2022-23

MECHANICAL ENGINEERING

DESIGN OF MACHINE ELEMENTS - 2

PREPARED BY
Mr. Abhishek Sharma

Techno India NJR Institute of Technology

Session 2022-23

Course File

DME-II (6ME4- 04)

Abhishek Sharma
(Assistant Professor)
Department of Mechanical

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

3rd Year - VI Semester: B.Tech. : Mechanical Engineering

6ME4-04: DESIGN OF MACHINE ELEMENTS- II

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	1
2	Fatigue Considerations in Design: Variable load, loading pattern, endurance stresses, Influence of size, surface finish, notch sensitivity and stress concentration.	3
	Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses.	3
	Design for finite life, Design of Shafts under Variable Stresses, Bolts subjected to variable stresses.	2
3	Design of IC Engine components: Piston, Cylinder, Connecting Rod and Crank Shaft.	8
4	Design of helical compression, tension, torsional springs, springs under variable stresses.	4
	Design of belt, rope and pulley drive system,	4
5	Design of gear teeth: Lewis and Buckingham equations, wear and dynamic load considerations.	4
	Design and force analysis of spur, helical, bevel and worm gears, Bearing reactions due to gear tooth forces.	4
6	Design of Sliding and Journal Bearing: Methods of lubrication, hydrodynamic, hydrostatic, boundary etc. Minimum film thickness and thermal equilibrium.	4
	Selection of anti-friction bearings for different loads and load cycles, Mounting of the bearings, Method of lubrication.	4
	TOTAL	41

Course Overview:

Student shall gain appreciation and understanding of the design function in Mechanical Engineering, different steps involved in designing and the relation of design activity with manufacturing activity.

The student shall learn to choose proper materials for different machine elements depending on their physical and mechanical properties. They will learn to apply the knowledge of material science in real life situations.

Student shall gain a thorough understanding of the different types of failure modes and criteria. They will be conversant with various failure theories and be able to judge which criterion is to be applied for a particular situation.

Student shall gain design knowledge of the different types of elements used in the machine design process, for e.g. bearing, gear, i.c.engine etc. and will be able to design these elements for each application.

Course Outcomes:

CO. NO.	Cognitive Level	Course Outcome
1	Synthesis	Ability to design mechanical system for fluctuating loads.
2	Synthesis	Ability to decide optimum design parameters for mechanical systems.
3	Design	Ability to analyze the stress and strain of mechanical components and understand, identify and quantify failure modes for mechanical part.
4	Design	Enhancement in proficiency of CAD software for designing Mechanical systems and to generate production drawing.
5	Design	Making actual models of machine elemnts like bearings, gears connecting rod with all calculations.

Course Outcome Mapping with Program Outcome:

Course Outcome	Program Outcomes (PO's)	
CO. NO.	Domain Specific (PSO)	Domain Independent (PO)

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	0	2	2	1	0	0	1	1	0	1
CO2	1	1	1	2	1	1	0	0	1	1	0	1
CO3	2	1	1	1	0	0	0	0	1	0	0	0
CO4	3	1	1	1	1	0	0	0	0	1	0	0
C05	3	2	3	2	2	0	0	0	0	1	0	1
Average	2.20	1.20	1.20	1.60	1.20	0.40	0.00	0.00	0.60	0.80	0.00	0.60

Course Coverage Module Wise

Lecture No.	Unit	Topic
1	**1**	Introduction: Objective, scope and outcome of the course.
2	**2**	Fatigue Considerations in Design: Variable load, loading pattern,
3	2	endurance stresses, Influence of size, surface finish
4	2	notch sensitivity and stress concentration.
5	2	Goodman line, Soderberg line,
6	2	Design of machine members subjected to combined, steady and alternating stresses.
7	2	Design for finite life,
8	2	Design of Shafts under Variable Stresses, Bolts subjected to variable stresses.
9	2	Numerical
10	2	Numerical
11	3	Design of IC Engine components:- I*ntroduction*
12	3	Design of Cylinder
13	3	Numerical -design of cylinder
14	3	Design of Connecting rod
15	3	Numerical -design of connecting rod
16	3	Design of piston
17	3	Numerical – design of piston

18	3	Design of crankshaft
19	3	Design of crankshaft
20	3	Numerical – design of crankshaft
21	4	Design of helical compression,
22	4	tension, torsional springs,
23	4	, springs under variable stresses.
24	4	Design of belt ,
25	4	rope and pulley drive system
26	4	Numerical
27	4	Numerical
28	4	Numerical
29	5	Design of gear teeth: Lewis and Buckingham equations,
30	5	wear and dynamic load considerations.
31	5	Design and force analysis of spur
32	5	helical, bevel and worm gears
33	5	Bearing reactions due to gear tooth forces.
34	5	Numericals
35	5	Numericals
36	5	Numericals
37	6	Design of Sliding and Journal Bearing:
38	6	Methods of lubrication, hydrodynamic, hydrostatic, boundary etc
39	6	Minimum film thickness and thermal equilibrium.
40	6	Selection of anti-friction bearings for different loads and load cycles,
41	6	Mounting of the bearings,
42	6	Method of lubrication.
43	6	Numericals
44	6	Numericals
45	6	Numericals

TEXT/REFERENCE BOOKS

1. Design of machine element by R.S.khurmi
2. Design of Machine elements by V.B.bhandari
3. Machine design by shigley.

Assessment Methodology:

1. Practical exam in lab where they have to prepare practical model related to design of machine element.(Once in a week)
2. Assignments one from each unit.
3. Midterm subjective paper where they have to attempt numericals.
4. Final paper at the end of the semester subjective.

