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Learning Outcomes based Curriculum Framework(LOCF)

For

B. Tech. Mechanical Engineering

4 Year RegularFull-Time

Graduate Programme

Faculty of Engineering and TechnologyChaudhary Devi Lal University

Sirsa-125055

2022-2023

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Credit Scheme for B. Tech. Mechanical Engineering 3rd Year (5th & 6th Sem)

Semester	Basic Science Courses BSC		Engineering Science' Core/ Elective/ Open Elective Courses (PC/PE/OE)		Humanities, Social Sciences Courses (HSMC)		Mandatory Courses		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
5th	00	00	09	24	01	03	0	00	27
6th	00	00	08	19	01	02	01	00	21

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Scheme B.Tech. (Mechanical Engineering) 3rd year

B. Tech Mech. Engg. 3rd Year Semester-V

#	Course Code	Course Title	Workload/ Credit			
			Theory	**Tutorial**	**Practical**	**Total**
1.	Open Elective-I To be opted by the students from other department		3/3	-/-	-/-	3/3
2.	HSMC/3-T	Fundamental of Management	3/3	-/-	-/-	3/3
3.	PC/ME/10-T	Kinematics of Machines	3/3	-/-	-/-	3/3
4.	PC/ME/11-T	Hydraulic Machines	3/3	1/1	-/-	4/4
5.	PC/ME/12-T	Internal Combustion Engines and Gas Turbines	3/3	-/-	-/-	3/3
6.	PC/ME/13-T	Design of Machine Elements	2/2	2/2	-/-	4/4
7.	PC/ME/10-P	Kinematics of Machines Lab	-/-	-/-	2/1	2/1
8.	PC/ME/11-P	Hydraulic Machines Lab	-/-	-/-	2/1	2/1
9	PC/ME/12-P	Internal Combustion Engines and Gas Turbines Lab	-/-	-/-	2/1	2/1
10.	EEC/ME/2-P	Industrial Training Presentation-I	-/-	-/-	0/4	0/4
11.	MC/5-P	Technical Presentation	-/-	-/-	2/-	2/-
					Total Credits	**28/27**

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B. Tech Mech. Engg. 3rd Year Semester-VI

#	Course Code	Course Title	Workload/ Credit			
			Theory	**Tutorial**	**Practical**	**Total**
1.	Open Elective-II To be opted by the students from other department		3/3	-/-	-/-	3/3
2.	PE/ME/1-T to PE/ME/4-T	Program Elective -I	3/3	-/-	-/-	3/3
3.	HSMC/4-T	Economics for Engineers	2/2	-/-	-/-	2/2
4.	PC/ME/14-T	Dynamics of Machines	3/3	-/-	-/-	3/3
5.	PC/ME/15-T	Automobile Engineering	3/3	-/-	-/-	3/3
6.	PC/ME/16-T	Heat Transfer	3/3	1/1	-/-	4/4
7.	PC/ME/14-P	Dynamics of Machines Lab	-/-	-/-	2/1	2/1
8	PC/ME/15-P	Automobile Engineering Lab	-/-	-/-	2/1	2/1
9.	PC/ME/16-P	Heat Transfer Lab	-/-	-/-	2/1	2/1
					Total Credits	**24/21**

List of Program Elective -I opted by the VI semester students

Program Elective -I	
Course Code	Course Name
PE/ME/1-T	Operation Research
PE/ME/2-T	Total Quality Control
PE/ME/4-T	Industrial Engineering

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Note: Students shall devote 6-8 weeks to training after 6th semester examination outside the College campus at approved works.
Open Elective-I, II :- Students are required to study one elective subject from any other Department each in 5th and 6th Semester respectively

*Non-credit qualifying mandatory courses. The assessment will be completely internal.

** Internal evaluation

*** The students shall devote 6-8 Week to industrial training after 6th semester examinations and shall submit a report. The evaluation of industrial training will be taken up in the 7th semester.

Assessment of industrial training presentation will be based on presentation/seminar, viva- voce, report and certificate for the training at the end of semester.

Note: Students will be allowed to use non-programmable scientific calculators only; however, sharing of calculator should not be permitted.

Course Code	**Definition/ Category**
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management Courses
MC	Mandatory Audit Courses
PC	Program Core
PE	Program Elective Courses
OE	Open Elective Courses
EEC	Employability Enhancement Courses (Project work/ Summer Training/ Industrial Training/ Practical Training/ Internship/Seminar, etc.)

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Credit Scheme for B. Tech. Mechanical Engineering 4th Year (7th & 8th Sem)

Semester	Basic Science Courses BSC		Engineering Science' Core/ Elective/ Open Elective Courses (PC/PE/OE)		Humanities, Social Sciences Courses (HSMC)		Mandatory Courses		Grand Total Credit
	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	No. of Courses	Total Credits	
7th	00	00	06	15	01	03	01	00	18
8th	00	00	08	21	00	00	00	00	21

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Scheme B.Tech. (Mechanical Engineering) 4th year

B. Tech Mech. Engg. 4th Year Semester-VII

#	Course Code	Course Title	Workload/ Credit			
			Theory	**Tutorial**	**Practical**	**Total**
1.	Open Elective-III To be opted by the students from other department		3/3	-/-	-/-	3/3
2.	PE/ME/5-T to PE/ME/8-T	Program Elective -II	3/3	-/-	-/-	3/3
3.	PC/ME/17-T	Refrigeration and Air-Conditioning	3/3	1/1	-/-	4/4
4.	HSMC/5-T	Industrial Psychology and organizational behavior.	3/3	-/-	-/-	3/3
5.	PC/ME/17-P	Refrigeration and Air-Conditioning Lab	-/-	-/-	2/1	2/1
6.	EEC/ME/3-P	Minor project	-/-	-/-	6/2	6/2
7.	EEC/ME/4-P	Industrial Training Presentation-II	-/-	-/-	4/2	4/2
					Total Credits	**25/18**

List of Program Elective -I opted by the VII semester students

Program Elective -II	
Course Code	Course Name
PE/ME/5-T	Automation in Manufacturing
PE/ME/6-T	Advanced Welding
PE/ME/7-T	Introduction to CNC
PE/ME/8-T	Modern Manufacturing Processes

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B. Tech Mech. Engg. 4th Year Semester-VIII

#	Course Code	Course Title	Workload/ Credit			
			Theory	Tutorial	Practical	Total
1.	PE/ME/9-T to PE/ME/12-T	Program Elective -III	3/3	-/-	-/-	3/3
2.	PC/ME/18-T	Power Plant Engineering	3/3	-/-	-/-	3/3
3.	PC/ME/19-T	Computer Aided Design and Manufacturing	3/3	-/-	-/-	3/3
4.	EEC/ME/7-T	Project and Production Management	3/3	-/-	-/-	3/3
5.	PC/ME/20-T	Maintenance Engineering	3/3	-/-	-/-	3/3
6.	PC/ME/19-P	Computer Aided Design and Manufacturing Lab	-/-	-/-	2/1	2/1
7.	EEC/ME/5-P	Major Project	-/-	-/-	10/4	10/4
8.	EEC/ME/6-P	Seminar	-/-	-/-	2/1	2/1
Total Credits						29/21

List of Program Elective -I opted by the VIII semester students

Program Elective -III	
Course Code	Course Name
PE/ME/9-T	Solar Energy Engineering
PE/ME/10-T	Flexible Manufacturing Systems
PE/ME/11-T	Rapid Prototyping
PE/ME/12-T	Product Design Development

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Program Elective-I, II and III Students are required to study one elective subject from Program Elective each in 6th, 7th and 8th Semester
Open Elective-III: - Students are required to study one elective subject from any other Department in 7th Semester.

*Non-credit qualifying mandatory courses. The assessment will be completely internal.

** Internal evaluation

Note: Students will be allowed to use non-programmable scientific calculators only; however, sharing of calculator should not be permitted.

List of open elective courses to be opted by ME branch to the students of other branches

List of open elective for Vth semester

Open Elective -I	
Course Code	Course Name
OE/ME/1-T	Industrial Engineering
OE/ME/2-T	Applied Thermodynamics
OE/ME/3-T	Applied Mechanics
OE/ME/4-T	Introduction to Mechanical Engineering

List of open elective for VIth semester

Open Elective –II	
Course Code	Course Name
OE/ME/5-T	Operation Research
OE/ME/6-T	Solar Energy Engineering
OE/ME/7-T	Introduction to CNC
OE/ME/8-T	Project and production management

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List of open elective for VIIIth semester

Open Elective –III	
Course Code	Course Name
OE/ME/9-T	Total quality Management
OE/ME/10-T	Introduction to CAD
OE/ME/11-T	Mechatronics
OE/ME/12-T	Robotics

Policy Document for providing exemptions in attendance to the B.Tech. students of the University for undertaking various internships/trainings during their final/penultimate semester

1. Background:

It has been realized that the students pursuing B. Tech. programmes offered by the University/affiliated Institutes/Colleges are facing challenges as under:

1. Students selected in industry during their programme are asked to join the industry for internship/training of duration up to one semester.
2. The provision is not there in these programmes to allow the students to join the internship by way of getting the required attendance of semester from internship/training.
3. So, students are not able to join such internship/training consequential to two-fold loss:
   (a) Job opportunity.
   (b) Skill development in industry environment.

But, presently, in the B. Tech. Programmes run by the University, there is no provision for the students to join the industry for such internship/training of/for more than 6–8-week duration. To facilitate the students for joining longer duration internships/trainings, a need for framing a policy document was felt.

Keeping in view the above challenges/statutory position and to avoid hardship to students and to improve the employability of the students, Ch. Devi Lal University, Sirsa has framed a policy to accord exemptions in attendance to students undertaking various internships/trainings during their final/penultimate semester of the B. Tech. Programmes.

2. Applicability of the policy with following Provisions:

The policy is applicable to the students studying in the final semester/ penultimate semester of B. Tech. programmes.

2.1 Provisions:

Student covered as per section title 'Applicability of the Policy' will be governed by the following provisions:

1. The student will be allowed to join the organization for internship/training in the final semester/ penultimate semester of the course for a period of up to one semester only if he/she must be passed/ cleared in all courses/subjects in all the semester examination whose results have been declared.
2. The student will earn his attendance from the organization during the period of internship.
3. Attendance will be certified by the organization, failing which student will be debarred from appearing in the University examinations of that semester.
4. The student will have to give an undertaking that he/she will appear in all the internal/external examination/practical as per requirements of the Programme and as per Schedule of the University examination for that programme. For this he/she will have to do the necessary preparation by himself/herself and Institute/department will not be responsible for the same.
5. If the student is selected in a company/industry/organization etc., and is asked to join the organization in the final semester/ penultimate semester for a period of upto one semester; then formally constituted Internship Facilitation Committee (IFC) will examine and give its recommendation as deemed fit.

2.2 Composition of Internship Facilitation Committee (IFC):

The composition of IFC will be as under:

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1. Dean, Faculty of Engg. & Tech./Director/ Principal (or Nominee) (Chairperson)
2. Chairperson/Head/ In-charge of the concerned Department/Branch (Member)
3. In-Charge Academic Branch/Academic In-charge of Institute (Member)
4. Senior most faculty of the department other than Chairperson/ Director/Head of the Department/Branch (Member)
5. Training and Placement officer/ In-Charge TPO of the Institute /College/Department (Member Secretary)

Any offer by the organisations providing internship on demanding charges from a student will be discouraged by the Internship Facilitation Committee (IFC). Member Secretary of the IFC will schedule the meeting and maintain all the records.

3. Conclusion:

The students can only be allowed to join the internship/training in company/ industry/ organization etc. with exemptions in attendance on the final recommendation of Internship Facilitation Committee (IFC) of the Institute / Department and permission given by the Department/Institute/College authority.

Detailed Syllabus

of

B. Tech (ME)

5th Semester

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INDUSTRIAL ENGINEERING (THEORY)

General Course Information

Course Code: OE/ME/1-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to take the right decisions to optimize resources utilization by improving productivity of the Lands, Buildings, People, Materials, Machines, Money, Methods and Management effectively.	L1
CO2	Student will be able to apply work study methods with the help of charting and diagrams to eliminate unproductive activities in different operations and job analysis.	L2
CO3	Student will be able to record the activities of the people, materials and equipment to find alternative methods which minimize waste and also to find the Standard Time of any activity through work measurement techniques.	L3
CO4	Student will be able to understand the need of ergonomics in Man–Machine Interface, Human Efficiency and the effort of the workers	L4
CO5	Student will be able to understand the concepts of value engineering and intellectual property rights	L5

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Course Contents

UNIT-I

Plant Layout: Objectives of Good Plant Layout, Importance of Plant Layout, Types of Plant Layout, Advantages and Limitations of Different Types of Plant Layouts

Material Handling: Function of Material Handling, Principles of Material Handling, Material Handling Devices, Relation between Plant Layout and Material Handling

UNIT-II

Work Study: Definition and Concept of Work Study, Need of Work Study, Advantages of Work Study, Techniques ofWork Study, Work Study and Management, Work Study and Productivity

Method Study: Objectives and Procedure of Method Study, Process Chart Symbols, Flow Diagram, String Diagram, Therblig, Multiactivity Charts

UNIT-III

Work Measurement: Objectives of Work Measurement, Basic Procedure for Time Study, Difference between Time Study and Motion Study, Various Time Estimates and Production Standard, Level of Performances, Allowances, VariousTime Recording Techniques in Time Study

Value Engineering: Types of Values, Concept of Value Engineering, Phases of Value Engineering Studies,Application of Value Engineering

UNIT-IV

Ergonomics: Concept of Ergonomics, Objectives of Ergonomics, Man Machine System Interface, Anthropometry,Ergonomics and Safety, Ergonomics and Fatigue

Intellectual Property Rights: Intellectual Property Rights, Patents, Trade Marks, Copy Rights, Law of Contract

Text and Reference Books

1. Industrial Engineering And Management by O P Khanna, Dhanpat Rai Publications 2018 edition
2. Industrial Engineering and Management by Hicks, Tata McGraw Hill, New Delhi
3. Work study and Ergonomics by Suresh Dalela and Saurabh, Standard Publishers
4. Motion and time study by R. Bernes, John-Wiley & Sons
5. Ergonomics at work by D.J. Oborne, John Wiley & Sons
6. Techniques of Value Analysis and Engineering by Miles, McGraw Hill

Course Articulation Matrix (CO to PO/PSO Mapping)

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

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

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APPLIED THERMODYNAMICS

General Course Information

Course Code: OE/ME/2-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Describe the conditions involving heat and work interactions.	L1
CO2.	Differentiate high and low grade energies	L2
CO3.	Solve the problems involving change in thermodynamic properties of substances.	L3
CO4.	Examine and compare the performance of energy conversion devices.	L4

Course Contents

Unit I:

Introduction-Macroscopic and Microscopic Approaches; Thermodynamic Systems- Closed, Open and Isolated; Property, State, Path and Process; Quasi-Static Process; Temperature, ZerothLaw of Thermodynamics, Concept of Ideal Gas, Type of Thermometers, Work Transfer as a Path Function, P-dv Work in Various Quasi-Static Processes, Free Expansion, Heat Transfer asa Path Function. Review of fundamentals; Heat and work.

Unit II:

First Law of Thermodynamics-Application to Closed System undergoing a Cycle, Closed System undergoing a Change of State, Different forms of Stored Energy, Enthalpy, PMM1. FirstLaw applied to Flow Processes, Mass and Energy Balance in a Simple Steady Flow Process, Second Law of Thermodynamics-Statements of Kelvin-Planck and Clausius Statement.

Unit III:

Refrigerator and Heat Pump, Reversibility and Irreversibility, Causes of Irreversibility, Conditions of Reversibility, Carnot Cycle, Introduction to Entropy, Temperature-Entropy Plot,PMM2. Heat Engines, External & Internal Combustion Engines, Elements of Heat Transfer: Conduction Heat Transfer, Convection Heat Transfer, Radiation Heat Transfer, Heat Exchangers. Boilers, Water tube and Fire Tube Boilers, Boiler mountings and accessories. Boiler efficiency.

Unit IV:

Properties of Pure Substance-PV-T, PT, TS Diagram, Mollier Diagram-Mixture of Gaseous and Vapours- Mixtures of Ideal Gases-Dalton's Law-Thermodynamic. Properties of Mixture- Mixtures of Ideal Gases. Vapour Power & Gas Power Cycles: Simple Steam Power Cycle, Rankine Cycle, Actual Vapour Cycle Processes, Comparison of Rankine and Carnot's Cycle, Reheat and Regenerative Cycles, Ericsson Cycle, Otto Cycle, Diesel Cycle and Dual Cycle.

REFERENCES:

1. Advanced engineering thermodynamics – Adrian Bejan, Wiley, 4th edition.

2. Engineering thermodynamics- P. Chattopadhay, OXFORD, Revised 1st edition.

3. Thermodynamics: An Engineering Approach- Yunus Cengel and Michael Boles, Tata McGraw Hill, 8th edition.

4. Engineering Thermodynamics - P K Nag, Tata McGraw Hill, 5th edition.

5. Fundamentals of Engineering Thermodynamics - Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey, Wiley, 7th edition.

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Course Articulation Matrix:

Course/Course Code: Applied Thermodynamics															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	2	1	1	1	1	1	2	3	3	1
CO2	3	3	3	2	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	3	--	3	1	1	2	2	2	2	3	3	2
CO4	3	3	3	3	--	3	1	1	2	2	2	3	3	3	2

Correlation level: 1- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

APPLIED MECHANICS

General Course Information

Course Code: OE/ME/3-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Describe forces, couples, moments, centre of gravity, work, power and energy	L1
CO2.	Calculate resultant force, moment and centre of gravity	L2
CO3.	Calculate efficiency of simple lifting machines	L3
CO4.	Discuss motion of particle and laws of motion	L4
CO5.	Conceptualize friction and its laws	L5

Course Contents

UNIT I

Definitions of mechanics, statics, dynamics. Engineering Mechanics, body, rigid body, mass, weight, length, time, scalar and vector, fundamental units, derived units, S.I. units. Force, unit force, Newton,
S.I. unit of a force, representation of a force by vector and by Bow's notation method. Characteristics of a force, effects of a force, principle of transmissibility. Resolution of a force, Method of resolution,Types of component forces, Perpendicular components and Non-perpendicular components. Analytical& graphical method for Law of

Parallelogram , Law of Triangle , Lami's Theorems , Law of Polygon.

