Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi Collegeof Engineering

Scheme and detailed syllabus (DJ19)

Third Year B.Tech

in

Production Engineering

(Semester V and VI)

(Autonomous College Affiliated to the University of Mumbai)

Scheme for Third Year Undergraduate Program in Production Engineering : Semester V (Autonomous)
(Academic Year 2021-2022)

sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)								Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration	Theory	Oral	Practical	Oral &Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Termwork			CA Total (B)				
																Laboratory Work	Tutorial / Mini project / Presentation	Term Work Total					
1	DJ19PEC501	Production Tooling.	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**4**	
	DJ19PEL501	Production Tooling Lab.	--	2	--	1	--	--	--	--	25	**25**	--	--	--	--	--	25	**25**	**50**	1		
2	DJ19PEC502	Design of Machine Elements.	3		--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**4**	
	DJ19PEL502	Design of Machine Elements Lab.	--	2	--	1	--	--	--	--	--	**--**	--	--	--	--	--	25	**25**	**25**	1		
3	DJ19PEC503	Machining Science and Technology.	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**4**	
	DJ19PEL503	Machining Science and Technology Lab.	--	2	--	1	--	--	--	--	--	**--**	--	--	--	--	--	25	**25**	**25**	1		
4	DJ19PEC504	Metrology & Quality Engineering.	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**4**	
	DJ19PEL504	Metrology & Quality Engineering Lab.	--	2	--	1	--	--	--	--	25	**25**	--	--	--	--	--	25	**25**	**50**	1		
5 @	DJ19PEDO5011	Thermal Engineering.	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**3**	
	DJ19PEDO5012	Plastic Engineering.																					
	DJ19PEDO5013	Industrial Robotics.																					
	DJ19PEDO5014	Sustainable Manufacturing.																					
	DJ19PEDO5015	Hydraulic Machinery.																					
6#	DJ19IHL2	Professional and Business Communication Lab.	--	4	--	2	--	--	--	--	--	**--**	--	--	--	--	--	**50**	**50**	**50**	2	2	
7	DJ19ILL1	Innovative Product Development-III	--	2	--	1	--	--	25	--	--	25	--	--	--	--	--	25	25	**50**	1	1	
			15	**14**	**0**	**22**	--	**375**	**25**	--	**50**	**450**	**125**	**125**	**125**	--	--	**175**	**300**	**750**	**22**		

@ Any 1 elective course

 # 2 hrs. of theory (class wise) and 2 hrs of activity based laboratory (batch wise)

Prepared by Checked by HOD, Principal

Scheme for Third Year Undergraduate Program in Production Engineering : Semester VI (Autonomous)
(Academic Year 2021-2022)

Sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)								Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration	Theory	Oral	Practical	Oral &Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Termwork			CA Total (B)				
																Laboratory Work	Tutorial / Mini project / Presentation	Term Work Total					
1	DJ19PEC601	Process Engineering	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**4**	
	DJ19PEL601	Process Engineering Lab.	--	2	--	1	--	--	25	--	--	**25**	--	--	--	--	--	25	**25**	**50**	1		
2	DJ19PEC602	Machine Tool Design	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**4**	
	DJ19PEL602	Machine Tool Design Lab.	--	2	--	1	--	--	25	--	--	**25**	--	--	--	--	--	25	**25**	**50**	1		
3	DJ19PEC603	Industrial Engineering	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**3**	
4	DJ19PEC604	Operations Research	3	--	--	3	--	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**3**	
5 @	DJ19PEDO6011	Internal Combustion Engineering	3	--	--	3	3	75	--	--	--	**75**	25	25	25	--	--	--	**25**	**100**	3	**3**	
	DJ19PEDO6012	Refrigeration & Air Condition																					
	DJ19PEDO6013	Rapid prototyping & Manufacturing																					
	DJ19PEDO6014	Logistics and Supply Chain Management																					
	DJ19PEDO6015	Maintenance Engineering.																					
6	DJ19PEL603	Additive Manufacturing Lab.	--	2	--	1	--	--	--	--	--	--	--	--	--	--	--	25	**25**	**25**	1	**1**	
7	DJ19PEL604	Data Analytics Lab.	--	2	--	1	--	--	--	--	--	--	--	--	--	--	--	25	**25**	**25**	1	**1**	
8	DJ19ILL2	Innovative Product Development-IV	--	2	--	1	2	--	--	--	25	**25**	--	--	--	--	--	25	25	**50**	1	1	
9	DJ19A5	Environmental Studies	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
			15	**10**	**0**	**21**	--	**375**	**50**	--	**25**	**450**	**125**	**125**	**125**	--	--	**125**	**250**	**700**	**20**		

@ Any 1 elective course

Prepared by Checked by HOD, Principal

<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : V</td></tr>
<tr><td colspan="8">Course : Production Tooling</td><td colspan="3">Course Code:DJ19PEC501</td></tr>
<tr><td colspan="8">Course: Production Tooling Lab</td><td colspan="3">Course Code: DJ19PEL501</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="3">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="5">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
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<tr><td>25</td><td>--</td><td>--</td><td>25</td><td>--</td><td>25</td></tr>
</table>

Objectives:

1. To acquaint with the concepts pertaining to planning and sequencing of operations.
2. To familiarize with the capabilities of designing simple, productive and cost effective jigs & fixtures.
3. To acquaint with the various press working operations for mass production of sheet metal components.
4. To familiarize with the sheet metal working techniques for design of press tools.

Outcomes: Learner will be able to…

1. Select location and clamping faces/points on jobs.
2. Design and develop simple productive and cost effective jigs & fixtures.
3. Identify press tool requirements to build concepts pertaining to design of press tools.
4. Prepare working drawings and setup for economic production of sheet metal components.
5. Demonstrate the principles of blank development in bent & drawn components.

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration**
01	**Introduction to Jigs and Fixture:** Introduction to Jigs and Fixtures, their difference and Significance. Material used for different elements of jigs/fixtures and recommended hardness where necessary. **Location & Locating Devices:** Locating principles, Degrees of freedom, Redundant location, Fool proofing and nesting. Locators: location from Flat and cylindrical surfaces, conical locators, centralizers. **Clamping & clamping Devices:** Clamping Principle, Examples of typical clamps such as multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic & hydraulic devices.	**08**
02	**Construction of Drill Jig** Introduction, Selection of location, supporting and clamping faces/points. Various types of Jig Bushes. Commonly used Drill jigs. Case Study on Drill Jig Design. **Construction of Milling fixture** Introduction, Selection of location, supporting and clamping faces/points. Tool setting &cutter guiding (Tenon's & Setting block). Case Study on Milling Fixture Design.	**12**
03	**Introduction to Press Working** Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. Theory of Shearing in Press Working. Optimum Cutting clearance, Construction of Basic shearing die. Functions of different elements of a press tool. Methods of feeding the strip/coil material.	**08**
04	**Design and Calculations for Piercing & Blanking Die** Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force. Recommending minimum tonnage of a press. Centre of Pressure (its importance and calculation). Design aspects of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Methods to reduce cutting loads on presses.Selection of materials and its hardness for different elements of Press tools.	**10**
05	**Bending & Drawing Dies** Theory of Bending. Spring back and measures to control it. Calculations for bending force & Blank development of Simple Bent components. Types of Bending dies. Minimum bend radius. Theory of Drawing. Metal flow in Drawing & forming operations. Blank development of Cylindrical Cup. Reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only.	**04**

Part A. List of Laboratory Experiments/ Design Exercises/Assignments:

1. Design of Simple Progressive Die with minimum three stages. (Assembly & BOM)
2. Design and drawing of Drill Jig (Assembly & BOM).
3. Design and drawing of Milling fixture (Assembly & BOM).
4. Assignment on design of jigs and fixtures.
5. Assignment on press tool design.

Part B. Industrial Visit

Detail reports of industrial visit based on syllabus, which would help the learner to understand topic/concept.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

The distribution of marks for term work shall be as follows:

3 Design/ Drawing sheets and 2 assignments	: 15 Marks.
Industrial visit report onProduction toolingpractices	: 05Marks
Attendance(Practical)	: 05Marks.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Books Recommended:

Text books:

1. *Production Engineering – P. C. Sharma, S. Chand & Co. Ltd., New Delhi.*
2. *Tool Design – C. Donaldson, LeCain&Goold, Tata McGraw Hill Co. Ltd., New Delhi.*
3. *Jigs and Fixtures - P. H. Joshi, Tata McGraw Hill Publishing Co. Ltd., New Delhi.*
4. *Introduction to Jig and Tool Design – M. H. A. Kempster, Edward Arnold publishers Ltd., London, UK.*
5. *Press Tools Design and Construction – P. H. Joshi, S. Chand & Co. Ltd., New Delhi.*

Reference Books:

1. *Jig and Fixture Design Manual - Erik K. Henrikson, Industrail Press, New York.*
2. *Non- Standards Calming Devices - Hiran E. Grant TMH, New Delhi.*
3. *Die Design Fundamentals – J. R. Paquin, Industrail Press, New York.*
4. *Techniques of Press Working Sheet Metal – Eary& Reed, Prentice Hall, New Jersey.*

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</table>

Objectives:

1. To prepare the students learn basic principles of engineeringdesign.
2. To familiarize the students with the concepts of strength design related to various components.
3. To acquaint the students use design data books & various codes ofpractices.

Outcomes: Learner will be able to…

1. Apply basic principles of machine design.
2. Design joints such as knuckle joint/turn buckle.
3. Design machine elements such keys, shafts, couplings/springs.
4. Design welded joint.
5. Design riveted/bolted joints.

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration**
01	1.1. Introduction - Steps involved in designing, types of designs, considerations in designing, Design−manufacturing interface, material selection, factor of safety and itsimplications. 1.2. **Operational Joints** - Introduction to cottered, pinned & threaded joints, & theirapplications. 1.3.Design of socket & spigottype 1.4.Design of Pinned Joints - Knucklejoint 1.5. Design of TurnBuckle	**10**
02	2.1 Determination of stresses in machine components with various cross sections. Circular, rectangular, triangular, trapezoidal, T & I sections subjected to direct & bending stresses. (Including stresses at critical sections) 2.2.Stressesincurvedmembers-Designofcranehooks&C-clampswith various cross sections (Circular, triangular, square, rectangular, trapezoidal) (Circular & oval rings to beexcluded).	**06**
03	**3.1. Design of shafts** 3.1.1. Design of shafts on the basis of strength. Shafts subjected to- bending alone, Torsion alone, combined action of torsion & bending, combined action of torsion & axial loads, combined actionoftorsion,bending&axialloads(Rankine'sandGuest's equations) 3.1.2. Concepts about design of shafts based on rigidity (lateral & torsional rigidity)- onlyImplications **3.2. Design of keys:** 3.2.1. Different types of keys andapplications. 3.2.2. Fitting of keys – types and effects of keyway onshaft 3.2.3. Stresses in keys and design of keydimensions. **3.3. Design ofcouplings:** 3.3.1 Classification of couplings & applicationareas. 3.3.2. Design of flanged couplings, muff couplings, bushed pin type Flexible coupling.	**10**
04	**4.1 Design of bolted joints**- stresses in bolts, joints for leak proof fluid tight applications (like cylinder to cylinder cover fastening in an IC engine), bolts of uniformstrength. **4.2 Design of riveted joints**- Type of rivets and riveted joints. Failure modes of riveted joints & efficiency of riveted joints. Design of riveted joints for riveting longitudinal & circumferential seams of pressure vessels. Familiarization of Indian Boiler Regulation(IBR) **4.3 Design of bolted and riveted joints** subjected to eccentricloading.	**08**
05	**5.1 Design of welded joints**- Types & classification of welded joints, applications.FamiliarizationofAWScode.Strengthofweldedjoints- Transverse & parallel fillet welds. Welded joints subjected totorsion– Circular fillet welds and adjacent fillet welds. **5.2** Design of welded joints subjected to eccentricloading. **5.3 Design of springs**: Classification and applications, design of helical compression and tension springs (only circular cross-section), co−axial springs. Design of leaf springs−straight and semi elliptical laminated leaf springs. Strain energy of springs−design of buffer springs	**08**

List of Design Exercises / Assignments:-

1. Design of Curved Beams
2. Design of Bolted, Welded and Riveted Joints
3. Design of springs.
4. Design of Socket and Spigot type Cotter Joint, Knuckle Joint, Turnbuckle (Any Two)
5. Design of Shafts (Two Design Problems)
6. Design of Rigid Flange Coupling, Bush Pin Type of Flexible Coupling.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

The distribution of marks for term work shall be as follows:

Assignments: 10Marks.

