Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded

Department of Production Engineering

Syllabus- (T.Y.)

B. Tech ProductionEngineering

From 2020-21

Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded

T.Y. B. Tech. Department of Production Engineering.

From Academic Year 2020-21

Program Educational Objectives (PEOs):

PEO-1 Provide knowledge and skills of broad spectrum of manufacturing processes.

PEO-2 Develop capabilities of Product Design and Analysis through learning opportunities to work with up-to-date platforms in CAD/CAM/CAE.

PEO-3 Provides students with requisite philosophies, tools and techniques of operations management for becoming key players in any business organization.

PEO-4 Encourage students to acquire knowledge application aptitude for basic sciences, environmental issues, analytical abilities, self-initiated learning, out of box thinking, soft skills, professional skills, leadership qualities and work in team

PEO-5 Develop / Provide foundation for taking up a higher studies, entrepreneurship and administrative services in India and abroad.

Program Outcomes (POs) & Program Specific Outcomes (PSOs):

Program Outcomes:

Engineering Graduates will be able to:

a. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

f. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal,

health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes:

The Production engineering curriculum prepares gradates to:

PSO-1 Apply principles of engineering, basic science and mathematics to model, analyze, design production systems and processes.

PSO-2 Plan, operate, control, maintain and improve production systems, components and processes.

PSO-3 Be prepared to work professionally as production/mechanical engineer.

PO/PSO ➡ ⬇ PEO	a	b	c	d	e	f	g	h	i	J	k	l	PSO1	PSO2	PSO3
I	√		√	√								√	√	√	√
II			√	√	√							√	√	√	√
III			√	√					√		√		√		√
IV						√		√	√	√	√	√			√
V						√	√	√	√	√	√	√			√

Correlation Matrix (Correlation between the PEOs and the POs)

Note: The cells filled in with ✓ indicate the fulfillment/correlation of the concerned PEO with the PO.

Department of Production Engineering

Curriculum Structure of T.Y. B. Tech.

(With effective from 2020-2021)

Semester I						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits**	
					Th	**Pr**
PCC-PE301	Mechanical Working of Metals	03	--	-	03	-
PCC-PE302	Machine Design	04	--	02	04	01
PCC-PE303	Production Planning and Control	03	--	02	03	01
PCC-PE304	Tool Design	03	--	02	03	01
PCC-PE305	Operations Research	03	--	02	03	01
LAB-PE306	Computational Lab	--	--	02	--	01
LAB-PE307	Manufacturing Lab-II	--	--	02	--	01
	Total	**16**		**12**	**22**	
Semester II						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits**	
					Th	**Pr**
PCC-PE311	Fluid Mechanics & Hydraulics Machines	03	--	02	03	01
PCC-PE312	Heat Transfer	03	--	02	03	01
PCC-PE313	Quality and Reliability	03	--	02	03	01
PEC-PE3**	Elective -I	03	--	02	03	01
PEC-PE3**	Elective -II	03	--	02	03	01
	Total	**15**	**--**	**10**	**20**	

L- No. of Lecture Hours/week, T- No. of Tutorial Hours/week, P- No. of Practical Hours/week.

Elective-I and II (Students can register for any two from the list provided)	
Course Code	**Name of the course**
PEC-PE316	Finite Element Analysis
PEC-PE317	Product Design and Development
PEC-PE318	Plastics and Composites
PEC-PE319	Renewable Energy Sources
PEC-PE320	Mechatronics
PEC-PE321	Automobile engineering
PEC-PE322	Object Oriented Programming
PEC-PE323	Maintenance Management
Open Elective(s): offered by other department	

Mechanical Working of Metals

(CREDITS Th.-03, P-00)

Course Code: PCC-PE-301 **Contact Hours: Th. 03, Pr. 00**

Course Objectives

Objective 1. The objective is to study the press working terminology and equipment, Press tool operations, Press selection and rating, Principle of metal cutting, working of cutting die, die clearance and its effect, types of die construction and design of piercing, blanking, compound and progressive.

Objective 2. Study of Design of Bending and drawing dies along with bending methods, spring back effect, bend allowance, solid form, curling, embossing, coining and bulging, deep and shallow drawing, metal flow in drawing, variables affecting metal flow during drawing.

Objective 3. Study of press working materials, strip layout, stripping devices, press tonnage, methods of reducing cutting forces, punch and die design and mounting, pilots, stock strip stops.

Objective 4. Study of types of forging processes, with equipment and machines used, design analysis of forging dies.

Objective 5. Study of classification of rolling processes, rolling mills, rolling of bars and shapes, forces and geometrical relationships in rolling, problems and defects in rolled products and analysis of rolling process.

Objective 6. Study of classification of extrusion processes, Extrusion equipment, deformation, Lubrication and defects in extrusion, hydrostatic extrusion, Extrusion of tubing. Production of seamless pipe and tubing.

Objective 7. Measurement of strain hardening exponent, n value, Measurement of strain-rate, sensitivity; m value, measurement of plastic strain ratio, r value.

Objective 8. Study of concept need, classification, types of formability test, critical assessment of formability tests, determination of forming limit diagram.

Objective 9. The knowledge of this subject is very essential for an engineer in selection of various alloys and composite materials for suitable application in industry.

Course Outcomes

On successful completion of this course, students should be able to:

PCC-PE-301.1 Classify different metal forming processes.

PCC-PE-301.2 Design dies for cutting, forging, bending, drawing, piercing, and blanking.

PCC-PE-301.3 Compute material properties, forces and defects in metal forming processes.

PCC-PE-301.4 Select equipment for metal forming processes.

Articulation Matrix

	Name of course	PO				PSO		
		1	2	3	5	1	2	3
PCC-PE-301	**Mechanical Working of Metals**							
PCC-PE-301.1	Classify different metal forming processes.	2				1		
PCC-PE-301.2	Design dies for cutting, forging, bending, drawing, piercing, and blanking.			3	2			2
PCC-PE-301.3	Compute material properties, forces and defects in metal forming processes.		2		2	1		2
PCC-PE-301.4	Select equipment for metal forming processes.		2			1		1

Evaluation Scheme:

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks

Course Contents

Unit	Description	Co Covered	Hrs.
1	**Introduction:** Principle of metal forming, classification of metal-forming process, plastic deformation, cold working, Hot working, materials for cold and hot working.	**CO1**	**04**
2	**Dies For Sheet Metal Cutting And Shaping:** Press working terminology and equipment; Press tool operations, Press selection and rating, Principle of metal cutting, working of cutting die, die clearance and its effect, types of die construction.	**CO1**	**05**
3	**Die Design Fundamentals:** Press working materials, strip layout, stripping devices, press tonnage, Methods of reducing cutting forces, punch and die design, mounting of punch and die, pilots, stock strip stops. Design of dies: Piercing, Blanking, Compound and progressive.	**CO2**	**04**
4	**Dies For Sheet Metal Shaping:** Bending methods, spring back effect, bend allowance. Forming dies: solid form, curling, embossing, coining and	**CO2**	**04**

	bulging. Drawing dies: deep and shallow drawing, metal flow in drawing, variables affecting metal flow during drawing. Design of Bending and drawing dies.		
5	**Forging Dies:** Types of forging dies, advantages and limitations; forging equipment and machines, press forging, drop forging, open die forging, close forging, dogging defects. Forging design, factors-draft, fillet, corner radius, parting line, shrinkage, die wear, mismatch, and tolerances, forging operations stock size determination, forging die design, forging Analysis.	**CO1 /CO2**	**04**
6	**Rolling Of Metals:** Classification of rolling processes, rolling mills, hot rolling, cold rolling, rolling of bars and shapes, Forces and geometrical relationships in rolling, problems and defects in rolled products, process Analysis.	**CO1/ CO2**	**04**
7	**Extrusion:** Classification of extrusion processes, Extrusion equipment, hot extrusion, cold extrusion, Deformation, Lubrication and defects in extrusion, hydrostatic extrusion, Extrusion of tubing. Production of seamless pipe and tubing.	**CO1/ CO2**	**03**
8	Introduction To Drawing Of Rods, Wires And Tubes.	**CO1**	**03**
9	**Measurement of Intrinsic Properties:** Measurement of strain hardening exponent, n value, Measurement of strain-rate, sensitivity; m value, measurement of plastic strain ratio, r value.	**CO2 /CO3**	**05**
10	Quality Evaluation Methods For Raw Materials Used In Metal Forming Applications.	**CO2 /CO3 /CO4**	**04**
11	**What is formability, need for formability test, and classification of formability tests:** bending, drawing, stretching, combined mode test, critical assessment of formability test, forming limit diagram: Determination of forming limit diagram.	**CO1 /CO4**	**05**

Text Books

1. Mechanical Metallurgy by George E. Dieter, McGraw-Hill Book Company, 1988.
2. Rao PN, Manufacturing Technology-Foundry, Forming and welding Tata McGraw Hill, 2006
3. Sharma P. C. – Production Engineering, (S. Chand and co. Ltd. New Delhi 7th edition 1982)

Reference Books

1. ASTME – Fundamentals of tool design- (Prentice Hall of India Pvt .Ltd New Delhi 1984)
2. Donaldson, Lecain, Good – Tool Design Tata McGraw – Hill co. Ltd 3rd Edition 1976)
3. Pollack Herman W- Tool Design (D. B. Tarapurwall sons and co. pvt. Ltd. Mumbai 1983)
4. Dieter George E. - Mechanical Metallurgy (International student Edition, McGraw – Hill International Book co. 2nd Edition 1981)
5. Manufacturing Science, Amitabha Ghosh and Ashok Kumar Mallik, 1985, Affiliated East West Press Pvt.Ltd., New Delhi.6. Metal Forming Hand Book by Schuler, Springer, 1998.
7. Materials and Processes in manufacturing, by E. Paul Degarmo, Prentice-Hall of India, 2005.
8. Primer course on sheet metal forming- by Prof. K. Narasimhan, IIT Bombay.
9. K. Narsimhan and V. M. Nanded, Formability Testing of Sheet Metals, Transaction of Indian Institute of Metal, Vol. 49, No. 5, October 1996, pp 659 - 676.

Machine Design

(CREDITS Th.-04, P-01)

Course Code: PCC-PE-302 **Contact Hours: Th. 04 , Pr. 02**

Course Objectives

Objective 1. To understand the basics of design procedure.