UNIT II

Definition of centroid. Moment of an area about an axis. Centroid of basic geometrical figures such assquare, rectangle, triangle, circle, semicircle and quarter circle. Centroid of composite figure. Center ofgravity, Centre of gravity of simple solids such as cylinder, sphere, hemisphere, cone, cube, and rectangular block. Centre of gravity of composite solids. Friction, force of friction, limiting frictional force, coefficient of friction, angle of friction, angle of repose, relation between angle of friction, angleof repose and coefficient of friction. Cone of friction, types of friction, laws of friction, advantages and disadvantages of friction. Equilibrium of bodies on level plane –external force applied horizontal and inclined up and down. Equilibrium of bodies on inclined plane – external forces is applied parallel to the plane, horizontal and incline to inclined plane.

UNIT III

Simple machine, compound machine , load , effort , mechanical advantage , velocity ratio, input on a machine, output of a machine, efficiency of a machine, expression for mechanical advantage, velocity ratio and efficiency of a machine. Ideal machine, ideal effort and ideal load, friction in machines, effort lost in friction and frictional load. Law of machine, maximum mechanical advantageand maximum efficiency of a machine, reversibility of a machine, condition for reversibility of a machine, self-locking machine. Study of simple machines, Simple axle and wheel, differential axle and wheel, single purchase crab, double purchase crab, simple screw jack. Pulleys : First, second andthird system of pulleys.

UNIT IV

Motion of particle - Speed, velocity, acceleration, uniform velocity, uniform acceleration and variable acceleration . Motion under constant acceleration/ retardation (equations of motion) , Motion under force of gravity ,Concept of relative velocity . Projectile, velocity of projection , angle of projection, time of light, maximum height, horizontal range and their determination. Definition of angular velocity,angular acceleration and angular displacement . Linear angular motion analogy. Relation between linearand angular velocity of a particle moving in a circular path. Motion of rotation under constant angularacceleration. Laws of motion - Newton's Laws of motion and their applications. Work, Power and Energy- Basics terminology of these three. Types of engine power and efficiency of an engine. Definition and concept of Impulse. Definition, unit and types of energies. Total energy of a body fallingunder gravity.

REFERENCES:

1. A text book of Applied Mechanics – R.S. Khurmi , S.C. Chand & Co. , New Delhi
2. Applied Mechanics – I.B. Prasad, Khanna Publishers, New Delhi
3. Applied Mechanics (Hindi) – R.S. Jog, Anand Publishers, Gwalior
4. Applied Mechanics (Hindi) – A.R. Page, Deepak Prakashan, Gwalior

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Course Articulation Matrix:

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

Correlation level: 1- Slight /Low **2**- Moderate/ Medium **3**- Substantial/High

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INTRODUCTION TO MECHANICAL ENGINEERING

General Course Information

Course Code: OE/ME/4-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Define and tell about basic mechanical engineering devices/machines.	L1
CO2.	Classify and explain elements of mechanical engineering.	L2
CO3.	Demonstrate the working operations of various modern mechanical engineering devices/machines.	L3
CO4.	Examine the performance of various basic and modern mechanical engineering devices/machines.	H1

Course Contents

UNIT I

Basics of Thermal Engineering, Heat, Internal energy, Enthalpy, Entropy, Efficiency, Statement of zeroth law, First law and Second Law of Thermodynamics. Constant volume process, constant pressure process, Isothermal process, Polytropic process, Adiabatic process, Reversible adiabatic process. Steam, Properties of steam, uses of steam in Industry. Heat engine cycles, Carnot cycle, Rankine cycle, Otto cycle , Diesel cycle.

UNIT II

Power Transmission Methods and Devices, Belt, Rope, Chain and Gear drive. Types and functioning of clutches, brakes and Dynamometer, Gear Trains. Engineering Materials, Classifications, ferrous metallic and non-ferrous metallic materials, non-metallic and other materials. Alloys, Composite materials.

UNIT III

Power Absorbing Devices, Air Compressor: Introduction, Uses of Compressed air, Reciprocating Compressors, Operation of a compressor, Work for Compression, power required, Reciprocating compressor efficiency, Multistage reciprocating compressor, Rotary compressors. Pump, Classification of pump, Reciprocating pump, Rotary Positive Displacement pump, Centrifugal pump, axial flow pump, specific speed ,Concept of priming and cavitations.

UNIT IV

Introduction to Advanced Manufacturing Systems, Components of CNC, DNC, advantages and applications of CNC,DNC. 3D Printing, Applications in modern mechanical engineering. Role of Robotics in Mechanical Engineering Industries and Society- Emerging Trends and Technologies in different sectors.

REFERENCES:

1. Elements of Mechanical Engineering – Mahesh Kumar, I.K. International, 2013
2. Elements of Mechanical Engineering- R.K. Rajput, Laxmi Publication.
3. Basics of Mechanical Engineering - Mridual Singal and R. K. Singal, I K Internation.
4. Basics of Mechanical Engineering- D.S. Kumar, Pub. – Kataria & Sons, New Delhi.
5. Basics of Mechanical Engineering – Sadhu Singh, S.Chand
6. Hydraulic Machines – Jagdish Lal, Pub.- Metropolitan, Allahbad.
7. Thermal Science and Engineering – D.S. Kumar, Pub. – Kataria & Sons, New Delhi.
8. Rao P.N. “CAD/CAM Principles and Applications” Eighth edition, 2013.
9. Fitzpatrick, “Machining and CNC Technology”, McGraw-Hill Higher Education, 3rd edition 2013.

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Course Articulation Matrix:

Course/Course Code: Introduction to Mechanical Engineering Semester:															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1	1	1	1	1	1	1	1	1	1
CO2	3	3	3	1	1	1	2	1	2	1	-	1	1	1	2
CO3	3	3	3	1	1	1	1	1	2	2	-	1	1	2	2
CO4	3	3	3	2	2	1	2	1	2	2	-	2	1	2	2

Correlation level: 1- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

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FUNDAMENTALS OF MANAGEMENT

General Course Information

Course Code: HSMC/3-T Course Credits: 3 Type: Humanities and Social Sciencesincluding Management Contact Hours: 3 hours/week Mode: Lecture (L) Examination Duration: 3 hours	**Course Assessment Methods (internal: 30; external: 70)** Three minor tests each of 20 marks will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (04 marks). Assignments, quiz etc. will have weightage of 06 marks For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Course outcomes

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	define fundamental concepts of management	L1
CO2.	explain the basic principles of management related to planning and decision making,HRM and motivation, and leadership.	L2
CO3.	apply the managerial skills to solve real world management problems.	L3
CO4.	identify leadership roles in various scenarios.	L4
CO5.	evaluate a business model based on principles of management.	L5
CO6.	prepare a plan for a start up in IT sector.	L6

Course Content

Unit I

Management Definition: Scope and process of management, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management, Evolution of Management, Scientific and Administrative Management, The Behavioural approach, The Quantitative approach, The Systems Approach, Contingency Approach, IT Approach.

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Unit II

Planning and Decision Making: General Framework for Planning, Planning Process, Types ofplans, Management by objectives, Development of business strategy.

Decision making and Problem Solving: Programmed and Non-Programmed Decisions,Steps in Problem Solving and Decision Making, Bounded Rationality and Influences on Decision Making, Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work.

Unit III

Organization HRM and Controls: Organizational Design & Organizational Structures, Delegation, Empowerment, Centralization, Decentralization, Organizational culture, Organizational climate and Organizational change, Talent management, Talent management Models and strategic human Resource planning; Recruitment and selection; Training and development, Performance Appraisal. Types of controls and controlling Techniques.

Unit IV

Leading and Motivation: Leadership, Power and authority, Leadership styles; Behavioural leadership, Situational leadership, Leadership skills, Leader as mentor and coach, Leadership during adversity and crisis; Handling employee and customer complaints, Team leadership. Motivation: Types of motivation, Relationship between motivation, performance and engagement, Content motivational theories.

Text and Reference Books:

- Robert N Lussier, *Management Fundamentals*, 5th edition, Cengage Learning, 2013.
- Stephen P. Robbins, *Fundamentals of Management*, Pearson Education, 2009.
- Weihrich Koontz, *Essentials of Management*, fifth edition, Tata Mc Graw Hill, 1990.
- Dubrin Andrew, *Management Essentials*, 9th edition, Cengage Learning, 2012.

CO-PO Articulation Matrix Fundamentals of Management for Engineers Course (HSMC/3-T)

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO12	PSO1 3	PSO1 4	PSO15
CO1	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
CO2	1	_	_	_	_	_	_	_	_	_	_	_	_	_	_
CO3	2		1	_	_	_	_	_	_	_	_	_	_	_	_
CO4	_	_	_	_	_	_	_	3	3	_	_	_	_	_	_
CO5	2	3	2		_	_	_	_	_	_	_	2	_	_	_
CO6	3	3	3	2	_	3	_	_	_	3	3	_	_	_	_

Correlation level: 1- Slight /Low 2- Moderate/ Medium 3- Substantial/High

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KINEMATICS OF MACHINES (THEORY)

General Course Information

Course Code: PC/ME/10-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the various terminologies of kinematics of machines like element, kinematic pair, kinematic chain, mechanism, machine, motion of elements andfundamental laws of kinematics.	L1
CO2	Students will be able to describe the concept of mechanisms, machines, their components andrelative motion between them.	L2
CO3	Students will be able to solve different kind of problems related to machines and mechanismswhile applying the principles of kinematics.	L3
CO4	Students will be able to analyze different mechanisms for displacement, velocity andacceleration graphically.	L4
CO5	Students will be able to select and design appropriate mechanism required for a specific typeof relative motion and for a particular application.	L5

Course Contents

UNIT-I

Introduction: Mechanism and Machines, Kinematic Links, Kinematic Pairs, Kinematic Chains, Degree of Freedom, Kinematic Inversion, Inversions of Four Bar Kinematic Chain, Inversions of Single Slider Kinematic Chain, Inversions of Double Slider Kinematic Chain, Problems

Mechanism with Lower Pairs: Pantograph, Straight Line Mechanisms, Exact Straight Line Motion Mechanisms, Approximate Straight Line Motion Mechanisms, Steering Gear Mechanisms, Davis Steering Gear, Ackerman Steering Gear, Problems

UNIT-II

Velocity in Mechanisms: Relative Velocity Method: Motion of a Link, Velocity of a Point on a Link by Relative Velocity Method, Velocities in a Slider Crank Mechanism, Instantaneous Centre Method: Space and Body Centrodes, Velocity of a Point on a Link by Instantaneous Centre Method, Aronhold Kennedy Theorem, Methods of Locating Instantaneous Centres in a Mechanism, Problem. **Acceleration in Mechanisms:** Acceleration diagram for a link, Acceleration of a point on a link. Acceleration in the Slider Crank Mechanism, Coriolis Component of Acceleration, Problems

UNIT-III

Cams: Classification of Cams and Followers, Disc Cam Nomenclature, Construction of Displacement, Velocity and Acceleration Diagrams for Different Types of Follower Motions, Determination of Basic Dimension, Synthesis of Cam Profile by Graphical Approaches, Problems

Friction: Types of Friction, Friction in Screw with Square and V Thread, Pivot and Collar Friction, Friction Clutches: Single Plate and Multi Plate Clutch, Cone Clutch, Centrifugal Clutch, Problems

UNIT-IV

Gears: Fundamental Law of Gearing, Forms of Gear Teeth, Path of Contact, Arc of Contact, Interference and Undercutting, Non Standard Gear Teeth, Helical, Spiral, Bevel and Worm Gears, Problems

Gear Trains: Synthesis of Simple, Compound and Reverted Gear Trains, Analysis of Epicyclic Gear Trains, Problems

Text and References Books

1. KJ, Waldron and GL, Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley Publishers, Edition, 2016.
2. A, Ghosh and AK, Malik, Theory of Mechanisms and Machines, East West Press Private Limited Publishers,Edition, 2017.
3. JJ, Uicker (Jr), GR, Pennock and JE, Shigley, Theory of Machines and Mechanisms, Oxford Publishers, 2016.
4. SS, Rattan, Theory of Machines, Tata McGraw Hill Publishers, Edition, 2017.

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Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
CO 1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO 2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO 3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO 4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO 5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

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

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HYDRAULIC MACHINES (THEORY)

General Course Information

Course Code: PC/ME/11-T Course Credits: 4.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 1 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the fundamentals of hydraulic machines and systems.	L1
CO2	Students will be able to understand various hydraulic machines and systems.	L2
CO3	Students will be able to apply the basics of fluid and power engineering to solve the problems related to hydraulic systems	L3
CO4	Students will be able to examine and compare the performance of given hydraulic machines orsystems.	L4
CO5	Students will be able to evaluate the performance of hydraulic machines like turbines, pumps and systems.	L5
CO6	Students will be able to design and select a better hydraulic machine/system under given conditions.	L6

Course Contents

UNIT-I

Impact of free jets & Basics of Fluid Machines: Introduction, Impulse momentum principle, Force exerted by a jet on a stationary and moving vertical flat plate, Force exerted by a jet on stationary and moving inclined flat plate, Force exerted by a jet on stationary and moving curved vane, Force exerted by a jet on a series of flat plates, Force exerted by a jet on a series of radial curved vanes, Force exerted by a jet on a hinged plate, Jet propulsion of ships, general classification of fluid machines, Hydraulic machines and its main parts, Numerical Problems.

Pelton Turbine (Impulse Turbine): Introduction, Classification of hydraulic turbines, Impulse turbine operation principle, General layout of a hydro-electric power plant, Heads and efficiencies of a hydraulic turbine, Water wheel, Pelton turbine (Pelton wheel), Governing of Pelton turbines, Velocity triangles, work done, and efficiency of the Pelton turbine, Design aspects of the Pelton turbine, Numerical Problems.

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UNIT-II

Francis Turbine (Radial Flow Reaction Turbines): Introduction, Radial flow reaction turbines: inward and outward radial flow reaction turbines, Construction, working operation and governing of Francis turbine, Velocity triangles, work done, and efficiency of radial flow reaction turbines and Francis turbine, Degree of reaction, Working proportions of a Francis turbine and radial flow reaction turbines, Design and shape of Francis turbine runner, Numerical Problems. **Propeller & Kaplan Turbines and Performances of Hydraulic Turbines:** Introduction, Construction and working of Propeller and Kaplan turbines, Governing of Kaplan turbines, Working proportions of Kaplan and propeller turbines, Draft tube: Theory & its Efficiency, Cavitation in turbines, Introduction to New types of turbines: Deriaz, Tubular and Bulb turbines, Unit quantities: speed, discharge and power, Specific speed, Model relationship and testing of turbines, Characteristic curves, Selection of turbines, Numerical problems.

UNIT-III

Centrifugal Pumps: Introduction, Classification of pumps, Construction and working of centrifugal pumps, Priming devices, Velocity triangles and work done by centrifugal pump, Head of a centrifugal pump, Pressure rise in the impeller, Losses, power and efficiencies of centrifugal pumps, Effect of outlet vane angle on manometric efficiency, Slip factor, Minimum starting speed, Design considerations, Multistage pumps, Specific speed of centrifugal pumps, Model testing of centrifugal pumps, Performance characteristics of centrifugal pumps, Maximum suction lift, Net positive suction head(NPSH), Cavitation in centrifugal pumps, Numerical problems.

Reciprocating Pumps: Introduction, Main parts and working of a reciprocating pump, Discharge, work done, and power required for driving single and double acting reciprocating pumps, Effect of variation of velocity in the suction and delivery pipes, Indicator diagrams: Maximum speed of a reciprocating pump and Effect of acceleration and friction in suction and delivery pipes on indicator diagram, Air vessels: Work done by a reciprocating pump and its Maximum speed with air vessel, Characteristic curves of a reciprocating pump, Rotary positive displacement pumps and Numerical problems.

UNIT-IV

Dimensional Analysis and Model Similitude: Introduction, Dimensional homogeneity, Methods of dimensional analysis: Rayleigh and Buckingham pi methods, Similitude-types of similarities, Dimensionless numbers and their significance, Similarity laws or model laws: Reynolds model law, Froude model law, Euler model law, Weber model law, Mach model law, Types of models, Scale effects in models and numerical problems

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Hydraulic systems: Introduction, Hydraulic press, Hydraulic accumulator, Hydraulic intensifier, Hydraulic ram, Hydraulic lift, Hydraulic crane, Hydraulic coupling, Hydraulic torque converter and Numerical problems.

Text and Reference Books

1. Fluid Mechanics and Hydraulics Machines, Mahesh Kumar, Pearson Education, 2019.
2. Hydraulics & Fluid Mechanics – Modi & Seth, Pub. - Standard Book House, N.Delhi, 2010
3. Hydraulic Machines – Jagdish Lal, Metropolitan, 1998
4. Fluid Mechanics and Hydraulic Machines – S S Rattan, Khanna Publishers, 1998
5. Introduction to Fluid Mechanics and Fluid Machines – S K Som and G Biswas, Tata McGraw Hill, 2009
6. Fluid Mechanics and Fluid Power Engineering – D S Kumar, S K Kataria and Sons, 2010
7. Fluid Mechanics and Hydraulic Machines-R. K. Rajput, S. Chand & Company, 2014
8. Fluid Mechanics and Hydraulic Machines-R. K. Bansal, Laxmi Publications, 2010
9. Fluid Mechanics-Cengel and Cimbala, Mc Graw Hill Education, 2014

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
CO1	3	1	1	--	--	2	3	2	2	3	--	3	3	3	2
CO2	3	1	1	--	--	2	3	2	2	3	--	3	3	2	2
CO3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2
CO4	3	2	3	3	3	3	3	3	3	3	3	3	3	2	2
CO5	3	3	2	3	2	2	3	1	1	2	1	1	3	2	3
CO6	3	3	3	3	3	3	3	2	1	3	1	2	3	2	3

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

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INTERNAL COMBUSTION ENGINES AND GAS TURBINES (THEORY)

General Course Information

Course Code: PC/ME/12-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to memorize the basics of Internal Combustion Engines and Gas Turbines	L1
CO2	Students will be able to extending their knowledge on the working and construction details ofInternal combustion engines and gas turbines.	L2
CO3	Students will be able to execute their knowledge to solve basic problems of Internal combustionengines and gas turbines.	L3
CO4	Students will be able to calculate the efficiency of Internal combustion engines and gasturbines.	L4
CO5	Students will be able to solve the practical problems directed to the designing of effectiveInternal combustion engines and gas turbines.	L5

Course Contents

UNIT-I

Air Standard Cycles: Introduction; classification of I.C. Engines, Cycles of operation in four stroke and two stroke I.C.Engines, Wankel Engines, Assumptions made in air standard cycle; Otto cycle; diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles; sterling and Ericsson cycles; air standard efficiency; mean effective pressure; Problems.

Carburetion, fuel Injection and Ignition systems: Mixture requirements for various operating conditions in S.I. Engines; elementary carburetor, Requirements of a diesel injection system; types of inject systems; petrol injection, Requirements of ignition system; types of ignition systems ignition timing; spark plugs.