Teaching and Learning resources unit-wise:

Unit-1

Introduction, Objective & scope of the course

Video Tutorials: https://www.youtube.com/watch?v=g3Vj7uO86ps

Theory conchttps: https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz:
https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

Unit-2

A. Fatigue consideration in design

Video Tutorials:https://www.youtube.com/watch?v=p41LFsvxhqo

Theory concepts:https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz:
https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

B.Design of machine members subjected to combined, steady and alternating stresses

Video Tutorials:https://www.youtube.com/watch?v=1M_Nh7aGJtU

Theory concept:- https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz:
https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

Unit-3

A. I.C.engine element Introduction

Video Tutorials:https://www.youtube.com/watch?v=fw8Jfoif1BM

Theory concepts:https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz:
https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

B. Design of cylinder, connecting rod, crankshaft.

Video Tutorials:https://www.youtube.com/watch?v=ZwqBia_gRGo&list=PLg9TnucUbzBW3tt1AtCBxcz6Hr1YqQYwQ

Theory concepts:https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz:https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

Unit-4

A. Design of spring elements

Video Tutorials: https://www.youtube.com/watch?v=yQBmD7ZrVV4

Theory concepts:https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz:
https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

B. Design of belt, rope , chain drive

Video Tutorials: https://www.youtube.com/watch?v=4JV1oxBHnT0

Theory concepts:https://nptel.ac.in/courses/112/106/112106137/

Sample
Quiz:https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

Unit-5

A. Introduction to gear

Video Tutorials: https://www.youtube.com/watch?v=QTCqDT7qEwo

Theory concepts: https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz: https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

B. Design of various gears.

Video Tutorials: https://www.youtube.com/watch?v=VWkAp4MmuZ8

Theory concepts: https://nptel.ac.in/courses/112/106/112106137/

Sample Quiz: https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

Unit-6

C. Introduction to bearings

Video Tutorials: https://www.youtube.com/watch?v=lNzERgqHCwM

Theory concepts: http://ecoursesonline.iasri.res.in/mod/page/view.php?id=2430

Sample Quiz: https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

D. Design of various bearings

Video Tutorials: https://www.youtube.com/watch?v=U6MYvY0ST8Q

Theory concepts: https://www.learnthermo.com/T1-tutorial/ch09/lesson-C/pg10.php

Sample Quiz: https://www.examveda.com/mechanical-engineering/practice-mcq-question-on-machine-design/

Previous Year Question Papers:

6E7011

Roll No. _____ [Total No. of Pages : 2]

6E7011

B.Tech. VI Semester (Main/Back) Examination, April/May - 2017
Mech. Engg.
6ME1A Design of m/c Element II
AE, ME, PI

Time : 3 Hours **Maximum Marks : 80**
Min. Passing Marks : 26

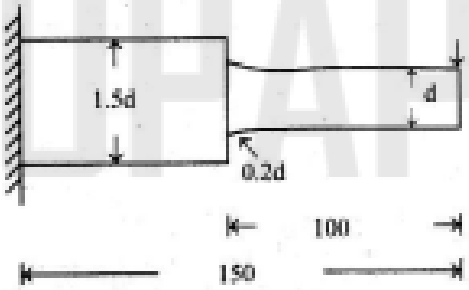
Instructions to Candidates:

*Attempt any **five questions**, selecting **one question** from **each unit**. All questions carry **equal** marks. (Schematic diagrams must be shown wherever necessary. Any data you feel missing suitable be assumed and stated clearly. Units of quantities used/calculated must be stated clearly.*

Unit-I

1. a) Explain modified goodman diagram for bending stresses. **(6)**

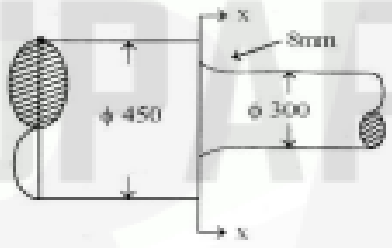
b) A cantilever beam made of cord drawn steel 40C8 (S_{ut} = 600N/mm² and S_{yt} = 380 N/mm²) as shown in fig. The force P acting at the free end varies from – 50N to + 150N. The expected Reliability is 90% and factor of safety is 2. Notch sensitivity at fillet is 0.9. Determine diameter of beam at the fillet cross section. **(10)**



(OR)

1. a) What is endurance strength? Draw S-N diagram, What are the factors that affect endurance strength. **(8)**

   b) The section of a steel shaft is shown in fig



The shaft is machined by a turning process. The section x-x is subjected to a constant bending moment of 500kN-m, the shaft material has $S_{ut} = 500MN/m^2$ & $S_{yt} = 350MN/m^2$ and endurance limit in bending for 7.5mm diameter specimen of 210 MN/m^2. Notch sensitivity is 0.8. Expected reliability is 90%. Determine life of shaft. Theoretical stress concentration factor can be taken from tabulated values. **(8)**

r/d	0.025	0.05	0.1
k_t	2.6	2.05	1.66

Unit-II

2. a) Explain Buckling of connecting rod. also prove for connecting rod cross section that $3.2\ I_{yy} = I_{xx}$. **(6)**

   b) Design a connecting rod for a high speed I.C engine using following data.

