Roll No.

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B. Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, APRIL/ MAY 2024

Department of Mechanical Engineering
(Offered to Department of Manufacturing Engineering and Department of Industrial Engineering)

V Semester

ME5553 MACHINE DESIGN

(Regulation 2019)

(Note: Use of PSG Design Data book may be permitted in the examination hall)

Time: 3hrs   Max. Marks: 100

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

CO 1   Design machine members subjected to static loads.
CO 2   Design shafts, couplings, welded joints, riveted joints and bearings for various applications.
CO 3   Design helical springs, flywheels, connecting rods and crankshafts for various applications.
CO 4   Design flexible elements like belt, ropes and chain drives for engineering applications.
CO 5   Design spur, helical gear drives and multi speed gear box for power transmission.

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analyzing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)

(Answer all the Questions)

Q. No	Questions	Marks	CO	BL
1	Pen down any four generalized design rules which are to be followed while planning for design.	2	1	L1
2	What do you mean by bilateral tolerance? Give an example.	2	1	L2
3	Identify and comment on the failure theory which is predominantly used for designing a component using the Cast Iron material?	2	2	L2
4	What do you mean by the dynamic load carrying capacity of a bearing?	2	2	L2
5	Differentiate between the close-coiled and open-coiled helical springs.	2	3	L2
6	Write a note on side crankshaft with a suitable sketch.	2	3	L2
7	List down the advantages of rigid drives over flexible drives.	2	4	L2
8	What do you meant by belt's creep and sagging?	2	4	L1
9	Contrast the sliding mesh and constant mesh gear box.	2	5	L2
10	In what aspect the pinion is to be designed in high speed geared transmission?	2	5	L2

PART- B (5 x 13 = 65 Marks)

| Q. No	Questions	Marks	CO	BL
11 (a)	Two plates, subjected to a tensile force of 50 kN, are fixed together by means of three rivets as shown in Fig. The plates and rivets are made of plain carbon steel 10C4 with a tensile yield strength of 250 N/mm^2. The yield strength in shear is 50% of the tensile yield strength, and the factor of safety is 2.5. Neglecting stress concentration, determine: (i) the diameter of the rivets; and (ii) the thickness of the plates.	13	1	L4
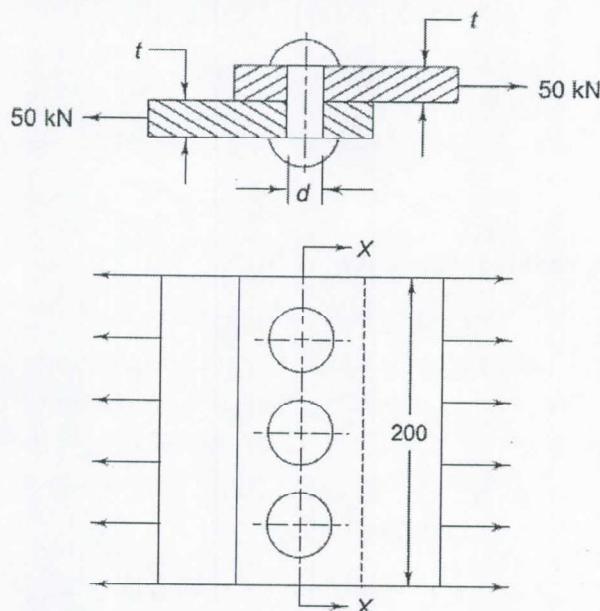
Figure 1: A riveted joint

OR

|				
11 (b)	A C-frame subjected to a force of 15kN is shown in Fig. 2. It is made of grey cast iron FG 300 and the factor of safety is 2.5. Determine the dimensions of the cross section of the frame. Use Rankine's theory.	13	1	L4
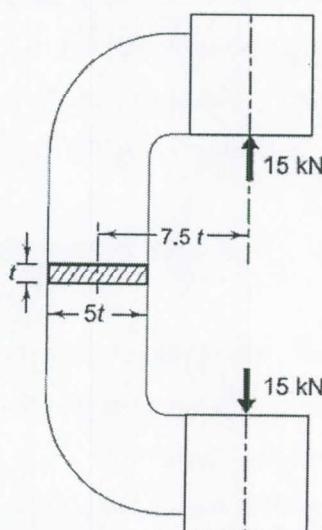
Figure 2: A 'C' Frame
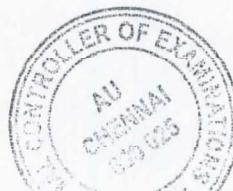
12 (a)	A rigid coupling is used to transmit 50 kW power at 300 rpm. There are six bolts. The outer diameter of the flanges is 200 mm, while the recess diameter is 150 mm. The coefficient of friction between the flanges is 0.15. The bolts are made of steel 45C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 3. Determine the diameter of the bolts. Assume that the bolts are fitted in large clearance holes.	**13**	2	L4