UNIT-II

Combustion in S.I and C.I. Engines: Introduction; stages of combustion in S.I. Engines; Ignition lag; Ignition limits; flame propagation; detonation; effects of engine variables on detonation; theories of detonation; octane rating of fuels; pre-ignition; S.I. engine combustion chambers, Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.

Lubrication and Cooling Systems: Functions of a lubricating system, Types of lubrication system; mist, wet sump and dry sump systems; properties of lubricating oil; SAE rating of lubricants, Necessity of engine cooling; disadvantages of overcooling; cooling systems; air-cooling, water cooling; radiators.

UNIT-III

Engine Testing and Performance: Performance parameters: BHP, IHP, mechanical efficiency, brake mean effective pressure and indicative mean effective pressure, torque, volumetric efficiency; specific fuel consumption (BSFC, ISFC), thermal efficiency; heat balance; Basic engine measurements; fuel and air consumption, brake power, indicated power and friction power, heat lost to coolant and exhaust gases; performance curves. Problems.

Air pollution from I.C. Engine and Its remedies: Pollutants from S.I. and C.I. Engines, Methods of emission control; Engine design technologies for emission reduction; Fuel & lubricant technologies; Exhaust after treatment technologies;The current scenario on the pollution control.

UNIT-IV

Gas Turbines: Introduction to Gas Turbines, Development, Classification and Application of Gas Turbines, Brayton cycle; Effect of Inter cooling, Reheating, Regeneration, Combined cycle, Advantages of gas turbines over I.C. engines, Problems.

Jet Propulsion: Introduction, Classification of jet propulsive engines, Working Principles, Turbo jet, Turbo-prob, Ramjet, Pulse jet propulsion units, Thrust Power and Propulsion Efficiency, Needs and Demands met by Turbo jet, Problems.

Text and References Books

1. Internal Combustion Engines –V. Ganesan, Tata McGraw-Hill.
2. Engineering fundamental of the Internal Combustion Engine – W.W. Pulkrabek, Pearson Education, 2007.
3. Internal Combustion Engines & Air pollution- Obert E.F, Hopper & Row Pub., New York
4. Internal Combustion Engines Fundamentals- J. B. Heywood, McGraw Hill, New York
5. Internal Combustion Engines- V.M. Domkundwar, Dhanpat Rai &Co., 2008

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6. Internal Combustion Engines- R.K. Rajput, Laxmi Publications, 2009
7. Internal Combustion Engines- Matur and Sharma, Dhanpat Rai &Co., 2007

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	-	1	1	1	1	1	1	2	3	3	1
CO2	3	3	3	2	-	1	1	1	1	1	1	2	3	3	1
CO3	3	3	3	2	-	1	1	1	1	1	1	2	3	3	1
CO4	3	3	3	2	-	1	1	2	3	2	2	3	3	3	3
CO5	3	3	3	2	-	1	1	2	3	2	2	3	3	3	2

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

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DESIGN OF MACHINE ELEMENTS (THEORY)

General Course Information

Course Code: PC/ME/13-T Course Credits: 4.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 2 2 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe the principles involved in evaluating the shape anddimensions of a component.	L1
CO2	Students will be able to interpret catalogues and standard machine components.	L2
CO3	Students will be able to compute the design and manufacturing problem for simple andcomplex mechanical components.	L3
CO4	Students will be able to compare the general mechanical engineering sciences in analysesspecific to the design of mechanical components and systems	L4
CO5	Students will be able to assess available design and can modify.	L5

Course Contents

UNIT-I

Design for Variable loading: Variable Loading: Different types of fluctuating/ variable stresses, Fatigue strength considering stress concentration factor, surface factor, size factor, reliability factor etc., Fatigue design for finite and infinite life against combined variable stresses using Goodman Criterion, Problems.

Shafts: Detailed design of shafts for static and dynamic loading, Rigidity and deflection consideration, Design Problems.

UNIT-II

Springs: Types of springs, Design for helical springs against tension and their uses, compression and fluctuating loads, Design problems.

Joints & Drives:, Design of cotter and knuckle joints, Design of flat belt drives, Design Problems.

UNIT-III

Bearings : Selection of ball and roller bearing based on static and dynamic load carrying capacity using load-life relationship, Selection of Bearings from manufacturer's catalogue, Selection of suitable lubricants, Design Problems.

Keys, Couplings & Brakes: Flat, Kennedy Keys, Splines, Couplings design – Rigid & Flexible coupling, Various typesof Brakes, Self energizing condition of brakes, Design of single block shoe brakes, Design Problems.

UNIT-IV

Clutches: Various types of clutches in use, Design of friction clutches – Single disc, Multidisc, Cone clutch, Design Problems.

Gears: Classification, Selection of gears, Terminology of gears, Selection of material for gears, Beam & wear strength of gear tooth, Buckingham equation, Design of spur, helical, bevel gear including the consideration for maximum powertransmitting capacity, Design Problems.

Text and Reference Books

1. Mechanical Engg. Design - Joseph Edward Shigley-MGH, New York. 11th edition, 2020.
2. Design of Machine Elements – V.B. Bhandari – Tata McGraw Hill, New Delhi. 5th edition 2021.
3. Machine Design: S.G. Kulkarini - Tata MacGraw Hill. First edition, 2008
4. Machine Design an Integrated Approach: Robert L.Norton, Pearson, 6th Edition. 2020.
5. Design of machine elements-C S Sharma, Kamlesh Purohit, PHI. First edition, 2004.
6. Design Data: Data Book of Engineers by PSG College-Kalaikathir Achchagam, 4th Edition, 2019

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
CO1	3	2	2	2	--	--	--	--	--	1	--	3	2	2	--
CO2	3	2	1	3	--	1	--	2	3	2	2	3	3	2	2
CO3	3	2	2	3	--	--	--	2	1	1	--	2	2	2	2
CO4	3	2	2	3	3	1	--	2	2	3	2	3	3	3	2
CO5	3	2	2	3	3	1	--	2	2	3	2	3	3	3	2

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

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KINEMATICS OF MACHINES (LAB)

General Course Information

Course Code: **PC/ME/10-P** Course Credits: 1 Mode: Practical Type: Program Course Contact Hours: 2 hours/week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to name various terms related to kinematics of machines like link,kinematic pair, kinematic chain, mechanism and machine.	L1
CO2	Students will be able to describe link, kinematic pair, kinematic chain, mechanism andmachine through models.	L2
CO3	Students will be able to solve different kind of problems related to links, mechanisms andmachines experimentally.	L3
CO4	Students will be able to analyse different links, kinematic pairs, kinematic chains,mechanisms though models and experimentally.	L4
CO5	Students will be able to select and design appropriate element, pair, mechanism and machinerequired for a particular application.	L5

Lab Contents

1. To Study Various Types of Kinematic Links, Pairs, Chains and Mechanisms.
2. To Study Inversions of Four Bar, Single Slider and Double Slider Crank Chains.
3. To Find Coefficient of Friction Between Belt and Pulley, and Rope and Pulley.
4. To Study Various Types of Cam and Follower Arrangements.
5. To Plot Follower Displacement Vs Cam Rotation for Various Cam Follower Systems.
6. To Generate Spur Gear Involute Tooth Profile using Simulated Gear Shaping Process.
7. To Study Various Types of Gears: Spur, Helical, Double Helical, Worm, Spiral and Bevel Gears.
8. To Study Various Types of Gear Trains: Simple, Compound, Reverted and Epicyclic Gear Trains.
9. To Determine the Speed Ratio of a Gear Train.
10. To Compute the Efficiency of an Epicyclic Gear Train.
11. Create various types of linkage mechanism in CAD and simulate for motion outputs and study the relevanteffects.
12. Creation of various joints like revolute, planes, spherical, cam follower and study the degree of freedom andmotion patterns available.

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

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Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO 1	3	1	1	1	--	--	--	--	--	--	--	3	3	--	--
CO 2	3	2	1	1	--	--	--	--	--	2	--	3	3	--	--
CO 3	3	3	2	1	1	--	--	--	1	2	--	3	3	--	--
CO 4	3	3	2	2	1	--	--	1	2	2	--	3	3	1	1
CO 5	3	2	3	2	2	--	--	1	2	2	--	3	3	2	3

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

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HYDRAULIC MACHINES (LAB)

General Course Information

Course Code: **PC/ME/11-P** Course Credits: 1 Mode: Practical Type: Program Course Contact Hours: 2 hours/week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn the basics elements of hydraulic machines and their layout.	L1
CO2	Students will be able to classify hydraulic machines.	L2
CO3	Students will be able to apply the basic principles of hydraulic machines and can demonstrate its working.	L3
CO4	Students will be able to operate hydraulic machines and evaluate their performance.	L4
CO5	Students will be able to compare the performance of hydraulic machines and able to createcharacteristic curves at given conditions.	L5

Lab Contents

1. Evaluate and compare the theoretical and experimental results obtained on impact-jet apparatus for curvedplate/vane at different conditions.
2. To determine the hydraulic power, mechanical power and efficiency of a Pelton turbine.
3. To draw the performance characteristics curves of Pelton turbine under different load conditions.
4. To determine the hydraulic power, mechanical power and efficiency of a Francis turbine.
5. To draw the constant head, constant speed and constant efficiency performance characteristics curves of aFrancis turbine.
6. To study the construction details of a Kaplan turbine, its fluid flow circuit and characteristic curves.
7. To evaluate the performance of a Centrifugal Pump at different operating conditions.
8. To evaluate the performance of a Reciprocating Pump and draw its characteristics curves.
9. To study the construction details of a Gear oil pump and its performance curves.
10. To study the constructional details of a Hydraulic Ram and its efficiency.
11. To study the model of Hydro power plant and draw its layout.

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

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Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	--	--	2	3	2	2	3	--	3	3	3	2
CO 2	3	1	1	--	--	2	3	2	2	3	--	3	3	2	2
CO 3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2
CO 4	3	2	3	3	3	3	3	3	3	3	3	3	3	2	2
CO 5	3	3	3	3	2	2	2	1	1	3	2	2	3	2	2

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

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INTERNAL COMBUSTION ENGINES AND GAS TURBINES (LAB)

General Course Information

Course Code: **PC/ME/12-P** Course Credits: 1 Mode: Practical Type: Program Course Contact Hours: 2 hours/week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to memorize the construction details of Internal combustion engines andgas turbines.	L1
CO2	Students will be able to summarize different types of Internal combustion engines and gasturbines.	L2
CO3	Students will be able to examine different types of Internal combustion engines, gas turbines.	L3
CO4	Students will be able to correlate different types of internal combustion engines, gas turbines onthe bases of their utilization.	L4
CO5	Students will be able to conduct experiments for the evaluation of performance parameters ofdifferent types Internal combustion engines, gas turbines.	L5

Lab Contents

1. To study the constructional details & working principles of two-stroke/ four stroke petrol engine.
2. To study the constructional detail & working of two-stroke/ four stroke diesel engine.
3. To study the constructional detail & working and operations of carburettor with compensating and starting Jetdevices.
4. Determination of Brake power (BP) and friction power (FP) of a four-stroke single-cylinder diesel engine withelectrical break dynamometer.
5. Determination of Brake power (BP) and friction power (FP) of a four-Stroke four-cylinder Petrol Engine withHydraulic Dynamometer.
6. Determination of Brake power (BP) and friction power (FP) of a single-cylinder two-Stroke Single Cylinder PetrolEngine with Rope Brake Dynamometer.
7. To determine of calorific of a sample of petrol/diesel by using bomb calorimeter.
8. To prepare heat balance sheet on a multi-cylinder diesel engine/petrol engine.
9. To find the indicated horse power (IHP) on multi-cylinder petrol engine/diesel engine by Morse Test.
10. Study and measures of exhaust gas emission from SI Engine (using exhaust gas analyser).
11. Study and measures of exhaust gas emission from CI Engine (using exhaust gas analyser).
12. To study open cycle constant pressure combustion gas turbine with inter cooler, regenerator and reheater.

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

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
CO 1	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO 2	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO 3	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO 4	3	3	3	2	-	2	2	2	2	3	2	3	3	3	3
CO 5	3	3	3	2	-	2	2	2	2	3	2	3	3	3	3

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

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INDUSTRIAL TRAINING PRESENTATION-I

General Course Information

Course Code: EEC/ME/2-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 4.0 Mode: Practical Contact Hours: 00 hours per week	**Course Assessment Methods** **Internal Examination (100 marks):** • 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. The Course Coordinator/Internal Examiners will maintain and submit the bifurcation of marks obtained by the students in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratory course exit survey and, compute and submit the attainment levels of the laboratory course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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-I is a Practical course, which the students of Mechanical Engineering should undergo in reputed Private / Public Sector / Government organization / companies as industrial training of six-eight week in the summer vacation after the IV semester.

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Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	--	--	--	--	--	2	2	--	--	--	2	3	3	3	3
CO 2	3	3	3	3	3	--	--	--	--	2	--	2	2	2	2
CO 3	--	--	--	--	--	--	--	2	3	--	--	--	--	--	2
CO 4	3	--	--	--	--	--	--	--	--	3	--	2	--	--	2
CO 5	--	--	--	--	--	1	--	3	--	2	2	2	2	2	3

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

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TECHNICAL PRESENTATION

General Course Information

Course Code: MC/5-P Course Category: Mandatory Course Course Credits: 0.0 Mode: Practical Contact Hours: 02 hours per week	**Course Assessment Methods** **Internal Examination (100 marks):** • This is a **non-credit course of qualifying nature**. • 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. The Course Coordinator/Internal Examiners will maintain andsubmit the bifurcation of marks obtained by the students in theproformas (attached herewith as Annexure I and II) to the respectivedepartments in addition to submitting and uploading of overall markson the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratorycourse exit survey and, compute and submit the attainment levels ofthe laboratory course based on direct and indirect evaluationcomponents and submit it to the Chairperson office along with the internal assessment marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to read and understand recent trends and technologies in the field ofMechanical Engineering	L1
CO2	Students will be able to prepare concise, comprehend and conclude selective topic in the fieldof Mechanical Engineering	L2
CO3	Students will be able to develop skills in presentation and discussion of research topics in apublic forum	L3
CO4	Students will be able to formulate innovative ideas in the field of engineering	L4

Course Contents

The students are required to give power point presentation on the topic related to current research area in the field of Mechanical Engineering. The presentation should be held in the class room/ seminar hall in presence of the course coordinator

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
CO1	3	2	1	2	--	--	--	--	--	--	2	2	3	--	2
CO2	3	1	2	2	--	--	--	--	--	2	--	2	2	--	--
CO3	--	--	--	--	--	--	--	--	--	3	--	2	--	--	--
CO4	3	2	2	2	--	--	--	--	--	2	--	2	2	2	2

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

Detailed Syllabus
of
B. Tech (ME)
6th Semester

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OPERATION RESEARCH (THEORY)

General Course Information

Course Code: OE/ME/5-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the concept of operation research	L1
CO2	Students will be able to learn the principles of linear programming problems and theirapplications	L2
CO3	Students will be able to apply the principles of transportation problems and assignmentproblems.	L3
CO4	Students will be able to formulate the OR models for various needs of the society andorganization.	L4
CO5	Students will be able to solve the problems of society and organization using OR techniques.	L5

Course Contents

Unit - I

Introduction: Definition, role of operations research in decision-making, applications in industry. Concept on O.R.model building –Types & methods.

Linear Programming (LP): Programming definition, formulation, solution- graphical, simplex Gauss-Jordanreduction process in simplex methods, BIG-M methods computational, problems.

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Unit - II

Deterministic Model: Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost or matrix minimal, Stepperg stone method, MODI methods, degeneracy, assignment, traveling salesman, problems.

Advanced Topic of LP: Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.

Unit - III

Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications inindustries, problems.

Project Line Models: Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, optimal project cost by crashing of network, resources leveling in project, problems.

Unit - IV

Simulation: Introduction, design of simulation, models & experiments, model validation, process generation, timeflow mechanism, Monte Carlo methods- its applications in industries, problems.

Decision Theory: Decision process, SIMON model types of decision making environment-certainty, risk, uncertainty,decision making with utilities, problems.

Text and Reference Books

1. Operation Research – Hira, D.S.
2. Operation Research – TAHA, PHI, New Delhi.
3. Principle of Operations Research – Ackoff, Churchaman, arnoff, Oxford IBH, Delhi.
4. Operation Research- Gupta & Sharma, National Publishers, New Delhi.
5. Quantitative Techniques- Vohra, TMH, New Delhi
6. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagher, Prentice HallofIndia, New Delhi.
7. Operation Research – Sharma, Gupta, Wiley Eastern, New Delhi.
8. Operation Research – Philips, Revindran, Solgeberg, Wiley ISE.

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	1	--	2	1	1	1	2	1	2	3	3	1
CO2	3	3	2	1	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	2	--	2	1	1	2	2	1	3	3	3	2

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

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SOLAR ENERGY ENGINEERING (THEORY)

General Course Information

Course Code: OE/ME/6-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to state heating/cooling and electrical applications of solar engineering.	L1
CO2	Students will be able to classify and explain different solar energy based devices/equipment and their effects on environment.	L2
CO3	Students will be able to use different solar based equipment/appliances for various domestic applications.	L3
CO4	Students will be able to examine performance of various solar engineering equipment/devices.	L4
CO5	Students will be able to evaluate the thermal performance of solar based equipment.	L5

Course Content

Unit-I

Introduction to solar system: Introduction, solar system – sun, earth and earth-sun angles, time, derived solar angles,

Solar Radiation: Estimation of solar radiation (direct and diffuse), measurement systems – pyrheliometers and otherdevices.

Unit-II

Effect of Solar radiation upon structures: Steady state heat transmission, solar radiation properties of surfaces,shading of surfaces, periodic heat transfer through walls and roofs.

Solar Collectors: Flat plate and concentrating – comparative study, design and materials, efficiency, selective coatings,heliostats.

Unit-III

Heating Applications of Solar Energy: Air and Water heating systems, thermal storages, solar ponds, solar pumps,solar lighting systems, solar cookers, solar drying of grains.

Cooling Applications of Solar Systems: Continuous and intermittent vapour absorption systems for cooling applications, absorbent – refrigerant combination, passive cooling systems.

Unit-IV

Solar Electric Conversion Systems: Photovoltaics, solar cells, satellite solar power systems.

Effects on Environment: economic scenario, ozone layer depletion, green house effect, global warming, Remedialmeasures by international bodies.

Text and Reference Books

1. Solar Energy: Fundamentals, Design, Modelling and Applications - GN Tiwari, CRC Press
2. Solar Energy – S P Sukhatme, Tata McGraw Hill
3. Solar Energy Process – Duffie and Bechman, John Wiley
4. Applied Solar Energy – Maniel and Maniel, Addison Wiley
5. Solar Energy: Fundamentals and Applications – R P Garg and Jai Prakash, TMH.

