



**Government of Karnataka**  
**DEPARTMENT OF COLLEGIATE AND TECHNICAL EDUCATION**

<b>Programme</b>	Mechanical Engineering Diploma	<b>Semester</b>	IV
<b>Course Code</b>	20ME43P	<b>Type of Course</b>	Programme Core
<b>Course Name</b>	<b>Product Design and Development</b>	<b>Contact Hours</b>	8 hours/week 104 hours/semester
<b>Teaching Scheme</b>	L:T:P :: 3:1:4	<b>Credits</b>	6
<b>CIE Marks</b>	60	<b>SEE Marks</b>	40

**1. Rationale:** Design department of industry is one of the major job areas for Diploma engineers. The fundamental knowledge of Strength of Materials, Engineering Materials, and Computer Aided Design and Drafting is essential to meet job requirement in this sector. To enable a student to work here, they should know how to design a simple machine element, usual procedures in development of product, fundamental knowledge in design of simple machine elements such as shafts, springs, couplings etc, codes, norms, standards and guidelines for selection of appropriate material. In addition to this, Diploma engineers are required to read and interpret the drawings. Therefore, it is essential that they have competency in preparing drawings of machine parts. This course aims at developing analytical abilities in the student to give solutions to simple engineering design problems using standard procedures. Hence this course has been introduced with the expectations that efforts will be made to provide appropriate learning experiences in the use of basic principles to the design solution for applied problems to develop the required skill and competencies.

**2. Course Outcomes/Skill Sets:** At the end of the Course, the student will be able to:

CO-01	Explain the key principles of product design considering Strength, Aesthetic and Ergonomic
CO-02	Design simple machine elements like shafts, springs, couplings and knuckle joints using standard data.
CO-03	Prepare CAD Part and Assembly drawings for couplings and knuckle joints based on designed parameter.
CO-04	Produce Component based on designed Parameters using 3- D Printing Techniques

**3. Course Content**

Week	CO	PO*	<b>Lecture (Knowledge)</b>	<b>Tutorial (Activity)</b>	<b>Practice (Skill)</b>
			3 hours/week	1 hour/week	4 hours/week (2hours/batch twice in a week)
1	01	01	<b>Product Development and Design:</b> 1.Explain Product Development- Stages of Product Development- Need and Feasibility study 2.Explain Development of design- Selection of Materials and Process 3.Explain Prototype –launching of product –Product life cycle	Ref Table 1	Discuss case studies of Product development by using Video
2	01	01	<b>General consideration in design:</b> Based on <ul style="list-style-type: none"> <li>Functional requirement</li> <li>Effect on environment</li> <li>Life, Reliability, Safety</li> </ul>	Ref Table 1	Case study

			<ul style="list-style-type: none"> <li>Principles of Standardization</li> <li>Assembly Feasibility</li> <li>Maintenance-Cost-Quantity</li> <li>Legal issues and Patents</li> <li>Aesthetic and Ergonomic factors</li> <li>Choice of Materials</li> <li>Feasibility of Manufacturing Processes</li> </ul>		
3	01	01	<b>Aesthetic and Ergonomic consideration in Design:</b> <ul style="list-style-type: none"> <li>Explain Aesthetic considerations- Basic types of product forms, Designing for appearance, shape, Design features, Materials, Finishes, proportions, Symmetry Contrast etc.</li> <li>Morgan's color code.</li> <li>Ergonomic considerations- Relation between man, machine and environmental factors. Design of displays and controls.</li> </ul>	Ref Table 1	Case Study on Ergonomics and Aesthetic design principles.
4	02	03,04	<b>Torsion of Shaft:</b> <ol style="list-style-type: none"> <li>Assumptions in Shear stress in a shaft subjected to torsion – Strength and Rigidity ( Solid and Hollow shaft)</li> <li>Power Transmitted by Solid and Hollow shaft - ASME and BIS Code for power Transmission</li> <li>Problems on Shafts subjected to only Shear based on Rigidity and Strength</li> </ol>	Ref Table 1	1. Validate the Problems on Shafts for Strength and Rigidity using Ansys (One each on Strength and Rigidity)
5	02	03,04	<ol style="list-style-type: none"> <li>Problems on Shafts subjected to only Shear based on Rigidity and Strength</li> <li>Problems on Shaft subjected to only Bending</li> <li>Problems on Shaft subjected to only Bending</li> </ol>	Ref Table 1	1. Recap of CAD commands  2. Practice on Section of Solids- a) Prisms b) Pyramid
6	02	03,04	<ol style="list-style-type: none"> <li>Problems on Shaft subjected to combined Shear and Bending.</li> <li>Problems on Shaft subjected to combined Shear and Bending</li> <li>Problems on Shaft subjected to combined Shear and Bending</li> </ol>	Ref Table 1	1. Practice on Section of Solids- a) Cylinder b) Cone
7	02,03	03,04	<b>Springs:</b> <ol style="list-style-type: none"> <li>Classification of springs- Application of springs- Leaf springs –Application</li> </ol>	Ref Table 1	Sections on Simple Machine Elements (CAD) a) Sectional front view, Front view with