Design Exercises with Drawings on A4 size sheet: 15Marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

NOTE:

Use of standard design data books like PSG Data Book or Design Data by Mahadevan is permitted at the examination and shall be supplied by the college.

Reference Books:

1. *Design of machine elements -- V. B. Bhandari. Tara Mc-Graw HillPub.*
2. *Design of machine elements -- Sharma,Purohit. Prentice Hall IndiaPub.*
3. *Machine Design - An Integrated Approach -- Robert L. Norton –PearsonEducation.*
4. *Machine Design - Pandya & Shah- Charotar PI/blishing.*
5. *Mechanical Engineering Design - J. E. Shigley - McGrawHill*
6. *Recommended Data Books - PSG, K.Mahadevan*
7. *Machine Design - Reshetov - MirPublication*
8. *Machine Design - Black Adams-McgrawHill*
9. *Fundamentals of Machine Elements - Hawrock, Jacobson McgrawHill*
10. *Design of Machine Elements - V.M.Faires*
11. *Design of Machine Elements -Spotts.*

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<tr><td rowspan="2">03</td><td rowspan="2">02</td><td rowspan="2">-</td><td rowspan="2">04</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td colspan="2">Tutorial / Mini project / presentation/ Journal</td></tr>
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</table>

Objectives:

1. To familiarize with the basic concepts of machining science like mechanics of metal cutting, effect of process parameter, cutting force, stress and strain etc.
2. To familiarize with the methods of temperature measurement during machining
3. To impart the knowledge on selection and applications of cutting fluid.
4. To develop the knowledge about tool life, tool wear mechanism, and surface roughness.
5. To familiarize with process of finding economic state of machining process.
6. To familiarize with various single and multipoint cutting tools designing processes.

Outcomes: Learner will be able to…

1. Understand the theories and mechanics of metal cutting along with working principles of tool dynamometer and analyze the machining operation to compute various machining parameters and tool forces involved.
2. Understand heat generation and its implications while metal cutting. Also, get exposure to cutting coolants, their properties and selection.
3. Get exposure to different cutting tool materials and their selection to suit specific application requirements and work piece finish.
4. Comprehend failure modes of cutting tool, correlate and determine optimum process parameters to manage tool wear and tool life.
5. Understand the tool geometry, tool nomenclature and design aspects of simple single point and multipoint cutting tools.

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration**
01	**Theory of Metal cutting and Dynamometry:** Tool geometry, Machining analysis, Orthogonal and oblique cutting, types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's original & modified model for orthogonal cutting, Lee and Shaffer model. Dynamometry: types, working principle and construction details.	**12**
02	**Thermal aspects in metal cutting and cutting fluid:** Significance of measuring temperature at cutting zone, sources of heat generation and temperature distribution, effect of machining parameters on temperature, experimental determination of cutting zone temperature . Cutting Fluids: types, functions, characteristics of an efficient lubricant in metal cutting, selection and application methods of cutting fluid, cutting fluid maintenance and environmental considerations.	**04**
03	**Cutting tool materials and Surface Integrity**: Important properties, composition and applications of Major cutting tool materials: Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools. General characteristics of surface, factors affecting surface quality , Measurement and specification of surface finish, BUE formation and its influence on finish,	**06**
04	**Tool life and Economics of machining:** Tool life definition, effect of cutting parameters and tool geometry on tool life. Machinability and Machinability Index, tool failure, flank wear and crater wear, Taylor's tool life equation, Experimental methods to find Taylor exponents. Machining economics, Components of product cost, determination of Optimum cutting speed and optimum tool life for minimum production cost and maximum production rate criteria.	**10**
05	**Design aspects of single and multipoint cutting tools:** Different systems of tool nomenclature like MRS, ORS and NRS. Interrelationship among different systems of nomenclature for tool angles. Constructional features of solid tool, tipped tools, mechanically regrindable and throw away tip type tools. Design of shanks and chip breakers. ISO coding system for tipped tools and tool holders. Form Tools : Types, Constructional details, filed of applications and profile design (circular and flat form tool) Broach: Nomenclature, design of circular and key way broaches.	**10**

Termwork:

Part A. Assignments/Case Studies/Presentations:

1. Metal cutting theory and dynamometry.
2. Temperature measurement in metal cutting and cutting fluids.
3. Cutting tool materials
4. Tool life and Machining Economics
5. Case study on application of Taguchi Design of Experiments in Machining.

Part B. Design Exercise:

1. Design single point cutting tool.
2. Design of Circular form tools.
3. Design of Flat form tool
4. Design of circular broach

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

The distribution of marks for term work shall be as follows:

Laboratory work(Part A)	: 10Marks.
Laboratory work(Part B)	: 10Marks.
Attendance and laboratory performance(Practical)	: 05Marks.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Books Recommended:

Text Books:

1. *"Fundamentals of Machining and Machine Tools (3rd Edition)", by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group (2006).).*
2. *"Metal Cutting Principles (2nd Edition)", by Milton Clayton Shaw, Oxford University Press (2005).*
3. *"Metal Cutting Theory and Practices", by Amitabha Bhattacharya, central book publishers (2011).*
4. *"Production Technology", by Dr. P C Sharma, S. Chand Publications (2006)*
5. *"Workshop Technology (10th edition)", by B.S. Raghuwanshi , DhanpatRai publications (2012)*

Reference Books:

1. *"Cutting Tools", by P. H. Joshi, A. H. Wheeler Publishing Co. Ltd. (1991).*
2. *"ASM Handbook, Vol. 16: Machining (9th Edition)", by Joseph R. Davis, ASM International (1989).*
3. *"Fundamentals of Metal Cutting and Machine Tools (2nd Edition)", by B. L. Juneja, G. S.Sekhon and Nitin Seth, New Age International Pvt. Ltd. (2003).*
4. *"Metal Cutting Theory and Cutting Tool Design", by V. Arshinov and G. Alekseev, Mir publishers, Moscow (1976).*
5. *"Typical Examples and Problems in Metal Cutting and Tool Design", by N. Nefedov and K. Osipov, Mir publishers, Moscow (1986).*
6. *"Manufacturing Technology (2nd edition)", by P. N. Rao, TMH (2001).*
7. *"Manufacturing Science (2nd edition)"by Ghosh, A., Mallik, A.K., EastWest Press, 2010.*
8. *"Principles of Metal Cutting", by G.Kuppuswamy, Universities Press (2013)*

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Program: Third Year Production Engineering										Semester: V		
Course: Metrology And QualityEngineering										Course Code:DJ19PEC504		
Course: Metrology And Quality Engineering Lab.										Course Code:DJ19PEL504		
Teaching Scheme (Hours / week)				Evaluation Scheme								
				Semester End Examination Marks (A)			Continuous Assessment Marks (B)				Total marks (A+ B)	
Lectures	Practical	Tutorial	Total Credits	Theory			Term Test 1	Term Test 2		Avg.		
				75			25	25		25	100	
				Laboratory Examination			Term work			Total Term work	50	
3	2	-	5	Oral	Practical	Oral &Practical	Laboratory Work	Tutorial / Mini project / presentation/ Journal				
				10	15	25	15	10		25		

Objectives:

1. To acquaint with principles of precision measuring instruments & their significance.
2. To familiarize with the handling & use of precision measuring instruments/ equipment's.
3. To acquaint with key features and the basics of Total Quality Management philosophy.
4. To familiarize with various quality tools and their uses in solving problems.

Outcomes: Learner will be able to…

1. Design Go and No Go gauges for a given assembly.
2. Analyze simple machined components for dimensional stability & functionality.
3. Identify,Handle & operate precision measuring instruments / equipment's in/for various manufacturing.
4. Integrate quality approaches for productivity improvement.
5. Comprehend and apply Quality standards in different situations.

Module	Detailed Syllabus: (Unit wise)	
	Description	Duration
01	**Introduction toMetrology** Definition of Metrology. Scope of Engineering Metrology.Standards of Measurements. Static Characteristics of Measurements. **Limits, fits and Tolerances** Basic Definitions, Taylor's principle, Hole Basis and Shaft Basis System, Design of Go & No-Go gauges for Hole and Shaft using Tolerance Disposition Diagram (refer PSG Databook).	**06**
02	**Comparators**: Understanding of features and operation of mechanical, optical, electrical/electronic and pneumatic comparators, advantages, limitations and field ofApplications. **Principles of interference**, concept of flatness, flatness testing, opticalflats, optical Interferometer and laser interferometer. **Surface texture measurement**: Importance of surface conditions, roughness and waviness, surface roughness standards specifying surface roughness parameters-Ra, Ry, Rz, RMS value etc., surface roughness measuring instruments – Tomlinson and Taylor Hobson versions, surface roughnesssymbols	**08**
03	**Screw Thread measurement**: Two wire and three wire methods, floating carriagemicrometer. **Gear measurement:** Gear tooth comparator, measurement using rollers and Parkinson'sTester. **Special measuring Equipment:** Principles of measurement using Tool Maker'smicroscope,profileprojector&3Dcoordinatemeasuringmachine.	**08**
04	**Quality** Evolution of Quality, Definition of Quality, Dimensions of Quality Planning, principles of TQM, set up policy and objectives of quality control, quality ofdesign and quality of conformance, compromise between quality & cost, quality cost and planning for quality, Costs of Quality **Qualitystandards** a.The ISO9001:2000 Quality Management SystemStandard b.The ISO 14001:2004 Environmental Management SystemStandard	**10**
05	**SQC and SQC tools** **Process Data Collection & presentation** – Bar Chart, Histogram and RunCharts. **Process Variability** – variables & Process Variation (Measures of accuracy & Centering, precision or spread, normal distribution and samplingaverages). **Process Control by Variable** – using X bar and R Chart and control charts for standarddeviation. **Process Control by Attribute** - for number of defectives or non- conforming units - np-charts, p-charts, c-charts andu-charts **Process capability**, OC curve, acceptance sampling AQL, LTPD, AOQL, producers and consumers risk (Single & Double sampling plan only). (Note: Emphasize the explanation with Numericalproblems). **Sampling Techniques** Sampling inspection and basic concepts, OC curves, consumer & Producer risk, single & double sampling plans and use of samplingtables.	**10**

List of Laboratory Experiments:

1. Use of linear and angular measuring instruments
2. Use of Profile projector.
3. Use of comparator.
4. Measurement of surface roughness.
5. Measurement of flatness.
6. Thread measurement.
7. Gear measurement.
8. Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

The distribution of marks for term work shall be as follows:

Laboratory work(Part A) : 10Marks.
Laboratory work(Part B) : 10Marks.
Attendance and laboratory performance(Practical) : 05Marks.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiment/ programsandjournal): :10Marks.
Assignments::10Marks. Attendance (TheoryandPractical):
:05Marks.