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	1	--	2	2	1	1	2	1	3	3	3	2
CO2	3	3	2	1	--	2	3	1	1	2	1	3	3	3	3
CO3	3	3	2	1	--	2	2	1	1	2	1	3	3	3	2
CO4	3	3	3	1	--	2	2	1	1	2	1	3	3	3	2
CO5	3	3	3	1	--	2	2	1	2	2	1	3	3	3	2

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

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INTRODUCTION TO CNC (THEORY)

General Course Information

Course Code: OE/ME/7-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe construction, working, tooling systems and programming of Computer Numeric Control (CNC) machines.	L1
CO2	Students will be able to explain the different features of CNC machines and decide its corresponding programming.	L2
CO3	Students will be able to illustrate parts of CNC machines and demonstrate the programming skills.	L3
CO4	Students will be able to analyze CNC machines and its programming.	L4
CO5	Students will be able validate CNC machines technology and determine programs for its working.	L5
CO6	Students will be able to design CNC machines and rewrite the programs for CNC machines.	L6

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Course Contents

UNIT-I

Computer Numerical Control (CNC) Technology: Evolution of CNC Machines, Principles and control of CNCmachines, Coordinate Systems, Applications of CNC Machine Tools.

Constructional features of CNC Machines: Structure of CNC Machine tools, Spindle and feed drives of CNCmachines, Actuation Systems of CNC Machines Tools, Feedback Devices used in CNC Machine.

UNIT-II

CNC Programming Fundamentals: Structure of Part Programs, Axes Identification in CNC Turning and MachiningCenters, Machine Zero and Home Position, ISO Standards for Coding.

Advanced Part Programming: Complex interpolations, Repetitive part programming, Subroutines and Macros,parametric part programming.

UNIT-III

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

Machining Centre Programming: Canned Cycles, Cutter Radius Compensation, Tool Length Compensation, PartProgram Numerical.

UNIT-IV

Computer Aided Part Programming: APT Language, Geometry Statements, Motion Statements, Post ProcessorStatements, Auxiliary Statements, Part Program Numerical

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

Text and Reference Books

1. Rao P.N. "CAD/CAM Principles and Applications" Eighth edition, 2013.
2. Jon S. Stenerson, Kelly Curran, "Computer Numerical Control: Operation and Programming", Prentice Hall, 3rd edition 2007.
3. Mattson Mike, "CNC Programming: Principles & Applications", Cengage learning, 1st edition 2013.
4. Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Higher Education, 3rd edition 2013.
5. Michael J. Peterson, "CNC Programming: Basics & Tutorial Textbook", Create Space Independent Publishing Platform, 1st edition2008.
6. Peter Smid, "CNC Tips and Techniques: A Reader for Programmers", Industrial Press Inc., 1st edition 2013.

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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	1	--	--	1	--	--	3	2	2	2
CO2	3	2	3	--	2	1	--	--	1	--	--	3	2	2	2
CO3	3	2	3	--	2	1	--	--	1	--	--	3	2	2	2
CO4	3	2	3	--	3	1	--	--	1	--	--	3	2	2	2
CO5	3	2	3	1	2	1	--	--	1	--	--	3	2	2	2
CO6	3	2	3	1	2	1	--	--	1	--	--	3	2	2	2

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

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PROJECT AND PRODUCTION MANAGEMENT

General course information

Course Code: OE/ME/8-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course outcomes:

Sr. No.	**Course outcomes** At the end of the course students will be able to:	**RBT* Level**
CO1.	Complete structure of project management and analyze the scope of project planning	L1
CO2.	Identify different project selection methods	L2
CO3.	Explain the importance of procurement and its techniques	L3
CO4.	Demonstrate the importance of inventory control, JIT in manufacturing.	L4
CO5.	Define the guidelines required for project control and its controlling techniques.	L5
CO6.	Outline the basic idea of projects and its initial management	L6

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Course Contents

UNIT I

Introduction & Overview: Definitions, Types of projects, Project life cycle(Project phases) and decisions. Concept of management, concept of a system, production system, production functions. Organization fundamentals. Guidelines for good practice, organization structures, organization charts, span of control, number of levels, number of executives, management functions. Go/ No go decisions based on:a) Project Identification and Screening, b) Project Appraisal: Market, Technical, social, Ecological & Financial, c) Project Selection: Pragmatic, pairwise, MADM approach. Development of Project Network: Project description, Work break down structure, Nomenclature, Rules for drawing and representation, consistency and Redundancy in Project Networks, Matrix representation

UNIT II

CPM & PERT: Activity times, Completion, Floats, Probability (ND usage), Examples, and Problems. Project Monitoring & Control: Project adjustments, Crashing: Direct &Indirect cost, Normal & Crash: duration & cost, Resource leveling: Types, usage, leveling, Problems, Managing Risk. Role of Human Factors: Dealing with people Team Building and Leadership in Projects, commitment, work culture, motivation, coordination, attitude, innovation. Physical environment. Project selection methods, DCF methods, project implementation, estimation, cost, price, value, scheduling, barcharts, network diagrams, PERT and CPM, schedule crashing, simple introduction to risk management, probability in project management,

UNIT III

Production Planning and Control basic terms, Customer needs, stake holder concept, project scope, feasibility study and report, base line plan, SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude. Concept of Production planning & Control. Breakeven analysis. Vendor selection methods, JIT, supply chains, quality, quality circles, quality control and quality assurance, cause and effect analysis, ISO and concepts of total quality management and six sigma, resource planning and allocation ,availability and constraints of resources, resource leveling and crashing.

UNIT IV

Project Control, Project scope, project change request, and control of schedule, resources, cost and quality, project communications, channels, means, meetings, project reports, project audits Project evaluation, project close-out reports, guidelines, audit reports, maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis, Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, selection and leasing of construction equipment special considerations in selection and location of projects, safety, health,humanandenvironmentallfactors,projectfinance,internationalprojects,jointventures, collaborations, impact of culture, implementation, and handing over of projects. Body of Knowledge (PMBOK), Role of Project manager and his/her qualities.

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REFERENCES:

1. Prasanna Chandra, " Projects-Planning, analysis, selection, implementation and review", Tata McGraw-Hill, New Delhi, 2010
2. Chitkara, " Construction Project Management", Tata McGraw-Hill, New Delhi
3. Harold Kerzner, " Project Management", Wiley, New York
4. Production Management by C. L. Mahajan; Satya Parkash an Company Limited, New Delhi
5. Industrial Engineering and Management by O.P. Khanna; Dhanpat Rai and Sons, New Delhi.

Course Articulation Matrix:

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

Correlation level: 1- Slight /Low **2-** Moderate/ Medium **3**- Substantial/High

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OPERATION RESEARCH (THEORY)

General Course Information

Course Code: PE/ME/1-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the concept of operation research	L1
CO2	Students will be able to learn the principles of linear programming problems and theirapplications	L2
CO3	Students will be able to apply the principles of transportation problems and assignmentproblems.	L3
CO4	Students will be able to formulate the OR models for various needs of the society andorganization.	L4
CO5	Students will be able to solve the problems of society and organization using OR techniques.	L5

Course Contents

Unit - I

Introduction: Definition, role of operations research in decision-making, applications in industry. Concept on O.R.model building –Types & methods.

Linear Programming (LP): Programming definition, formulation, solution-graphical, simplex Gauss-Jordan reduction process in simplex methods, BIG-M methods computational, problems.

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Unit - II

Deterministic Model: Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost ormatrix minimal, Stepperg stone method, MODI methods, degeneracy, assignment, traveling salesman, problems.

Advanced Topic of LP: Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.

Unit - III

Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications inindustries, problems.

Project Line Models: Network diagram, event, activity, defects in network, PERT & CPM, float in network, variance and probability of completion time, project cost- direct, indirect, total, optimal project cost by crashing of network, resources leveling in project, problems.

Unit - IV

Simulation: Introduction, design of simulation, models & experiments, model validation, process generation, time flow mechanism, Monte Carlo methods- its applications in industries, problems.

Decision Theory: Decision process, SIMON model types of decision making environment- certainty, risk, uncertainty,decision making with utilities, problems.

Text and Reference Books

9. Operation Research – Hira, D.S.
10. Operation Research – TAHA, PHI, New Delhi.
11. Principle of Operations Research – Ackoff, Churchaman, arnoff, Oxford IBH, Delhi.
12. Operation Research- Gupta & Sharma, National Publishers, New Delhi.
13. Quantitative Techniques- Vohra, TMH, New Delhi
14. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagher, Prentice HallofIndia, New Delhi.
15. Operation Research – Sharma, Gupta, Wiley Eastern, New Delhi.
16. Operation Research – Philips, Revindran, Solgeberg, Wiley ISE.

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	1	--	2	1	1	1	2	1	2	3	3	1
CO2	3	3	2	1	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	2	--	2	1	1	2	2	1	3	3	3	2

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

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TOTAL QUALITY CONTROL (THEORY)

General Course Information

Course Code: PE/ME/2-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to understand the philosophy and core values of Total Quality Control	L1
CO2	Student will be able to learn about the statistical quality control in production and apply the knowledge of control charts for monitoring the quality of process/product	L2
CO3	Student will be able to understand the standard sampling plans, learn the rejection process for a product in an industry.	L3
CO4	Student will be able to understand the different quality standards in industry.	L4
CO5	Student will be able to apply sampling method to check the quality of a product lot.	L5

Course Contents

UNIT-I

Quality Control: Introduction, objectives, quality of design, quality of production, quality of conformance to design, quality of inspection, process monitoring, quality and productivity, quality cost. Advantages of Statistical Quality Control in Industry.

Fundamentals of Statistics and Probability in Quality Control: Events and probability, laws of probability. Statistical Distributions: Normal, Binomial and Poisson distribution,

their importance in SQC. Poisson Probability as approximation to Normal Probability, use of Normal and Poisson distribution tables.

UNIT-II

Control Charts for Variables: Fundamentals of process control, tools of process control, quality characteristic, Designand use of Control Charts for Variables: Trial control limits, control limits for future use, revision of control limits. Causeand effect diagram, inferences on the state of the process from control charts, Type I and Type II errors and methods to reduce them. Use of X (X bar) charts and R- charts, X (X bar) and σ- charts. Efficiency of a control chart. OC curve of acontrol chart. Computing average run length for X- chart.

Trend Control Charts: Control Charts with Reject Limits and Modified Control Charts. Relationship betweenSpecification Limits and Control Chart Limits, Process capability analysis and its importance in quality of conformance.

UNIT-III

Control Charts for Attributes: Defects and Defectives, control charts for fraction defectives and percent fraction defectives and number of defectives. Control charts for number of defects. Comparison of control charts for variables with the charts for attributes. Computing Average run length for a p-chart.

Product Control and its Tools: Fundamentals of lot-by-lot acceptance sampling by attributes: Notations, OC curve and

its importance in acceptance sampling, AQL and LTPD for a sampling plan, Producer and consumer risks, Single and Double sampling plans and constructing OC curves, interpretation of the operating characteristics curve, Effect of changeof sample size and acceptance number on OC curve, ATI, ASN, AOQ and AOQL concepts, economics of inspection. Item- by- item sequential sampling plans, OC curve and ASN curve for sequential sampling plan.

UNIT-IV

Standard Sampling Plans: Types of Standard Sampling Plans, Difference between Acceptance Rectification and Acceptance- Rejection Plans, single and double sampling plans based on AOQL and LTPD..

Motivation for quality assurance, zero defect program, quality circles, total quality management. Indian Standards on Process and Product Control. ISO-9000 Standards.

Text and Reference Books

1. Quality control Application – By Hansen BL, Ghare PH; Prentice Hall of India.
2. Statistical Quality Control – By E.L. Grant & R.S. Levenworth; T MH.
3. Quality Control – Paranthaman, D.; Tata McGraw Hill, India
4. Quality Planning and Analysis – Juran J.M. and F.M. Gryna, TMH, India
5. Total Quality Control – By Feigenbaum, A.V.; McGraw Hill International.
6. Statistical Quality Control – By Montgomery, D.C.; John Wiley & Sons (Asia)

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	2	2	2	1	1	1	3	2	1	3	3
CO2	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO3	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO4	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO5	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3

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

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INDUSTRIAL ENGINEERING (THEORY)

General Course Information

Course Code: PE/ME/4-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to take the right decisions to optimize resources utilization by improving productivity of the Lands, Buildings, People, Materials, Machines, Money, Methods andManagement effectively.	L1
CO2	Student will be able to apply work study methods with the help of charting and diagrams toeliminate unproductive activities in different operations and job analysis.	L2
CO3	Student will be able to record the activities of the people, materials and equipment to findalternative methods which minimize waste and also to find the Standard Time of any activity through work measurement techniques.	L3
CO4	Student will be able to understand the need of ergonomics in Man–Machine Interface, HumanEfficiency and the effort of the workers	L4
CO5	Student will be able to understand the concepts of value engineering and intellectual propertyrights	L5

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Course Contents

UNIT-I

Plant Layout: Objectives of Good Plant Layout, Importance of Plant Layout, Types of Plant Layout, Advantages and Limitations of Different Types of Plant Layouts

Material Handling: Function of Material Handling, Principles of Material Handling, Material Handling Devices, Relation between Plant Layout and Material Handling

UNIT-II

Work Study: Definition and Concept of Work Study, Need of Work Study, Advantages of Work Study, Techniques ofWork Study, Work Study and Management, Work Study and Productivity

Method Study: Objectives and Procedure of Method Study, Process Chart Symbols, Flow Diagram, String Diagram, Therblig, Multiactivity Charts

UNIT-III

Work Measurement: Objectives of Work Measurement, Basic Procedure for Time Study, Difference between Time Study and Motion Study, Various Time Estimates and Production Standard, Level of Performances, Allowances, VariousTime Recording Techniques in Time Study

Value Engineering: Types of Values, Concept of Value Engineering, Phases of Value Engineering Studies,Application of Value Engineering

UNIT-IV

Ergonomics: Concept of Ergonomics, Objectives of Ergonomics, Man Machine System Interface, Anthropometry,Ergonomics and Safety, Ergonomics and Fatigue

Intellectual Property Rights: Intellectual Property Rights, Patents, Trade Marks, CopyRights, Law of Contract

Text and Reference Books

7. Industrial Engineering And Management by O P Khanna, Dhanpat Rai Publications 2018 edition
8. Industrial Engineering and Management by Hicks, Tata McGraw Hill, New Delhi
9. Work study and Ergonomics by Suresh Dalela and Saurabh, Standard Publishers
10. Motion and time study by R. Bernes, John-Wiley & Sons
11. Ergonomics at work by D.J. Oborne, John Wiley & Sons
12. Techniques of Value Analysis and Engineering by Miles, McGraw Hill

Course Articulation Matrix (CO to PO/PSO Mapping)

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

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

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ECONOMICS FOR ENGINEERS

General Course Information

Course Code: HSMC/4-T Course Credits: 2 Type: Humanities and Social Sciences including Management courses Contact Hours: 2 hours/week Mode: Lectures (L) Examination Duration: 2 hours	**Course Assessment Methods (internal: 30; external: 70)** Three minor tests each of 20 marks will be conducted. The average of the highest marks obtained by a student in the any of the two minor examinations will be considered. Class Performance will be measured through percentage of lectures attended (04 marks). Assignments, quiz etc. will have weightage of 06 marks For the end semester examination, nine questions are to be set by the examiner. A candidate is required to attempt 5 questions in all. All questions carry equal marks. Question number 1 will be compulsory and based on the entire syllabus. It will contain seven parts of 2 marks each. Question numbers 2 to 9 will be given by setting two questions from each of the four units of the syllabus. A candidate is required to attempt the remaining four questions by selecting one question from each of the four units.

Course Outcome

Sr. No.	Course Outcome	RBT Level
CO1	outline the principles of economics in general and economics in Indian context.	L1
CO2	discuss concepts related to economics in general and particularly relevant to Indianscenario.	L2
CO3	apply the principles of economics for solving problems related to Engineering sector.	L3
CO4	carry out cost/benefit/, life cycle and breakeven analyses on one or more economicalternatives.	L4
CO5	judge the issues and challenges of sustainable development.	L5

Course Content

Unit I

Definition of Economics- various definitions, Nature of economic problem, Production possibility curve, Economics laws and their nature. Relation between Science, Engineering, Technology and Economics. Concepts and measurement of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility - its practical applications and importance.

Unit II

Meaning of Demand, Individual and Market demand schedules, Law of demand, shape of demand curve, Elasticity of Demand, measurement of elasticity of demand, factors affecting elasticity of demand, practical importance and applications of the concept of elasticity of

demand.
Meaning of production and factors of production; Law of variable proportions, Returns to scale, Internal and External economics and diseconomies of scale.

Unit III

Various concepts of cost- Fixed cost, variable cost, average cost, marginal cost, money cost, real cost, opportunity cost. Shape of average cost, marginal cost, total cost etc. in short run and long run both.
Meaning of Market, Types of Market - Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition(Main features of these markets)
Issues, Strategies and challenges for sustainable development for developing economies

Unit VI

Elements of Business/Managerial Economics and forms of organizations, Cost & Cost Control Techniques, Types of Costs, Lifecycle Costs, Budgets, Break Even Analysis, Capital Budgeting, Application of linear Programming. Investment Analysis- NPV, ROI, IRR, Payback Period, Depreciation, Time Value of Money (present and future worth of cash flows).
Business Forecasting- Elementary techniques. Statements- Cash Flows, Financial. Case Study Method. Nature and Characteristics of Indian Economy (brief and elementary introduction). Privatization - meaning, merits, and demerits. Globalisation of Indian economy- merits and demerits.WTO and TRIPs agreements.

Text and Reference Books:

- Alfred William Stonier, D. C. Hague, *A text book of Economic Theory*, 5th edition,Longman Higher Education, 1980.
- K. K. Dewett, M. H. Navalur, *Modem Econornic Theory*, S. Chand, 2006.
- H. L. Ahuja, *Modern Microeconomic: Theory and Applications*, S. Chand, 2017.
- N. Gregory Mankiw, *Principles of Economics*, 7th edition, South-Western CollegePublishing, 2013.
- Ruddar Dutt & K. P. M. Sundhram, *Indian Economy*, S. Chand, 2004.
- V. Mote, S. Paul, G. Gupta, *Managerial, Economics*, McGraw Hill Education, 2017.
- Saroj Pareek, *Text book of Business Economics*, Neha Publishers and Distributors, 2013.

