Geoffrey Boothroyd, CRC Taylor & Francis

Course Articulation Matrix (CO to PO/PSO Mapping)

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

1 : (Slight/Low), 2:(Moderate/Medium), 3 :(Substantial/High)