			2. Terminology of Helical spring- Materials and Specification of springs 3. Design of helical spring		Right half in Section, Front view with Left half in Section b) Sectional Top View c) Sectional Side View
8	02,03	03,04	Design of helical spring	Ref Table 1	Sections on Simple Machine Elements (CAD) a) Sectional front view, Front view with Right half in Section, Front view with Left half in Section b) Sectional Top View c) Sectional Side View
9	02,03	03,04	<b>Coupling:</b> Design of Muff coupling	Ref Table 1	Using CAD, prepare Part Models for Muff coupling based on designed parameter and assemble the same. Extract the Sectional views for the above machine element indicating Surface Texture and Bill of Materials
10	02,03	03,04	Design of Protected type Flange Coupling	Ref Table 1	Using CAD, prepare Part Models for Protected type Flange Coupling based on designed parameter and assemble the same. Extract Sectional views for the above machine element indicating Surface Texture and Bill of Materials
11	02,03,	03,04,07	Design of Knuckle Joint		Using CAD, prepare Part Models for Knuckle Joint based on designed parameter and assemble the same. Extract Sectional views for the above machine element indicating Surface Texture and Bill of Materials
12	04	03,04,07	<b>3D Printing</b> 1. Introduction, Process, Classifications, Advantages of		



			<p>additive over conventional Manufacturing, Applications, Modelling for Additive Manufacturing</p> <p>2. Additive Manufacturing Techniques, 3D Printing Materials and its forms, Post Processing Requirement and Techniques.</p> <p>3. Product Quality, Inspection and Testing, Defects and their causes, Additive Manufacturing Application Domains</p>	Study the latest technological changes in this course and present the impact of these changes on industry	Preparation of 3D Printer for printing – Modelling, Saving CAD file into STL file, Slicing, Material loading and printing parameter selection
13	04	03,04,07	<p>1. Working of Fused Deposition Modelling (FDM) Machine- Single and Multi Nozzle printers, Machine Configuration- Cartesian, Delta, Polar and robotic arm configuration 3D printers</p> <p>2. Common FDM materials- PLA, ABS, PA, TPU,PETG, PEEK and PEI, Printer Parameters - Temperature of the nozzle and the platform, the build speed, the layer height, Warping, Layer Adhesion, Support Structure, In-fill &amp; Shell Thickness</p> <p>3. Benefits &amp; Limitations of FDM, Software Tools- 3D modelling, Slicers &amp; 3D Printer Hosts</p>		Printing of Designed and Modelled component (flange coupling and knuckle joint) on any available 3D printing machine and carryout post processing of additively manufactured product (Inspection and defect analysis).
<b>Total in hours</b>			<b>39</b>	<b>13</b>	<b>52</b>

- **\*PO= Program Outcome as listed and defined in year 1 curriculum**
- **Course Co-Ordinator must prepare PO – CO mapping with strength ( Low/Medium/High) before course planning**

**Table 1: Suggestive Activities for Tutorials:** (The List is only shared as an Example and not inclusive of all possible activities of the course. Student and Faculty are encouraged to choose activities that are relevant to the topic and on the availability of such resources at their institution)

Sl.No.	Suggestive Activities for Tutorials
01	<p>Presentation on design of Bicycles for Indian children focusing on Aesthetic and Ergonomics by Explaining market analysis- user study – Problem identification – Product design and specification- Concept generation- Material and Manufacturing Processes- Final concept selection</p> <p><a href="http://www.sastechjournal.com">www.sastechjournal.com</a></p>
02	<p>Presentation on types of suspension springs used in Automobile vehicles by explaining leaf-spring, Coil spring , Torsion Spring, Air bags , Rubber Springs</p> <p><a href="http://www.theengineerspost.com">www.theengineerspost.com</a></p>
03	<p>Presentation on different types of Keys used in Transmission system and importance such as parallel key, Saddle key, Sunk Key , Gib headed key, Feather Key, Woorruff Key with Advantages and applications</p>
04	<p>Presentation on Antifriction Bearing by explaining rolling contact- journal ball bearing construction- Cylindrical bearing – Needle bearing – Foot step Bearing – Plumber Bearing</p>

05	Presentation on Friction Clutches used in Automobiles by explaining parts- Single plate- Multi plate- Purpose –Application
06	The Role of Additive Manufacturing in the Era of Industry 4.0
07	Application of Additive Manufacturing in health care industry