Objective 2. To study the fundamentals of theories of failure.

Objective 3. To analyze the machine elements subject to static and fluctuating load.

Objective 4. To design of machine elements for real life applications.

Course Outcomes

On successful completion of this course, students should be able to;

PCC-PE-302.1 Understand basic design procedure and the necessary design considerations.

PCC-PE-302.2 Define and distinguish static and fluctuating loads/stresses.

PCC-PE-302.3 Derive empirical relations for different machine elements using relevant theories of failure.

PCC-PE-302.4 Analyze behavior of machine components under static and fluctuating loads/stresses.

PCC-PE-302.5 Design shafts, gears, clutches, power screws etc. for real life applications when subjected to static loading.

Articulation Matrix

	Name of course	PO			PSO	
		1	2	3	1	3
PCC-PE-302	**Machine Design**	2	2	3	2	2
PCC-PE-302.1	Understand basic design procedure and the necessary design considerations.	1			1	
PCC-PE-302.2	Define and distinguish static and fluctuating loads/stresses.	1			2	
PCC-PE-302.3	Derive empirical relations for different machine elements using relevant theories of failure.		2	2	2	2
PCC-PE-302.4	Analyze behavior of machine components under static and fluctuating loads/stresses		2	3	2	2
PCC-PE-302.5	Design shafts, gears, clutches, power screws etc. for real life applications when subjected to static loading.		2	3	2	2

Evaluation Scheme:

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Term work/Practical	Continuous evaluation up to Mid Term	50 Marks
	Continuous evaluation post Mid Term	50 Marks

Course Contents

Unit	Description	Co Covered	Hrs.
1	**Introduction:** Mechanical Engineering design, Traditional design methods, Design synthesis, Aesthetic considerations in design, Ergonomic considerations in design, Use of standard in design, Selection of preferred sizes, value analysis, Engineering materials, Selection of materials, manufacturing considerations in design, statistical considerations in design	**CO1**	**05**
2	**Design of Machine Part Subjected to Static Load:** Modes of failure, F. O. S., Stress due to B. M., stress due to torsional moment, Eccentric axial loading, combined stress Direct and bending e. g. C- clamp, frame, screw press, frame etc. **Design of Machine Parts Subjected To Fluctuating Load:** Stress concentration, stress concentration factors, methods to reduce stress concentration effects, fluctuating stresses, fatigue failure, notch sensitivity, endurance limit, Rotating beam test. Fatigue strength, factor affecting fatigue strength, Soderburg, and Goodman diagram, S. N. diagram, cumulative damage in fatigue: - Miner's equation.	**CO2/3/4**	**14**
3	**Power Screws:** Forms of threads, force analysis of square threads and trapezoidal threads, self-locking in power screws, collar friction, stresses in screw, Differential and compound screws, Recirculating type ball screws.	**CO5**	**06**
4	**Shafts, Keys and Couplings:** Transmission shafting, Design against static load and torsional rigidity, keys: Design of various types of keys, couplings: design of rigidity and flexible couplings.	**CO4/5**	**06**

5	**Springs:** Types of springs, terminology of springs, spring materials, design of different types of springs, optimum design of helical springs, multi leaf springs **Friction Clutches:** Torque transmitting capacity, single disc and multiple disc clutches, fraction materials, cone clutches, and centrifugal clutches.	**CO5**	**10**
6	**Gears:** Types of gears, V. R. for each type, selection of types of gear, modes of failure, gear design for maximum power transmitting capacity, Design of spur and helical gear, Lewis equation, Buckingham's Equation, Wear strength of spur & helical gears, gear lubrication. **Belt Drives:** Flat and V- belts, geometrical relationships, ratio of belt tension, selection of V belt and flat belts, condition for maximum power transmission.	**CO1/4/5**	**14**

Term Work

1. Numerical/ assignments based on above syllabus.
2. Drawing/CAD sheets based on design of any two machine components

Text Books/Reference Books

1. Design of machine element -V. B. Bhandari (Tata McGraw – Hill Co. Ltd)

2. Design of Machine elements -M. F. Spotts (Prentice Hall of India Ltd.)

3. Mechanical Engineering Design. -J. E. Shigley (McGraw- Hill Int. Ltd.)

4. Machine Design -Pandey and Shah (Charotar Publisher Co.)

5. Machine Design -Schaums series (McGraw Hill Co - Ltd.)

Production Planning and Control

(Credits Theory-03, Practical-01)

Course Code: PCC-PE-303 **Contact Hours: Th. 03, Pr. 02**

Course Objectives

Objective 01. To gain an understanding and appreciation of the fundamental principles and methodologies relevant to planning, design, operation, and control of Production Systems.

Objective 02. To reinforce analytical skills already learned, and build on these skills to further increase ones "portfolio" of useful analytical tools.

Objective 03. To gain ability to recognize situations in a production system environment those suggest the use of certain quantitative methods to assist in decision making.

Objective 04. To learn how to think about, approach, analyze, and solve production system problems using both technology and people skills.

Objective 05. To increase knowledge and broaden perspective of the "industrial world" in which one will contribute his / her talent and leadership as an Industrial Engineer.

Course Outcomes

On successful completion of this module, students should be able to

PCC-PE-303.1 Discuss the different types of production systems.

PCC-PE-303.2 Analyze the product development and design technique.

PCC-PE-303.3 Use forecast techniques to forecast the demand.

PCC-PE-303.4 Differentiate between production layouts.

PCC-PE-303.5 Understand the production order procedure.

PCC-PE-303.6 Construct and model Aggregate production plans.

PCC-PE-303.7 Gain the knowledge of different inventory control systems and inventory models.

Articulation Matrix

	Name of Course	**PO**					**PSO**		
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
PCC-PE-303	**Production Planning and Control**	**1**	**2**	**3**	**3**	**2**	**1**	**2**	**3**
PCC-PE-303.1	Discuss the different types of production systems.	1					1		
PCC-PE-303.2	Analyze the product development and design technique.		2				1	2	
PCC-PE-303.3	Use forecast techniques to forecast the demand.				3				3
PCC-PE-303.4	Differentiate between production layouts.	1					1	1	
PCC-PE-303.5	Understand the production order procedure.	1				2	1		

	Name of Course	PO					PSO		
		1	2	3	4	5	1	2	3
PCC-PE-303.6	Construct and model Aggregate production plans.			3		2		2	
PCC-PE-303.7	Gain the knowledge of different inventory control systems and inventory models.	1		3					3

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	Co Covered	Hrs
01	**Introduction:** Functions of PPC, types of production, production consumption cycle, coordination of production decisions. Product Development and Design: Product Design and Company Policy, Product Analysis: Marketing Aspect, Product Characteristics, Economic Analysis, production Aspect.	**CO1/ CO2**	**06**
02	**Forecasting:** Introduction, Time Series Methods, Casual Methods, Forecast Errors. Facility Layout: Introduction, Flow Systems, Types of Layout: Product, Process, Group Layout, Computerized Layout Planning.	**CO3/ CO4**	**08**
03	**Production Order:** Purpose of production order, procedure for formulating production order, process outlines, process and activity charts, production master program, operation and route sheet, production order	**CO5**	**06**
04	**Batch Production:** Quantities in batch production, criteria for batch size determination, minimum cost batch size, production range, maximum profit batch size, maximum return and maximum rate of return economic batch size.	**CO5**	**06**
05	**Machine Output:** Machine output, multi-machine supervision by one operator, machine interference, balancing of machine lines, analysis of	**CO5**	**06**

	process capacities in a multi-product system		
06	**Production And Operations Planning:** Aggregate Planning, Strategies and techniques for Aggregate Planning, Production Planning in Mass Production Systems and Assembly Line Balancing, Sequencing problems such as 1 machine n jobs, 2 machines n jobs & its extension, m machines 2 jobs, scheduling jobs with random arrivals	**CO6**	**08**
07	**Inventory Control:** Inventory and its purpose, the relevant costs, selective inventory analysis (ABC analysis), Classical Inventory Model, EOQ with quantity discounts, EOQ for multiple items with constraints on resources, Safety Stock, determining safety stock when usage and lead time vary, Fixed Order Period Inventory Control System	**CO7**	**08**

Term Work

At least six assignments based on theoretical concepts and problems.

Text Books

1. Simuel Eilon, Elements of Production Planning and Control, Macmillan Publications
2. James L. Riggs, Production Systems Planning and Analysis & Control

Reference Books

1. Narasimhan, Mcleavey, Billingten, Production Planning & Inventory Control, Prentice Hall of India
2. Chary S. N., Theory and Problems in Production and Operation Management, Tata McGraw Hill, Edition 1995.
3. Martend Telsang, Industrial Engineering, S. Chand Publication.

Tool Design

(Credits Theory-03, Practical-01)

Course Code: PCC-PE-304 **Contact Hours: Th. 03, Pr. 02**

Course Objective

This course encompasses the fundamental of machining method, in terms of tool-work material interactions. The contents if framed with the following objectives:

Objective 1. To understand tool configuration, it's functioning and wear characteristics.

Objective 2. Tool materials and developments& application be informed to students

Objective 3. To understand orthogonal cutting process and forces involved in the cutting

Objective 4. To evolve design of jigs and fixtures for the effective use of machining processes

Course Outcomes:

On the successful completion of the course, students should be able to:

PCC-PE-304.1 Apply basic tool engineering concepts like tool designation, right selection of cutting tool, machining parameters in tooling applications.

PCC-PE-304.2 Interpret tool failure criteria using Taylor's equation for several materials and their effect on machinability.

PCC-PE-304.3 Compute different forces in metal cutting, angles involved in chip formation by using merchant circle diagram.

PCC-PE-304.4 Compare types of metal cutting like orthogonal and oblique cutting.

PCC-PE-304.5 Understand basics of locating and clamping devices including degrees of freedom, 3-2-1 principle.

PCC-PE-304.6 Implement the design knowledge of jigs and fixture with different design considerations and features.

Articulation Matrix

Course Code	Course Name	PO			PSO		
		1	2	3	1	2	3
PCC-PE-304	**Tool Design**	**1**	**2**	**2**	**1**	**2**	**2**
PCC-PE-304.1	Apply basic tool engineering concepts like tool designation, right selection of cutting tool, machining parameters in tooling applications.	1			1		
PCC-PE-304.2	Interpret tool failure criteria using Taylor's equation for several materials and their effect on machinability.						