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Books Recommended:

1. *Engineering Metrology, K. J. Hume, Kalyani publication*
2. *Engineering. Metrology, I.C. GUPTA, DhanpatRai Publications.*
3. *Statistical quality control, A.L. Grant, McGraw Hill International, New York.*
4. *Engineering. Metrology, R. K. Jain, Khanna Publisher.*
5. *Engineering. Metrology, Hume K.G., M C Donald, Technical &Scientific, London.*
6. *Quality Control and Industrial Statistics, Duncon A.J., D.B. Taraporevela& Co. Bombay.*
7. *Statistical quality Control, Mahajan M., DhanpatRai& Sons, Delhi.*
8. *Introduction to Statistical Quality Control, By Douglas C. Montgomery wileyindia publication*
9. *Quality control by D.H. Besterfield , Pearson education.*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : V</td></tr>
<tr><td colspan="8">Course: Thermal Engineering</td><td colspan="3">Course Code: DJ19PEDO5011</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="5">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="5">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Objectives:

1. To understand the working of various energy conversion units used in engineering practice.
2. To develop a problem solving approach and be able to apply in engineering practice.
3. To develop a body of knowledge in the field of Heat Transfer and its various modes.
4. To understand the engineering processes involved in power and refrigeration and air conditioning systems.

Outcomes: On completion of the course, learner will be able to:

1. Understand the working principle of Reciprocating Air Compressor and its applications.
2. Understand the working principle of Gas Turbines and its applications.
3. Understand the working principle, classification and various components of I. C. Engines.
4. Apply the knowledge of Heat Transfer in analyzing the various heat transfer equipment's.
5. Understand the working and applications of Refrigeration and Air conditioning systems.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	**Reciprocating Air Compressors**: Classification, Terminology, Work and power calculations with and without clearance for single and two stage compression, volumetric efficiency and FAD, Intercooling and advantages of Multistage compression.	**08**
02	**Gas Turbines:** Classification, Application, open cycle and closed cycle gas turbine. Calculation of thermal efficiency. Methods for improvements of thermal efficiency of gas turbine plants (Numericals only on calculating thermal efficiency and work ratio).	**08**
03	**I.C. Engines:** Classification, components of engines, 2 stroke and 4 stroke engine, SI & CI engine. Study of simple carburetor, fuel injection systems, ignition system, combustion process in SI and CI engines. Cooling and lubrication systems. Testing &Performance of IC engines and Heat Balance Sheet.	**08**
04	**Heat Transfer:** Modes of heat transfer, Fouriers Law of heat conduction Newtons law of cooling. Conduction: thermal conductivity, heat transfer coefficient(convective and overall), 1D steady state heat conduction through plane wall, composite wall, hollow cylinder and hollow sphere. Convection: Free and Forced convection. Radiation: Stefan Boltzman's Law, Kirchoff's Law, Weins law. Heat Exchangers: classification, LMTD (Numericals only on 1D conduction and calculation of LMTD).	**10**
05	**Refrigeration:** Applications of refrigeration, terminology, Bell Colemann cycle, Vapour compression refrigeration cycle. Calculations for COP, power capacity and mass flow rate. Vapour Absorption System (Ammonia water system) (Numericals only on VCR). **Air conditioning:** Properties of moist air, basic psychometric processes. Introduction to air conditioning, applications, comfort air conditioning, summer, winter and year round air conditioning system.	**08**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Text books:

1. *Thermal Engineering, by R. K. Rajput, LaxmiPublication.*
2. *Thermal Engineering, by Ballaney, Khanna Publication.*
3. *A Course in Thermal Engineering, by Domkundwar, Kothoraman and Khaju.*

Reference Books:

1. *Thermal Engineering, by Mahesh Rathore, Tata McGrawHill*
2. *Refrigeration and Air conditioning, by C.P. Arora, Tata McGraw HillPublications*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : V</td></tr>
<tr><td colspan="8">Course : Plastic Engineering</td><td colspan="3">Course Code: DJ19PEDO5012</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td>Total marks (A+ B)</td></tr>
<tr><td rowspan="2">Lectures</td><td rowspan="2">Practical</td><td rowspan="2">Tutorial</td><td rowspan="2">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td><td></td></tr>
<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td rowspan="3">03</td><td rowspan="3">--</td><td rowspan="3">--</td><td rowspan="3">03</td><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">--</td></tr>
<tr><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Objectives

1. To familiarize with the vast potential of plastics materials in domestic engineering and specialty application areas.
2. To familiarize with the various processing techniques.
3. To familiarize with the design of moulds and dies.

Outcomes: Learner will be able to:

1. Demonstrate applicability of plastics in place of conventional materials.
2. Design various tools for plastics processing.
3. Illustrate various plastic processing techniques.
4. Design different types of moulds with their application.
5. Demonstrate trouble shooting skills in manufacturing plastic parts.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	**Materials** Brief introduction to plastics materials, their classifications & types, Important properties of plastics & fields of application, Overview of additives for plastics processing & their significance, Introduction to plastics blends, alloys and composites, Principles of recycling of plastics and waste management.	**06**
02	**Processing Techniques.** Injection Moulding: Moulding materials, moulding cycle-phases, and significance. Molding machinery types, constructional and design features, plasticizing screw, injection and clamping units, Technical specifications and selection. Processing Techniques: Process parameters and their influence on product quality, troubleshooting. Compression Moulding - Moulding equipment, Moulding cycle, Material Bulk Factor - implications, Moulding Techniques- process parameters and their influence. Trouble shooting. Transfer Moulding: Integral Pot &Auxiliary Ram, Transfer processes, Techniques and comparison, process Parameters and their influence. Trouble shooting.	**06**
03	**Processing Techniques - Extrusion & Blow Moulding** **Extrusion Process**: Constructional and design features of extrusion machinery plasticizing screw. Technical specification and selection. Extrusion lines for pipes, Films (monolayer and multilayer, blown and cast films), sheets, Extrusion coating, monofilaments, box strapping, cables/wires and profiles. (Coverage for the above should include materials, plant layouts, in line equipment, extrusion techniques, process parameters and their influence on extruded products and trouble shooting). **Blow Moulding:**Materials for blow moulding, Types of Machinery, technical specifications and selection. (Extrusion Blow Moulding, Injection blow moulding and stretch Blow moulding). Processing Techniques: Process parameters and their influence on product quality, troubleshooting Comparison between types of Blow Molding Processes.	**08**
04	**Other Processing Techniques** Auxiliary equipment for plastics processing: Oven driers,Hopper dryers, Dececant dryers, Granulators, mould temperature controllers, proportionating devices, chilling units, automatic material conveying systems. Significance of auxiliary equipment for plastics processing. FRP Processing: Raw materials and ancillaries used, Techniques like hand lay-up, spray up and filament winding processes, applications. Applications of FRP.	**06**
05	**Design of Moulds** **Compression and transfer moulds**: General arrangement of compression moulds-flash, semi positive and positive versions. General arrangement of transfer moulds-moulds for integral pot and auxiliary transfer techniques. **Injection Moulds:** General arrangement of two plate moulds. Design of mould	**16**

	components, design of feedings, cooling and ejection systems, three plate moulds, Designing of moulds for articles with undercuts- split moulds, split actuation techniques, moulds with side cores, moulds for internally threaded articles, Fully automatic moulds, standard and innovative mould components. Hot runner systems: General arrangement, design of manifold blocks, flow ways and nozzles,advantages and limitations. **Blow Moulds, Extrusion Dies and mould materials.** Blow Moulds:General arrangement and mould components, design of neck and base pinch off sand flash pockets, Venting of moulds, selection of parting lines. Extrusion Dies: Design of extrusion dies for pipes, films, sheets, cables and profiles.	

Assessment:

Internal Assessment for 20 marks:

Consisting **Two Compulsory Class Tests**

1. First test based on approximately 40% of curriculum contents and second test based on remaining contents (approximately 40%, but excluding contents covered in Test I).
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to the number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks.**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum.**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3).
4. Only **Four questions need to be solved.**

Reference Books:

1. *Moulding of Plastics*, Bickales.
2. *Design of Extrusion dies*, M. V. Joshi.
3. *Injection of Mould Design*, R. G. W .Pyre.
4. *Plastic Materials*, Brydson.
5. Extrusion Technology – Allen Griff.
6. *Practical guide to Blow Moulding*, Lee.
7. *Injection Moulding: Theory and Practice*, Rubin.
8. *Handbook of Composite fabrication*, Akovali.
9. *Plastic product materials and process selection Handbook*, Ros

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : V</td></tr>
<tr><td colspan="8">Course: Industrial Robotics</td><td colspan="3">Course Code:DJ19PEDO5013</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="4">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">--</td></tr>
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Objectives:

1. To acquaint with the significance of robotic system in agile and automated manufacturing processes.
2. To familiarize with the robotic elements/ peripherals, their selection and interface.
3. To familiarize with the basics of robot kinematics.

Outcomes: On completion of the course, learner will be able to:

1. Illustrate the importance of robot in automation.
2. Acquire skills in robot language and programming.
3. Demonstrate the concepts of kinetics and dynamics of robotand acquire skill in robot task planning for problem solving.
4. Select various sensors/robot peripherals for deployment in a manufacturing system.
5. Identify an application of robots in manufacturing.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	Introduction Automation, robotics, Robotic system & Anatomy, Classification and Future Prospects.	**02**
02	2.1 Drives Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators and Power Transmission system. 2.2 Robot & its Peripherals 2.3 End Effecters: Type mechanical and other grippers, Tool as end effecter. Sensors: Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems, Vision systems and Equipment. Introduction to the Microcontroller (Arduino) and interfacing with a sensor	**12**
03	3.1 Machine vision Introduction, Low level & High level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Object Description & recognition, interpretation and Applications. 3.2 Programming for Robots Method, Robot Programme as a path in space, Motion interpolation, motion & task level Languages, Robot languages, Programming in suitable languages and characteristics of robot.	**10**
04	4.1 Robot Kinematics Forward, reverse & Homogeneous Transformations, Manipulator Path control and Robot Dynamics. 4.2 Robot Intelligence & Task Planning Introduction, State space search, Problem reduction, use of predictive Logic, Means. Ends Analysis, Problem solving, Robot learning and Robot task planning.	**12**
05	5.1 Robot application in manufacturing Material transfer, machine loading & un loading, processing operation, Assembly & inspectors, robotic Cell design & control, Social issues & Economics of Robotics.	**06**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting Two Compulsory Class Tests for 25 marks, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the tests will be considered for final grading.

Books Recommended:

1. *Industrial Robotics, Technology, Programming & Applications, Grover, Weiss, Nagel, Ordey, McGraw Hill.*
2. *Robotics: Control, Sensing, Vision & Intelligence, Fu, Gonzalex, Lee, McGraw Hill.*
3. *Robotic technology & Flexible Automation, S R Deb. TMH.*
4. *Robotics for Engineers, YoramKoren ,McGraw hill.*
5. *Fundamentals of Robotics, Larry Health.*
6. *Robot Analysis & Control, H Asada, JJE Slotine.*
7. *Robot Technology, Ed. A Pugh, Peter Peregrinus Ltd. IEE, UK.*
8. *Handbook of Industrial Robotics, Ed. Shimon.John Wiley.*

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<table>
<tr><td colspan="6">Program: Third Year Production Engineering</td><td colspan="4">Semester : V</td></tr>
<tr><td colspan="6">Course: Sustainable Manufacturing</td><td colspan="4">Course Code: DJ19PEDO5014</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="6">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">--</td></tr>
<tr><td>03</td><td>--</td><td>--</td><td>03</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
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</table>

Objectives:

1. To introduce basic concepts related to sustainability and sustainable development.
2. To get conversant with indigenous and global concerns about sustainability and its implications in Manufacturing.
3. To familiarize with various technological innovations, approaches & environmental standards /legislations to promote sustainable development.