CO-PO Articulation Matrix Economics for Engineers (HSMC/2-T)

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO13	PSO14	PSO15
CO1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	2	2	2	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	2	3	3	-	-	-	2	-	-	3	-	-	-
CO5	3	_	3	3	_	_	3	-		3	3	3	-	-	-
3-High 2-Medium 1-Low															

DYNAMICS OF MACHINES (THEORY)

General Course Information

Course Code: PC/ME/14-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the various mechanical systems like flywheel, transmission drives, governor, gyroscope, brake, dynamometer and balancing, and state forces and theireffect acting on them, and fundamental laws of dynamics.	L1
CO2	Students will be able to describe different mechanical systems and their dynamic behaviour.	L2
CO3	Students will be able to solve different kind of problems related to force analysis in differentmechanical systems.	L3
CO4	Students will be able to analyse different mechanical systems dynamically.	L4
CO5	Students will be able to select and design appropriate mechanical system required for aparticular application.	L5

Course Contents

UNIT-I

Flywheel: Turning Moment Diagrams, Fluctuation of Energy, Coefficient of Fluctuation of Energy and Speed, Application in Engines and Punching Presses, Problems

Belts, Ropes and Chain Drives: Types of Belt Drives, Velocity Ratio, Slip, Belt Length, Crowning of Pulleys, V- Belts,Condition for Transmission of Maximum Power, Centrifugal Tension, Chain Drive, Types of Chains, Merits and Demerits of Chain Drive over Belt Drive, Problems

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UNIT-II

Governors: Governor, Types of Governors, Centrifugal Governors, Watt Governor, Porter Governor, Proell Governor, Hartnell Governor, Hartung Governor, Wilson- Hartnell Governor, Pickering Governor, Sensitiveness of Governors, Stability of Governors, Hunting of Governors, Effort and Power of a Governor, Problems

Gyroscope: Gyroscope, Gyroscopic Couple, Gyroscopic Stabilization of Aeroplane and Ship, Stability of Four Wheel and Two Wheel Vehicles Moving on Curved Path, Problems

UNIT-III

Brakes: Brake, Types of Brakes, Block or Shoe Brake, Band Brake, Differential Band Brake, Band and Block Brake, Internal Expanding Shoe Brake, Braking Effect in a Vehicle, Problems

Dynamometers: Dynamometer, Types of Dynamometers, Prony Brake Dynamometer, Rope Brake Dynamometer, Epicyclic Train Dynamometer, Belt Transmission Dynamometer, Torsion Dynamometer, Problems

UNIT-IV

Balancing of Rotating Parts: Static Balancing, Dynamic Balancing, Balancing of Rotating Masses, Balancing of Several Masses Rotating in Same Plane by Graphical Method, Balancing of Several Masses Rotating in Different Planesby Graphical Method, Problems

Balancing of Reciprocating Parts: Balancing of Reciprocating Masses, Partial Balancing of Locomotives, Effect of Partial Balancing of Reciprocating Parts of Two Cylinder Locomotives, Balancing of Multi Cylinder Inline Engines, Radial Engines and V- Engines, Problems

Text and Reference Books

1. KJ, Waldron and GL, Kinzel, Kinematics, Dynamics and Design of Machinery, Wiley Publishers, Edition, 2016.
2. A, Ghosh and AK, Mallik, Theory of Mechanisms and Machines, East West Press Private Limited Publishers,Edition, 2017.
3. JJ, Uicker (Jr), GR, Pennock and JE, Shigley, Theory of Machines and Mechanisms, Oxford Publishers, 2016.
4. SS, Rattan, Theory of Machines, Tata McGraw Hill Publishers, Edition, 2017.

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)

AUTOMOBILE ENGINEERING (THEORY)

General Course Information

Course Code: PC/ME/15-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to understand the basic structure, components and types of automotives.	L1
CO2	Students will be able to extending their knowledge to the technological advancements inautomotives.	L2
CO3	Students will be able to discuss the requirements of various components used in an automobile.	L3
CO4	Students will be able to examine the structure an automotive on the basis of its use.	L4
CO5	Students will be able to build a technologically advanced automotive.	L5

Course Contents

UNIT-I

Introduction to Automobiles: Classification, Components, Requirements of Automobile Body; Vehicle Frame, Separate Body & Frame, Unitized Body, Car Body Styles, Bus Body & Commercial Vehicle Body Types; Front EngineRear Drive & Front Engine Front Drive Vehicles, Four Wheel Drive Vehicles, Safety considerations; Safety features oflatest vehicle; Future trends in automobiles.

Clutches : Requirement of Clutches – Principle of Friction Clutch – Wet Type & Dry Types; Cone Clutch, Single PlateClutch, Diaphragm Spring Clutch, Multi plate Clutch, Centrifugal Clutches, Electromagnetic Clutch, Over Running Clutch; Clutch Linkages.

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UNIT-II

Power Transmission: Requirements of transmission system; General Arrangement of Power Transmission system; Object of the Gear Box; Different types of Gear Boxes; Sliding Mesh, Constant Mesh, Synchro- mesh Gear Boxes; Epi-cyclic Gear Box, Freewheel Unit. Overdrive unit-Principle of Overdrive, Advantage of Overdrive, Transaxle, Transfer cases.

Drive Lines, Universal Joint, Differential and Drive Axles: Effect of driving thrust and torque reactions; HotchkissDrive, Torque Tube Drive and radius Rods; Propeller Shaft, Universal Joints, Slip Joint; Constant Velocity Universal Joints; Front Wheel Drive; Principle, Function, Construction & Operation of Differential; Rear Axles, Types of loads coming on Rear Axles, Full Floating, Three quarter Floating and Semi Floating Rear Axles.

UNIT-III

Suspension Systems: Need of Suspension System, Types of Suspension; factors influencing ride comfort, Suspension Spring; Constructional details and characteristics of leaf springs.

Steering System : Front Wheel geometry & Wheel alignment viz. Caster, Camber, King pin Inclination, Toe-in/Toe- out; Conditions for true rolling motions of Wheels during steering; Different types of Steering Gear Boxes; Steering linkages and layout; Power steering – Rack & Pinion Power Steering Gear, Electronics steering.

UNIT-IV

Automotive Brakes, Tyres & Wheels : Classification of Brakes; Principle and constructional details of Drum Brakes, Disc Brakes; Brake actuating systems; Mechanical, Hydraulic, Pneumatic Brakes; Factors affecting Brake performance, Power & Power Assisted Brakes; Tyres of Wheels; Types of Tyre & their constructional details, Wheel Balancing, TyreRotation; Types of Tyre wear & their causes.

Emission Control System & Automotive Electrical : Sources of Atmospheric Pollution from the automobile, EmissionControl Systems – Construction and Operation of Positive Crank Case Ventilation (PVC) Systems, Evaporative Emission Control, Heated Air Intake System, Exhaust Gas Recirculation (EGR) Systems, Air Injection System and Catalytic Converters; Purpose construction & operation of lead acid Battery, Capacity Rating & Maintenance of Batteries; Purpose and Operation of Charging Systems, Purpose and Operations of the Starting System;Vehicle LightingSystem.

Text and Reference Books

1. Automobile Engineering by Anil Chhikara, Satya Prakashan, New Delhi.
2. Automobile Engineering by Dr. Kirpal Singh, standard Publishers Distributors.
3. Automotive Mechanics – Crouse / Anglin, TMH.
4. Automotive Technology – H.M. Sethi, TMH, New Delhi.
5. Automotive Mechanics – S.Srinivasan, TMH, New Delhi.
6. Automotive Mechanics – Joseph Heitner, EWP.
7. Motor Automotive Technology by Anthony E. Schwaller – Delmer Publishers, Inc.
8. The Motor Vehicle – Newton steeds Garrett, Butter Worths.

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	--	1	1	1	1	1	1	3	3	3	1
CO2	3	3	3	2	--	1	1	1	1	1	1	3	3	3	1
CO3	3	3	3	2	--	1	2	1	1	1	1	3	3	3	2
CO4	3	3	3	3	--	1	3	2	1	1	1	3	3	3	3
CO5	3	3	3	3	--	1	3	2	1	1	1	3	3	3	3

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

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HEAT TRANSFER (THEORY)

General Course Information

Course Code: PC/ME/16-T Course Credits: 4.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 1 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define and relate different modes of heat transfer.	L1
CO2	Students will be able to describe, explain and compare the mechanisms of heat transfer.	L2
CO3	Students will be able to apply the basic principles of heat transfer in daily routine thermalsystems and can demonstrate its working.	L3
CO4	Students will be able to examine and compare the operations of various heat transfer devices.	L4
CO5	Students will be able to evaluate the performance of various heat transfer devices.	L5
CO6	Students will be able to design and select a better heat exchanging/transfer device under given conditions.	L6

Course Contents

UNIT-I

Basics and Laws: Definition of Heat Transfer, Reversible and irreversible processes, Modes of heat flow, Combined heat transfer system and law of energy conservation.

Steady State Heat Conduction: Introduction, I-D heat conduction through a plane wall, long hollow cylinder, hollow sphere and Conduction equation in Cartesian, polar and spherical co-ordinate systems, Numericals.

UNIT-II

Steady State Conduction with Heat Generation: Introduction, 1 – D heat conduction with heat sources, Extended surfaces (fins), Fin effectiveness, Numericals.

Transient Heat Conduction: Systems with negligible internal resistance, Transient heat conduction in plane walls, cylinders, spheres with convective boundary conditions, Numericals.

UNIT-III

Convection: Forced convection-Thermal and hydro-dynamic boundary layers, Equation of continuity, Momentum and energy equations, Some results for flow over a flat plate and flow through tube, Fluid friction and heat transfer (Colburnanalogy), Free convection from a vertical flat plate, Empirical relations for free convection from vertical and horizontal planes, Numericals.

Thermal Radiation: The Stephen-Boltzmann law, black body radiation, Shape factors and their relationships, Heat exchange between non black bodies, Electrical network for radiative exchange in an enclosure of two or three gray bodies,Radiation shields, Numericals.

UNIT-IV

Heat Exchangers: Classification, Performance variables, Analysis of a parallel/counter flow heat exchanger, Heat exchanger effectiveness, Numericals.

Heat Transfer with Change of Phase: Laminar film condensation on a vertical plate, Drop-wise condensation, Boilingregimes, Free convective, Nucleate and film boiling, Numericals.

Text and reference Books

1. Heat and Mass Transfer: Fundamentals and Application, Yunus A Cengel; Afshin J. Ghajar, Mc Graw Hill
2. Heat Transfer – J.P. Holman, John Wiley & Sons, New York.
3. Fundamentals of Heat & Mass Transfer–Incropera, F.P. & Dewitt, D.P –John Willey New York.
4. Conduction of Heat in Solids – Carslow, H.S. and J.C. Jaeger – Oxford Univ. Press.
5. Conduction Heat Transfer – Arpasi, V.S. – Addison – Wesley.
6. Compact Heat Exchangers – W.M. Keys & A.L. Landon, Mc. Graw Hill.
7. Thermal Radiation Heat Transfer – Cengel, R. and J.R. Howell, Mc. Graw Hill.
8. Heat Transmission – W.M., Mc.Adams , Mc Graw Hill.

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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	1	--	2	1	1	1	2	1	2	3	3	1
CO2	3	3	2	1	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	2	--	2	1	1	2	2	1	3	3	3	2
CO6	3	3	3	3	--	2	2	2	2	2	2	3	3	3	2

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

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DYNAMICS OF MACHINES (LAB)

General Course Information

Course Code: **PC/ME/14-P** Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the various mechanical systems like flywheel, transmissiondrives, governor, gyroscope, brake, dynamometer, balancing.	L1
CO2	Students will be able to describe different mechanical systems through models andexperimental setups.	L2
CO3	Students will be able to solve different kind of problems related to force analysis in differentmechanical systems experimentally.	L3
CO4	Students will be able to analyse dynamically and determine the parameters involved in thevarious mechanical systems experimentally.	L4
CO5	Students will be able to select and design appropriate mechanical system required for aparticular application.	L5

Lab Contents

1. To perform experiment on Watt Governor, to Prepare Performance Characteristic Curves, and to find stability andsensitivity.
2. To Perform Experiment on Porter Governor, to Prepare Performance Characteristic Curves, and to Find Stabilityand Sensitivity.
3. To Perform Experiment on Proell Governor, to Prepare Performance Characteristic Curves, and to Find Stabilityand Sensitivity.
4. To Perform Experiment on Hartnell Governor, to Prepare Performance Characteristic Curves, and to Find Stabilityand Sensitivity.
5. To Study Gyroscopic Effects Through Models.
6. To Determine Gyroscopic Couple on Motorized Gyroscope.
7. To Perform the Experiment for Static Balancing on Static Balancing Machine.
8. To Perform the Experiment for Dynamic Balancing on Dynamic Balancing Machine.
9. Determine the Moment of Inertial of Connecting Rod by Compound Pendulum Method and Triflair SuspensionPendulum.
10. To Find BHP of an Engine by Using Rope Brake Dynamometer.

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

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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)

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AUTOMOBILE ENGINEERING (LAB)

General Course Information

Course Code: **PC/ME/15-P** Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define the basic structure of different automotives.	L1
CO2	Students will be able to summarize various components used in an automobile.	L2
CO3	Students will be able to discuss the requirements of various components used in an automobile.	L3
CO4	Students will be able to explain the working of various components used in an automobile.	L4
CO5	Students will be able to design and develop an effective automotive system.	L5

Lab Contents

1. To study and prepare report on the constructional details of chassis, frame and body of automotives.
2. To study and prepare report on the constructional details, working principles and operations of AutomotiveClutches.
3. To study and prepare report on the constructional details, working principles and operations of AutomotiveTransmission systems.
4. To study and prepare report on the constructional details, working principles and operation of AutomotiveDrive Lines, Differential and drive Axles.
5. To study and prepare report on the constructional details, working principles and operations of AutomotiveSuspension Systems.
6. To study and prepare report on the constructional details, working principles and operations of AutomotiveSteering Systems.
7. To study and prepare report on the constructional details, working principles and operations of AutomotiveTyres & wheels.
8. To study and prepare report on the constructional details, working principles and operations of AutomotiveBrake Systems.
9. To study and prepare report on the constructional details, working principles and operations of AutomotiveStarting and Lighting System.
10. To study and prepare report on the constructional details, working principles and operations of AutomotiveEmission / Pollution control systems.
11. Modeling of any two automotive systems on 3D CAD using educational softwares (eg. 3D modelingpackage/Pro Engineering/I-Deas/ Solid edge etc.)
12. Crash worthiness of the designed frame using Hypermesh and LS-Dyna solver or other software.

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

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	-	1	2	1	2	2	2	3	3	3	1
CO2	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO3	3	3	3	2	-	1	2	1	2	2	2	3	3	3	1
CO4	3	3	3	2	-	2	2	2	2	3	2	3	3	3	3
CO5	3	3	3	2	-	2	2	2	2	3	2	3	3	3	3

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

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HEAT TRANSFER (LAB)

General Course Information

Course Code: **PC/ME/16-P** Course Credits: 1 Mode: Practical Type: Program Core Contact Hours: 2 hours per week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define and relate different modes of heat transfer.	L1
CO2	Students will be able to describe, explain and compare the mechanisms of heat transfer.	L2
CO3	Students will be able to apply the basic principles of heat transfer in daily routine thermalsystems and can demonstrate its working.	L3
CO4	Students will be able to examine and compare the operations of various heat transfer devices.	L4
CO5	Students will be able to evaluate the performance of various heat transfer devices.	L5
CO6	Students will be able to design and select a better heat exchanging/transfer device undergiven conditions.	L6

Lab Contents

1. To find out total thermal resistance and total thermal conductivity of a composite slab.
2. Evaluate the heat transfer coefficient, Nusselt number and heat transfer rate from vertical cylinder under natural convectionmode.
3. To determine the value of Stefan Boltzmann constant for radiation heat transfer.
4. To find out the emissivity of gray surface (or gray body) from the given test rig.
5. To determine the thermal conductivity of the given metallic rod.
6. To evaluate the convective heat transfer coefficient, Nusselt number and rate of heat transfer by forced convection for flowof air inside a horizontal pipe.
7. To determine the thermal conductivity of insulating powder filled in spherical copper container at various heat inputs.
8. To determine the value of heat transfer co-efficient under forced condition and to find (a) theoretical values of temperatures along the length of fin (b) effectiveness and efficiency of the pin-fin for insulated and boundary condition.
9. To determine the thermal conductivity of a poor conducting material (asbestos sheet) by ‘guarded hot plate method’.
10. To determine LMTD, effectiveness and overall heat transfer coefficient for parallel and counter flow heat exchanger.
11. To study the heat pipe demonstrator.
12. To study the two phases heat transfer unit.

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

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	1	--	2	1	1	1	2	1	3	3	3	1
CO2	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO3	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	2	--	2	1	1	2	2	1	3	3	3	1
CO5	3	3	3	2	--	2	1	1	2	2	1	3	3	3	1
CO6	3	3	3	2	--	2	1	1	2	2	2	3	3	3	2

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

Detailed Syllabus

of

B. Tech (ME)

7th Semester

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TOTAL QUALITY MANAGEMENT (THEORY)

General Course Information

Course Code: OE/ME/9-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to understand the philosophy and core values of Total Quality Control	L1
CO2	Student will be able to learn about the statistical quality control in production and apply the knowledge of control charts for monitoring the quality of process/product	L2
CO3	Student will be able to understand the standard sampling plans, learn the rejection process fora product in an industry.	L3
CO4	Student will be able to understand the different quality standards in industry.	L4
CO5	Student will be able to apply sampling method to check the quality of a product lot.	L5

Course Contents

UNIT-I

Quality Control: Introduction, objectives, quality of design, quality of production, quality of conformance to design, quality of inspection, process monitoring, quality and productivity, quality cost. Advantages of Statistical Quality Controlin Industry.

Fundamentals of Statistics and Probability in Quality Control: Events and probability, laws of probability. Statistical Distributions: Normal, Binomial and Poisson distribution, their importance in SQC. Poisson Probability as approximation to Normal Probability, use of Normal and Poisson distribution tables.

UNIT-II

Control Charts for Variables: Fundamentals of process control, tools of process control, quality characteristic, Design and use of Control Charts for Variables: Trial control limits, control limits for future use, revision of control limits. Cause and effect diagram, inferences on the state of the process from control charts, Type I and Type II errors and methods to reduce them. Use of X (X bar) charts and R- charts, X (X bar) and σ- charts. Efficiency of a control chart. OC curve of a control chart. Computing average run length for X- chart.

Trend Control Charts: Control Charts with Reject Limits and Modified Control Charts. Relationship between Specification Limits and Control Chart Limits, Process capability analysis and its importance in quality of conformance.