PCC-PE-304.3	Compute different forces in metal cutting, angles involved in chip formation by using merchant circle diagram.		2			2	
PCC-PE-304.4	Compare types of metal cutting like orthogonal and oblique cutting.						2
PCC-PE-304.5	Understand basics of locating and clamping devices including degrees of freedom, 3-2-1 principle.	1			1		
PCC-PE-304.6	Implement the design knowledge of jigs and fixture with different design considerations and features.			1	1		

Evaluation Scheme

Theory	Mid Term Examination	30 Mark
	End Term Examination	50 Mark
	Continuous Evaluation	20 Mark
Term work/ Practical	Continuous Evaluation	50 Mark
	Internal Viva-voce	50 Mark

Course Content:

Unit	Description	Co Covered	Hrs
01	**Theory of Metal Cutting**: Elements of machining by cutting, Tool geometry of single point cutting tool, tool signature, effect of tool angles on machining, Tool materials - properties, selection and applications, introduction to multi-point cutting tools.	**CO1**	**08**
02	**Machinability:** Introduction of machinability, machinability index, Chip-formation, types of chips, built-up-edge, chip breakers, orthogonal cutting and force diagram, Merchant's circle.	**CO2/CO3/CO4**	**08**
03	**Tool Life:** Factors affecting tool life, Taylor's equation, tool failure, tool wears, types of tool failures, Tool condition monitoring. Effect of various parameters on tool life.	**CO2/CO3**	**06**
04	**Locating And Clamping Devices:** Degrees of freedom, 3-2-1 method of location, choosing a locating surfaces, redundant locaters, fool proofing, locating methods and devices, clamping methods, power clamping: pneumatic, hydraulic, hydro–pneumatic, vacuum, magnetic and non-conventional clamps.	**CO5**	**06**

05	**Jig / Fixture Design Considerations:** Design principles of Jig/Fixture and their parts, fastening elements, construction elements, and process planning for Jig/Fixture manufacturing.	**CO6**	**04**
06	**Jig Design:** Drill bush types, fixed, plain, headed renewable, slip, threaded and special, design principles for drill bush, drill bush materials, jig feet, Types of jigs, templates, plate, angle-plate, leaf, turnover, box, multi-station and indexing jigs.	**CO6**	**08**
07	**Fixture Design:** Cutter setting and mounting devices, milling fixture design, single piece, sting, progressive, index and rotary milling, design of lathe, boring and broaching fixtures.	**CO6**	**08**

Term Work

It shall consist of at least six assignments based on the following

a. Preparation of single point cutting tools for turning, parting, threading.

b. Tool signature and basic shapes of cutting tools

c. Demonstration of different tools (single and multi-point cutting tools)

d. Two sheet each on locating i.)Elements& clamping elements, ii.)Jig design and iii.)Fixture design

Text Books

1. Metal Cutting Theory and Practice, a. Bhattacharyya, Central Book Publishing, Calcutta (1984)
2. Tool Design: Donaldson, Tata McGraw–Hill publishing Co. Ltd., New Delhi

Reference Books

1. Introduction to Jig and Tool Design: Kempster M. H. A. English language book society.
2. Jigs and Fixtures by Joshi P. H., Tata McGraw Hill, New Delhi
3. Production Technology by HMT, TMH publications
4. Production Science: Pandya and Singh, Standard Publications
5. Metal cutting theory and cutting tool design: V. Arshinov, G. Alekseev: Mir Publishers, Moscow.
6. Properties and Selection of Tool materials, V. A. Kortesoja, ASM publications, Ohio (1975).

Operations Research

(Credits Theory-03, Practical-01)

Course Code: PCC-PE-305. **Contact Hours: Th. 03, Pr. 02**

Course Objective

Objective 01 To formulate various real life problems including use of analytic tools to evaluate the same.

Objective 02 To simulate solution methodology using computer tools**.**

Objective 03 Apply various models to the real life case studies and develop decision making skills for the same.

Course Outcomes

After completion of this course a student should be able to:

PCC-PE-305.1 Conceptualize and formulate various real life problems.

PCC-PE-305.2 Learn various analytical techniques to evaluate the problems.

PCC-PE-305.3 Use software tool for solving LPP.

PCC-PE-305.4 Generate optimal solutions for various queuing, transportation, assignment and dynamic programming problems

Articulation Matrix

	Name of Course	**PO**					**PSO**		
		1	**3**	**4**	**5**	**7**	**1**	**2**	**3**
PCC-PE-305	**Operation Research**	**1**	**2**	**3**	**2**	**3**	**1**	**2**	**3**
PCC-PE-305.1	Conceptualize and formulate various real life problems.	1		3			1		
PCC-PE-305.2	Learn various analytical techniques to evaluate the problems.	1			2		1	2	
PCC-PE-305. 3	Use software tool for solving LPP.		2			3			3
PCC-PE-305.4	Generate optimal solutions for various queuing, transportation, assignment and dynamic programming problems.	1		3	2			2	

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	CO Covered	Hrs
01	**Introduction**: Development of OR techniques, definition, characteristics, phases in OR, limitations and applications of OR techniques. **Linear Programming**: Analysis and model formulation various real life problems, Canonical and standard form of LPP, Assumptions in LP, Graphical, Simplex, Dual Simplex, Big M method, Special cases of LP solutions, Concept of Duality, Advantages and Limitations of LP models.	**CO1**	**10**
02	**Transportation and Assignment Models:** Assumptions in transportation model, Transportation, Transshipment, Assignment, Travelling salesman problems and their solution techniques.	**CO4**	**08**
03	**Dynamic Programming:** Model formulation, Bellman's optimality principle, Backward and forward recursions, various DP problems. Integer Linear Programming: Model formulation, Gomory's cutting plane method, Branch and Bound method, Zero-One Programming.	**CO2**	**06**
04	**Games theory:** Model formulation, Two person zero sum games, Max-min principle, Saddle point, Games without saddle points, Dominance property, Oddments method, Graphical method of solution, Games as LP problems.	**CO4**	**08**
05	**Introduction to Nonlinear Programming:** Introduction, Lagrange Multipliers method, Convex Nonlinear Programming Problem, Kuhn Tucker Theory, One dimensional search – Interval halving search, Fibonacci search, Golden section search, Steepest descent method.	**CO3**	**08**
06	**Introduction to Queuing Theory:** Introduction and applications of queuing models, Basic structure and characteristics of queuing models, single channel queuing theory, birth-death process, finite queue variation, finite calling population variation further above model.	**CO4**	**08**

Term Work

Numericals based on the above syllabus. At least 2 assignments using Microsoft Solver for LPP.

Text Books

1. Prem Kumar Gupta, D. S. Hira, Problems in Operations Research: Principles and Solutions, S. Chand, 1991
2. J. K. Sharma, Operations Research: Theory And Application, Laxmi pub. India.

3. Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut.

Reference Book

1. Belegundu, ― Optimization Concepts and Applications in engineering, Cambridge Uni. Press, India
2. Hillier F.S., and Lieberman G.J., Operations Research, Eight Edition, Mc. Tata McGraw Hill, India
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Second Edition, Mc. WSE Willey
4. Operations Research - An introduction, Hamdy A Taha, Pearson Education.

Computational Lab

(Credits Theory-00, Practical-01)

Course Code: LAB-PE-306 **Contact Hours: Th. 00 Pr. 02**

Course Objectives

Objective 01. To introduce software tools Octave/Matlab useful for engineering and scientific computations.

Objective 02. To understand various mathematical and numerical computational methods.

Objective 03. To apply basic programming fundamentals to solve engineering problems.

Course Outcomes

Upon completion of the course, students will be able to:

LAB-PE-306.1 To understand software usage like Octave/Matlab to solve engineering and scientific problems.

LAB-PE-306.2 To evaluate various solutions to specified mathematical problems.

LAB-PE-306.3 To learn various tools and commands to execute the programs.

LAB-PE-306.4 To understand various 2D and 3D plotting in Octave/Matlab.

LAB-PE-306.5 To implement and use various numerical methods computations.

LAB-PE-306.6 To apply and solve various engineering problems using Octave/Matlab.

Articulation Matrix

	Name of Course	**PO**					**PSO**		
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
LAB-PE-306	**Computing Tools for Engineers**	1	2	3	3	3	1	2	3
LAB-PE-306.1	To understand software usage like Octave/Matlab to solve engineering and scientific problems.	1				3	1		3
LAB-PE-306.2	To evaluate various solutions to specified mathematical problems.	1	2		3		1	2	
LAB-PE-306.3	To learn various tools and commands to execute the programs.	1			2	3	1		3
LAB-PE-306.4	To understand various 2D and 3D plotting in Octave/Matlab.		2			2	1		

LAB-PE-306.5	To implement and use various numerical methods computations.		2	3	3		1		3
LAB-PE-306.6	To apply and solve various engineering problems using Octave/Matlab.			3	2	3	1	2	

Evaluation Scheme

Term work/Practical	Continuous evaluation upto Mid Term	50 Marks
	Continuous evaluation post Mid Term	50 Marks

Course Content

Introduction to Engineering and scientific computing using different software.

- Introduction of Scilab, and problems, numerical on the basis of Scilab
- Introduction of Octave, and problems, numerical on the basis of Octave
- Basic of Matlab, and problems, numerical on the basis of Scilab

Term Work

The term work shall consist of the assignments based on the above syllabus. The student shall submit the record of term work in the form of journal.

Text Books

1. [Long] P.J.G. Long, Introduction to Octave, available at the website,
http://wwwmdp.eng.cam.ac.uk/web/CD/engapps/octave/octavetut.pdf (September 2005).

Reference Books

1. Scilab/Octave/Matlab, spreadsheet software manuals

Manufacturing Lab-II

(Credits Theory-00, Practical-01)

Course Code:LAB-PE-307 **Contact Hours: Th. 00 Pr. 02**

Course Objectives

Objective 1. The objective is to study details of CNC milling, Programming, DNC machines.

Objective 2. Manufacturing of a job consisting of operations like turning, trading, knurling, shaping, drilling.

Objective 3. Study of grinding and radial drilling machines for demonstration of a job.

Objective 4. Study of simulation software to design tool cutting, rolling, forging, drawing, sheet metal forming processes.