Outcomes: learner will be able to:

1. Illustrate the agenda of indigenous and global sustainability to fulfil green expectations.
2. Demonstrate the knowledge about management of waste, pollution & energy conservation.
3. Demonstrate the knowledge of sustainability issues with its implementation in manufacturing.
4. Illustrate the relevance and implications of environment friendly materials.
5. Illustrate the implications of environment management in the context of modern industrial practices.
6. Develop the sustainability approach in environmental strategy and manufacturing.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	Sustainability: Basic concepts related to sustainability and sustainable development. Issues and challenges facing sustainable development. Global & indigenous sustainability agenda, green expectations & green movement. Management of Energy: Sources of energy, renewable energy. Energy audit and implications.	**10**
02	Management of waste & pollution: Types, sources and nature of wastes, waste processing, green processing & engineering operations, Energy recovery, and 3 R principle. Types of pollution and management:-Anti pollution approaches & guide lines.	**08**
03	Environment friendly materials : Materials for sustainability , eco-friendly and new age energy efficient and smart materials , alternative manufacturing practices, materials and selection of manufacturing processes, control on use of renewable materials , Bio-degradable materials recycling of materials.	**08**
04	Environment Management : Innovations for reuse , bio-processing technology , sustainable loading on ecosystems , concept of eco-efficiency and its implementation , Environment analysis from raw materials to disposal (cradle to grave concept) sustainable design and materials for sustainable design , Environmental standards and legislations. ISO 14000, carbon foot print, antipollution boards, Environment management in business world, changing scenario in global perspective.	**08**
05	Integrating sustainability approach: Environmental issues in operating strategy, creating sustainable manufacturing, promoting sustainability awareness, sustainability rating schemes, ecolabellingprogrammes, human values and professional ethics in sustainable manufacturing. Encouraging innovations in sustainable manufacturing.	**08**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting Two Compulsory Class Tests for 25 marks, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the tests will be considered for final grading.

Books Recommended:

Text books:

1. *Advances in sustainable Manufacturing By Gunther Seliger and Marwan M.K. khraishah, Springer Series*
2. *Sustainable Development By M.K. Ghosh Roy Ane Books Pvt.Ltd,*

Reference Books:

1. *Strategic Management of Sustainable manufacturing operations (Advances in logistics opreations& Management) By. RameshwarDubey&AngappaGunabekaran by Imuste Productivity press.*
2. *Analysis for Smart energy management: Tools and applications for sustainable manufacturing. By Seogchanoh and Alfred .J.Hildreth , Springer Series.*
3. *Green Management by M.Karpagam, GeethaJaikumar, Ane Books Pvt.Ltd.*
4. *Design for Environment: A guide to sustainable Product Development.*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="2">Semester : V</td></tr>
<tr><td colspan="8">Course: Hydraulic Machinery</td><td colspan="2">Course Code:DJ19PEDO5015</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="6">Evaluation Scheme</td></tr>
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<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>--</td><td colspan="2">--</td><td>--</td></tr>
</table>

Objectives:

1. To study the classification of turbines, work done and efficiency of the different turbines andalso to study about draft tube theory to determine its function and efficiency.
2. To study the performance characteristics and governing of different types of turbines.
3. To select and analyze an appropriate turbine with reference to given situation in power plants.
4. To study different types of pumps, work done, efficiency and characteristic curves of the pumps.

Outcomes: learner will be able to:

1. Understand the working principles and analyze the performance characteristics of the turbines.
2. Understand the governing of turbine and the characteristic curves of turbines.
3. Understand the working principles and evaluate the performance characteristics of the pumps.
4. Understand the working principles and select the hydraulic machines for given application.
5. Used this study for design and planning of Hydroelectric Power plant with the available water resources and requirement of power.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	**Basics of Hydraulic Machinery** **Impact of Jet Impulse:** Momentum principle, jet impingement - on a stationary flat plate, inclined plate and a hinged plate, at the center of a stationary vane, on a moving flat plate, inclined plate, a moving vane and a series of vanes, Jet striking tangentially at the tip of a stationary vane and moving vane(s), jet propulsion of ships. Introduction to hydro-electric power plant.	**08**
02	**Impulse Turbine:** Classification of turbines, Heads and efficiencies, water wheels, components, construction and operation of a Pelton wheel, work done, effective head, available head and efficiency of a Pelton wheel, design aspects, speed ratio, flow ratio, jet ratio. **Reaction Turbine:** Component parts, construction and operation of a Francis turbine, Propeller turbine, Kaplan turbine, differences between the Francis and Kaplan turbines, work done by the turbine runner, working proportions and design parameters, slow, medium and fast runners, degree of reaction, inward/outward flow reaction turbines, construction and operation of a draft tube - its function and different forms, Numericals.	**10**
03	**Performance of hydraulic turbines:** Performance Characteristics and governing of impulse turbines, Performance Characteristics and Governing of reaction turbine, Geometric similarity, Unit quantities, Specific speed and model relationships for turbines, Scale effect, cavitation – its causes, harmful effects and prevention, Thomas cavitation factor, permissible installation height, Numericals.	**08**
04	**Hydraulic Pumps:** **Centrifugal pump:** Definition, classifications, working principles, velocity triangles, specific speed, pumps in series and parallel, Methods of priming, efficiency and performance curves, cavitation & NPSH. **Reciprocating pump:** Classification, working principle, discharge, slip, indicator diagram, work saved by air vessels and performance curves, cavitation in pumps. **Rotary pumps:** working principles of gear and vane pumps.	**10**
05	**Miscellaneous Hydraulic Machines:** Introduction, Hydraulic coupling, and hydraulic torque converter, Hydraulic ram, Hydraulic press, Hydraulic accumulator, Hydraulic intensifier, Hydraulic crane and Hydraulic lift.	**06**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Text books:

1. *Fluid Mechanics and Hydraulic machine by R. K. Bansal, Laxmi Publications (p) ltd., New Delhi.*
2. *Fluid mechanics and fluid machines byR. K. Rajput, S. Chand & Co.*
3. *Fluid Mechanics and Fluid Power Engineering by D. S. Kuma, S. K. Karthaand sons.*
4. *S S Rattan, Fluid Mechanics and Hydraulic Machines, Khanna Publishers*
5. *Fluid Mechanics & Fluid machines by Narayanapillai, Universities press.*
6. *Hydraulic Machines by Banga& Sharma, Khanna Publishers.*

Reference Books:

1. *Fluid Mechanics, Hydraulic and Hydraulic Machines by Modi & Seth, Standard book house.*
2. *Introduction to Fluid Mechanics and Fluid Machines by S K Som and G Biswas, Tata McGraw Hill.*
3. *Hydraulic Machines by Dr. J. Lal, Metropolitan Book Co. Pvt. Ltd., Delhi*
4. *Hydraulic Machines-Theory and Design by V. P. Vasandani, Khanna Publishers*
5. *Fluid Mechanics and Hydraulic Machines by Domkundwar&Domkundwar, Dhanpatrai& Co*

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<table>
<tr><td colspan="5">Program: Third Year Production Engineering</td><td colspan="5">Semester: V</td></tr>
<tr><td colspan="5">Course: Professional and Business Communication Lab.</td><td colspan="5">Course Code: DJ19PEL505</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="9">Evaluation Scheme</td></tr>
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</table>

*2 hrs. Theory (Class wise) and 2 hrs. Tutorial (Batch wise)

Objectives:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance communication and interpersonal skills
3. To develop effective presentation skills
4. To hone written skills for technical documentation

Outcomes: learner will be able to:

1. Plan, organize and write technical documents like reports, proposals and research papers in the prescribed format using appropriate language and style with an understanding of ethics in written communication
2. Apply techniques of writing resume, participating in a group discussion and facing interviews
3. Develop interpersonal skills in professional and personal situations
4. Understand the documentation process of meetings and conduct meetings in a professional manner
5. Understand communication across cultures and work ethics
6. Design and deliver effective presentations using Power Point

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	**Technical Writing** **Report Writing:** Types of report, parts of formal report, collection of data and survey analysis, pre-writing of report, language and style in reports, formatting of reports, referencing in report **Proposal Writing: Types** of technical proposals, format of proposal, language and style, presentation of proposal **Technical Paper Writing:** Parts of a technical paper, language and formatting, referencing in IEEE format **Plagiarism:** Types of plagiarism, consequences of plagiarism	**08**
02	**Employment Skills** **Group Discussion:** Purpose of a GD, types of GD, criteria for evaluating a GD, Dos and Don'ts of a GD, Tips to be successful in GD **Cover Letter & Resume Writing:** Format and content of cover letter, types of resume, structure, content and formatting of resume **Interview Skills:** Types and modes of interview, Preparation for interview, Dos and Don'ts of interview, frequently asked questions during interview	**06**
03	**Introduction to Interpersonal Skills** **Emotional Intelligence:** Definition, difference between IQ and EQ, how to develop EQ **Leadership:** Types of leadership, leadership styles, case studies **Team Building:** Difference between group and team, importance of team work, strategies to be a good team player **Time Management:** Importance of time management, cultural views of time, 80/20 rule, time wasters, setting priorities and goals, **Conflict Management:** Types of conflicts, strategies to manage conflict, case studies	**06**
04	**Meetings and Documentation** Planning and preparation for meetings, strategies for conducting effective meetings, notice, agenda and minutes of a meeting, business meeting etiquettes	**02**
05	**Cross-cultural communication and Ethics** Communication across cultures, professional and work ethics, responsible use of social media, introduction to Intellectual Property Rights	**04**
06	**Presentation Skills** Presentation strategies, overcoming stage fear, techniques to prepare effective PowerPoint presentation	**02**

List of Assignments

1. Business Proposal (PowerPoint presentation)
2. Resume writing
3. Interpersonal Skills (documentation of activity)
4. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
5. Business ethics
6. Presentation Skills

Evaluation Scheme:

Laboratory: (Term work)

Term work shall consist of 6 assignments, Group Discussion and Power Point Presentation based on the written report

The distribution of marks for term work shall be as follows:

Assignments …….	(25) Marks
Project Report and Presentation……	(15) Marks
Group Discussion……..	(10) Marks
**TOTAL: ……... **	**(50) Marks**

The final certification and acceptance of term work will be subject to satisfactory *performance* of laboratory work and upon fulfilling minimum passing criteria in the term work.

Books Recommended:

Reference Books

1. *Fred Luthans, "Organizational Behavior", McGraw Hill, edition*
2. *Lesiker and Petit, "Report Writing for Business", McGraw Hill, edition*
3. *Huckin and Olsen, "Technical Writing and Professional Communication", McGraw Hill*
4. *Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 12th edition*
5. *Heta Murphy, "Effective Business Communication", McGraw Hill, edition*
6. *6. Sharma R.C. and Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw-Hill Education*
7. *Ghosh, B. N., "Managing Soft Skills for Personality Development", Tata McGraw Hill. Lehman,*
8. *Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.*
9. *Dr. Alex, K.," Soft Skills", S Chand and Company*
10. *Subramaniam, R., "Professional Ethics" Oxford University Press.*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : V</td></tr>
<tr><td colspan="8">Course : Innovative Product Development - III</td><td colspan="3">Course Code: DJ19ILL1</td></tr>
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<tr><td>25</td><td>--</td><td>--</td><td>25</td><td>25</td><td>25</td></tr>
</table>

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcome: Learner will be able to:

- Identify the requirement for a product based on societal/research needs.
- Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
- Use standard norms of engineering concepts/practices in the design and development of an innovative product.
- Draw proper inferences through theoretical/ experimental/simulations and analyses the impact of the proposed method of design and development of the product.
- Develop interpersonal skills, while working as a member of the team or as the leader.
- Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
- Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for the proposed product design and development:

- Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department).
- Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members.
- Students in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
- Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
- Faculty supervisor may provide inputs to students during the entire span of the activity, spread over 2 semesters, wherein the main focus shall be on self-learning.
- A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.
- The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ Head of the department.
- The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over two semesters, i.e. during the semesters V and VI.

Guidelines for Assessment of the work:

- The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
- In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.
- Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:

i.	Marks awarded by the supervisor based on log-book	20
ii.	Marks awarded by review committee	20
iii.	Quality of the write-up	10

In the last review of the semester VI, the marks will be awarded as follows.