UNIT-III

Control Charts for Attributes: Defects and Defectives, control charts for fraction defectives and percent fraction defectives and number of defectives. Control charts for number of defects. Comparison of control charts for variables with the charts for attributes. Computing Average run length for a p-chart.

Product Control and its Tools: Fundamentals of lot-by-lot acceptance sampling by attributes: Notations, OC curve and its importance in acceptance sampling, AQL and LTPD for a sampling plan, Producer and consumer risks, Single and Double sampling plans and constructing OC curves, interpretation of the operating characteristics curve, Effect of change of sample size and acceptance number on OC curve, ATI, ASN, AOQ and AOQL concepts, economics of inspection. Item- by- item sequential sampling plans, OC curve and ASN curve for sequential sampling plan.

UNIT-IV

Standard Sampling Plans: Types of Standard Sampling Plans, Difference between Acceptance Rectification and Acceptance- Rejection Plans, single and double sampling plans based on AOQL and LTPD..

Motivation for quality assurance, zero defect program, quality circles, total quality management. Indian Standards on Process and Product Control. ISO-9000 Standards.

Text and Reference Books

1. Quality control Application – By Hansen BL, Ghare PH; Prentice Hall of India.
2. Statistical Quality Control – By E.L. Grant & R.S. Levenworth; T MH.
3. Quality Control – Paranthaman, D.; Tata McGraw Hill, India
4. Quality Planning and Analysis – Juran J.M. and F.M. Gryna, TMH, India
5. Total Quality Control – By Feigenbaum, A.V.; McGraw Hill International.
6. Statistical Quality Control – By Montgomery, D.C.; John Wiley & Sons (Asia)

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	2	2	2	1	1	1	3	2	1	3	3
CO2	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO3	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO4	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3
CO5	3	3	2	2	2	2	2	1	1	1	3	2	1	3	3

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

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INTRODUCTION TO COMPUTER AIDED DESIGN (THEORY)

General Course Information

Course Code: OE/ME/10-T Course Category: Open Elective Course Course Credits: 3.0 Contact Hours: 3 hours/week (L: 3; T: 0; P:0)Mode: Lectures Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to define Computer Aided Design (CAD), geometrical essentials,modeling schemes, and product design.	L1
CO2	Students will be able to discuss CAD, geometry fundamentals, modelling approaches, andproduct design.	L2
CO3	Students will be able to demonstrate concepts related to CAD, geometrical basics, modellingtools, and product design.	L3
CO4	Students will be able to analyze CAD, geometrical elements, modelling methods, and productdesign.	L4
CO5	Students will be able validate CAD, geometrical features, modelling processes, and productdesign.	L5
CO6	Students will be able reorganise CAD, geometrical foundations, modelling techniques andproduct design.	L6

Course Contents

UNIT-I

Overview: Overview of CAD, history of CAD, scope of CAD, configuration for CAD workstations, benefits of CAD, applications, CAD software, file standards, types of modeling – feature based, parametric, form modeling, types of geometric modeling.

Geometry: Coordinate system, introduction to transformations, transformation of point & line, 2D translation, rotation, reflection, scaling, 3D translation, rotation, reflection, scaling, combined transformations.

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UNIT-II

Curves and surfaces: Curve representation of lines, arcs, circle; Introduction to synthetic curves – cubic, Bezier, b- spline; Introduction to – plane surface, ruled surface, surface of revolution, tabulated cylinder, and cubic, Bezier, b-spline surfaces.
Solids: Solid primitive models, types of representation – boundary, constructive solid geometry, sweep, cell decomposition.

UNIT-III

2-D modeling: CAD sketching, sketch entities, sketch editing tools – fillet, chamfer, trim, extend, break, offset, pattern,mirror, constraints, geometric dimensioning & tolerancing.
3-D modeling: 3-D modeling tools – extrude, revolve, cut, sweep, loft, helix, hole, thread, 3D editing tools – fillet,chamfer, draft, pattern, mirror, combine, split, assembly modeling.

UNIT-IV

Product design: Product life cycle, design thinking, conceptual design, top-down approach, bottom-up approach,iterative design.
Design for engineering: Design for manufacturing – machining, casting, welding, additive manufacturing, design forassembly, optimal selection of materials & manufacturing processes, design for quality.

Text and Reference Books

1. Rao P.N. "CAD/CAM Principles and Applications" Eighth edition, 2013. Tata McGraw Hill India.
2. Zeid, I., "CAD/CAM", McGraw Hill, 2008.
3. Groover and Zimmer, "CAD/ CAM", Prantice Hall.
4. Krishnamoorathy, C. S. and Rajeev, J. S., "Computer Aided Design (Software and Analysis Tools)", NarosaPublication House, 2nd edition, 2005.

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	1	--	--	--	2	--	3	3	2	2
CO2	3	2	2	2	2	1	--	--	--	2	--	3	3	3	2
CO3	3	2	2	3	2	1	--	--	2	2	--	3	3	3	2
CO4	3	2	2	3	3	2	--	--	2	2	--	3	3	3	2
CO5	3	3	3	2	2	1	--	--	2	2	--	3	3	3	2
CO6	3	2	2	3	2	1	--	--	2	2	--	3	3	3	2

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

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MECHATRONICS (THEORY)

General Course Information

Course Code: OE/ME/11-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to construct the block diagram of any physical Mechatronics deviceused in day-to-day life	L1
CO2	Students will be able to calculate the output to input relation of any physical model in theform of a transfer function	L2
CO3	Students will be able to evaluate the performance of any physical system in terms of its performance parameters.	L3
CO4	Students will be able to develop the mathematical model of any physical model from anyengineering domain	L4
CO5	Students will be able to recognize the key features of different type of controllers and developa suitable controller to obtain the desired performance from the system.	L5

Course Content

UNIT-I

Introduction and Basics: Mechatronics, Measurement System with its constituent elements; Open and Closed Loop Systems; Sequential Controllers; Micro-processor Based Controllers; The Mechatronics Approach.

Hardware of Measurement Systems: A review of Displacement, Position Velocity, Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature, Light Sensors / alongwith Performance Terminology; Selection of Sensors; Input Data by Switches; Signal Conditioning; Brief Review of Operational Amplifier; Protection; Fitering; Wheat StoneBridge; Digital Signals; Multiplexers; Data Acqusition; Digital Signal Processing; Pulse Modulation; Data Presentation Systems – Displays; Data Presentation Elements; Magnetic Recording; Data Acquisition Systems; Testing & Calibration; Problems.

UNIT-II

Pneumatic, Hydraulic, Mechanical and Electrical Actuation Systems: Pneumatic and Hydraulic Systems; Directional Control Valves; Valve Symbols; Pressure Control Valves; Cylinder Sequencing; Process Control Valves; Rotary Actuators; Mechanical Systems – Types of Motion, Kinematic Chains, Cams, Gear Trains, Ratchet & Pawl, Belt & Chain Drives, Bearings, Mechanical Aspect of Motor Selection; Electrical Systems; Mechanical & Solid State Switches; Solenoids; D.C. & A.C. Motors; Stepper Motors; Problems.

System Modeling and Performance: Engg. Systems; Rotational – Translational Systems; Electro-mechanical Systems; Hydraulic – Mechanical Systems; A review of modeling of First and Second Order Systems and Performance Measures; Transfer Functions for first order System, Second Order System, Systems in series & Systems with Feedback Loops; Frequency Response of First Order and Second Order Systems; Bode Plots: Performance Specifications: Stability; Problems.

UNIT-III

Closed Loop Controllers: Continuous and Discrete Processes – Lag, Steady State Error; Control Modes; Two- step Mode; Proportional Mode – Electronic Proportional Controllers; Derivative Control – Proportional plus Derivative Control; Integral Control - Proportional plus Integral Control; PID Controller – Operational Amplifier PID Circuits; Digital Controllers – Implementing Control Modes; Control System Performance; Controller Tuning – Process ReactionMethod & Ultimate Cycle Method; Velocity Control; Adaptative Control; Problems.

Digital Logic and Programmable Logic Controllers: A Review of Number Systems & Logic Gates; Boolean Algebra; Kanaugh Maps; Sequential Logic; Basic Structure of Programmable Logic Controllers; Input/ Output Processing; Programming; Timers, Internal Relays and Counters; Master & Jump Controls; Data Handling; Analogue Input/ Output; Selection of a PLC; Problems.

UNIT-IV

Microprocessors and Input/Output Systems: Control; Microcomputer Structure; Micro- controllers; Applications; Programming Languages; Instruction Sets; Assembly Language Programs; Subroutines; Why C Language ? A review ofProgram Structure, Branches, Loops, Arrays, Pointer; Examples of Programs; Interfacing; Input/ Output; Interface Requirements; Peripheral Interface Adaptors; Serial Communication Interface; Examples of Interfacing; Problems.

Design and Mechatronics: Design Process; Traditional and Mechatronics Design; Possible Mechatronics design solutions for Timed Switch, Wind Screen Wiper Motion, Bath Room Scale, A Pick & Place Robot, Automatic Camera, Engine Management System & Bar Code Recorder.

Text and Reference Books

1. Mechatronics by W. Bolton, Published by Addition Wesley.
2. Mechatronics System Design – Devdas Shetty and Richard A. Kolx Brooks/ Cole.
3. Introduction to Mechatronics and Measuring System: david G. Alciation and Michael B. Hist

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and Tata McGrawHill.

4. Mechtronics – Sensing to Implementation - C.R.Venkataraman, Sapna .

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	1	2	2	2	--	--	1	2	2	3	3	2	2
CO2	3	1	2	2	2	2	--	--	2	2	2	3	3	2	2
CO3	3	2	3	3	2	2	--	--	2	3	2	3	3	2	3
CO4	3	2	2	2	3	2	--	--	1	3	2	3	3	2	2
CO5	3	2	3	3	2	2	--	--	2	3	2	3	3	2	3

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

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ROBOTICS (THEORY)

General Course Information

Course Code: OE/ME/12-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn standard terminologies, applications, design specifications, andmechanical design aspects both kinematics, Trajectory planning, work cell control and dynamics of industrial robotic manipulators.	L1
CO2	Students will be able to understand the robot kinematics and trajectory planning.	L2
CO3	Students will be able to apply the concepts of robotic workspace analysis for design of robotic manipulator for required work cell applications.	L3
CO4	Students will be able to develop the algorithms for design of robotic work cell controller andits programming for given serial robotic manipulator.	L4
CO5	Students will be able to control and programme robot according to use and requirement.	L5

Course Content

UNIT-I

Robotic Manipulation: Automation and Robots; Robot Classification – Drive Technologies, Work-Envelope Geometries, Motion Control Methods, Applications; Robot Specifications – No. of Axes, Capacity and Speed, Reach and Stroke, Tool Orientation, Repeatability, Precision, Accuracy, Operating Environment, An Example; Rhino X-3.

Direct Kinematics: The Arm Equation Homogenous Co-ordinates – Frames, Translations and Rotations, Composite Homogenous Transformations; Screw Transformations; Link Co-ordinates; The Arm Equation; A Five-Axis ArticulatedRobot; A Four-Axis SCARA Robot; A Six-Axis Articulated Robot; Problems.

UNIT-II

Inverse Kinematics: Solving the Arm Equation: The Inverse Kinematics Problem; General Properties of Solutions; Tool Configuration; Inverse Kinematics of a Five-Axis Articulated Robot, Four-Axis SCARA Robot, Six-AxisArticulated Robot and Three-Axis Planer Articulated Robot; A Robotic Work Cell; Problems.

Work Space Analysis and Trajectory Planning: Work Space Analysis; Work Envelope of a Five-Axis Articulated Robot; Work Envelope of a Four Axis SCARA Robot; Work Space Fixtures; The Pick and Place Operation; ContinuousPath Motion; Interpolated Motion; Straight Line Motion; Problems.

UNIT-III

Differential Motion and Statics: The Tool Configuration Jacobian Matrix; Joint – Space Singularities; Generalised Inverses; Resolved – Motion Rate Control; n > 6; Rate Control of Redundant Reboots : n > 6; Rate Control using (1)
– Inverses; The Manipulator Jacobian; Induced Joint Torques and Forces; Problems.

Manipulator Dynamics: Lagrange's Equation; Kinetic & Potential Energy; Generalised Force; Lagrange – Euler Dynamic Model; Dynamic Models of a Two-Axis Planer Articulated Robot and A Three-Axis SCARA Robot; Direct & Inverse Dynamics; Recursive Newton – Euler Formulation; Dynamic Model of a One-Axis Robot; Problems.

UNIT-IV

Robot Control: The Control Problems; State Equations; Constant Solutions; Linear Feedback Systems; Single-Axis PIDControl; PD-Gravity Control; Computed –Torque Control; Variable-structure Control; Impedance Control; Problems.

Methods of Robot Programming: Robot programming methods, introduction to basic robot programming languages,and various on-line and off-line robot programming methods.

Text and Reference Books

1. Fundamental of Robotics (Analysis &Control) by Robert J. Schilling, Published by PHI, Pvt. Ltd., New Delhi.
2. Introduction to Robotics (Mechanics & Control) by John J. Craig, Published by Addition Wesley (Intl. StudentEdition).
3. Analysical Robotics & Mechatronics by Wolfram Stadler, Published by Mc-Graw Hill, Inc., New Delhi.
4. Industrial Robotics – Technology, Programming &Applications byMikell P. Grover, Weiss, Nagel andOrdef,Published by Mc-Graw Hill International Edition.
5. A Robot Engg. Test Book – Mohsen Shahinpoor, Harper & Low, Publishing New York.
6. Robotic Engineering – An Integrated Approach: Richard D.Klafter, Thomas A. Chmielewski and

Michael NeginPHI 1989.
7. Foundations of Robotics Analysis and Control – Tsuneo Yashikawa MIT Press 1990, Indian Reprint 1998.
8. Robots and Control - R.K.Mittal and I.J.Nagrath – Tata McGraw Hill 2003.

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	1	2	--	--	--	--	--	2	--	2	3	2	2
CO2	3	1	2	2	2	--	--	--	--	2	--	2	2	2	2
CO3	2	2	2	2	3	--	--	2	--	3	--	2	3	2	2
CO4	3	2	2	2	3	--	--	2	--	3	--	2	2	2	2
CO5	3	2	2	2	3	--	--	2	--	3	--	2	2	2	2

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

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AUTOMATION IN MANUFACTURING (THEORY)

General Course Information:

Course Code: PE/ME/5-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 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 inHydraulics/Pneumatics Electro-pneumatic controls and devices.	L2
CO3	Students will be able to illustrate the principles of Rapid Prototyping, classifications ofdifferent RP techniques along with their applications.	L3
CO4	Students will be able to develop the concepts of Automatic transfer machines with assemblyautomation.	L4
CO5	Students will be able to analyze the performance of automation system.	L5

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Course Contents

UNIT-1

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 ofassembly system.

Text and Reference Books

1. Groover, M. P., "Automation, Production systems and Computer Integrated Manufacturing", 2nd Ed., PrenticeHall, 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
CO5	3	3	1	2	--	1	2	1	1	2	1	3	3	3	1

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

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ADVANCED WELDING (THEORY)

General Course Information

Course Code: PE/ME/6-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 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 weldingDefects	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
CO5	Students will be able to identify and analyze the welding defects	L5

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Course Contents

UNIT-1

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 Brazewelding 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 stressesand 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
CO5	3	2	2	1	--	--	--	2	--	2	--	3	2	2	2

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

INTRODUCTION TO CNC (THEORY)

General Course Information

Course Code: PE/ME/7-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to describe construction, working, tooling systems and programming of Computer Numeric Control (CNC) machines.	L1
CO2	Students will be able to explain the different features of CNC machines and decide its corresponding programming.	L2
CO3	Students will be able to illustrate parts of CNC machines and demonstrate the programming skills.	L3
CO4	Students will be able to analyze CNC machines and its programming.	L4
CO5	Students will be able validate CNC machines technology and determine programs for its working.	L5
CO6	Students will be able to design CNC machines and rewrite the programs for CNC machines.	L6

Course Contents

UNIT-I

Computer Numerical Control (CNC) Technology: Evolution of CNC Machines, Principles and control of CNC machines, Coordinate Systems, Applications of CNC Machine Tools.

Constructional features of CNC Machines: Structure of CNC Machine tools, Spindle and feed drives of CNCmachines, Actuation Systems of CNC Machines Tools, Feedback Devices used in CNC Machine.

UNIT-II

CNC Programming Fundamentals: Structure of Part Programs, Axes Identification in CNC Turning and MachiningCenters, Machine Zero and Home Position, ISO Standards for Coding.

Advanced Part Programming: Complex interpolations, Repetitive part programming, Subroutines and Macros,parametric part programming.

UNIT-III

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

Machining Centre Programming: Canned Cycles, Cutter Radius Compensation, Tool Length Compensation, PartProgram Numerical.

UNIT-IV

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

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. Rao P.N. "CAD/CAM Principles and Applications" Eighth edition, 2013.
2. Jon S. Stenerson, Kelly Curran, "Computer Numerical Control: Operation and Programming", Prentice Hall, 3rd edition 2007.
3. Mattson Mike, "CNC Programming: Principles & Applications", Cengage learning, 1st edition 2013.
4. Fitzpatrick, "Machining and CNC Technology", McGraw-Hill Higher Education, 3rd edition 2013.
5. Michael J. Peterson, "CNC Programming: Basics & Tutorial Textbook", Create Space Independent Publishing Platform, 1st edition2008.
6. 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	2	3	--	2	1	--	--	1	--	--	3	2	2	2
CO2	3	2	3	--	2	1	--	--	1	--	--	3	2	2	2
CO3	3	2	3	--	2	1	--	--	1	--	--	3	2	2	2
CO4	3	2	3	--	3	1	--	--	1	--	--	3	2	2	2
CO5	3	2	3	1	2	1	--	--	1	--	--	3	2	2	2
CO6	3	2	3	1	2	1	--	--	1	--	--	3	2	2	2

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

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MODERN MANUFACTURING PROCESSES (THEORY)

General Course Information

Course Code: PE/ME/8-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 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 modernmachining 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
CO5	Students will be able to compare different non-traditional machining processes on the basis ofpower consumption and material removal rate.	L5

Course Contents

UNIT-I

Unconventional Machining Process: Characteristics of Modern Machining Processes, Basic Principles of NewMachining 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 Limitationsof 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 Parametersof USM, Applications, Advantages and Limitations of USM.

Abrasive Jet Machining (AJM): Features of AJM (Schematic Diagrams), Practical Applications of AJM, Advantagesand 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
CO5	3	--	2	--	--	2	2	3	2	2	2	3	3	2	2

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

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REFRIGERATION AND AIR-CONDITIONING (THEORY)

General Course Information:

Course Code: PC/ME/17-T Course Credits: 4.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 1 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 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 andapplications 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 varioustypes 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 strapevaporative 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 –C.P. Arora, McGraw Hill Education, 4th edition, 2021.
2. A course in Refrigeration & Air Conditioning – Arora & Domkundwar, Dhanpat Rai & Sons, Reprint 2019.
3. Refrigeration & Air conditioning –R.C. Jordan and G.B. Priester, Prentice Hall of India.