Objective 5. Study of intrinsic properties of material.

Objective 6. Presentation of one component manufacturing process.

Course Outcomes

On successful completion of this course, students should be able to:

LAB-PE-307.1 Describe the basics working principle of CNC Lathe, Milling, Drilling.

LAB-PE-307.2 Acquire CNC machining skill by working on CNC lathe, CNC milling machine.

LAB-PE-307.3 Write NC/ CNC part program for lathe operation.

LAB-PE-307.4 Use of simulation software to design tool cutting, rolling, forging, drawing, sheet metal forming processes.

LAB-PE-307.5 Determination of intrinsic properties of material.

LAB-PE-307.6 Visualization of one component manufacturing process.

Evaluation Scheme

Term work/Practical	Continuous evaluation upto Mid Term	50 Marks
	Continuous evaluation post Mid Term	50 Marks

Course Contents

1. Details of CNC Turning, CNC Milling, Programming, DNC and related topics.
2. A job consisting of operations like turning, trading, knurling, shaping, drilling.
3. Demonstration job on grinding and radial drilling.

Each student will prepare and submit the following jobs.

i. A job on CNC Lathe- 01 Job
ii. A job on CNC Milling- 01 job

4. Use of simulation software to design tool cutting, rolling, forging, drawing, sheet metal forming processes.

5. Determination of intrinsic properties of material.

6 . Each student will prepare video presentation of one component manufacturing process.

Note: The student shall submit the assignment based on CNC programming of term work in the form of journal.

References Books

1. Books of Machining Process and Manuals of the Machine Tool being used.

FLUID MECHANICS AND HYDRAULIC MACHINES

(Credits Theory-03, Practical-01)

Course Code: PCC-PE-311 **Contact Hours: Th. 03 Pr. 02**

Course Objectives

Objective 1. To understand the basics of fluid properties.

Objective 2. To study the fundamentals of fluid kinematics/dynamics.

Objective 3. To analyze real life problems associated with fluid mechanics.

Objective 4. To prepare foundation for advanced topics such as CFD.

Objective 5. To have knowledge of hydraulic machines

Course Outcomes

On successful completion of this course, students should be able to:

PCC-PE-311.1 Describe the basic properties of fluids.

PCC-PE-311.2 Define and differentiate between fluid statics and fluid dynamics.

PCC-PE-311.3 Solve real life problems in the field of fluid mechanics.

PCC-PE-311.4 Acquire fundamentals to study the advanced topics such as CFD.

PCC-PE-311.5 Interpret the basics of hydraulic machines/systems.

Articulation Matrix

	Name of course	**PO**			**PSO**	
		1	2	3	1	3
	Fluid Mechanics and Hydraulic machines	**2**	**2**	**2**	**2**	**2**
PCC-PE-311.1	Describe the basic properties of fluids.	2			2	
PCC-PE-311.2	Define and differentiate between fluid statics and fluid dynamics.			2		
PCC-PE-311.3	Solve real life problems in the field of fluid mechanics.			3		1
PCC-PE-311.4	Acquire fundamentals to study the advanced topics such as CFD.	1				
PCC-PE-311.5	Interpret the basics of hydraulic machines/systems.	1				1

Evaluation Scheme:

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Term work/Practical	Continuous evaluation upto Mid Term	50 Marks
	Continuous evaluation post Mid Term	50 Marks

Course Contents

Unit	Description	CO covered	Hrs
1	**Introduction:** Definition of fluid, Properties of fluids, Viscosity, Compressibility, Bulk modulus of elasticity, Surface tension and capillarity **Fluid Statics:** Pressure at a point, Pascal's law, Hydrostatic pressure on plane and curved surfaces, Absolute, Gauge, Atmospheric and vacuum pressures, pressures, Measurement of pressure by manometers and gauges, Buoyant equations Buoyance, Centre of buoyancy, Stability of floating bodies, Metacenter, Metacentric height and its determination.	**CO1/ CO2/ CO-3**	**10**
2	**Fluid Kinematic:** Types of fluid flows: Steady, Unsteady, Uniform and non-uniform, laminar and turbulent, Compressible and incompressible, rotational and irrotational, Rate of flows, continuity equation for one dimensional, Velocity and acceleration, Velocity potential function and stream function, vortex flow.	**CO2/ CO-3**	**06**
3	**Dimensional analysis:** Introduction, secondary or derived quantities, dimensions of physical quantities, dimensional homogeneity, methods of dimensional analysis, model analysis, types of forces acting in moving fluid, dimensionless numbers, model laws.	**CO-4**	**05**
4	**Fluid Dynamics:** Equation of motion, Euler's equation, Bernoulli's equation, and practical applications of Bernoulli's equation: Venturimeter, orifice meter, Pitot tube, Momentum equation.	**CO-4**	**07**

5	**Flow through pipes:** Introduction, loss of energy in pipes, frictional loss in pipe flow, equations for loss of head, minor losses, flow through pipes; series, parallel, compound, branched.	**CO-4**	**07**
6	**Introduction to hydraulic machines:** Turbines, classification of hydraulics turbines, pelton turbine, Francis turbine, centrifugal pumps, main parts of centrifugal pump, workdone by centrifugal pump, reciprocating pump.	**CO-5**	**06**

Term Work

Term work shall consist of the record of following laboratory experiments.

1. Verification of Bernoulli s equation.
2. Calibration of Venturimeter.
3. Calibration of Orifice meter.
4. Determination of Hydraulic Coefficients for an orifice
5. Study of pressure measuring devices.
6. Study hydraulics turbine setup
7. Study of centrifugal setup

Text books /Reference books

1. Fluid mechanics and Hydraulic Machines by Dr. R. K. Bansal, Laxmi publications (P) ltd., New Delhi.
2. Hydraulics and Fluid Mechanics by Modi and Seth
3. Theory and Application of Fluid Mechanics by Subramanya
4. Fluid Mechanics by V. L. Streeter and E. Benjamin, Wiley.

Heat Transfer

(Credits Theory-03, Practical-01)

Course Code: PCC-PE-312 **Contact Hours: Th. 03 Pr.02**

Course Objectives

This subject is introduced to third year students with an objective of understanding fundamentals of heat transfer. Following are the objectives of the course:

Objective 1. To introduce a basic study of the phenomena of heat and mass transfer.

Objective 2. To differentiate heat transfer by conduction, convection and radiation.

Objective 3. To develop methodologies for solving a wide variety of practical engineering problems

Objective 4. To provide useful information concerning the performance and design of heat exchanger.

Objective 5. To get idea about steady state problems of Heat Transfer

Course Outcomes

On successful completion of this course, students should be able to:

PCC-PE-312.1 Define, differentiate and interpret basic modes of heat transfer.

PCC-PE-312.2 Compute temperature distribution and heat transfer rate for 1-D problems

PCC-PE-312.3 Design of heat exchanger as per the requirement.

PCC-PE-312.4 Select suitable heat exchanger, based on the heat transfer process, geometry and construction for a given application.

PCC-PE-312.5 Understand significance of different non dimensional numbers in convective heat transfer.

PCC-PE-312.6 Analysis of the extended surface (Fins).

Articulation Matrix

	Name of Course	**PO**				**PSO**		
		1	**2**	**3**	**7**	**1**	**2**	**3**
PCC-PE-312	**HEAT TRANSFER**	**2**	**2**	**2**	**1**	**2**		**1**
PCC-PE-312.1	Define, differentiate and interpret basic modes of heat transfer.	2				2		
PCC-PE-312.2	Compute temperature distribution and heat transfer rate for 1-D problems		2					1

PCC-PE-312.3	Design heat exchanger as per the requirement.			2				1
PCC-PE-312.4	Select suitable heat exchanger, based on the heat transfer process, geometry and construction for a given application.			2	1	1		
PCC-PE-312.5	Understand significance of different non dimensional numbers in convective heat transfer.	2				1		
PCC-PE-312.6	Analysis of the extended surface (Fins).		2					1

Evaluation Scheme:

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Term work/Practical	Continuous evaluation upto Mid Term	50 Marks
	Continuous evaluation post Mid Term	50 Marks

Course Contents

Unit	Description	CO covered	Hrs
1	**Unit 01 One Dimensional Heat Transfer:-** Part A: Introduction to Heat Transfer: Introduction, modes of heat transfer, Mass Transfer, steady state heat transfer, thermal conductivity and coefficient of heat transfer, isotropic and an-isotropic materials, insulating material, factors affecting the above properties, steady and unsteady state of heat transfer, heat transfer with internal heat generation, practical applications, Fick's Law. Part B: Conduction Heat Transfer: Steady State heat conduction, one-dimensional conduction, three dimensional heat conduction equation in Cartesian coordinates and its reduction to Fourier's equation, Poisson and Laplace equations, three dimensional heat conduction equation in cylindrical and spherical coordinates(no derivation) and its reduction to one dimensional form, heat conduction through objects solid slabs Steady heat conduction through cylindrical objects heat conduction through composite cylinders. Critical thickness of insulation, Effect of variable conductivity.	**CO-1/2/6**	**16**

	Part C: Extended Surface (Fins)Meaning, Significance and Classification, Fin analysis with different boundary condition, Fin efficiency, Fin effectiveness, overall fin effectiveness, steady state heat conduction with heat dissipation to surrounding, Thermometric well, electrical analogy for study of heat transfer problems.		
2	**Unit 02 Convection Heat Transfer:-** Introduction to natural and forced convection, empirical relation, introduction to hydrodynamic and thermal boundary level, significance of different non dimensional numbers in convective heat transfer. Nusselt number, Reynolds number, Grashoff number,Prandlt number, etc, Application of convection heat transfer for Solar drying.	**CO-1/2/5**	**06**
3	**Unit 03 Radiation Heat Transfer:-** Introduction, definitions, laws of radiation- Planks, Wiens, Kirchoff's law, Stefan Boltzman law and Lamberts cosine law, intensity of radiation, solid angle, Surface absorption, reflection and transmission, emissivity, shape factor and shape factor algebra, concept of black body, white body, transparent body, heat transfer between black bodies, heat transfer between gray bodies, irradiation and radiosity, concept of surface resistance and space resistance, Electrical network approach for solving steady state radiation problems, Radiations shields.	**CO-1/2**	**10**
4	**Unit 04 Heat Exchangers:-** Classification, temperature distribution in parallel, counter flow arrangement, condenser and evaporator, concept of overall heat transfer coefficient, fouling factor, LMTD relations, effectiveness, and effectiveness by NTU method, practical application of heat exchangers, simple numerical problems, introduction to heat pipe.	**CO-3/4**	**10**

Term Work

Term work shall consist of the record of following laboratory experiments.