- Marks awarded by the supervisor (Considering technicalpaper writing) 30
- Marks awarded by the review committee 20

Review/progress monitoring committee may consider the following points during the assessment.

- In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.
    i. First shall be for finalization of the product selected.
    ii. Second shall be on finalization of the proposed design of the product.
- In the semester VI, the expected work shall be procurement of components/systems, building of the working prototype, testing and validation of the results based on work completed in semester V.
    i. First review is based on readiness of building the working prototype.
    ii. Second review shall be based on a presentation as well as the demonstration of the working model, during the last month of semester VI. This review will also look at the readiness of the proposed technical paper presentation of the team.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

The semester reviews (V and VI) may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

- The write-up should be prepared as per the guidelines given by the department.
- The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course: Process Engineering</td><td colspan="3">Course Code:DJ19PEC601</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="3">Total marks (A+ B)</td></tr>
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Objectives:

1. To familiarize with the significance of process engineering with its relevance to manufacturing operations.
2. To prepare a skills in preparing machining sequence and estimate manufacturing time.
3. To acquaint with the significance and control of tolerance in design & manufacturing.
4. To appraise with basics of process and operation planning.

Outcomes: Learner will be able to…

1. Determine machine sequences to cater to the manufacturing requirements,
2. Analyze part prints.
3. Prepare tolerance control charts with its balancing.
4. Prepare process picture, process routing/process sheets.
5. Design cams for part production on single spindle automats.

Detailed Syllabus (Unit Wise)		
Unit	**Description**	**Duration**
01	**Introduction Process Engineering** Differentiation between Product Engineering and Process Engineering. Role of process engineering in a manufacturing setup, organization chart, functions of process engineering. Determining machining sequences - criteria and manufacturing sequence.	**02**
02	**Preliminary Part Print Analysis** General characteristics, determining the principal processes, alternate processes, functional surfaces of the work piece, areas suitable for processing, nature of work to be performed, finishing and identifying operations, case study for understanding preliminary part print analysis.	**10**
03	**Tolerance Design** **Dimensional Analysis:** Types of dimensions, concept of baseline dimension, basic geometric dimensioning and tolerance (GD & T). **Tolerance Analysis**: Rules for adding and subtracting tolerance, tolerance stacks, design and process tolerance stacks, tolerance chart, purpose and use of tolerance chart, definitions and symbols, determining lay−out of tolerance chart, stock removal, constructing and balancing of tolerance chart.	**10**
04	**Process planning** Classifying operations (Study of Basic Processes Operations, Principal Processes and Auxiliary Processes, Identification of major, critical, qualifying, re-qualifying and supporting operations), product and process critical area, selection of equipment and Tooling. **Operation Routing** Process plan sheet design for complete manufacturing part with details of sequence of operations, machine or equipment used, Process pictures, machining parameters i.e. cutting speed, feed, depth of cut, tooling and gauge details, cutting tools specifications and gauge details, machining timecalculations. Tool layout for turning on production lathe.	**10**
05	**Cam Design for TraubAutomat** Automats major classification and types, tools and tool holders. Single spindle automats and its tooling, tool layout and cam design for part production on Single spindle automat.	**10**

Term Work:

Part A.Design Exercise /Assignment.

01 Assignment on introduction to process engineering.
02 Assignment on Part print analysis.
03 Prepare Tolerance Chart Design for one component.
04 Design process planning sheet with process picture.
05 Design of Cams for Traub Automat.

Term work shall consist of assignments based on the syllabus and exercises as mentioned in the table above.

Part B. Industrial Visit

Detailed report, based on an Industrial visit to a manufacturing firm, covering few of the essential concepts mentioned in subject of Process Engineering. The report should cover the importance of optimization of various resources like Time, Material etc. in today's manufacturing firms.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Consisting Two Compulsory Class Tests for 25 marks, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the tests will be considered for final grading.

Term Work

The distribution of marks for term work shall be as follows:

Design Exercise :	15 marks
Assignments :	05 marks
Industrial Visit Report :	05 marks

The final certification and acceptance of term work ensures the satisfactory performance of Laboratory work and minimum passing in the term work.

Practical/Oral Examination

Each student will be given a small exercise based on syllabus, which will be assessed/ verified by examiners during the oral examination. Evaluation of practical/oral examination to be done, based on the performance of design task

The distribution of marks for oral-practical examination shall be as follows:

Exercise :	15 marks
Oral :	10 marks

Reference Books:

1. *Process Engineering for Manufacturing, Donald F. Eary and Gerald E.Johnson,PrenticeHall, Inc.*
2. *Production Technology, HMT.*
3. *Manufacturing Engineering,V. Danilevsky, Mir publication.*
4. *Tolerance Design and Analysis,Wade.*
5. *HSS and Carbide Tool Catalogues for Turning, Drilling, Milling, Boring etc. from Tool manufactures.*
6. *Westerman Tables for the Metal Trade, Wiley, Eastern Limited.*
7. *PMT Catalogue Traub Automat*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="2">Semester : VI</td></tr>
<tr><td colspan="8">Course: Machine Tool Design</td><td colspan="2">Course Code:DJ19PEC602</td></tr>
<tr><td colspan="8">Course: Machine Tool Design Lab.</td><td colspan="2">Course Code:DJ19PEL602</td></tr>
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(Hours / week)</td><td colspan="6">Evaluation Scheme</td></tr>
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<tr><td>25</td><td>--</td><td>--</td><td>25</td><td>--</td><td>25</td></tr>
</table>

Objectives:

1. To familiarize with the constructional & design features of machine tool structures like bed, columns, slide ways/guideways and mechanical drives.
2. To prepare for skills in designing feed gear boxes, bearings, power screws, clutches etc. used in machine tools.
3. To acquaint with the usage of standards & hand books and retrieve relevant data from these for designing/selection of machine tool components.
4. To appraise about safety and safety standards pertaining to machine tools.
5. To acquaint with the recommended procedure of carrying out acceptance tests on machine tools & their significance.

Outcomes: Learner will be able to…

1. Design machine tool structures, drive elements/drives.
2. Design feed gear boxes.
3. Design power screws and clutches
4. Design ofbearings.
5. Illustrate the safety aspects/ acceptance tests in machining tools.

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration**
01	**1.1 Elements of Machine Tools:** Types and capabilities of various machine tools. General purpose, and special purpose machine tools. **1.2. Design of machine tool structures** :- 1.2.1 Design of bed & columns- Materials of construction, Profiles, Static and dynamic stiffness. Designing for strength and rigidity. Methods of enhancing rigidity. Design of machine tool bed cross-section like lathe bed. Design of simple machine tool columns like pillar drill column etc. on the basis of strength and rigidity. 1.2.2 Machine tool guideways - Materials of construction, Classification of guideways, Types of slideways, Clearance adjustment and wear compensation techniques, Fundamentals of hydrostatic guideways. Design of guideways for wear and stiffness. **1.3 Design of mechanical drives:** 1.3.1 **Design of belt drives** - Design of belts, belt materials, belt types:- specification and selection, types of pulleys and design of pulleys. 1.3.2 Design of gear drives - Types of gears, materials, application, and selection. Design of spur gears - Design on the basis of beam strength (W. Lewis equation), Design on the basis of wear and fatigue (Buckingham's Equation) Design of chain drives- Types of chains and sprockets. Principles of designing sprockets and roller chains. Design of chain drives- Types of chains and sprockets. Principles of designing sprockets and roller chains.	**10**
02	**Design of speed and feed boxes** **2.1 Stepped and Stepless speed** outputs, selection of spindle speed ranges, construction of structural, speed, gearing & deviation diagrams, layout of speeds on arithmetic and geometric progression, kinematic advantages of geometric progression series, selection of values of common ratio. **2.2 Stepless drives :** Mechanical stepless drives − single disc, double disc and cone disc transmissions, speed regulation by epicyclic gear train, positive infinitely variable drives (PIV drives) − Kopp‘s , Meander and Svetozarav‘s drives. **2.3Feed boxes:** Quadrant change gear mechanism, speed boxes with gear cone and sliding key, Norton gear drive, Meander gear drives, gear boxes with clutched drive, Schopke drive and Ruppert drive. **2.4Design of gear boxes** for feed and speeds having 2−3 stages and 4−12 speeds.	**12**
03	**Design of clutches** **3.1** Design considerations, materials of clutch plates & linings. Running conditions- wet & dry. **3.2** Design of plate clutches. Single and multiplate clutches involving design of clutch plates, springs & operating lever.	**04**
04	**Design of machine tool bearings** Bearing materials & their characteristics. Types of bearings- selection & application. **4.1 Design of ball & roller bearings** – Bearing designation (ISI, ISO, SAE, and SKF). Calculation of equivalent load, cubic mean load, static & dynamic load bearing capacities. Selection of ball & roller bearing from handbook. Mounting & maintenance of bearings. **4.2 Design of journal bearings** – Terminology. Theory of lubrication,	**08**

	bearing characteristic Number, Sommerfeld Number, calculations involving bearing dimensions, clearance, coefficient of friction, heat generated, heat dissipated and power lost in friction. Mounting & maintenance of bearings.	
05	**5.1 Design of power screws**: Materials of construction. Power screw profiles and selection, design of machine tool power screws based on strength, buckling and stiffness, power requirements and efficiency, mounting of power screws, Elementary treatment on ball recirculating power screws. **5.2 Safety of machine tools & acceptance tests :** *5.2.1* Safety concepts, various safety devices incorporated in machine tools to safeguard safety of man, tools and equipment. Interlocked, fool proof safety systems. Introduction to safety standards. *5.2.2* Acceptance tests on machine tools: Significance, performance and geometrical tests on lathe, milling, drilling and shaping machines.	**08**

List of Laboratory Experiments:

01 Design of mechanical drives (At least one design and drawing)
02 Design and drawing of machine tool guideways, slideway profiles, wear compensation techniques.
03 Design and drawing of machine tool structure profiles.
04 Demonstration of acceptance test on at least one machine tool.
04 Assignment on power screws.
05 Assignment on clutches.
06 Assignment each on antifriction bearing & journal bearing.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

Oral Examination:

1. Oral examination shall be conducted based on term work and syllabus content.
2. Examiners are expected to give a small task or ask questions either to evaluate understanding of basic fundamentals or to evaluate their capability of applying basic theory to practical applications.