4. Refrigeration & Air conditioning –W.F. Stocker and J.W. Jones, TMH, 2nd edition 2014.
5. Refrigeration & Air conditioning- Manohar Prasad Wiley Estern limited, New Delhi, 2nd edition 2005.
6. Refrigeration & Air conditioning- R.C. Arora, PHI Learning, 2012
7. Basic Refrigeration & Air conditioning, Ananthanarayanan, Mcgraw-Hill education, 2005
8. A text book of Refrigeration & Air conditioning- R.S. Khurmi, J.K. Gupta, S.Chand limited, 2008
9. Refrigeration & Air conditioning, G F Hundy, A. R. Trott, T. C. Welch, Elsevier Science, 2008

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	--	3	3	2	1
CO2	3	1	1	1	--	2	1	--	1	2	--	3	3	2	1
CO3	3	2	2	3	--	3	3	--	2	2	--	3	3	3	2
CO4	3	3	2	3	--	3	3	--	2	2	--	3	3	3	3
CO5	3	1	2	3	--	3	3	--	3	2	--	3	3	3	3
CO6	3	2	3	3	--	3	3	--	3	2	--	3	3	3	2

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

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INDUSTRIAL PSYCHOLOGY & ORGANIZATIONAL BEHAVIOUR

General Course Information

Course Code: HSMC/5-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 2 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	**Demonstrate** fundamental knowledge about need and scope of industrial - organizational psychology and behavior.	L1
CO2.	Analyse the job requirement, have understanding of fatigue,boredom and improve the job satisfication	L2
CO3.	**Understand** the approaches to enhance the performance	L3
CO4.	**Knowledge** of theories of organizational behavior, learning and social system	L4
CO5.	**Understand** the mechanism of group behavior, various aspects of team, leadership and conflict manaegment	L5
CO6.	**Evaluate** the organizational culture, manage the change and understands organizational development approaches.	L6

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Course Contents

UNIT-1

Industrial psychology, development of industrial psychology, scope of psychology, major problems of industrial psychology. Attitudes and Job Satisfaction: Attitudes: Meaning, components of attitude, attitude formation, determination and change, and cognitive theory of dissonance, measuring the A-B relationship. Personality Development, Job Satisfaction: Meaning, Theories, causes, importance of job satisfaction, ways of measuring job satisfaction.

UNIT-II

Human Engineering and Stress Management, fatigue study, monotony, boredom and work environment. Organizational Stress: Concept, causes, effects and coping strategies of stress. To deal with interpersonal and organizational relations. Meaning, theories of personality, personality, inter-personal relationship, and group dynamics, determinant of inter-personal relationship, management of inter-personal relationship, groupd ynamics, formal and informal group decision making.

UNIT-III

Design of Work Environments: Human engineering and physical environment techniques of job analysis, Social environment: Group dynamics in Industry Personal psychology, Selection, training, placement, promotion, counselling, job motivations, job satisfaction. Special study of problem of fatigue, boredom and accidents, Understanding Consumer Behavior: Consumer behaviour, study of consumer preference, effects of advertising, Industrial morale: The nature and scope of engineering psychology, its application to industry

UNIT - IV

Learning and Development, Meaning and definitions of learning, nature, component of earning, factors affecting learning, theories of learning, classical conditioning, operant conditioning, cognitive and social theory. Conditions of the learning development process. Personality, Inter-Personal Relationship. Training of Staff, Training module.

REFERENCES:

1. Vikram Bisen and Priya, Indistrial Psychology, New Age Publication, 2010.
2.Michael Aamodt, Organizational/ Industrial Psychology, Wadsworth Cengage Learning,2010
3.Robbins, S.P. Organizational Behaviour. Prenctice-Hall, latest edition.
4.Spector, P.E. Industrial and Organizational Psychology: Research and Practice. International Student Version. Latest Edition. Wiley.
5.Davis K. & Newstrom J.W., Human Behaviour at work, Mcgraw Hill International, 1985
6.Stephen P. Robbin & Seema Sanghi, Organizational behavior, Pearson, 2011
7.L.M. Prasad, Organizational behavior, S Chand & sons
8.Blum M.L. Naylor J.C., Horper & Row, Industrial Psychology, CBS Publisher
9.Luthans Fred, Organizational Behaviour, McGraw Hill International.
10.Morgan C.t., King R.A., John Rweisz & John Schoples, Introduction to Psychology, Mc Hraw Hill, 1966
11.Schermerhorn J.R.Jr., Hunt J.G &Osborn R.N., Managing, Organizational Behaviour, John Willy
12.Arnold J., Robinson, Iran, T. and Cooper, Cary L, Work Psychology, Macmillan India Ltd
13.Muchincky (2009). Psychology applied to work. New Delhi: Cengage.

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14.Griffin, Ricky W: Organizational Behaviour, Houghton Mifflin co., Boston.
15.Ivancevich; John and Micheeol T. Matheson, Organizational Behaviour and Management, Tata McGraw-Hill, New Delhi.

16.Newstrom, John W. and Keith Davis: Organizational Behavior: Human Behavior at Work, Tata McGraw-Hill, New Delhi.
17. Steers Richard m. and J. Stewart black: Organizational Behavior, Hrper Collins college

Course Articulation Matrix:

Course/Course Code- Industrial psychology & Organizational Behaviour Semester:														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	1	1	1	1	1	1	-	1	1	1	1	1
CO2	3	3	3	1	1	1	1	1	1	-	-	1	1	1	1
CO3	3	3	2	1	1	1	1	1	1	1	-	1	1	2	2
CO4	3	2	2	1	1	1	2	1	1	1	-	2	1	2	2

Correlation level: 1- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

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REFRIGERATION AND AIR-CONDITIONING (LAB)

General Course Information:

Course Code: **PC/ME/17-P** Course Credits: 1 Mode: Practical Type: Program Course Contact Hours: 2 hours/week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to understand the fundamentals of refrigeration and air conditioning test rig.	L1
CO2	Student will be able to describe the components of the Refrigeration and air-conditioning systems.	L2
CO3	Student will be able to compare the performance of refrigeration system at different load conditions	L3
CO4	Student will be able to apply the knowledge of refrigeration and air conditioning principles to conduct experiments.	L4
CO5	Student will be able to analyze and evaluate the performance of refrigeration and air conditioning systems	L5

Lab Contents

1. To determine the C.O.P of vapour compression refrigeration system and draw P-h and T-S diagrams.
2. To find the COP of vapor absorption refrigeration system.
3. To study the cut- sectional models of Reciprocating and Rotary Refrigerant compressor.
4. To study the various controls used in Refrigerating & Air Conditioning systems.
5. To study the Mechanical heat pump and find its C.O.P.
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.*

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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	1	--	1	1	--	--	2	--	3	3	2	1
CO3	3	--	1	2	2	1	1	2	1	2	--	3	3	2	1
CO4	3	1	2	3	2	2	2	2	2	2	2	3	3	3	2
CO5	3	2	2	3	3	2	2	2	2	2	2	3	3	3	3

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

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MINOR PROJECT

General Course Information:

Course Code: EEC/ME/3-P Course Category: Project work, Seminar and Internship in Industry Course Credits: 2.0 Mode: Practical Contact Hours: 06 hours per week	**Course Assessment Methods (Internal: 50; External: 50)** • The internal assessment is based on the level of participation in laboratory sessions, day to day work done by the students, presentation and demonstration, the performance in VIVA-VOCE, the quality of project file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internal examinations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator/project guide will conduct these minor evaluations in the slots assigned to them as per their timetable. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the project coordinator/project guides, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by the students in internal as well as external evaluations in the proformas (attached herewith as Annexure I and II) to the respective departments in addition to submitting and uploading of overall marks on the university portal as per the requirement of the result branch. The project course coordinator will also conduct course exit survey and, compute and submit the attainment levels of the course based on direct and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

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 summarize 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

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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/objectivesin theform 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)

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INDUSTRIAL TRAINING PRESENTATION-II

General Course Information:

Course Code: EEC/ME/4-P Course Category: Project work, Seminar andInternship in Industry Course Credits:2.0 Mode:Practical Contact Hours: 04 hours per week	**Course Assessment Methods Internal Examination (100 marks):** • 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. The Course Coordinator/Internal Examiners will maintain andsubmit the bifurcation of marks obtained by the students in theproformas (attached herewith as Annexure I and II) to the respectivedepartments in addition to submitting and uploading of overall markson the university portal as per the requirement of the result branch. The laboratory course coordinator will also conduct laboratorycourse exit survey and, compute and submit the attainment levels ofthe laboratory course based on direct and indirect evaluationcomponents and submit it to the Chairperson office along with theinternal assessment marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to get the exposure of 'real' working environment and get acquaintedwith the organization structure, business operations and administrative functions.	L1
CO2	Students will be able to demonstrate competency in relevant engineering fields throughproblem identification, formulation and solution.	L2
CO3	Students will be able to develop the ability to work as an individual and in group with thecapacity 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 six-eight week 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)

Detailed Syllabus
of
B. Tech (ME)
8th Semester

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POWER PLANT ENGINEERING (THEORY)

General Course Information:

Course Code: **PC/ME/18-T** Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to define and state various thermal power plants.	L1
CO2	Students will be able to classify, compare and explain different power plants.	L2
CO3	Students will be able to demonstrate the constructional details and working principle of power plants.	L3
CO4	Students will be able to differentiate conventional/non-conventional/ direct energyconversion devices and power plants.	L4
CO5	Students will be able to evaluate the performance, operating characteristics and electricalenergy costing of a given thermal power plants.	L5

Course Content

UNIT-I

Introduction: Energy resources and their availability, types of power plants, selection of the plants, review of basic thermodynamic cycles used in power plants.

Hydro Electric Power Plants : Rainfall and run-off measurements and plotting of various curves for estimating streamflow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

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UNIT-II

Steam Power Plants: Flow sheet and working of modern-thermal power plants, super critical pressure steam stations, site selection, coal storage, preparation, coal handling systems, feeding and burning of pulverized fuel, ash handling systems, dust collection-mechanical dust collector and electrostatic precipitator.

Combined Cycles: Constant pressure gas turbine power plants, Arrangements of combined plants (steam & gas turbinepower plants), re-powering systems with gas production from coal, using PFBC systems, with organic fluids, parametersaffecting thermodynamic efficiency of combined cycles. Problems.

UNIT-III

Nuclear Power Plants: Principles of nuclear energy, basic nuclear reactions, nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.

Power Plant Economics: load curve, different terms and definitions, cost of electrical energy, tariffs methods of electrical energy, performance & operating characteristics of power plants- incremental rate theory, input-out put curves,efficiency, heat rate, economic load sharing, Problems.

UNIT-IV

Non-Conventional Power Generation: Solar radiation estimation, solar energy collectors, low, medium & hightemperature power plants, OTEC, wind power plants, tidal power plants, geothermal power plants.

Direct Energy Conversion Systems: Fuel cell, MHD power generation-principle, open & closed cycles systems,thermoelectric power generation, thermionic power generation.

Text and Reference Books

1. Power Plant Engineering –Arora & Domkundwar, Dhanpat Rai & Co, 2011.
2. Power Plant Engineering –Samsher Gautam, Vikash publications, 2013.
3. Power Plant Engineering –P.C. Sharma, Katson Books, 2010.
4. Power Plant Engineering –G.D. Rai, Khanna Publishers, 2010.
5. Power Plant Engineering –R.K. Rajput, Laxmi Publishers, 2012.
6. Power station Engineering and Economy by B. G.A. Skrotzki and W.A. Vopat, Mc Graw Hill PublishingCampany Ltd., New Delhi.
7. Power Plant Engineering- P.K. Nag Tata McGraw Hill second Edition, 2001.
8. Power Plant Engg.- M.M. El-Wakil McGraw Hill, 1985.

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Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO3
CO 1	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO 2	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO 3	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO 4	3	3	2	1	--	2	1	1	1	2	1	3	3	3	1
CO 5	3	3	2	1	--	2	1	1	2	2	2	3	3	3	1

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

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COMPUTER AIDED DESIGN AND MANUFACTURING (THEORY)

General Course Information

Course Code: **PC/ME/19-T** Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Student will be able to define the scope and applications of CAD/CAM and geometric modeling techniques.	L1
CO2	Student will be able to understand the basic overview of geometric transformations, curves, surface and solids.	L2
CO3	Student will be able to use computer assisted part programming for CNC machines	L3
CO4	Student will be able to generate CNC part programmes	L4

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Course Contents

UNIT-I

Introduction to CAD/CAM: Historical developments, product life cycle, CAD/CAM systems, scope of CAD/CAM, CAD/CAM applications, 3D modeling approaches, types of geometric modeling, coordinate systems, sketching and sketch planes, basic features of a CAD/CAM system (extrusion, revolution, hole, cut, sweep, loft, fillet, chamfer, rib, shell, draft, patterns spiral and helix), feature based modeling, parametric modeling.

UNIT-II

Transformations: Introduction, transformation of points and line, 2-D translation, rotation, reflection, scaling, homogeneous representation, concatenated transformation, mapping of geometric models, 3-D scaling, shearing, rotation, reflection and translation, combined transformations.

Curves: Algebraic and geometric forms of straight lines and conics, Introduction to cubic Splines, Bezier curves and B-Spline curves.

UNIT-III

Surfaces: Introduction to plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-Spline surface, surface manipulations.

Solids: Geometry and topology, Solid models and representation schemes, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration, solid manipulators.

UNIT-IV

CNC Technology: Introduction, types of NC systems, NC machine tools, principle of operation of CNC, advantages and limitations of CNC systems, Direct numerical control (DNC) and its application, MCU and other components.

Part Programming: Integrating CAD, NC and CAM, preparing CAD data for NC system, NC part programming, coordinate systems, NC programming languages, G & M codes, computer aided part programming using APT, Automatic NC program generation from CAD models.

Text and Reference Books

1. Zeid, I., "CAD/CAM", McGraw Hill, 2008.
2. Groover and Zimmer, "CAD/ CAM", Prantice Hall.
3. Rogers, D. F. and Adams, J. A., "Mathematical Elements for Computer Graphics", McGraw Hill.
4. Radhakrishnan, P. and Kothandaraman, C. P., "Computer Graphics & Design", Dhanpat Rai Publication", 2ndedition, 2005.
5. Krishnamoorathy, C. S. and Rajeev, J. S., "Computer Aided Design (Software and Analysis Tools)", NarosaPublication House, 2nd edition, 2005.
6. Kundra T. K., Rao P. N. and Tiwari N. K, "Numerical Control and Computer Aided Manufacturing", McGrawHill.

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	1	--	--	--	2	--	3	3	2	2
CO2	3	2	2	2	2	1	--	--	--	2	--	3	3	3	2
CO3	3	2	2	3	2	1	--	--	2	2	--	3	3	3	2
CO4	3	2	2	3	3	2	--	--	2	2	--	3	3	3	2

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

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MAINTENANCE ENGINEERING

General course information

Course Code: **PC/ME/20-T** Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO	Impart the knowledge on importance and objectives of maintenance	L1
CO	To familiarize the students with preventive maintenance, condition based maintenance and reliability centered maintenance	L2
CO	Expose the students to application of computers to maintenance management.	L3
CO	Understand simulation technique used in maintenance. Equipment's and various tools used in CBM	L4

Course Contents

UNIT- 1

Introduction: Objectives and Functions of maintenance. Factors influencing plant availability, Maintenance control, Maintenance Strategies, Organization for Maintenance. Failure Statistics: Breakdown time distributions, Running-in failures, Time independent failures, Wear-outfailures, Failure Probability, Survival Probability and age specific failure rates. .

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UNIT-2

Overhaul and Repair: Meaning and difference, optimal overhaul / Repair / Replace maintenance policy for equipment subject to breakdown. Replacement Decisions: Deterministic and stochastic replacement situations, failure and preventive replacement, Optimal Interval between preventive replacement of equipment subject to breakdown, group replacement.

UNIT-3

Maintenance Systems: Fixed time maintenance, Condition based Maintenance, Operate to failure, Opportunity Maintenance, Design out maintenance, Total Productive Maintenance. OEE calculations, Maintenance Planning: Establishing maintenance plan and schedule, illustrative examples, Preventive Maintenance: Designing a Technically sound preventive maintenance program, failure data, FMECA, Maintenance to prevent failures, lubrication program development.

UNIT-4

NUCREC Method of prioritizing maintenance work. Spare Parts Management: Classification of spares, traditional approach to spares inventory, MUSIC-3D Approach to spares inventory, optimum number of spares to satisfy given service level, simulation technique used in maintenance.

Equipment's and Tools used in CBM, Oil analysis, vibration analysis, Infrared thermography, Vibration analyzer, Sensors, PLC & others.

REFERENCES:

1. Maintenance planning and control - Higgin L.R. Mc Graw Hill Book Company

2. Maintenance planning and control - Kelley Anthony, East-West Press Pvt. Ltd.,

3. Maintainability principle and practices – Blanchard B.S., Lowey E.E., Mc Graw Hill.

4. Practical NDT – Raj B., Jayakumar T., Thavasimutyi K., Narora Publishing House.

5. Engineering maintenance management – Niebel Benjamin W., Marcel Dekher

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Course Articulation Matrix:

Course/Course Code: **Maintenance Engineering**															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	--	2	1	1	1	1	1	2	3	3	1
CO2	3	3	3	2	--	2	1	1	1	1	1	2	3	3	1
CO3	3	3	3	3	--	2	1	1	2	2	1	2	3	3	1
CO4	3	3	3	3	--	3	1	1	1	2	2	3	3	3	2

Correlation level: 1- Slight /Low **2-** Moderate/ Medium **3-** Substantial/High

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COMPUTER AIDED DESIGN AND MANUFACTURING (LAB)

General Course Information

Course Code: **PC/ME/19-P** Course Credits: 1 Mode: Practical Type: Program Course Contact Hours: 2 hours/week.	**Course Assessment Methods (Internal: 50; External: 50)** Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to draw part drawings and three-dimensional models using CAD techniques.	L1
CO2	Students will be able to generate part programs for industrial components using CAM techniques	L2
CO3	Students will be able to demonstrate working of CNC machines	L3
CO4	Students will be able to examine the industrial drawings and manufactured parts.	L4
CO5	Students will be able to create a product from conceptualization to reality.	L5

Lab Contents

1. To prepare part drawing on CAD softwares (Auotcad, Draftsight etc.)
2. To perform parametric modelling on CAD softwares (Creo/Solid Works/Catia/Inventor etc.).
3. To understand CNC codes and their syntax in respect of CNC Turning Center, CNC Machining Center, and CNCWire Cut EDM.
4. To perform component identification and work setting of CNC Turning Center.
5. To perform component identification and work setting of CNC Machining Center.
6. To perform component identification and work setting of CNC Wire Cut EDM.
7. To prepare part program for CNC Turning center using CAM software (Cam Concept, Fusion 360, Master Cametc.)
8. To prepare part program for CNC Machining center using CAM software (Cam Concept, Fusion 360, Master Cametc.)
9. To prepare part program for CNC Wire Cut EDM using CAM software (Elcam etc.)
10. To machine an industrial part using CNC Turning Center.
11. To machine an industrial part using CNC Machining Center.
12. To machine an industrial part using CNC Wire Cut EDM.

