

Department of Mechanical Engineering
NIT Hamirpur (H.P.)
End Semester Examination
(Nov. 16, 2023: Thursday)

Class: B.Tech. 5th Semester
Subject: Machine Design-I (ME-311)

Max. Marks: 50
Time Allowed: 3 hrs.

Instructions to the candidates:

- i All questions are compulsory.
- ii Draw neat sketch and label it properly wherever necessary.
- iii Define clearly the notations used in the questions before use.
- iv Relevant pages of approved data book will be provided. Any missing data may be suitably assumed.

1. a) How will you find the allowable stress for brittle parts using factor of safety?
- b) A commercial steel shaft 1.4m long supported between bearings (Fig.1) carries a pulley of diameter 600mm weighing 1 kN located 400mm to the right of the right hand bearing and receives 25kW at 1000rpm by a horizontal belt drive. The power from the shaft is transmitted by a spur pinion of 20° pressure angle having pitch circle diameter 200mm to a spur gear such that the tangential force on the gear acts vertically upwards. The pinion is keyed to the shaft at 200mm to the right of the left end bearing. Taking the ratio of belt tensions as 3, factors k_b and k_t as 1.5 and $F_r = F_t \tan(20^\circ)$, design the shaft required. (1, 9)

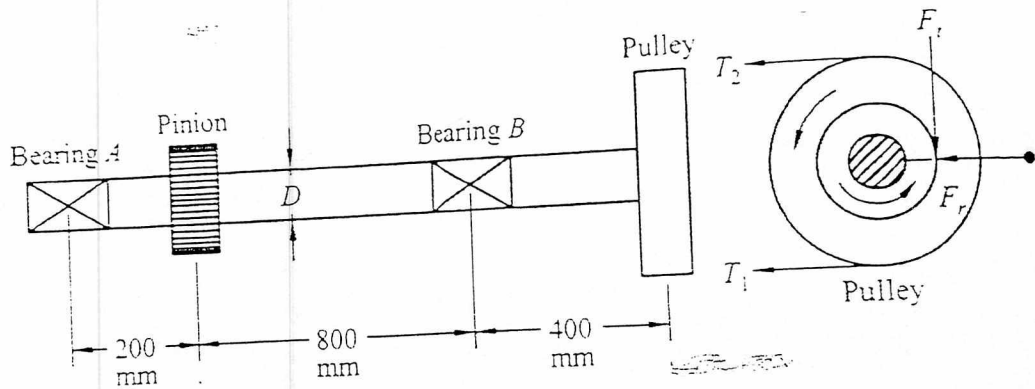


Fig. 1

2. a) When shall you recommend a flexible coupling for connecting the shafts?
- b) Design and sketch a cotter joint of socket and spigot type to sustain an axial load of 100 kN. The material selected for the joint has the following design stresses: $\sigma_t = 120$ MPa, $\sigma_c = 160$ MPa and $\tau = 80$ MPa. (2, 8)

3. a) What are primary and secondary shear stresses in eccentrically loaded welded joints?
b) Design and sketch the longitudinal joint for a Cornish boiler whose inner diameter is 1,680 mm and the pressure of steam is 2.1 MPa gauge. The joint is triple riveted butt joint with an efficiency of about 85%. The pitch in the outer row of the rivets is to be double of that in the inner rows and width of the cover plates is unequal. The ultimate tensile stress for the plates is 470 N/mm^2 , the ultimate crushing stress is 780 N/mm^2 and the ultimate shear stress is 390 N/mm^2 . Factor of safety is to be 5.

(2, 8)

4. a) How does helical torsion spring differ from helical compression spring?
b) A semi-elliptical laminated spring is to carry a load of 5000N and consists of 8 leaves 46 mm wide, two of the leaves being of full length. The spring is to be made 1000 mm between the eyes and is held at the centre by a 60 mm wide band. Assume that the spring is initially stressed so as to induce equal stress of 500 N/mm^2 when fully loaded. Design the spring giving (i) thickness of leaves, (ii) eye diameter, (iii) length of leaves and (iv) maximum deflection. Assume $E = 2.1 \times 10^5 \text{ N/mm}^2$.

(2, 8)

5. a) Why is piston pin located at or above the middle of skirt length?
b) Design the connecting rod of a four-stroke diesel engine for the following data:
Cylinder bore = 75 mm, Stroke = 100 mm, Weight of reciprocating parts = 1.5 kg,
Speed = 2000 rpm, Obliquity ratio = 4.5, Maximum explosion pressure = 2 N/mm^2 ,
Factor of safety = 5, $\sigma_y = 300 \text{ N/mm}^2$. Assume suitable values of bending stress for pin and small end. Choose I-section for the connecting rod.

(1, 9)