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of Composite slab.
3. Experiment on natural convection apparatus.
4. Determination of Emissivity of test –plate.
5. Stefan Boltman's apparatus.

6. Experiment on heat exchangers.
7. Determination of critical radius of insulation.

Text books

1. Heat and Mass transfer- Dr. D. S. Kumar, S. K. Kataria and Sons publishers.
2. Hear and Mass Transfer - R K Rajput, S. Chand Publication.

Reference books

1. Heat transfer - Dr. S. P.Sukhatme, Universities Press (India) Pvt. Ltd.
2. Heat transfer -J. P. Holman, McGraw-Hillinternational.
3. “Fundamentals of Heat Transfer”, Frank P. Incropera and David P. De Witt, Wiley,Eastern Limited.
4. “Engineering Heat Transfer”, Gupta and Prakash, Nemchand and Brothers.

Quality and Reliability

(Credits for Theory-03, Practical-01)

Course Code: PCC-PE-313 **Contact Hours: Th. -03, Pr. -02**

Course Objectives:

Objectives 1. To understand fundamental concepts of quality Control.

Objectives 2. To study various quality control tools and techniques.

Objectives 3. To study the quality control charts, process capability analysis and its applications.

Objectives 4. To study the fundamentals of Acceptance Sampling, its use and economics.

Objectives 5. Introduction to the Reliability Engineering.

Course Outcomes:

After successful completion of this course a student should be able to;

PCC-PE-313.1. Interpret the basic principles of probability theory, standard distributions.

PCC-PE-313.2. Understand and solve numerical on confidence interval, test of hypothesis.

PCC-PE-313.3. Solve numerical examples on statistical process control, rules for out of control, average run length, warning limits, probability of false alarm, etc.

PCC-PE-313.4. Solve numerical examples on variable and attribute control charts.

PCC-PE-313.5. Solve numerical examples on process capability analysis.

PCC-PE-313.6. Design a single/double sampling plan, construct its OC curve, and estimate ATI, AOQ and other indices, evaluate economics of sampling.

PCC-PE-313.7. Solve numerical on system reliability estimation.

Articulation Matrix

	Course	**PO**							**P S O**		
		1	**2**	**3**	**4**	**5**	**6**	**10**	**1**	**2**	**3**
PCC-PE-313	**QUALITY AND RELIABILITY ENGINEERING**	**2**			**3**	**2**			**3**	**2**	**2**
PCC-PE-313.1	Interpret the basic principles of probability theory, standard distributions.	3	2								
PCC-PE-313.2	Understand and solve numerical on confidence interval, test of hypothesis.		3		2			2			

PCC-PE-313.3	Solve numerical examples on statistical process control, rules for out of control, average run length, warning limits, probability of false alarm, etc.		2		3			1				
PCC-PE-313.4	Solve numerical examples on variable and attribute control charts.			3	2	1		1				
PCC-PE-313.5	Solve numerical examples on process capability analysis.	2	3	2				1				
PCC-PE-313.6	Design a single/double sampling plan, construct its OC curve, and estimate ATI, AOQ and other indices, evaluate economics of sampling.	2	3		2							
PCC-PE-313.7	Solve numerical on system reliability estimation.			3		2						

Evaluation Scheme

Examination	Evaluation Components	Marks
Theory	In-Sem. Evaluation (ISE)* and Attendance	20
	Mid Term Examination	30
	End Term Examination	50
Term Work/ Practical	Attendance	20
	Subject Seminar	20
	Continuous Evaluation, Mid - term viva, End-term Viva-voce.	60

***the rubric for the ISE shall be declared at beginning of course

Course Contents

Unit	Description	CO Covered	Hrs
01	**Introduction:** Quality, components of quality control viz; quality of design, quality of conformance, quality assurance, statistical process control, role of Q. C. in industries **Basic Probability Concepts:** The histogram, numerical indices for summarizing data (mean, median,	**CO1**	**05**

	standard deviation, etc) probability distribution (Normal, Exponential, Poisson, Binomial) concept, nature and applicability.		
02	**Statistical Estimation:** Sampling Distribution, Centre Limit Theorem, Confidence Interval, Accuracy of estimates, Hypothesis Testing, Type of Tests.	**CO2**	**05**
03	**Fundamentals of Statistical Process Control:** Causes of variation, Statistical basis for control limits, Selection of control limits, Warning limits, Effect of sample size, Effect of choice of control limits, Interpretation of Lack of Statistical Control, Rules for out of control process, Estimation of Probability of false alarm, Average Run Length.	**CO3**	**06**
04	**Installing Control Charts:** **Control Charts for Variables:** X & R, σ Charts, Estimation of Control Limits, Effect of shift in mean of the process, O. C. curve for control charts, Interpretation of Patterns of Variation on variable control Charts. **Control Charts for Attributes:** Advantages and disadvantages, Estimation of control limits for p, c, np, u-Charts. **Process Capability Analysis:** Objectives of Analysis, Estimation of Process Capability, Process Capability Indices, Viz: Cp, Cpk, Cpm, and their Interpretation, Estimation of rework and scrap.	**CO4 / CO5**	**10**
05	**Acceptance Sampling:** **Concepts** and importance of sampling, economics of sampling inspection cost of inspection, break even quality. **Symbols and terms** used in relation to sampling plans. Lot-by-lot acceptance using single sampling plan, OC curves, sampling risk, AQL, LTPD, alpha and beta risk, construction of OC curve for given sampling plan, estimating alpha and beta risks for a given plan. Effect of; lot size, sample size, acceptance number, on producer's and customer's risk. **Design of sampling plans** for given sampling risks. Estimation of performance indices such as; Average outgoing Quality, the the AOQL, and Average total inspection etc. **Double sampling plans**, Grubb's tables for selection of plans, analysis of double sampling plans, Estimation of performance indices, minimizing average total inspection. **Use of ANSI/ASQC Z 1. 4 standards**, for attribute sampling plans switching	**CO6**	**08**

	procedure, for normal and tightened inspections. Use of Dodge - Romig sampling plans. Construction of OC curves. Estimation of average inspection, average sample number, sampling risks, etc. for single and double sampling plans selected for the standard plan. AOQL, and Average total inspection etc.		
06	**Reliability Engineering:** Introduction, Bathtub curve, causes of failure, concepts/definitions of reliability availability, maintainability. Computation of component reliability: failure rate, hazard rate, MTBF, MTTF etc. Reliability of series, parallel and standby systems configuration, redundancy. Product/component design analysis using FMECA and fault tree analysis	**CO7**	**05**

Term Work:

The Term Work shall consist of;

1. Minimum 2-3 experiments based Centre Limit Theorem, Sample size vs Accuracy of estimation, Control Charts and Process Capability Analysis etc.
2. Minimum of six assignments based on relevant topics in Course Contents.
3. Subject seminars:
    A. Based on topic from the course content, and
    B. Based on relevant advances/case studies available in the literature.

Text Books:

1. Quality Planning and Analysis - J. M. Juran, Frank M. Gryna - Tata McGraw Hill.
2. Fundamentals of Quality Control and Improvement – Amitava Mitra Pearson Education Inc.

References Books:

1. Quality control handbook by J. M. Juran, Frank M. Gryna - Tata McGraw Hill.
2. Statistical Quality Control - E. L. Grant, R. S. Leavenwort --- Tata McGraw Hill
3. Mechanical Reliability – L. S. Srinath.

Finite Element Analysis

(Credits Theory-03, Practical-01)

Course Code: PEC-PE-316 **Contact Hours: Th. 03, Pr. 02**

Course Objectives

Objective 01. To improve the problem solving ability using numerical method like FEA.

Objective 02. To understand and use the commercial finite element packages effectively through hands on practice during practical.

Course Outcomes

On successful completion of this module, students should be able to

PEC-PE-316.1 Identify mathematical model for solution of common engineering problems.

PEC-PE-316.2 Formulate simple problems into finite elements.

PEC-PE-316.3 Solve structural, thermal, fluid flow problems.

PEC-PE-316.4 Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.

PEC-PE-316.5 Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts

Articulation Matrix

	Name of Course	**PO**					**PSO**		
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
PEC-PE-316	**Finite Element Analysis**	**1**	**2**	**3**	**3**	**3**	**1**	**2**	**3**
PEC-PE-316.1	Identify mathematical model for solution of common engineering problems	1	2				1		
PEC-PE-316.2	Formulate simple problems into finite elements.		2	3	2		1		
PEC-PE-316.3	Solve structural, thermal, fluid flow problems.	1						2	
PEC-PE-316.4	Use professional-level finite element software to solve Engineering Problems in Solid mechanics, fluid mechanics and heat transfer.					3			3
PEC-PE-316.5	Derive Element Matrix Equation by different methods by applying basic laws in mechanics and integration by parts	1	2	3	3		1		

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	CO	Hrs.
01	**Fundamental Concept Of FEM:** Introduction, History background, stresses & equilibrium boundary conditions, strain displacement relations, stress – strain relations, temperature, effects, Variational approach solution techniques	**CO1**	**06**
02	**Description of The Method:** Step wise procedure of Finite element method, Variational techniques for derivation of finite element equations, assembly procedure, solution methods.	**CO1**	**08**
03	**FEA of One Dimensional Problems:** Introduction, finite element modelling, shape functions, variational approach, weighted residual approach, Assembly of finite element equations, Higher- order element, Boundary conditions, Temperature effects.	**CO2 / CO4**	**10**
04	**FEA of Two Dimensional Problems:** Introduction, FE modelling, formulation of constant strain triangular element, problem modelling& boundary conditions.	**CO2**	**08**
05	**Pre-processor and Post Processors:** Introduction, Mesh Generation, post processing, requirements of a pre-processor and post processor, pre-processor and post processors in analysis software.	**CO5**	**08**
06	**Introduction to FEA Software** like ANSYS, NASTRAN, COSMOS-WORKS. Applications of FEA To Heat Transfer and Sheet Metal Forming.	**CO4**	**08**

Term Work

The term work shall consist of the following assignments, using ANSYS, Nastran, Hyper-mesh and other analysis softwares.