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

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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	1	1	1	2	2	1	3	3	3	1
CO2	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1
CO3	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1
CO4	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1
CO5	3	3	3	2	2	1	1	1	2	2	1	3	3	3	1

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

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MAJOR PROJECT

General Course Information

Course Code: EE**C/ME/5-P** Course Credits: 4.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 0 0 10 Contact Hours: 10 hours per week	**Course Assessment Methods** **Internal Examination (50 marks):** • The internal assessment is based on the level of participation in laboratory sessions, day to day work done by the students, presentation and demonstration, the performance in VIVA-VOCE, the quality of project file and ethical practices followed. • Two internal examinations (each of 50 marks) for the laboratory courses (Minor Laboratory Evaluations: MLE I and MLE II) will be conducted in the week before or after the internalexaminations for the theory courses. • The overall internal marks will be calculated as the average of the two minor laboratory course evaluations. The course coordinator/project guide will conduct these minor evaluations in the slots assigned to them as per their timetable. The marks for MLE I and MLE II must be submitted within a week of the conduct of these laboratory course evaluations. **End semester examination (50 marks):** • The external examination will be conducted by external examiner appointed by the Controller of Examination along with the internal examiner, preferably the project coordinator/project guides, appointed by the Chairperson of the Department. • The final practical examination of duration three hours will be conducted only in groups of 20-25 students. The Course Coordinator/Internal Examiners/External Examiners will maintain and submit the bifurcation of marks obtained by thestudents in internal as well as external evaluations in the proformas(attached herewith as Annexure I and II) to the respectivedepartments in addition to submitting and uploading of overall markson the university portal as per the requirement of the result branch. The project course coordinator will also conduct course exit survey and, compute and submit the attainment levels of the course based ondirect and indirect evaluation components and submit it to the Chairperson office along with the internal assessment marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to relate the theoretical studies that they learned in the precedingsemesters with practical concepts.	L1
CO2	Students will be able to recognise their skill for the solution of identified problem and to develop a prototype mechanical system.	L2
CO3	Students will be able to apply the analytical and design procedures to synthesize a workingprototype of a functional mechanical system.	L3
CO4	Students will be able to examine the conditions faced by an engineer starting from thedevelopment / modification of an existing functional mechanical system.	L4
CO5	Students will be able to appraise the necessity of project management, teamwork, timemanagement, system integration skills and other related human factors involved in the design and development cycle of an engineering system.	L5

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Course Content

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 demonstrate his ideas/design/development in front of the committee constitute of a project coordinator, project guide and senior teachers of the department.
The student will be required to submit three copies of his/her project report to the office of the concerned department for record (one copy each for the deptt. Office, Project guide and University/College library).

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	3	3	3	3	2	2	1	2	3	3	3	3	3	3	3
CO 2	3	3	3	3	2	2	1	2	3	3	3	3	3	3	3
CO 3	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3
CO 4	3	3	3	3	2	3	1	2	3	3	3	3	3	3	3
CO 5	3	3	3	2	2	3	1	2	3	3	3	3	3	3	3

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

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SEMINAR

General Course Information

Course Code: EE**C/ME/6-P** Course Credits: 1.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 0 0 2 Examination Duration: 3 hours	Course Assessment Methods (Internal: 50; External: 50) Internal continuous assessment of 50 marks by course coordinator as per the course assessment method (Annexure I). For the end semester practical examination the assessment will be done out of 50 marks by the external and internal examiners as per the course assessment method (Annexure I).

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn recent trends and technologies in the field of MechanicalEngineering	L1
CO2	Students will be able to recognizing problems after doing research literature survey usingvarious resources	L2
CO3	Students will be able to prepare concise, comprehend and conclude selective topic in the fieldof Mechanical Engineering	L3
CO4	Students will be able to develop skills in presentation and discussion of research topics in apublic forum	L4

Course Content

The students are required to give power point presentation on the topic related to current research area in the field of Mechanical Engineering. The students are also required to submit a detailed report on the topic of seminar. The presentation should be held in the class room/ seminar hall in presence of the course coordinator.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	3	2	1	2	2	--	--	--	--	--	2	2	3	--	2
CO 2	3	1	2	2	--	--	--	--	--	2	--	2	2	--	2
CO 3	--	--	--	--	--	--	--	--	--	3	--	2	--	--	--
CO 4	3	2	2	2	--	--	--	--	--	3		2	2	2	2

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

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SOLAR ENERGY ENGINEERING (THEORY)

General Course Information

Course Code: PE/**ME/9-T** Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to state heating/cooling and electrical applications of solar engineering.	L1
CO2	Students will be able to classify and explain different solar energy based devices/equipment and their effects on environment.	L2
CO3	Students will be able to use different solar based equipment/appliances for various domestic applications.	L3
CO4	Students will be able to examine performance of various solar engineering equipment/devices.	L4
CO5	Students will be able to evaluate the thermal performance of solar based equipment.	L5

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Course Content

Introduction to solar system: Introduction, solar system – sun, earth and earth-sun angles, time, derived solar angles,

Solar Radiation: Estimation of solar radiation (direct and diffuse), measurement systems – pyrheliometers and otherdevices.

Unit-II

Effect of Solar radiation upon structures: Steady state heat transmission, solar radiation properties of surfaces,shading of surfaces, periodic heat transfer through walls and roofs.

Solar Collectors: Flat plate and concentrating – comparative study, design and materials, efficiency, selective coatings, heliostats.

Unit-III

Heating Applications of Solar Energy: Air and Water heating systems, thermal storages, solar ponds, solar pumps,solar lighting systems, solar cookers, solar drying of grains.

Cooling Applications of Solar Systems: Continuous and intermittent vapour absorption systems for coolingapplications, absorbent – refrigerant combination, passive cooling systems.

Unit-IV

Solar Electric Conversion Systems: Photovoltaics, solar cells, satellite solar power systems.

Effects on Environment: economic scenario, ozone layer depletion, green house effect, global warming, Remedialmeasures by international bodies.

Text and Reference Books

1. Solar Energy: Fundamentals, Design, Modelling and Applications - GN Tiwari, CRC Press
2. Solar Energy – S P Sukhatme, Tata McGraw Hill
3. Solar Energy Process – Duffie and Bechman, John Wiley
4. Applied Solar Energy – Maniel and Maniel, Addison Wiley
5. Solar Energy: Fundamentals and Applications – R P Garg and Jai Prakash, TMH.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	3	3	2	1	--	2	2	1	1	2	1	3	3	3	2
CO 2	3	3	2	1	--	2	3	1	1	2	1	3	3	3	3
CO 3	3	3	2	1	--	2	2	1	1	2	1	3	3	3	2
CO 4	3	3	3	1	--	2	2	1	1	2	1	3	3	3	2
CO 5	3	3	3	1	--	2	2	1	2	2	1	3	3	3	2

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

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FLEXIBLE MAUFACTURING SYSTEM (THEORY)

General Course Information

Course Code: PE/**ME/10-T** Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to state automation in mechanical perspective.	L1
CO2	Students will be able to inter relate different automated assembly systems.	L2
CO3	Students will be able to generalize the technology in optimisation of machine arrangement.	L3
CO4	Students will be able to compare robotics, material handling, computer-controlled system withtheir application & benefits.	L4
CO5	Students will be able to evaluate a flexible manufacturing system.	L5

Course Content

UNIT-I

Automation: Types of automation, reasons for automating, automation strategies, Detroit-type automation: Automated flow lines, methods of work part transport, Transfer mechanisms, buffer storage, automation for machining operations.

Automated assembly systems: Design for automated assembly, types of automated assembly systems, part feeding devices.

UNIT-II

Group Technology: Part families, parts classification and coding, types of classification and coding systems. Machine cell design: The composite part concept, types of cell designs, determining the best machine arrangement, benefits of group technology.

Flexible Manufacturing Systems: Components of an FMS, types of systems, where to apply FMS technology, FMS work stations. Material handling and storage system: Functions of the handling system, FMS layout configurations. Material handling equipment. Computer control system: Computer function, FMS data file, system reports. Planning the FMS, analysis methods for FMS, applications and benefits.

UNIT-III

Robotic technology: Joints and links, common robot configurations, work volume, types of robot control, accuracy and repeatability, other specifications, end effectors, sensors in robotics.

UNIT-IV

Robot programming: Types of programming, lead through programming, motion Programming, interlocks, advantages and disadvantages. Robot languages: Motion programming, simulation and off-line programming, workcell control.
Robot applications: Characteristics of robot applications, robot cell design, types of robot applications: Material handling, processing operations, assembly and inspection.

Text and Reference Books:

1. Automation, Production Systems and Computer Integrated Manufacturing. Groover M.P, Prentice Hall of India, 4th edition
2. CAD/CAM – Groover M.P, Zimmers E.W, Prentice Hall of India, 2013.
3. Approach to Computer Integrated Design and Manufacturing Nanua Singh, John Wiley and Sons, 1998.
4. Production Management Systems: A CIM Perspective Browne J, Harhen J, Shivnan J, Addison Wesley, 2nd Ed.1996.

Course Articulation Matrix (CO to PO/PSO Mapping)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO 1	3	3	3	2	--	1	1	1	2	1	2	3	3	3	2
CO 2	3	3	3	2	--	1	1	1	2	1	2	3	3	3	3
CO 3	3	3	3	2	--	1	1	1	2	1	2	3	3	3	2
CO 4	3	3	3	2	--	1	1	1	2	1	2	3	3	3	2
CO 5	3	3	3	2	--	1	1	1	2	1	2	3	3	3	3

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

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RAPID PROTOTYPING (THEORY)

General Course Information

Course Code: PE/**ME/11-T** Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course Outcomes

Sr. No.	Course Outcome	RBT Level
CO1	Students will be able to learn need & development, benefits and applications of RapidPrototyping systems.	L1
CO2	Students will be able to understand different types of Rapid Prototyping processes like 3Dprinting, Stereolithography, Selective Laser Sintering, Laminated Object Modeling and Fusion Deposition Modeling, Electron Beam Melting.	L2
CO3	Students will be able to point out the applications of Rapid Prototyping particularly in product design & development, medical, tooling, fashion & jewellery, architecture and automotivefields.	L3
CO4	Students will be able to define virtual prototyping and identify simulation components.	L4
CO5	Students will be able to employ reverse engineering in prototype modeling and RapidPrototyping in rapid tooling.	L5

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Course contents

UNIT-I

Introduction to RP: Need & Development of RP systems, RP process chain, Impact of Rapid prototyping and Tooling on Product Development, Benefits, Digital prototyping, Virtual prototyping, Freeform fabrication. Additive Manufacturing, Classification of AM Processes.

RP Applications: Design, Concept Models, Form & fit checking, Ergonomic Studies, Functional testing, Requesting Price quotes, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, Archeology, Paleontology & forensic Science, miniaturization.

UNIT-II

Liquid and Solid Based Rapid Prototyping Systems: Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, 3D printing: Working Principles, details of processes, products, materials, advantages,limitations and applications - Case studies.

Powder Based Rapid Prototyping Systems: Selective Laser Sintering, Direct Metal Laser Sintering, 3D Printing, LaserEngineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations.

UNIT-III

Data Processing for Rapid Prototyping: Process planning for rapid prototyping, CAD model preparation, Data Requirements & geometric modeling techniques: Wire frame, surface and solid modeling data formats - Data interfacing,Tessellation of surfaces, STL file generation Defects in STL files and repairing algorithms, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool pathgeneration.

Issues of Rapid Prototyping parts: Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface roughness problem in Rapid Prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost, material, color, dimensional accuracy, stability, machine-ability, environmental resistance, operational properties.

UNIT-IV

Rapid Tooling: Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuumcasting, use of Rapid tooling for injection mold.

Reverse Engineering: Introduction to reverse engineering, integration of reverse engineering and rapid prototyping, useof RP for reverse engineering.

Text and Reference Books

1. Rapid Prototyping: Principle and Applications, Rafiq I Noorani, Wiley & Sons, 2006
2. Rapid prototyping: Principles and applications, Chua C.K., Leong K.F., and Lim C.S., Yes Dee Publishing Pvt.Ltd, Third edition,2010.

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3. Rapid Prototyping And Engineering Applications, Frank W. Liou, CRC Press, Special Indian Edition, 2007.
4. Journey from Rapid Prototyping to Rapid Manufacturing , Somnath Chattopadhyaya, LAP Lambert AcademicPublishing,,2011.
5. Rapid Prototyping Technology: Selection and Application, Kenneth G. Cooper, Cooper Cooper, Marcel DekkerInc, 1st Edition, 2001.
6. Additive Manufacturing Technologies, Gibson I., Rosen D., Stucker B., Khorasan M., Springer InternationalPublishing, 3rd Edition, 2021.

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	2	1
CO2	3	--	--	--	2	--	--	--	--	--	--	3	3	2	1
CO3	3	3	3	--	2	--	--	--	--	--	2	3	3	2	2
CO4	3	--	2	--	3	--	--	--	--	--	2	3	3	2	2
CO5	3	2	2	--	3	--	--	--	--	--	2	3	3	2	2

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

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PRODUCT DESIGN AND DEVELOPMENT (THEORY)

General Course Information

Course Code: PE/**ME/12-T** Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 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, designstrategies, 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
CO5	Students will be able to design product as per customer needs and satisfaction consideringvarious factors including economics, ethical, aesthetics and ergonomics.	L5

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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

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Course Articulation Matrix (CO to PO/PSO Mapping)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	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
CO5	3	2	3	1	2	--	--	1	--	1	1	3	2	2	2

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

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PROJECT AND PRODUCTION MANAGEMENT

General course information

Course Code: EEC/ME/7-T Course Credits: 3.0 Mode: Lecture (L) and Tutorial (T) Type: Program Core Teaching Schedule L T P: 3 0 0 Examination Duration: 3 hours	**Course Assessment Methods; Max. Marks: 100 (Internal: 30; External: 70)** Three minor tests, each of 20 marks, will be conducted. The third minor will be conducted in open book mode by the Course Coordinator. No date sheet will be issued for the third minor at the level of the Departments. For the purpose of internal assessment, the average of the highest marks obtained by a student in any two minor examinations will be considered. All the minor examination question papers will be prepared and evaluated by following the Outcome Based Education framework. Class Performance will be measured through percentage of lectures attended (4 marks) Assignments (4 marks) and class performance (2 marks). The end semester examination will be 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 four units. All questions carry equal marks.

Course outcomes:

Sr. No.	Course outcomes At the end of the course students will be able to:	RBT* Level
CO1.	Complete structure of project management and analyze the scope of project planning	
CO2.	Identify different project selection methods	
CO3.	Explain the importance of procurement and its techniques	
CO4.	Demonstrate the importance of inventory control, JIT in manufacturing.	

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CO5.	Define the guidelines required for project control and its controlling techniques.	
CO6.	Outline the basic idea of projects and its initial management	

UNIT I

Introduction & Overview: Definitions, Types of projects, Project life cycle (Project phases) and decisions. Concept of management, concept of a system, production system, production functions. Organization fundamentals. Guidelines for good practice, organization structures, organization charts, span of control, number of levels, number of executives, management functions. Go/ No go decisions based on:a) Project Identification and Screening, b) Project Appraisal: Market, Technical, social, Ecological & Financial, c) Project Selection: Pragmatic, pairwise, MADM approach. Development of Project Network: Project description, Work break down structure, Nomenclature, Rules for drawing and representation, consistency and Redundancy in Project Networks, Matrix representation

UNIT II

CPM & PERT: Activity times, Completion, Floats, Probability (ND usage), Examples, and Problems. Project Monitoring & Control: Project adjustments, Crashing: Direct &Indirect cost, Normal & Crash: duration & cost, Resource leveling: Types, usage, leveling, Problems, Managing Risk. Role of Human Factors : Dealing with people Team Building and Leadership in Projects, commitment, work culture, motivation, coordination, attitude, innovation. Physical environment. Project selection methods, , DCF methods, project implementation, estimation, cost, price, value, scheduling, barcharts, network diagrams, PERT and CPM, schedule crashing, simple introduction to risk management, probability in project management,

UNIT III

Production Planning and Control basic terms, Customer needs, stake holder concept, project scope, feasibility study and report, baseline plan, SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude. Concept of Production planning & Control. Breakeven analysis. Vendor selection methods, JIT, supply chains, quality, quality circles, quality control and quality assurance, cause and effect analysis, ISO and concept softotal quality management and sixsigma, resource planning and allocation, availability and constraints of resources, resource leveling and crashing.

UNIT IV

Project Control, Project scope, project change request, and control of schedule, resources, cost and quality, project communications, channels, means, meetings, project reports, project audits Project evaluation, project close-out reports, guidelines, audit reports, maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis, Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, selection and leasing of construction equipment special considerations in selection and

location of projects, safety, health, human and environment all factors, project finance, international projects, joint ventures, collaborations, impact of culture, implementation, and handing over of projects. Body of Knowledge (PMBOK), Role of Project manager and his/her qualities.

REFERENCES:

1. Prasanna Chandra, " Projects-Planning, analysis, selection, implementation and review", Tata McGraw-Hill, New Delhi, 2010
2. Chitkara, " Construction Project Management", Tata McGraw-Hill, New Delhi
3. Harold Kerzner, " Project Management", Wiley, New York
4. Production Management by C.L. Mahajan; Satya Parkashan Company Limited, New Delhi
5. Industrial Engineering and Management by O.P. Khanna; Dhanpat Rai and Sons, New Delhi.

Course Articulation Matrix:

Course/Course Code: Semester:															
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO 2	3	2	2	2	1	1	2	1	2	1	1	1	2	2	1
CO 3	3	2	3	2	2	2	1	2	1	2	-	1	1	1	2
CO 4	3	2	3	1	1	1	2	1	2	2	-	1	1	2	2

Correlation level: 1- Slight /Low **2-** Moderate/ Medium **3**-Substantial/High