Reference Books:

1. *Principles of machine tools, Sen and Bhattacharya, New Central Book Agency.*
2. *Machine tool design and Numerical Control, N.K.Mehta, Tata MGH*
3. *Machine tool Engineering, G R Nagpal, Khanna Publishers.*
4. *Design of Machine tool, S.K. Basu and D.K.Pal, Oxford and IBH publishing Co.*
5. *The design and construction of machine tools, H.C.Town.*
6. *Machine tool design hand book: Central Machine Tool Research Institute, Bangalore. Tata MGH*
7. *PSG Design Data book: PSG College of engineering and technology, Coimbatore.*
8. *Machine Tool Design (Volume 3), (English, Paperback, V. Vermakov, N. Acherkan, Nicholas Weinstein)*
9. *Machine Tool Structures: v. 1, by F. Koenigsberger (Author), J. Tlusty (Author)*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course : Industrial Engineering</td><td colspan="3">Course Code: DJ19PEC603</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="2">Continuous Assessment Marks (B)</td><td>Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td><td></td></tr>
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<tr><td colspan="3">Laboratory Examination</td><td colspan="2">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">--</td></tr>
<tr><td>03</td><td>--</td><td>--</td><td>03</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
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Objectives:

1. To familiarize with concept of integration of various resources and the significance of optimizing them in manufacturing and allied industries.
2. To acquaint with various productivity enhancement techniques

Outcomes: On completion of the course, learner will be able to:

1. Illustrate the need for optimization of resources and its significance
2. Manage and implement different concepts involved in method study and understanding of work content in different situations.
3. Understand the importance of Ergonomics at the workplace.
4. Demonstrate the concept of value analysis and its relevance.
5. Describe different aspects of work system design and facilities design pertinent to manufacturing industries.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	**Introduction to Industrial Engineering (IE):** Definition, History and Development of IE, Contributions to IE, Activities and approaches of IE, Objectives and Functions of IE. **Productivity:** Definition, Productivity in Enterprise, Task of Management, Productivity of Materials, Land, Building, Machine and Power. Measurement of Productivity, Factors affecting productivity, Productivity Improvement tools/techniques, like 5S, Poka-Yoke, Kaizen, Kanban, QFD, FMEA, Ishikawa diagram, SMED, etc.	**10**
02	**Method Study:** Objectives and procedure for methods analysis, Recording techniques, Micro motion and macro-motion study: Principles of motion economy, Normal work areas and work place design. **Work Measurement**: Objectives, Work measurement techniques - time study, work sampling, pre- determined motion time standards (PMTS) Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, and standard time, Maynard's Operation Sequence Technique (MOST). **Job Evaluation and Wage Plan:** Objective, Methods of job evaluation, job evaluation procedure, merit rating (performance appraisal), methods of merit rating, wages and incentives.	**12**
03	**Ergonomics:** Introduction: Inter disciplinary nature of ergonomics modern ergonomics human performance – information processing – factors affecting human performance – physical workload and energy expenditure. Workspace Design - Anthropometry – workspace design for standing and seated workers – Arrangements of components within a physical space – Interpersonal aspect of workplace design. Recent Advances and Trends. Trends in work system design – Application of Ergonomics in automobile industry.	**08**
04	**Value Analysis and Engineering:** An Overview Of Value Analysis -Concepts and approaches of value analysis and engineering - importance of value, evaluation of function, problem solving system. Value analysis case studies, Effective organization for value work, function analysis system techniques- FAST diagram.	**06**
05	**Facility Design:** Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; line balancing; materials handling systems; industrial safety.	**06**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.

3. Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Text books:

1. *Industrial Engineering and Management, Dr O. P. Khanna, DhanpatRai and Sons, Delhi*
2. *Introduction to Work study, International Labour Office, Geneva*
3. *Industrial Engineering and Production Management, M. S. Mahajan, DhanpatRai and Co. Ltd. Delhi.*
4. *Production (Operations) Management, L. C. Jhamb, Everest Publishing House, Pune.*
5. *Industrial Engineering and Production Management,yMartandTelsang, S. Chand & Co. Ltd., New Delhi.*

Reference Books:

1. *Production and Operations Management, Joseph G. Monks*
2. *Introduction to Ergonomics, R. S. Bridger, McGraw Hill, INC*
3. *Techniques of Value Analysis and Engineering, Lawrence D. Miles, McGraw Hill Book Co.*
4. *Total Quality Management, D. H. BesterField, Prentice Hall of India, New Delhi.*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="4">Semester : VI</td></tr>
<tr><td colspan="8">Course : Operations Research</td><td colspan="4">Course Code: DJ19PEC604</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td>Total marks (A+ B)</td></tr>
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Objectives:

1. To familiarize the students with various tools of optimization for management of various resources.
2. To acquaint the students with various simulation tools for optimization for various resources.

Outcomes: On completion of the course, learner will be able to:

1. Apply the concept of linear programming for solving specialized problems on transportation, assignments & sequencing.
2. Apply principles of queuing & game theory models to solve real life problems.
3. Demonstrate the concept of dynamic programming in modelling and solving problems.
4. Illustrate different types of simulation models applicable to Inventory/queuing.
5. Acquire skills in identifying & applying cost effective strategies in managing of manufacturing projects.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	1.1 **Linear Programming:** Linear Programming Problem: Formulation, Graphical solution, Simplex method, Big−M method, Two−phase method, Principle of Duality, Dual Simplex. 1.2 **Transportation problem:** Formulation - Optimal solution (MODI), Degeneracy. 1.3 **Assignment problem:** Formulation - Optimal solution, Traveling Salesman problem. 1.4 **Sequencing:** Introduction – Flow Shop sequence. Sequencing – n jobs through two machines - n jobs through three machines – Job shop sequencing - two jobs through 'm' machines.	**14**
02	2.1 **Queuing Models:** Introduction - Single Channel - Poisson arrivals - exponential service times - with infinite population and finite population models – Multichannel - Poisson arrivals – exponential service times with infinite population single channel Poisson arrivals. 2.2 **Game Theory**: Introduction - Minimax&Maximin - Criterion and optimal strategy - Solution of games with saddle points – Rectangular games without saddle points - 2 X 2 games - dominance principle – mX2 & 2Xn games, Graphical method.	**08**
03	**Dynamic programming**: Introduction – Bellman's Principle of optimality - Applications of dynamic programming- capital budgeting problem - Shortest Path problem – Minimum Spanning Tree.	**06**
04	**Simulation**: Definition - Types of simulation models - phases of simulation - applications of simulation - Inventory and Queuing problems - Advantages and Disadvantages - Simulation Languages.	**06**
05	**Project Management:** Programme Evaluation and Review Technique, Critical Path Method, Network Updating, Crashing of Network and Resources levelling.	**08**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting Two Compulsory Class Tests for 25 marks, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2 Total duration allotted for writing each of the paper is 1hr.
3 Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Reference Books:

1. *Operations Research: Principle and Practices, A. Ravindran, D. Phillips, Wiley India.*
2. *Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.*
3. *Operations Research, R. Panneerselvam, PHI Publications.*
4. *Operations Research, A. M. Natarajan, P. Balasubramani, A. Tamilarasi, Pearson Education.*
5. *Operations Research, An Introduction, Hamdy A. Taha, Pearson Education*
6. *Operations Research, Prem Kumar Gupta, D. S. Hira, S. Chand Limited.*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester: VI</td></tr>
<tr><td colspan="8">Course: Internal Combustion Engines</td><td colspan="3">Course Code: DJ19PEDO6011</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Objectives:

1. To acquire knowledge about the IC engine cycles, classification and working Principles
2. To describe combustion phenomena in IC engines
3. To give complete knowledge of type of fuels used in IC engines and the fuel supply systems
4. To describe the testing and performance parameters along with heat balance Sheet.
5. To explain the effects of exhaust emission on human health and various pollution norms.

Outcomes: learner will be able to:

1. Understand the thermodynamic analysis of IC engine cycles and analyze the combustion process in SI and CI Engines.
2. Analyze fuel supply systems, ignition and governing systems of IC Engines.
3. Evaluate the performance of IC engines and the importance of alternate fuels.
4. Illustrate various standard pollution norms like EURO, Bharat for I.C. engines.
5. Develop an understanding for future internal combustion engine technology and market trends.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	**Introduction:** IC engines and components of IC engine, Comparison of two stroke & four stroke engines, Comparison between SI & CI engines, Valve and port timing diagram, Working cycles - Otto, Diesel and Dual cycle,Air standard cycles, Fuel air cycle and actual cycle. Variation in specific heat, Dissociation and their effect on engine performance. Review of other losses in IC engines	**04**
02	**Fuels and its supply system for SI and CI engine:** Important qualities of IC engine fuels, rating of fuels, Carburation, mixture requirement for different loads and speeds, simple carburetor and its working, types of carburetors, Electronic fuel injection system (MPFI), types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation. **Combustion in SI and CI Engines:** **Combustion in SI Engines:** Stages of combustion, ignition lag, flame propagation, factors affecting flame propagation, abnormal combustion, phenomenon of detonation in SI engines, effect of engine variables on detonation. Combustion chambers. Rating of fuels in SI engines. **Combustion in CI engines:** Stages of combustion, ignition delay, factors affecting delay period, phenomenon of knocking in CI engine, effect of engine variables on knocking, comparison of knocking in SI & CI engines, types of combustion chambers, rating of fuels in CI engines.	**12**
03	**Engine systems and components** **Ignition and Governing System:** Battery and magneto ignition system, spark plug, firing order, quality, quantity & hit and miss governing **Engine Lubrication and Cooling:** Lubrication of engine components, Lubrication system – wet sump and dry sump, crankcase ventilation, Types of cooling systems – liquid and air cooled, comparison of liquid and air cooled systems. **Supercharging/Turbo-charging:** Objectives, Effects on power output and engine efficiency, Methods, Types and Limitations.	**10**
04	**Testing and Performance of engines:** Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power by Willan's Line Method* and Morse Test*, calculation of brake thermal efficiency, brake power and brake specific fuel consumption of I.C Engines, variable compression ratio engines, heat balance sheet of I.C Engines (Numerical on Performance and Heat balance sheet of I.C Engine)	**08**
05	**Engine Emission and Control** S.I. engine emission (HC, CO, NOx) Control methods - Evaporative (ELCD), Thermal, Catalytic converters, C.I. Engines Emission (CO, NOx, Smog, Particulate) Control methods - Chemical, EGR. Standard pollution norms like EURO, Bharat and Introduction to alternative fuels for I.C. engines.	**08**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Text books:

1. *Internal Combustion Engine by V Ganeshan, McGraw Hill Education Pvt Ltd.*
2. *Internal Combustion Engine by M. L. Mathur and R. P. Sharma, DhanpatRai Publications (P) Ltd.*
3. *Fundamentals of Internal Combustion engine by H. N. Gupta, PHI Learning.*
4. *Internal Combustion Engines, by Mohanty, Standard Book House.*
5. *Internal Combustion Engines, by Shyam Agrawal, New Age International.*

Reference Books:

1. *Internal Combustion Engine Fundamentals by John B. Heywood, McGraw Hill Education Pvt Ltd.*
2. *Internal Combustion Engines, by Willard W. Pulkrabek, Pearson Education.*
3. *Internal Combustion Engines, by Richard Stone, Palgrave Publication*
4. *Internal Combustion Engines 2nd Edition by Colin Ferguson and Allan Kirkpatrick, Wiley India Pvt. Ltd.*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="4">Semester : VI</td></tr>
<tr><td colspan="8">Course : Refrigeration and Air-conditioning</td><td colspan="4">Course Code: DJ19PEDO6012</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td>Total marks (A+ B)</td></tr>
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Objectives:

1. To familiarize with the working and operating principles of Vapour Compression and Vapour Absorption systems.
2. To familiarize with the components of refrigeration and air conditioning systems.
3. To familiarize with the design air conditioning systems using cooling load calculations.

Outcomes: learner will be able to:

1. Demonstrate fundamental principles of refrigeration and air conditioning.
2. Locate various important components of the refrigeration and air conditioning system.
3. Illustrate the properties of refrigerants.
4. Use psychometric chart.
5. Design and analyses complete air conditioning systems.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	Introduction to Refrigeration: Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator, Carnot heat pump, unit of refrigeration, Coefficient of Performance, Energy Efficiency Ratio (EER), BEE star rating.	**05**
02	Vapour Compression Refrigeration System: Simple vapour compression cycle, Effect of liquid sub cooling & superheating, effect of evaporator and condenser pressures, methods of sub cooling, use of P-h charts, Actual VCR cycle. Refrigerants- Desirable properties of refrigerants, ASHRAE numbering system for refrigerants. Thermodynamic, Chemical and Physical properties. Secondary refrigerants, ODP and GWP, Montreal protocol and India‘s commitment, Recent substitutes for refrigerants	**12**
03	Vapour Absorption Refrigeration: Importance of VAR system, COP of ideal VAR system, Ammonia-water VAR system, Lithium Bromide – Water VAR system, Single and double effect, Electrolux refrigeration system. Solar VAR system	**05**
04	Psychrometry: Need for air conditioning, Principle of psychromerty, Psychometric properties, chart and processes, air washers, requirements of comfort air conditioning, summer and Winter Air conditioning.	**08**
05	Design of air conditioning systems: Different Heat sources,- Adiabatic mixing of two air streams, Bypass factor, sensible heat factor, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point, Ventilation and infiltration, Inside and Outside Design condition, Cooling Load estimation , Introduction to Unitary Products viz. Room/Split and Packaged Air Conditioners, Introduction to recent developments viz. Variable Refrigerant Flow systems, VAV control systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone.	**12**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Text books:

1. *Refrigeration and air-conditioning by C P Arora, Tata McGrawHill*
2. *Refrigeration and air-conditioning by V. M. Domkundwa, Dhanpatrai& Co.*
3. *Refrigeration and air-conditioning by Manohar Prasad, New Age Int (P) Ltd*

Reference Books:

1. *Principles of refrigeration by R J Dossat, Willey Eastern Publication*
2. *Basic Refrigeration and air-conditioning by P.Ananthanarayana, Tata McGraw Hill*
3. *Refrigeration and air-conditioning by W F Stoker and J W Jones, Tata McGrawHill*
4. *Modern Air-conditioning practice by C.P. Arora, Tata McGraw Hill*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course : Rapid prototyping & Manufacturing</td><td colspan="3">Course Code: DJ19PEDO6013</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td>Total marks (A+ B)</td></tr>
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Objectives:

1. To acquaint with various rapid prototyping and additive manufacturing technologies.
2. To familiarize with the concept of Direct Digital Manufacturing.
3. To familiarize with the various Rapid tooling and Reverse engineering techniques.
4. To introduce the concept of Digital Manufacturing.