1. Assignment on mesh generation for different geometries

2. Assignment on static structural analysis.
3. Assignment on steady state thermal analysis
4. Assignment on thermo-structural analysis

Term Work

It shall consist of tutorial and case presentation based on the syllabus.

Text Books

1. Introduction to Finite Element Method in Engineering by S. S. Rao, Butterworth Heinmann Publication.

Reference Books

1. Finite Element Procedures by Bathe K. J., Prentice Hall of India, New Delhi.
2. Finite Element Analyisby S.S. Bhavikatti ., New Age international Publishers, New Delhi.
3. ANSYS & other software manuals.

Product Design and Development

(Credits Theory-03, Practical-01)

Course Code: PEC-PE-317 **Contact Hours: Th. 03, Pr. 02**

Course Objective

The course is aimed to appreciate the design and development as the central activity for the product utility view point. The general objectives for the course are

Objective 01. To provide the realistic understanding of the design process.

Objective 02. To develop the attitude and approaches towards product development than merely presentencing design techniques.

Objective 03. To understand modern tools and methods like collaborative practices, internet based design, PLM in context of product development.

Objective 04. To study example case studies to learn from the implemented practices for product design and development.

Course Outcomes

PEC-PE-317.1 Employ engineering principles to execute a design from concept to finished product.

PEC-PE-317.2 Select the optimum material and manufacturing process for a given component under a set of given working condition.

PEC-PE-317.3 Recommend a substitute material and/or a process for making a component in order to improve its performance, cost or other attributes under a given set of service conditions.

PEC-PE-317.4 Demonstrate design and development of the product, the associated manufacturing equipment and processes, and the repair tools and processes using concurrent engineering.

PEC-PE-317.5 Realize concept of PDM and PLM.

Articulation Matrix

	Name of Course	**PO**					**PSO**		
		1	**3**	**4**	**5**	**7**	**1**	**2**	**3**
PEC-PE-317	**Product design and Development**	**1**	**3**	**3**	**3**	**3**	**1**	**2**	**3**
PEC-PE-317.1	Employ engineering principles to execute a design from concept to finished product.	1					1		
PEC-PE-317.2	Select the optimum material and manufacturing process for a given component under a set of given working condition.		3	3			1		

	Name of Course	PO					PSO		
		1	3	4	5	7	1	2	3
PEC-PE-317.3	Recommend a substitute material and/or a process for making a component in order to improve its performance, cost or other attributes under a given set of service conditions.	1			2			2	
PEC-PE-317.4	Demonstrate design and development of the product, the associated manufacturing equipment and processes, and the repair tools and processes using concurrent engineering.		3			3		2	
PEC-PE-317.5	Realize concept of PDM and PLM.				3		1		3

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	CO	Hrs.
01	**Introduction:** Engineering design, Process and purpose of design, Types of design, importance of design, morphology of design, design considerations.	**CO1**	**06**
02	**Product Design Process:** Steps in design: need identification & problem definition, Functional requirement analysis, defining a product development team, gathering information, concept generation & evaluation, organization for design, product specification and detailed design.	**CO1**	**10**
03	**Material And Manufacturing Process Selection In Design:** Factors influencing material and process selection, approaches, tools and software used in selection.	**CO2**	**06**
04	**Development of Design:** Concept to product, design for: function, manufacture/production, shipping, handling, installation, use, maintenance etc.	**CO3**	**10**

05	**Design Cost Evaluation:** Need, methods, design to cost and life cycle, economics and financial feasibility, costing and use of software for estimation.	**CO4**	**08**
06	**Product Development Approaches**: Concurrent engineering, partnership with supplier, collaborative and Internet based design. **Design Project Management:** PDM, PLM and related software tools. Case studies based on Concurrent and collaborative product development approaches, Modular product design, mechanical and electronic products design.	**CO5**	**08**

Term Work

It shall consist of tutorial and case presentation based on the syllabus.

Text Books

1. Engineering Design by Dieter George E. McGraw Hill Pub. Company, 2008.
2. Product design and development by Ulrich Karl T and Eppinger Steven D., McGraw Hill Pub. Company 1995.
3. Product Design and Manufacture by Chitale AK and Gupta RC, Prentice-Hall of India, New Delhi
4. Fundamentals of Design and manufacturing, GK Lal, Vijay Gupta, N Venkata Reddy, Narosa Publications, 2006

Reference Book

1. Handbook of Product Design for Manufacturing, Bralla, James G., McGraw Hill Pub 1986
2. Design for X, G. Q. Huang, Chapman & Hall, 1996.

Plastics and Composite

(Credits Theory-03, Practica-l01)

Course Code: PEC-PE-318 **Contact Hours: Th. 03, Pr. 02**

Course Objectives:

Objective 1. To create awareness about composites/plastics as an alternative material.

Objective 2. To provide information about composites, its manufacture, applications.

Objective 3. To provide knowledge of design of composite for a particular application.

Course Outcomes:

At the end of course students will able to;

PEC-PE-318.1 Apply the basic principles of plastics on materials

PEC-PE-318.2 Application of composite materials on various materials.

PEC-PE-318.3 Analyse the different properties of composite lamina and laminate.

PEC-PE-318.4 Interpret the manufacturing method for plastics and composite materials

PEC-PE-318.5 Carry out various tests of composites as per test standards.

Articulation Matrix

	Name of Course	**PO**			**PSO**		
		1	**2**	**3**	**1**	**2**	**3**
	Elective -Plastic and composites	3	2	2	3	3	2
PEC-PE-318	Apply the basic principles of plastics on materials	3	2	1	3	2	1
PEC-PE318.1	Application of composite materials on various materials.	3	2	1	3	2	1
PEC-PE318.2	Analyze the different properties of composite lamina and laminate.	3	1	2	1	3	2
PEC-PE318.3	Interpret the manufacturing method for plastics and composite materials	1	2	2	1		
PEC-PE318.4	Carry out various tests of composites as per test standards.		1	2	1	2	

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Term work/Practical	Continuous Evaluation	50 Marks
	External Viva-voce	50 Marks

Course contents

Unit	Description	CO Covered	Hrs.
01	**Plastic Materials** Introduction, Structure and mechanical properties of plastics, types of plastics-thermoplastics and thermosets, Processing of Plastics, Extrusion, Injection moulding, Thermoforming, Compression moulding, Transfer moulding, General behaviour of polymer melts, Machining of plastics.	**CO1**	**06**
02	**Introduction to Composite Materials** Definition, Classification and characteristics, mechanical behaviour of composite materials, Types of matrices material and, reinforcements, Fibre composites, laminated composites-terminology, manufacturing, applications of composite materials.	**CO2**	**06**
03	**Macro Mechanics of A Lamina** Introduction, stress strain relation for anisotropic materials, stiffnesses, compliances, and engineering constants for orthotropic materials. restrictions of engineering constants, stress strain relation for plane stress in an orthotropic materials, stress train relation for an arbitrary orientation, Invariant properties of a orthotropic lamina, strength of an orthotropic lamina, Numerical problems.	**CO3**	**10**
04	**Macro Mechanical Behaviour of A Laminate** Introduction, classical lamination theory, special cases of laminate stiffnesses-single layered configurations, symmetric, anti-symmetric laminates. Strength of laminates.	**CO3**	**08**
05	**Manufacturing of Plastics /Composites** Layup and curing - open and closed mould processing, Hand layup techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance,	**CO4**	**06**

	Introduction.		
06	**Testing of Composites** Material qualification, Types of defects, NDT methods.	**CO5**	**04**

Term Work

Minimum of one assignment is mandatory from each unit.

Text Books

1. Composite Materials handbook, Mein Schwartz McGraw Hill Book Company, 1984.

2. Mechanics of composite materials, Autar K. Kaw CRC Press New York.

Reference Books

1. Fundamentals of Polymer Engineering, Anil Kumar, Rakesh K. Gupta, CRC Press, 2003.

2. Mechanics of Composite Materials, Rober M. Jones, McGraw Hill Kogakusha Ltd. 1975

3. Stress analysis of fibre Reinforced Composite Materials, Michael W, Hyer MGH International.

4. Composite Material Science and Engineering, Krishan K. Chawla Springer.

Renewable Energy Sources

(Credits Theory-03, Practical-01)

Course Code: PEC-PE-319 **Contact Hours: Th. 03 Pr. 02**

Course Objectives

Objective 01. To study energy generation, different energy sources and their utilization and impact on environment

Objective 02. To gain knowledge of solar radiation and its applications

Objective 03. To understand the wind energy and its nature.

Objective 04. To analyze the performance of solar collectors and wind turbines.

Objective 05. To learn fuel cell and its efficiency.

Course Outcomes

On successful completion of this module, students should be able to

PEC-PE-319.1 Interpret energy reserves of India and potential of different energy sources.

PEC-PE-319.2 Measure the solar radiation parameters and performance of different solar collectors.

PEC-PE-319.3 Calculate different parameters of wind turbine rotor.

PEC-PE-319.4 Implicit the importance and applications of geothermal and ocean energy.

PEC-PE-319.5 Demonstrate knowledge in field of fuel cell and potential for power generation.