#### 4. CIE and SEE Assessment Methodologies

Sl. No	Assessment	Test Week	Duration In minutes	Max marks	Conversion
1.	CIE-1 Written Test	5	80	30	Average of three tests 30
2.	CIE-2 Written Test	9	80	30	
3	CIE-3 Written Test	13	80	30	
4.	CIE-4 Skill Test-Practice	6	180	100	Average of two skill test reduced to <b>20</b>
5	CIE-5 Skill Test-Practice	12	180	100	
6	CIE-6 Portfolio continuous evaluation of Tutorial sessions through Rubrics	1-13		10	10
Total CIE Marks					60
Semester End Examination (Practice)			180	100	40
<b>Total Marks</b>					<b>100</b>

#### 5. Format for CIE written Test

Course Name	<b>Production Design and Development</b>	Test	I/II/III	Sem	IV
Course Code	<b>20ME43P</b>	Duration	80 Min	Marks	30
<b>Note:</b> Answer any one full question from each section. Each full question carries 10 marks.					
Section	Assessment Questions		Cognitive Levels(R/U/A)	Course Outcome	Marks
I	1				
	2				
II	3				
	4				
III	5				
	6				
Note for the Course coordinator: Each question may have one, two or three subdivisions. Optional questions in each section carry the same weightage of marks, Cognitive level and course outcomes.					

#### 5. (a) For CIE Skill Test -4

**Duration: 240 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	02	One Question on Design of Shaft Subjected to Strength and Rigidity <ul style="list-style-type: none"> <li>Fixing the Diameter of Shaft after design ---30 Marks</li> <li>Validate the Designed parameters of Shaft for Strength and Twisting using Ansys- 30 Marks</li> </ul>	60
2	03	One question on Section of Solids (Prism/Pyramid/Cone/Cylinder) <ul style="list-style-type: none"> <li>Placing the Section plane and drawing the section – 20 Marks</li> <li>Extracting the True shape of the Section – 10 Marks</li> </ul>	30
3	01,02,03	Portfolio evaluation based on the average of all Practice Sessions (1-6 Weeks)	10
<b>Total Marks</b>			<b>100</b>

SL. No.	CO	Particulars/Dimension	Marks
1	03,04	One Question on Design and Assembly drawing of Simple Machine parts like Muff Coupling/Flange Coupling/ Knuckle Joint <ul style="list-style-type: none"> <li>Design of Simple Machine part by using Data Hand Book --35 Marks</li> <li>Preparation of Part Models for the Designed values by using CAD Software -- 35 Marks</li> <li>Assembly of Part Models using CAD software With Bill of Materials - -20 Marks</li> </ul>	90
2	03,04	Portfolio evaluation based on the average of all Practice Sessions (7-12 Weeks)	10
<b>Total Marks</b>			<b>100</b>

### 6. Rubrics for Assessment of Activity (Qualitative Assessment)

Sl. No.	Dimension	Beginner	Intermediate	Good	Advanced	Expert	Students Score
		2	4	6	8	10	
1		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	8
2		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	6
3		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
4		Descriptor	Descriptor	Descriptor	Descriptor	Descriptor	2
Average Marks= (8+6+2+2)/4=4.5							5

**Note:** Dimension and Descriptor shall be defined by the respective course coordinator as per the activities

### 7. Reference:

Sl. No.	Description
1	A Text book of Machine Design R.S. Khurmi & J.K.Gupta S. Chand publication
2	Machine design S G Kulkarni McGraw Hill Education Publications
3	Introduction to Machine design V B Bhandari McGraw Hill Education Publications
4	Design Of Machine Elements Vol I, Vol II J.B.K. Das , P.L.Srinivas Murthy Sapna Publication
5	Machine Component Design William Orthwein Jaico publication
6	Design Data Hand Book for Mechanical Engineers K Mahadevan & K Balaveera Reddy CBS publications
7	Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi.
8	J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013
9	D.T. Pham and S.S. Dimov, "Rapid manufacturing: The technologies and applications of rapid prototyping and rapid tooling", London-New York, Springer, 2001
10	Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
11	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
12	CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017



13	L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001
14	Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012

## 8. LIST SOFTWARES/WEBSITES

1. [http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left\\_home.html](http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_home.html)
2. [http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left\\_mod4.html](http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/left_mod4.html)

## 9. SEE Scheme of Evaluation

**Duration: 180 Min**

SL. No.	CO	Particulars/Dimension	Marks
1	02,03	One Question on Design and Assembly of Simple Machine parts like Muff coupling/Flange Coupling/ Knuckle Joint <ul style="list-style-type: none"> <li>• Design of Simple Machine part by using Data Hand Book -----35 Marks</li> <li>• Preparation of Part Models for the Designed valves By using CAD Software —25 Marks</li> <li>• Assembly of Part Models By using CAD Software With Bill of Materials---20 Marks</li> </ul>	80
2	01,02,03,04	Viva voce	20
	<b>Total Marks</b>		<b>100</b>

## 10. Equipment/software list with Specification for a batch of 20 students

Sl. No.	Particulars	Specification	Quantity
01	Latest version of CAD software	-----	20 user
02	Desk top computer	Latest configuration	20 no's
03	Laser printer	-----	02 no's
04	3-D Printing Machine		01 no