OR

|				
12 (b)	A steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Fig. 3. The bolts are made from plain carbon steel 45C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 3. Specify the size of bolts.	**13**	2	L4
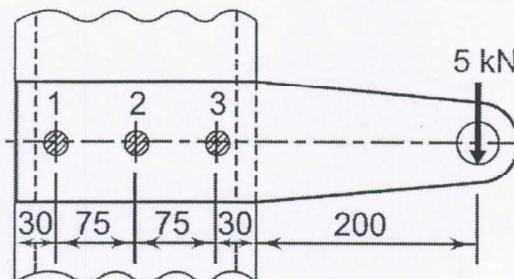
Figure 3: A Bolted connection

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13 (a)	An automotive single plate clutch consists of two pairs of friction surfaces, one between the friction lining and the pressure plate and the other between the friction lining and the flywheel as shown in Fig. 4. Eight identical helical compression springs, arranged in parallel, provide the required axial thrust on the friction surface. The total spring force exerted by all springs is 2400 N and the corresponding deflection of each spring is approximately 15 mm. The spring index can be taken as 8. The springs are made of patented and cold-drawn steel wire with ultimate tensile strength of 1390 N/mm^2 and modulus of rigidity of 81370 N/mm^2. The permissible shear stress for the spring wire can be taken as 30% of the ultimate tensile strength. Design the spring.	**13**	3	L4
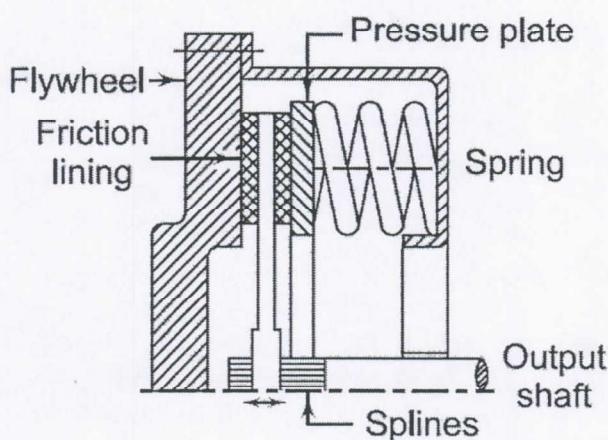
Figure 4: Single plate clutch and spring assembly

OR

13 (b) Determine the dimensions of cross-section of the connecting rod   **13**   3   L4
for a diesel engine with the following data:
Cylinder bore = 100 mm;
Length of connecting rod = 350 mm;
Maximum gas pressure = 3 MPa; and
Factor of safety = 5
[Note: Design for I Section as shown in Fig. 5]
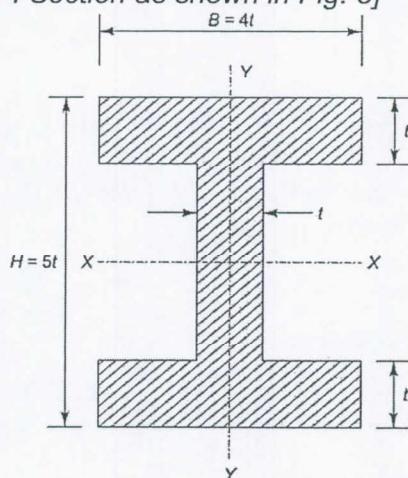
Figure 5: I section proportion with respect to web thickness 't'