Articulation Matrix

CO	Name of Course	PO					PSO		
		1	2	3	4	5	1	2	3
PEC-PE-319	Renewable Energy Sources	1	2	3	2	1	1	2	3
PEC-PE-319.1	Interpret energy reserves of India and potential of different energy sources.	1				1	1		
PEC-PE-319.2	Measure the solar radiation parameters and performance of different solar collectors.	2		3			1		
PEC-PE-319.3	Calculate different parameters of wind turbine rotor.			3	2			2	
PEC-PE-319.4	Implicit the importance and applications of geothermal and ocean energy.	1				2	1		
PEC-PE-319.5	Demonstrate knowledge in field of fuel cell and potential for power generation.	1				3	1		

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	CO	Hrs.
01	**Energy Resources and Utilization** : Conservation and forms of energy, energy reserves in India, nuclear power, hydroelectric power potential, India's power scene, renewable energy sources, energy parameters, cogeneration, rational energy use of energy, energy efficiency and conservation, new technologies, distributed energy systems and dispersed generation.	**CO1**	**04**
02	**Environmental aspects of electric energy generation** : Atmospheric pollution, hydrocarbons, particulates, thermal pollution, hydroelectric projects, operational phase of hydro power projects, operational safety in nuclear power plants, disposal of nuclear waste, global environmental awareness, impact of renewable energy generation on environment, GHG emissions from various energy sources, cost of electricity production from different energy sources, electromagnetic radiation from high voltage overhead lines, energy options for Indian economy.	**CO1**	**05**
03	**Solar radiation and measurement** : Solar constant, spectral distribution of extraterrestrial radiation, terrestrial solar radiation, solar radiation geometry, computation of COSθ, sunrise, sunset, day length, LAT, Empirical equation of for estimating the availability of solar radiation, solar radiation measurement and Solar radiation data for India.	**CO2**	**06**
04	**Solar collector and applications** : Solar Thermal energy collectors, design parameters, analysis, performance, laws of thermal radiation, radiation heat transfer between real bodies, radiation optics, transitivity, heat losses and coefficient, Solar Thermal energy storage. Solar thermal energy conservation systems - Solar water heating, solar distillation, thermodynamic cycles and power plants, solar ponds, solar pumping system,	**CO2**	**07**

	solar cooker, solar passive technologies, solar furnace, solar green house		
05	**Solar photovoltaic systems** : Photovoltaic effect, solar photovoltaic system, materials for solar cells, characteristics, efficiency, applications PV system, plastic solar cell with nanotechnology, peltier cooling, solar photovoltaic in India, JNNSM	**CO2**	**04**
06	**Wind energy** : Classification, types of rotors, terminology, operation of wind turbines, wind energy extraction, wind characteristics, wind speed, energy estimation, power density duration curve, density function, field data analysis, direction and wind speed, variation of wind speed, wind scale, energy pattern factor in wind power studies, land for wind energy, design of wind turbine rotor, regulating system, wind power generation curve, horizontal axis wind turbine generator, modes of wind power generation, advantages and disadvantages. Wind energy farms.	**CO3**	**06**
07	**Ocean Energy** : Tidal Energy, Tidal characteristics, Tidal Energy estimation, Development of a tidal power scheme, Yearly power generation from Tidal Plants, Economics of Tidal Power, Wave energy-characteristics-energy and power from the waves, wave energy conversion devices.	**CO4**	**05**
08	**Geothermal energy**: Structure of earth's interior, sites, field, gradient, resources, power generation, geothermal resources in India, utilization, global status of electricity generation from geothermal resources, advantages of geothermal energy.	**CO4**	**05**
09	**Fuel Cells** : Principle of operation of an acidic Fuel Cell, Technical parameter, Fuel Processor, methanol fuel cell, fuel cell types, Advantages of fuel cell power plants, fuel cell battery powered bus system, comparison between acidic and alkaline hydrogen-oxygen fuel cells, state of art fuel cells, energy output of a fuel cell, efficiency and EMF of a fuel cell, Gibbs-Helmholtz equation, hydrogen fuel cell analysis with thermodynamic potentials, comparison of electrolysis and the fuel cell process, operating characteristics of fuel cells, thermal efficiency, future potential. Hybrid Energy Systems : Need for hybrid systems, types, electric and hybrid electric vehicles, hydrogen powered electric vehicle	**CO5**	**06**

Term Work

It shall consist of assignments and case presentation based on the syllabus.

Text Books

1. D.P.Kothari, K.C.Singal and Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, Prentice Hall of India, New Delhi, 2009

Reference Books

1. Chetan Singh Solanki, “Renewable Energy Technologies”, Prentice Hall of India, New Delhi, 2009
2. G. D. Rai, “Non- conventional Energy Sources”, Khanna publishers, New Delhi, 2011.
3. Malti Goel, “Energy Souces and Global Warming”, allied publishers Pvt Ltd. New Delhi, 2005.
4. S.P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, TMH, New Delhi, 2008.

Mechatronics

(Credits Theory-03, Practical-01)

Course Code: PEC-PE-320 **Contact Hours: Th. 03, Pr. 02**

Course Objectives:

Objective 01. To impart knowledge about Mechatronics system and its elements.

Objective 02. To study techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Objective 03. To study the hydraulic, pneumatic and other actuation systems employed in manufacturing industry.

Objective 04. To reinforce analytical skills already learned, and use these skills to in analysing and designing Mechatronic systems.

Course Outcomes:

PEC-PE-320.1. Demonstrate how Mechatronics integrates knowledge from different disciplines in order to realize engineering and consumer products that are useful in everyday life.

PEC-PE-320.2. To acquire knowledge about mechatronics system.

PEC-PE-320.3. Application of theoretical knowledge: understanding selection of suitable sensors and actuators.

PEC-PE-320.4. Interpret the basics of system models (System building blocks, Engineering systems, Dynamic responses of systems)

PEC-PE-320.5. To have the knowledge of controllers.

PEC-PE-320.6. Design Mechatronics component, system or process to meet desired needs.

Articulation Matrix

	Name of Course	**PO**							**PSO**		
		1	**2**	**3**	**4**	**5**	**6**	**7**	**1**	**2**	**3**
PEC-PE-320	**Mechatronics**										
PEC-PE-320.1	Demonstrate how Mechatronics integrates knowledge from different disciplines	3	1				2	2			1
PEC-PE-320.2	To acquire knowledge about mechatronics system.						2	2	1	1	
PEC-PE-320.3	Application of theoretical knowledge	2	1			1			2		
PEC-PE-320.4	Interpret the basics of system models	2		2	1				1		
PEC-PE-320.5	To have the knowledge of controllers.										
PEC-PE-320.6	Design Mechatronics component	2		3				1			1

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	CO Covered	Hrs
01	**Introduction:** Mechatronics, The design process, Systems, Programmable logic controller, Examples of Mechatronics systems.	**CO1/ CO2**	**02**
02	**Sensors and Transducers**: Definition, terminology, types of sensors (displacement, position and proximity, velocity and motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors) selection of sensors, problems.	**CO3**	**06**
03	**Signal Conditioning:** Introduction, operational amplifier, protection, filtering, Wheatstone bridge, digital signals, multiplexers, data acquisition, digital signal processing, pulse modulation, problems.	**CO3**	**06**
04	**Pneumatic and hydraulic actuation systems:** Actuation systems, Pneumatic and hydraulic systems, Directional control valves, pressure control valves, cylinders, process control valves, Rotary actuators.	**CO3**	**08**
05	**Basic System Models:** Mathematical models, mechanical system building blocks, electrical system building blocks, Fluid system building blocks, thermal system building blocks.	**CO4**	**04**
06	**System Models:** Mechanical translational and rotational systems, electrochemical, hydro-mechanical systems.	**CO4**	**04**
07	**Dynamic Responses of Systems:** Modelling dynamic systems, first-order systems, second-order systems, performance measures for second-order systems.	**CO4**	**04**
08	**Controllers:** Continuous and discrete processes, control modes, two-step mode, proportional mode, derivation control, integral control, PID	**CO5/ CO6**	**06**

	controller, digital controllers, control system performance.		

Term Work:

Students shall conduct following activities in group and prepare report of about 5 pages for each activity:

a. Prepare a list of mechatronics devices with specifications available nearby.

b. Prepare power point presentation or animation for understanding working of different sensors, actuators, PLC and transducers.

c. Prepare a report on use of mechatronics elements in washing machine, lift, ATM, etc.

Text Books:

Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, W. Bolton, Pearson Education Asia, (1999)

Reference Books:

1. Introduction to Mechatronics and Measurement Systems, D. G. Alciatore and M. B. Histand, Tata McGraw& Hill (2003)
2. Mechatronics (HMT), Tata McGraw Hill (1998).

Automobile Engineering

(Credits Theory-03, Practical-01)

Course Code: PEC-PE-321 **Contact Hours: Th. 03, Pr. 02**

Course Objectives

Objective 01. To make student capable of applying knowledge and skill to design, analyse and evaluate mechanical and automotive engineering systems.

Objective 02. To make student capable of identifying and solving engineering problems systematically, critically, creatively and analytically.

Objective 03. To help student to become competent, possess leadership qualities and be able to act professionally in the field of mechanical and automotive engineering.

Course Outcomes

On successful completion of this module, students should be able to

PEC-PE-321.1 Identify the main components of automobiles and its classification.

PEC-PE-321.2 Define the function of the clutches in automobile.

PEC-PE-321.3 Compare between the manual transmission and automatic transmission system in automobile.

PEC-PE-321.4 Describe the steering geometry and steering system forces and different types of brakes, wheel and tries.

PEC-PE-321.5 Acquire knowledge of various suspension types and methods of analysis to determine their essential properties.

PEC-PE-321.6 Explain the working principle of electrical and electronics accessories used in Automobile.

Articulation Matrix

	Name of Course	**PO**					**PSO**		
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
PEC-PE-321	**Automobile Engineering**								
PEC-PE-321.1	Identify the main components of automobiles and its classification.	1					1	2	
PEC-PE-321.2	Define the function of the clutches in automobile.		2	3			1	2	
PEC-PE-321.3	Compare between the manual transmission and automatic transmission system in automobile.	1		3				2	
PEC-PE-321.4	Describe the steering geometry and steering system forces and different types of brakes, wheel and tries.	1	2		4		1	2	3

PEC-PE-321.5	Acquire knowledge of various suspension types and methods of analysis to determine their essential properties.	1	2	3	4		1	2	3
PEC-PE-321.6	Explain the working principle of electrical and electronics accessories used in Automobile.			3					

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	CO Covered	Hrs
01	**Introduction:** History of automobiles, classification, vehicle specifications, chassis layout, main components of automobiles	**CO1**	**06**
02	**Engine And Transmission:** Main components of engine, Power requirements, Clutches: single and multiple plate clutch, diaphragm clutch, electro-magnetic clutch, overrunning clutch, fluid couplings, torque convertors, clutch linkages, Gear box, speed selection, sliding mesh, constant mesh, synchro mesh types, gear shift mechanisms, epicyclic and automatic transmission, Universal joint, Constant velocity joint, Propeller shaft, Slip joint, Hotchkiss drive, Differential	**CO2/ CO3**	**08**
03	**Brakes, Wheels And Tyres:** Need of brakes, types: mechanical, hydraulic, pneumatic, vacuum brakes, Drum and Disc brakes, their relative merits, Power brakes, **Brake components:** Master cylinder, wheel cylinder, brake actuating linkages, Wheel types and their relative merits, wheel balancing, Specifications of tyres, construction details and materials, tyre wear.	**CO4**	**06**
04	**Steering System:** Introduction, Steering linkages, Steering geometry - toe in, toe out, camber, caster angles, kingpin inclination, wheel alignment, Steering system forces and moments, Power Steering, Steer by wire	**CO4**	**06**