Outcomes: learner will be able to:

1. Demonstrate an importance of rapid prototyping/additive manufacturing techniques.
2. Design and develop of products using rapid manufacturing technology.
3. Design and develop of products using additive manufacturing technology.
4. Select appropriate Reverse engineering techniques for a particular case.
5. Select appropriate Rapid tooling techniques for a particular case.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
01	**Introduction to Rapid Prototyping (RP) and Additive Manufacturing (AM)** Prototype Fundamentals, Historical Development, Fundamentals of Rapid Prototyping, Advantages of Rapid Prototyping, Additive Manufacturing (AM) Definition, Applications of AM parts, The Generic AM process, AM industry: present and future. **Design for Additive Manufacturing** AM Unique Capabilities: Shape Complexity, Hierarchical Complexity, Functional Complexity, Material Complexity, Core DFAM Concepts and Objectives, Complex Geometry, Integrated Assemblies, Customized Geometry, Multifunctional Designs, Elimination of Conventional DFM Constraints.	**06**
02	**Vat Polymerization AM process:**Stereo lithographyapparatus(SLA), historyof SLA, material requirements, scan patterns, applications, benefits and limitations. Other liquid polymer-based systems: Solid Ground Curing (SGC), Microstreolithography, Digital LightProcessing (DLP), Continuous Liquid Interface Production (CLIP), Large-Scale, Rapid Liquid Printing. **Powder Bed Fusion AM Process:** Selective Laser Sintering (SLS): process workflow and material requirements, powder production methods, powderfusion mechanism, other Powder Bed Fusion -based systems: Multi-Jet Fusion(MJF), Selective Laser Melting (SLM): Electron Beam Melting(EBM) Process. **Extrusion based AM processes:** Fused deposition Modeling(FDM), history of FDM, material requirements, workflow: material loading, liquefaction,bonding, solidification, support generation, nozzle dynamics, applications,benefits and limitations, other solid based AM processes: ceramics, metals, biomaterials, composites, non-planer systems, contour crafting, concrete printing.	**12**
03	**Binder Jetting (BJ) & Material Jetting AM Process:** workflow, thermal and piezoelectric inkjet, material requirements, material jetting fluid mechanics, drop-on-demand and continuous methods of MJ, material jetting of metals, ceramics, nanomaterial, BJ AM Process: process workflow, materialrequirements, powder characterization for BJ process, binder-powderinteraction, binder properties. **Sheet Lamination AM Processes:** Laminated Object Manufacturing (LOM), LOM of paper, polymer and composite sheets, LOM mechanism: gluing, adhesive bonding, bond then from, from then bond, thermal bonding, sheetmetal clamping, Ultrasonic Additive Manufacturing (UAM), ultrasonic welding fundamentals, UAM process parameters. **Directed Energy Deposition (DED) Processes:** Process workflow, materialsfeeding for DED: powder (Laser Engineered Net Shaping) & wire, processparameters and optimization, Electron Beam Additive Manufacturing (EBAM) plasma-based DED, Cold Spray.	**10**
04	**Rapid Tooling and Reverse Engineering** **Introduction to Rapid Tooling**, Indirect Rapid Tooling Processes, Direct Rapid Tooling Processes, Emerging Trends in Rapid Tooling **Reverse Engineering (RE):** Introduction, RE generic process, RE hardware and software, Integration of RE and RP for Layer-based Model Generation, Applications and case studies of RE in automotive, aerospace and medical device industry, Barriers for adopting RE.	**08**

05	**Digital Manufacturing** Definition of digital manufacturing, Concept of Direct Digital Manufacturing (DDM), DDM Drivers, Key Technologies of Digital Manufacturing, Future of DDM, Application Case Studies, Various Digital Technologies in Product Life Cycle, Resource and Environment, Management, Control and Product Recognition.	**06**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Text books:

1. *Rapid Prototyping Principles and Applications, Chua C.K., Leong K.F., and Lim C.S 2nd Edition, World Scientific, 2003.*
2. *Rapid Prototyping Technology Selection and Application, Kenneth G. Cooper, Marcel Dekker Inc, 2001*
3. *Rapid Prototyping Theory and Practice, Ali Kamrani, and EmadAbouel Nasr (Eds.), Springer, 2006.*
4. *Rapid Manufacturing: An Industrial Revolution for the Digital Age, N. Hopkinson, R.J.M. Hague and P.M. Dickens (Eds.), John Wiley & Sons, 2006.*

Reference Books:

1. *Fundamentals of Digital Manufacturing Science, Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, Springer, 2012.*
2. *Rapid Tooling: Technologies and Industrial Applications, Peter D. Hilton and Paul F. Jacobs (Eds.), Marcel Dekker, 2000.*
3. *Collaborative Design and Planning for Digital Manufacturing Lihui Wang, Andrew Y.C. Nee. (Eds.), Springer, 2009.*
4. *Additive Manufacturing Technologies, Ian Gibson, D.W. Rosen, and B. Stucker, 2nd Edition, Springer, 2015.*
5. *Understanding Additive Manufacturing, Andreas Gebhardt, Hanser, 2011.*
6. *Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D. T. Pham and S.S. Dimov, Springer, 2001.*
7. *Reverse Engineering: An Industrial Perspective, Vinesh Raja and Kiran J. Fernandes (Eds.), Springer, 2008.*

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<table>
<tr><td colspan="6">Program: Third Year Production Engineering</td><td colspan="4">Semester: VI</td></tr>
<tr><td colspan="6">Course: Logistics and Supply Chain Management</td><td colspan="4">Course Code: DJ19PEDO6014</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="6">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>--</td><td colspan="2">--</td></tr>
</table>

Objectives:

1. To acquaint with the concept of key drivers of supply chain performance and their interrelationships with strategy.
2. To impart analytical and problem solving skills necessary to develop solutions for a variety of supply chain management.
3. To acquaint with the design problems and develop an understanding of information technology in supply chain optimization.
4. To acquaint with the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.

Outcomes: Learner will be able to…

1. Demonstrate the functional strategy map of supply chain management.
2. Design supply chain strategy of a firm.
3. Demonstrate concepts and ideas related to Materials management.
4. Illustrate various aspects pertaining to logistics for any organization.
5. Use technology to change logistics and supply chain management.

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration**
01	**Building a Strategic Framework to Analyze Supply Chains** Building a Strategic Framework to Analyze Supply Chains Understanding the Supply Chain: What Is a Supply Chain? The Objective of a Supply Chain, The Importance of Supply Chain Decisions, Decision Phases in a Supply Chain, Process Views of a Supply Chain, Examples of Supply Chains. **Supply Chain Performance-** Achieving Strategic Fit and Scope: Competitive and Supply Chain Strategies, Achieving Strategic Fit, Expanding Strategic Scope, Obstacles to Achieving Strategic Fit Supply Chain Drivers and Metrics: Drivers of Supply Chain Performance, Framework for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing.	**06**
02	**Designing the Supply Chain Network** Designing the Supply Chain Network, Designing Distribution Networks and Applications to e-business: The Role of Distribution in the Supply Chain, Factors Influencing Distribution Network Design, Design Options for a Distribution Network, E-Business and the Distribution Network, Distribution Networks in Practice.	**08**
03	**Designing the Supply Chain Network** Designing the Supply Chain Network, Designing Distribution Networks and Applications to e-business: The Role of Distribution in the Supply Chain, Factors Influencing Distribution Network Design, Design Options for a Distribution Network, E-Business and the Distribution Network, Distribution Networks in Practice.	**08**
04	**Designing Global Supply Chain Networks** Designing Global Supply Chain Networks, The Impact of Globalization on Supply Chain Networks: The Offshoring Decision: Total Cost, Risk Management in Global Supply Chains, The Basic Aspects of Evaluating Global Supply Chain Design, Evaluating Network Design Decisions Using Decision Trees, Evaluation of Global Supply Chain Design, Decisions Under Uncertainty, Making Global Supply Chain Design, Decisions Under Uncertainty in Practice. **Managing Cross-Functional Drivers in a Supply Chain** Sourcing Decisions in a Supply Chain: The Role of Sourcing in a Supply Chain, In-House or Outsource, Third and Fourth-Party Logistics Providers, Supplier Scoring and Assessment, Supplier Selection-Auctions and Negotiations, Contracts, Risk Sharing, and Supply Chain Performance, Design Collaboration, The Procurement Process, Sourcing Planning and Analysis, The Role of IT in Sourcing, Risk Management in Sourcing, Making Sourcing Decisions in Practice.	**10**
05	**IT in a Supply Chain** Information Technology in a Supply Chain: The Role of IT in a Supply Chain, The Supply Chain IT Framework, Customer Relationship Management, Internal Supply Chain Management, Supplier Relationship Management, The Transaction Management Foundation, The Future of IT in the Supply Chain, Risk Management in IT, Supply Chain IT in Practice. **Coordination in a Supply Chain** Coordination in a Supply ChainCoordination in a Supply Chain: Lack of Supply Chain Coordination and the Bullwhip Effect, The Effect on Performance of Lack of Coordination, Obstacles to Coordination in a Supply Chain, Managerial Levers to Achieve Coordination, Building Strategic Partnerships and Trust Within a Supply Chain, Continuous Replenishment and Vendor-Managed Inventories, Collaborative Planning, Forecasting, and Replenishment.	**10**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75marks.
2. Total duration allotted for writing the paper is 3hrs.

Continuous Assessment (B):

Theory:

1. Consisting **Two Compulsory Class Tests for 25 marks**, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in TestI)
2. Total duration allotted for writing each of the paper is 1hr.
3. Average of the marks scored in both the tests will be considered for finalgrading.

Books Recommended:

Reference Books:

1. *Supply Chain Management–Strategy, Planning & Operation. Sunil Chopra & Peter Mind, Pearson Education Asia, 2001, ISBN: 81-7808-272-1.*
2. *Supply Chain Redesign–Transforming Supply Chains into Integrated Value Systems. Robert B Handfield, Ernest L Nichols, Jr., Pearson Education Inc., 3rd Edition (3rd Impression), 2007, ISBN: 81-317- 0401-7*
3. *Modelling the Supply Chain -Jeremy F Shapiro, Duxbury, Thomson Learning, 2002, ISBN 0-534-37363 3. Designing & Managing the Supply Chain. David Kimchi Levi, Philip Kaminski & Edith Kimchi Levi; Mc Grew Hill*
4. *Supply Chain Redesign: Transforming Supply Chains into Integrated Value Systems, Robert B Handfield, Ernest L Nicholas.*
5. *The Management of Business Logistics: A Supply Chain Perspective, Coyle*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="4">Semester : VI</td></tr>
<tr><td colspan="8">Course : Maintenance Engineering.</td><td colspan="4">Course Code: DJ19PEDO6015</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="12">Evaluation Scheme</td></tr>
<tr><td colspan="6">Semester End Examination Marks (A)</td><td colspan="5">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="6">75</td><td>25</td><td>25</td><td colspan="2">25</td><td>100</td></tr>
<tr><td colspan="6">Laboratory Examination</td><td colspan="5">Term work</td><td rowspan="3">--</td></tr>
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<tr><td colspan="2">--</td><td>--</td><td>--</td><td>--</td><td>--</td><td colspan="2">--</td></tr>
</table>

Objectives:

1. To acquaint with various principles, functions and practices adopted in industry for the successful management of maintenance activities.
2. To appraise with the importance of maintenance in productivity enhancement and cost reduction.
3. To make conversant with preventive maintenance and breakdown maintenance functions.
4. To appraise with modern approaches in the field of maintenance.