14 (a) The layout of a leather belt drive transmitting 15 kW of power is   **13**   4   L4
shown in Fig. 6. The centre distance between the pulleys is twice
the diameter of the bigger pulley. The belt should operate at a
velocity of 20 m/s approximately and the stresses in the belt
should not exceed 2.25 N/mm^2. The density of leather is
0.95g/cc and the coefficient of friction is 0.35. The thickness of
the belt is 5 mm. Calculate:
  (i)   the diameter of pulleys;
  (ii)   the length and width of the belt; and
 (iii)   the belt tensions.
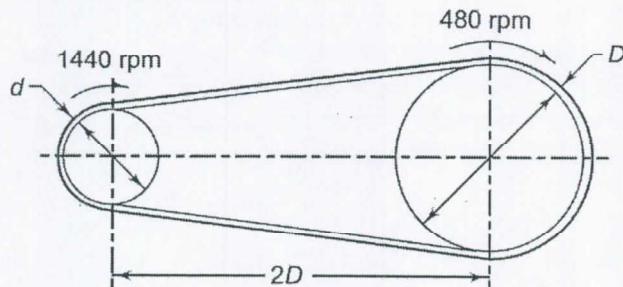
Figure 6: A belt drive

OR

14 (b) A temporary elevator is assembled at the construction site to   **13**   4   L4
raise building materials, such as cement, to a height of 20 m. It is
estimated that the maximum weight of the material to be raised is
5 kN. It is observed that the acceleration in such applications is 1
m/s2. 10 mm diameter, 6 × 19 construction wire ropes with fibre
core are used for this application. The tensile designation of the
wire is 1570 and the factor of safety should be 10 for preliminary
calculations. Determine the number of wire ropes required for this
application. Neglect bending stresses.

15 (a)	A pair of spur gears consists of a 20 teeth pinion meshing with a 120 teeth gear. The module is 4 mm. Calculate:	13	5	L4
	(i) the centre distance;			
	(ii) the pitch circle diameters of the pinion and the gear;			
	(iii) the addendum and dedendum;			
	(iv) the tooth thickness;			
	(v) the bottom clearance; and			
	(vi) the gear ratio.			

OR

| 15 (b) | Design a 9 speed gearbox for an all geared headstock of a lathe. Maximum and minimum speeds are 600 r.p.m. and 25 r.p.m. respectively. The drive is from an electric motor giving 2 kW at 1440 r.p.m. | 13 | 5 | L4 |

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

| Q. No	Questions	Marks	CO	BL
16.	The Fig. 7 shows a shaft supported by two bearings placed 1 m apart. A 600 mm diameter pulley is mounted at a distance of 0.3m to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 2.25 kN. Another pulley 0.4 m diameter is placed 0.2 m to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulleys is 180° and $\mu = 0.24$. Determine the suitable diameter for a solid shaft, allowing working stress of 63MPa in tension and 42MPa in shear for the material of shaft. Assume that the torque on one pulley is equal to that on the other pulley.	5	2	L5
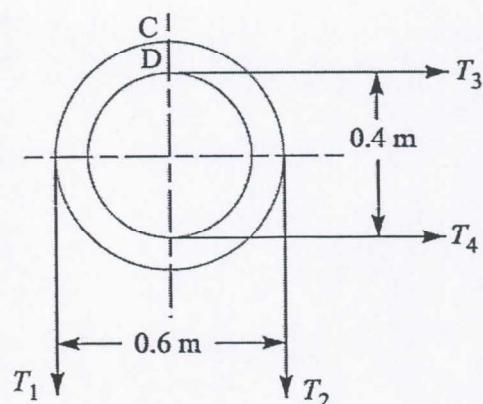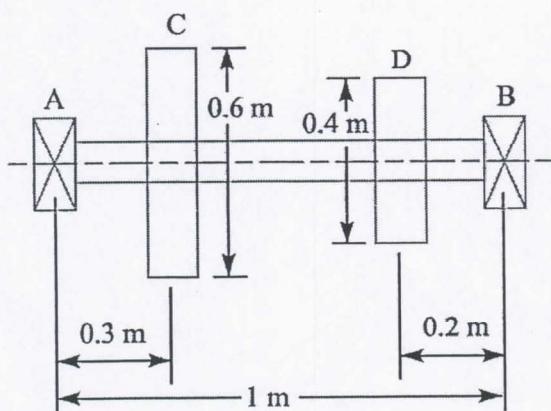
Figure 7: Shaft with pulleys and bearings