05	**Suspension System:** Solid axle suspension, Independent suspension, Suspension geometry, Roll centre analysis, Active suspensions	**CO5**	**06**
06	**Vehicle Dynamics:** Introduction to vehicle dynamics, fundamental approach to modelling, Aerodynamics, Rolling resistance, Total road loads, Excitation sources of vehicle ride vibrations, Vehicle response properties, perception of ride power limited and traction limited performance of automobile for acceleration, braking, hill climbing, etc.	**CO3**	**08**
07	**Electrical And Electronic Systems:** Generators, Alternators, Principle and operation of cut-out and regulators, Starter motors, Bendix drive, Solenoid drive, Lighting and electrical accessories, Panel board instruments, Air conditioning, Power windows, Central locking, Multi-point fuel injection, Introduction to electronic control systems **Vehicle Testing:** Need, Testing standards, Different vehicle tests	**CO6**	**08**

Term Work

1. Study of Chassis Layout of a commercially available vehicle
2. Study of a type of braking system including testing and trouble shooting
3. Demonstration of steering system, measurement of steering geometry to understand its impact on vehicle performance
4. Study of one type of suspension system
5. Study of King pin inclination, Camber, Castor, Toe in / out, Scrub radius, etc. for a commercially available vehicle
6. Study of Engine with all subsystems of a commercially available vehicle
7. Study of complete transmission system of a commercially available vehicle
8. Study of Electrical / Electronic system of a commercially available vehicle

Text Books

1. Automobile Engineering (Vol. I & II) by Dr. Kirpal Singh, Standard Publishers
2. Fundamentals of Vehicle Dynamics by Thomas Gillespie

Reference Books

1. Automotive Technology by H. M. Sethi
2. Automobile Mechanics by W. H. Crouse, McGraw Hill Publishing Co.
3. Magazines like Automotive Engineering International, Overdrive, Auto India, etc.

Object Oriented Programming

(Credits:Theory-03, Practical-01)

Course Code: PEC-PE-322 **Contact Hours: Th. 03, Pr. 02**

Course Objectives

Objective 01. To get acquainted with the OOP concepts.

Objective 02. To learn C++/C#/Java programming language.

Objective 03. To develop skills of working in complex software projects.

Course Outcomes

On successful completion of this module, students should be able to

PEC-PE-322.1 Demonstrate programming skills using C++/C#/Java programming language.

PEC-PE-322.2 Collect, understand, analyze and document the software development requirements.

PEC-PE-322.3 Design and develop algorithms for software.

PEC-PE-322.4 Implement/apply OOP concepts in complex software development.

Articulation Matrix

	Name of Course	**PO**							**PSO**		
		1	**2**	**3**	**5**	**8**	**9**	**10**	**1**	**2**	**3**
PEC-PE-322	**Object Oriented Programming**	**1**	**2**	**3**	**3**	**1**	**1**	**1**	**2**	**1**	**3**
PEC-PE-322.1	Demonstrate programming skills using C++/C#/Java programming language.		2	1	3			2	1		2
PEC-PE-322.2	Collect, understand, analyze and document the software development requirements.			1		1	1	2		2	1
PEC-PE-322.3	Design and develop algorithms for software.		1	3	2			2		1	1
PEC-PE-322.4	Implement/apply OOP concepts in complex software development.		1	2	1	1	2	2		2	3

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce	50 Marks

Course Content

Unit	Description	CO Covered	Hrs
01	**OOP concepts and overview:** Object oriented programming concepts and programming in C/C++/C#/Java; Requirements engineering and Computer based Software engineering.	**CO2, CO3**	**08**
02	**Classes and objects:** Classes, objects and basic Object-Oriented programming features (like encapsulation)	**CO1**	**06**
03	**Programming in OOP:** Algorithms/flowcharts, Decision making, loop controls, arrays, Functions, pointers	**CO1, CO3**	**10**
04	**Overloading, Inheritance and polymorphism**: Operator and function overloading, namespace and using struct and union, Inheritance: Generalization / Specialization of Object Modeling in C++; Polymorphism: Static and Dynamic Binding	**CO1**	**06**
05	**Templates and exceptions:** Type Casting and Exceptions : cast operators; Exceptions and standard exception classes, Templates and STL – Function and Class templates and using STL like containers, algorithms	**CO1**	**05**
06	**Programming applications development:** Algorithm and Program development for various topics in manufacturing planning and control, design and analysis, data structures, numerical methods, CAD/CAM, Costing and estimation, databases, computer graphics.	**CO1, CO2, CO3, CO4**	**10**

Term Work

The term work shall consist of programming assignments based on the above syllabus.

Reference Books

1. E. Balagurusamy, Programming in C++, 4th ed., New Delhi: McGraw Hill Education (India) Private Limited, 2015

2. S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, 6th ed., New York: McGraw Hill Companies Inc., 2010

3. Y. Kanetkar, Let us C++, 2nd ed., New Delhi: BPB Publications, 2017

4. E. Balagurusamy, Programming in Java, New Delhi: McGraw Hill Education (India) Private Limited.

Maintenance Management

(Credits:Theory-03, Practical-01)

Course Code: PEC-PE-323 **Contact Hours: Th. 03, Pr. 02**

Course Objectives

Objective 01. To make students aware of various basic aspects related to maintenance and its management in the industry.

Objective 02. To understand problems based techniques related with maintenance, replacement of machines, etc

Course Outcomes

On successful completion of this module, students should be able to

PEC-PE-323.1 To discuss wear and theories of failure.

PEC-PE-323.2 To suggest maintenance schemes.

PEC-PE-323.3 To demonstrate the skills related to life cycle costing and condition based monitoring.

PEC-PE-323.4 To understand various aspects of maintenance in practical situations.

PEC-PE-323.5 To identify various types of defects in working of different types of machines.

PEC-PE-323.6 To use different fault diagnostic tools like thermography, oil analysis, Vibration monitoring, etc

Articulation Matrix

CO	Name of Course	PO					PSO		
		1	**2**	**3**	**4**	**5**	**1**	**2**	**3**
PEC-PE-323	Maintenance Management	1	2	3	4	5	1	2	3
PEC-PE-323.1	To discuss wear and theories of failure.	1	2					2	
PEC-PE-323.2	To suggest maintenance schemes	1				2	1		
PEC-PE-323.3	To demonstrate the skills related to life cycle costing and condition based monitoring.	1		3				2	
PEC-PE-323.4	To understand various aspects of maintenance in practical situations			3	2		1		
PEC-PE-323.5	To identify various types of defects in working of different types of machines.		2		3			2	
PEC-PE-323.6	To use different fault diagnostic tools like thermography, oil analysis, Vibration monitoring etc.		2		2	2			3

Evaluation Scheme

Theory	Teacher Evaluation Component	20 Marks
	Mid Term Examination	30 Marks
	End Term Examination	50 Marks
Practical	Continuous Evaluation	50 Marks
	Internal /External Viva-voce Based on assignments/Case study/Practical.	50 Marks

Course Content

Unit	Description	CO Covered	Hrs
01	Introduction, Objectives, economic aspect of maintenance, planning of maintenance work optimum degree of maintenance efforts, types of failure probability distribution and their significance in formation of maintenance policy.	**CO2**	**02**
02	Lubrication: Introduction to lubrication engineering, type, classification of lubricants with their properties and characteristics.Science of friction and wear; theories of lubrication; Bearing lubrication technique for minimization of friction and wear.	**CO1**	**02**
03	Wear: Theories of wear – Wear –fundamentals, Different types of wear, such as abrasive, corrosive, seizure, scoring, scuffing, pitting, spalling, adhesive, etc. and techniques for minimization of wear with examples.	**CO1 / CO2**	**02**
04	Maintenance Systems: Break down maintenance, routine maintenance, planned maintenance, preventive maintenance, predictive maintenance, corrective maintenance, design out maintenance, proactive maintenance, and Reliability Centered Maintenance. Total Productive Maintenance: Organization, merits and demerits.	**CO2 / CO5**	**05**
05	Defect/failure generation and analysis Basics of failure, failure generation, and fault tree analysis, ETA, RCA, failure mode and effects analysis. Reliability: Definition and basic concepts; Failure data, failure modes, and reliability in terms of hazard rate and failure density function; Hazard models and bath tub curve; applicability of Weibull distribution. Reliability calculations for series, parallel and parallel-series systems.	**CO1 / CO5**	**07**

06	Condition monitoring Condition signals and monitoring, condition monitoring techniques like performance, visual, temperature, vibration, lubricant, leakage, crack, corrosion, noise/sound monitoring, SOAP, etc. Non-destructive testing as an aid to maintenance, principle methods, such as dye-penetrant, magnetic particle testing and ultrasonic tests, Tero-technological approach to maintenance.	**CO6**	**08**
07	Replacement analysis: Introduction, reasons for replacement, factors affecting replacement methods used for selecting alternatives, cost comparison for replacement analysis considering inflation and technological advancements, present worth method, Annual cost method, rate of return method, depreciation method, life average method etc.	**CO3**	**07**

Term Work

Minimum eight assignments based on the above syllabus.

Reference Books

1. Production Planning Control & Industrial Management. - K.C.Jain & L.N. Aggarwal.
2. Maintenance engineering and management –sushil kumar srivastav (chand)
3. Production and operation Management - Nair (TMH)
4. Production and operation Management – S N chary(TMH)
5. Production hand book - IVth Edition (Willey)
6. Fundamentals of Production Systems and Engineering. - Sekhan & A.S.Sachdeva.
7. Production Management - Lallan Prasad & A.M. Banerjee
8. Singh and C.S. Dhillon, “Engineering Relaibility-New Techniques and Applications”,John Wiley and Sons, Tata McGraw Hill Publishing Company Limited, New Delhi.
9. Industrial Engineering and Management - O.P. Khanna
10. Industrial Organization and Engineering Economics-T.R.Banga & S.C.Sharma.