   Cylinder bore = 125mm, length of connecting rod = 300mm

b) A railway wagon moving at a velocity of 1.5m/s is brought to rest by a bumper consisting of two helical springs arranged in parallel. The mass of wagon is 1500kg. The springs are compressed by 150mm is bringing the Wagon to rest. The spring index can be taken as 6. The springs are made of oil hardened and tempered Steel wire with S_{ut} = 1250 N/mm² and modulus of rigidity = 81370N/mm². The permissible shear stress for spring wire can be taken as 50% of S_{ut}. Design spring and calculate. **(10)**

i) Wire diameter

ii) Mean coil diameter

iii) Number of active coils

iv) Total number of coils

v) Solid length

vi) Free length

vii) Pitch of coil

viii) Required spring rate

ix) Actual spring rate

(OR)

3. a) Prove that for Belt drive - **(8)**

$$\frac{P_1 - mv^2}{P_2 - mv^2} = e^{\mu\theta}$$

Where P_1 and P_2 are tension in tight and slack side

$\mu \rightarrow$ coefficient of friction

$\theta \rightarrow$ Angle of lap

$m \rightarrow$ mass per meter of belt

b) It is required to design a V-Belt drive to connect a 7.5kW, 1440 rpm induction motor to a fan, running at approximately 480rpm, for a service of 24h/day. Space available for a center distance is about 1m. **(8)**

Unit-IV

4. a) Derive lewis equation for Beam strength of gear. **(6)**

b) It is required to design a pair of spur gear with 20° full depth involute teeth consisting of 20 teeth pinion meshing with 50 tooth gear. The pinion shaft is connected to a 22.5kW, 1450rpm electric motor. The starting torque of motor can be taken as 150% of rated torque. The material for pinion is plain carbon steel Fe410 (S_{ut} = 410N/mm²). While gear made of grey cast iron FG200 (S_{ut} = 200N/mm²). Factor of safety = 1.5, design of gear based on Lewis equation & using velocity factor to account for dynamic load. **(10)**

(OR)

4. a) Explain following : **(8)**

i) Herring bone-gear

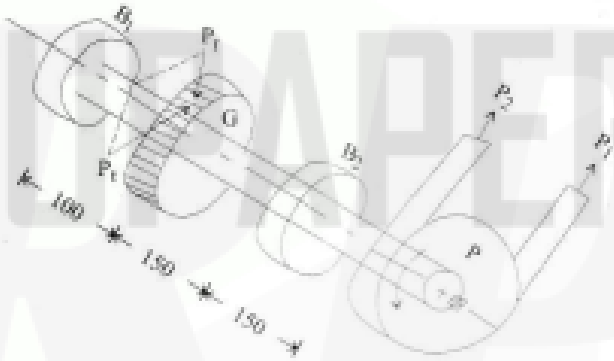
ii) Wear strength of helical gear

b) A pair of parallel helical gears consisting of a 20teeth pinion meshing with a 100 teeth gear. The pinion rotates at 720rpm. The normal pr. angle is 20°. While helix angle is 25°. The face width is 40mm and the normal module is 4mm. The pinion as well as gear made of 40C8 (S_{ut} = 600N/mm²). and heat treated to surface hardness of 300BHN. The service factor and factor of safety are 1.5 and 2 respectively. Assume velocity factor account for dynamic load and calculate power transmitting capacity of gears. **(8)**

Unit-V

5. a) Write short note on Mounting of Bearings. **(6)**

b) A transmission shaft rotating at 720rpm and transmitting power from the pulley p to the spur gear G as shown in fig. the Belt tensions and gear tooth forces are as follows P_1 = 498N, P_2 = 166N, P_t = 497N, P_r = 181N. The weight of the pulley is 100N. The diameter of shaft at Bearing B_1 & B_2 is 10mm & 20mm respectively. The load factor is 2.5and the expected life for 90% of Bearing is 8000 hrs. Select single row deep groove ball bearings at B_1 & B_2. **(10)**



(OR)

5. a) Derive Petroff's equation for sliding contact Bearings. **(8)**

b) The following data is given for a 360° Hydrodynamic bearings.

radial load = 10kN

Viscosity of Lub. = 30 mPa–S

Journal speed = 1440 rpm

Unit Bearing pr. = 1000 kPa

Clearance ratio (r/c) = 800

Assuming that the total heat generated in the bearing is carried by the total oil flow in the bearing calculate - **(8)**

i) Dimensions of bearings

ii) Coeff. of friction

iii) Power lost in friction

iv) Total oil flow

v) Side leakage and

vi) Temperature rise