Outcomes: Learner will be able to…

1. Acquire awareness and interest about the significance of maintenance function.
2. Develop skills to diagnose and trace the faults.
3. Keep pace with the ongoing and emerging trends in the field of maintenance engineering.
4. Plan and implement maintenance management strategies & functions.

Detailed Syllabus (Unit Wise)		
Unit	**Description**	**Duration**
01	**Principles of Maintenance & Maintenance Planning** Introduction to maintenance, Types of maintenance, Basic Principles of maintenance planning, Objectives of planned maintenance activity, Importance and benefits of sound Maintenance systems, Reliability, Maintainability and machine availability trade off, concepts of MTBF, MTTR and MWT and factors of availability.	**08**
02	**Preventive Maintenance** Significance of Preventive maintenance, maintenance planning & schedules, repair cycle, Concepts of lubrication & lubricants, Types of lubricants & selection, Techniques of lubrication.	**08**
03	**Breakdown Maintenance** Logical fault location methods, Sequential fault location, Repair methods for machine beds, columns, and slide and guide ways. Repair methods for drive elements like shafts, spindles, couplings, gears and gear box, lead screw, bearings, keys, belts, chains, sprockets etc. maintenance of pneumatic and hydraulic components like valves and actuators.	**08**
04	**Condition Monitoring** Condition Monitoring, Cost comparison with and without condition monitoring, On load testing and offload testing, Methods and instruments for condition monitoring, Temperature sensitive tapes, Pistol thermometers and wear debris analysis	**08**
05	**Maintenance of Machine Tools & Material Handling Equipment** Maintenance of Material handling equipment like crane, fork lift and conveyors, Maintenance of machine tools like lathes, shaping, milling & drilling machines. **Maintenance Management** Maintenance strategies, Types and techniques, planned and unplanned maintenance, Computer aided maintenance, maintenance scheduling, spare part management, inventory control, maintenance records and documentation. Concepts of Total Productive Maintenance (TPM). Predictive maintenance techniques.	**10**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Consisting Two Compulsory Class Tests for 25 marks, First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the tests will be considered for final grading.

Books Recommended:

Reference

1. *Industrial Maintenance Management, Srivastava S.K., S. Chand and Co.*
2. *Installation, Servicing and Maintenance, Bhattacharya S.N., S. Chand and Co.*
3. *Maintenance Planning, White E.N., I Documentation, Gower Press.*
4. *Industrial Maintenance, Garg M.R., S. Chand & Co.*
5. *Maintenance Engineering Hand book, Higgins L.R., McGraw Hill.*
6. *Condition Monitoring, Armstrong, BSIRSA.*
7. *Handbook of Condition Monitoring, Davies, Chapman &Hall.*
8. *Advances in Plant Engineering and Management, Seminar Proceedings–IIPE.*

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course : Additive Manufacturing Lab.</td><td colspan="3">Course Code: DJ19PEL603</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="2">Lectures</td><td rowspan="2">Practical</td><td rowspan="2">Tutorial</td><td rowspan="2">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>25</td><td>-</td><td>25</td></tr>
</table>

Objectives:

1. Develop STL file for CAD models with appropriate support structures and orientation.
2. Build complex engineering assemblies in plastic material with minimum build-time.
3. Evaluate the process parameters of AM machine to improve the quality of the parts produced.

Outcomes: Learner will be able to…

1. Prepare CAD model and convert the same in .STL file.
2. Simulate the .STL file in FDM machine software.
3. Prepare a physical model.

Sr. No	Design Exercise / Assignment
1	Review of Solid Modeling Packages and modeling 3D Model software (Autocad,Solidworks, Creo, UG NX, Proe, or any other).
2	Components of FDM 3D printer.
3	Generating STL files from the CAD Models & Working on STL files.
4	Processing the CAD data in CURA (open source software or any other)
5	Simulation of process parameters in CURA Software for optimizing build-time and material consumption.
6	Understanding properties of various plastic filaments used in FDM printers
7	Fabricating the component on 3D Printer
8	Evaluating the quality of the fabricated part in terms of surface finish and dimensional accuracy andestimating the cost of the part.

Term Work:

Term work shall consist of step files with screen clippings of every step and the 7^{th}experiments should have the physical product.

The distribution of marks for term work shall be as follows:

Laboratory .....25 marks

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course : Data Analytics Lab.</td><td colspan="3">Course Code: DJ19PEL604</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
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<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="5">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
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<tr><td colspan="5">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">25</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>25</td><td>--</td><td>25</td></tr>
</table>

Objective: The course will help the students to get familiar with:

1. Basics of Data Modelling.
2. Data Preprocessing Techniques
3. Supervised Learning Methods.
4. Unsupervised Learning Methods.
5. Dimensionality Reduction.
6. Ensemble Methods.

Outcomes: Learner should be able to:

1. Perform data cleaning and transformations on a given dataset.
2. Perform data modeling using regression and classification methods.
3. Apply dimensionality reduction on high dimensional datasets.
4. Apply the concepts of Neural Network on non-linear datasets.
5. Apply ensemble techniques for imbalance datasets.
6. Apply clustering techniques for unsupervised datasets.

Detailed Syllabus: (unit wise)	
Unit	**Description**
01	**Data Exploration**: Analyze different types of dataset (with continuous and discrete class labels) using statistical measures and graphs. Apply data cleaning and data transformation methods to prepare data for modelling. (At least two different types of datasets should be chosen by each student to perform statistical analysis and data cleaning)
02	**Regression & Decision Tree**: Analyze different algorithms used for modelling data sets with continuous or discrete class labels. Explore algorithms such as: linear regression, polynomial regression, logistic regression, decision tree using Gini index and CART. (At least four experiments on above mentioned algorithms specially on linear regression, logistic regression and decision tree)
03	**Dimensionality Reduction & KNN**: Explore feature extraction and feature transformation methods and analyze the effect using lazy learning algorithm (KNN). (Implement PCA on a dataset with high dimensionality and perform prediction using KNN)
04	**Neural Networks**: Explore the concept of perceptron, non-linear data, feed forward network, delta learning and back propagation algorithm. (Choose a dataset with high dimensionality, perform neural network using Tensor flow. Analyze the results by varying the error, optimizers, batch sizes and number of epochs)
05	**Ensemble Models**: Explore Random Forest, XG Boost algorithms and analyze the results for imbalanced datasets.(At least two experiments on ensemble models)
06	**Clustering**: Explore unsupervised datasets and appreciate clustering algorithms for grouping the datasets into different categories. (At least two experiments on clustering methods.)

Term Work:

Term work shall consist of programme's from every module.
Laboratory work ..... 25 Marks

Books Recommended:

Text books:

1. *Max Kuhu&Kjell Johnson, Applied Predictive Modelling by Springer Publication*
2. *Olson, David L., Wu, Desheng, Predictive Data Mining Models, Springer 2020*
3. *Andreas C. Muller & Sarah Guido, Introduction to Machine Learning with Python, Oreilly*
4. *Ai Publishing, Data Preprocessing with Python for Absolute Beginners: Step-by-Step Guide with Hands-on Projects and Exercises, APEX PERSUASION 2020*

Reference Books:

1. *Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, , Morgan Kaufmann Publishers*
2. *Alvaro Fuentes,Hands-On Predictive Analytics with Python: Master the Complete Predictive Analytics Process, from Problem Definition to Model Deployment*

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<table>
<tr><td colspan="5">Program: Third Year Production Engineering</td><td colspan="4">Semester : VI</td></tr>
<tr><td colspan="5">Course : Innovative Product Development - IV</td><td colspan="4">Course Code: DJ19ILL2</td></tr>
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<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="3">--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
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<tr><td>25</td><td>--</td><td>--</td><td>25</td><td>25</td><td>25</td></tr>
</table>

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcome: Learner will be able to:

- Identify the requirement for a product based on societal/research needs.
- Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
- Use standard norms of engineering concepts/practices in the design and development of an innovative product.
- Draw proper inferences through theoretical/ experimental/simulations and analyses the impact of the proposed method of design and development of the product.
- Develop interpersonal skills, while working as a member of the team or as the leader.
- Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
- Demonstrate product / project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for the proposed product design and development:

- Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department).
- Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members.
- Students in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
- Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
- Faculty supervisor may provide inputs to students during the entire span of the activity, spread over 2 semesters, wherein the main focus shall be on self-learning.
- A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.
- The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ Head of the department.
- The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over two semesters, i.e. during the semesters V and VI.

Guidelines for Assessment of the work:

- The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
- In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.
- Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:

i.	Marks awarded by the supervisor based on log-book	20
ii.	Marks awarded by review committee	20
iii.	Quality of the write-up	10

In the last review of the semester VI, the marks will be awarded as follows.

- Marks awarded by the supervisor (Considering technical paper writing) 30
- Marks awarded by the review committee 20

Review/progress monitoring committee may consider the following points during the assessment.

- In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.
  i. First shall be for finalization of the product selected.
  ii. Second shall be on finalization of the proposed design of the product.
- In the semester VI, the expected work shall be procurement of components/systems, building of the working prototype, testing and validation of the results based on work completed in semester V.
  i. First review is based on readiness of building the working prototype.
  ii. Second review shall be based on a presentation as well as the demonstration of the working model, during the last month of semester VI. This review will also look at the readiness of the proposed technical paper presentation of the team.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

The semester reviews (V and VI) may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

- The write-up should be prepared as per the guidelines given by the department.
- The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

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<table>
<tr><td colspan="8">Program: Third Year Production Engineering</td><td colspan="3">Semester: VI</td></tr>
<tr><td colspan="8">Course : Environmental Studies</td><td colspan="3">Course Code: DJ19A5</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td colspan="3">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">-</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation / Journal</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>--</td><td>-</td></tr>
</table>

Objectives:

1. Understand environmental issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Familiarise environment related legislation
3. To give insights into environment strategies for product lifecycle.

Outcomes: Students should be able to

1. Understand how human activities affect environment
2. Understand the various technology options that can make a difference
3. To gain the knowledge about environment strategies in product lifecycle.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Social Issues and Environment** • Ecological footprint and Carrying Capacity • Depleting nature of Environmental resources such as soil, water minerals and forests • Carbon emissions and Global Warming.	**4**
2	**Technological growth for Sustainable Development** • Social, Economicand Environmental aspects of Sustainable Development • Renewable Energy Harvesting • Concept of Carbon credit, Green Building • Power and functions of Central Pollution Control Board and State Pollution Control Board.	**4**
3	**Environment Aspect in Product lifecycle** • Need for Life Cycle Environmental Strategies • Useful Life Extension Strategies • End-of-Life Strategies • Introduction of Environmental Strategies into the Design Process. • Life Cycle Environmental Strategies and Considerations for Product Design.	**5**

Books Recommended:

Text books:

1. *Environmental Studies From Crisis to Cure, R. Rajagopaln, 2012*
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, ―Product Design for the environment-A life cycle approach, Taylor & Francis 2006, ISBN: 0849327229

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