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Total Number of Pages : 03

Course: B.Tech  
Sub\_Code: RME6C001

6<sup>th</sup> Semester Regular / Back Examination: 2022-23

SUBJECT: Design of Machine Elements

BRANCH(S): MMEAM, MECH

Time : 3 Hour

Max Marks : 100

Q.Code : M496

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

**Part-I**

**Q1 Answer the following questions: (2 x 10)**

- Mention four important factors that influence the magnitude of factor of safety.
- What are preferred numbers?
- Mention four method used to reduce stress concentration.
- A shaft transmits 6 kW at 240 rpm. The maximum twisting moment exceeds the mean value by 30%. Determine the diameter of the shaft, if the permissible shear stress for the shaft material is 45 MPa.
- What is meant by the efficiency of a riveted joint?
- Name the modes of failure of a cotter in the cotter joint and mention the role of gib in a cotter joint.
- What should be the suitable materials for spring design?
- A leaf spring with graduated leaves is a beam of uniform strength. Explain
- What is "Nipping in leaf springs"?
- A bore is made in a solid shaft, in order to reduce its weight to 60%. What will be the percentage reduction in its torsional strength?

**Part-II**

**Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) (6 x 8)**

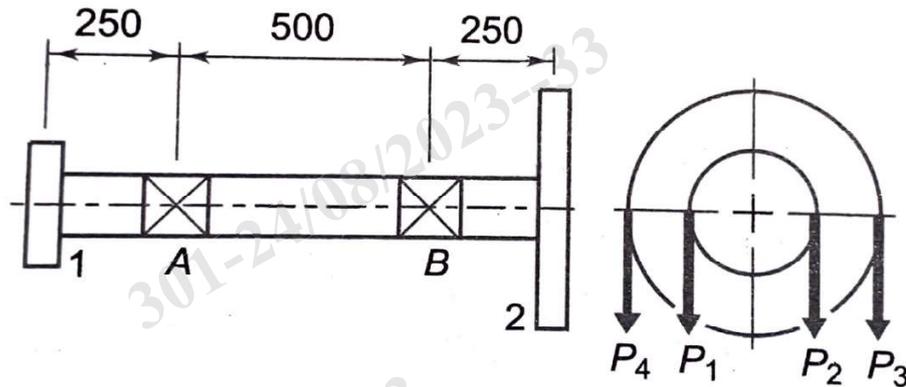
- What are basic steps involved in design of machine components? Discuss briefly.
- State the following theories of failure and their use
  - Maximum principal stress theory of failure
  - Maximum shear stress theory of failure
- A steel shaft of 60 mm diameter is subjected to a bending moment of 12 kN-m and a torque T. If the yield point of the steel in tension is  $910 \text{ N/mm}^2$ , find the maximum value of this torque without causing yielding of the shaft according to maximum distortion energy theory.
- Two steel shafts of 50 mm diameter are connected by means of a flange coupling. The flanges are welded on the shaft ends. Determine the size of the welds required on the surface of each shaft, both on the inner and outer faces of the flange, to transmit full torque capacity of the shafts. Assume the permissible shear stress in the shaft is 60 MPa, and that in the weld is 95 MPa.

- e) A plate of 100mm wide and 10mm thick is to be welded with another plate by means of transverse welds at the ends. If the plates are subjected to a load of 70kN, find the size of weld for static as well as fatigue load. The permissible tensile stress should not exceed 70 MPa.
- f) Sketch two views of a knuckle joint and write the equations showing the strength of joint for the most probable modes of failure.
- g) A double riveted double cover butt joint in plates 20 mm thick is made with 25 mm diameter rivets at 100 mm pitch. The permissible stresses are  $\sigma_t = 120\text{MPa}$ ;  $\tau = 100\text{MPa}$ ; and  $\sigma_c = 150\text{MPa}$ . Find the efficiency of joint, taking the strength of the rivet in double shear as twice than that of single shear.
- h) A single riveted lap joint is made in 15 mm thick plates with 20mm diameter rivets. Determine the strength of the joint, if the pitch of rivets is 60mm. Take  $\sigma_t = 120\text{MPa}$ ;  $\tau = 80\text{MPa}$ ; and  $\sigma_c = 160\text{MPa}$ .
- i) A knuckle joint is required to withstand a tensile load of 25 kN. Design the joint if the permissible stresses are  $\sigma_t = 56\text{MPa}$ ;  $\tau = 40\text{MPa}$ ; and  $\sigma_c = 70\text{MPa}$ .
- j) A journal bearing, 100mm in diameter and 150mm long; carries a radial load of 7kN at 1200rpm. The diametral clearance is 0.075 mm. Find the viscosity of the oil being used at the operating temperature, if 1.2kW power is wasted in friction.
- k) Explain what do you understand by A.M. Wahl's factor and state its importance in the design of helical springs?
- l) A closely coiled helical spring is made of 10 mm diameter steel wire, the coil consisting of 10 complete turns with a mean diameter of 120 mm. The spring carries an axial pull of 200 N. Determine the shear stress induced in the spring neglecting the effect of stress concentration, Determine also the deflection in the spring, its stiffness and strain energy stored by it if the modulus of rigidity of the material is 80 kN / mm<sup>2</sup>.

### Part-III

#### Only Long Answer Type Questions (Answer Any Two out of Four)

- Q3** The layout of a shaft carrying two pulleys 1 and 2, and supported on two bearing A and B is shown in figure below. The shaft transmits 7.5kW power at 360 rpm from the pulley 1 to the pulley 2. The diameters of pulley 1 and 2 are 250 mm and 500 mm and respectively. The masses of pulleys 1 and 2 are 10 kg and 30kg respectively. The belt tension act vertically downward and the ratio of belt tension on the tight side to slack side for each pulley is 2.5:1. The shaft is made of plain carbon steel 40C8 ( $\sigma_{yt} = 380 \text{ N/mm}^2$ ) and the factor of safety is 3. Estimate suitable diameter of shaft. If the permissible angle of twist is 0.5° per metre length, calculate the shaft diameter on the basic of torsional rigidity. Assume  $G = 79300 \text{ N/mm}^2$ . (12)



(i) Differentiate between cotter joint and knuckle joint. (2+2)

(ii) Name the modes of failure of knuckle pin.

- Q4 a)** The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5kN. Find the diameter of the bolt required according to any three theories of failure. Take permissible tensile stress at elastic limit=100MPa and Poisson's ratio = 0.3. (8)
- b)** Determine the diameter of a circular rod made of ductile material with a fatigue strength (complete stress reversals),  $\sigma_e = 265$  MPa and a tensile yield strength of 350 MPa. The member is subjected to a varying axial load from  $W_{\min} = -300 \times 10^3$  N to  $W_{\max} = 700 \times 10^3$  N and has a stress concentration factor = 1.8. Use factor of safety as 2.0. (8)
- Q5 a)** Determine rivet diameter, rivet pitch, distance between rows of rivets, strap thickness, and efficiency of a triple riveted double strap, chain butt joint, to join two plates of 15 mm thick. The permissible stresses are:  $\sigma_t = 80$ MPa,  $\sigma_c = 120$ MPa, and  $\tau = 60$ MPa. (8)
- b)** A boiler is made by welding the plates longitudinally and circumferentially. The diameter of the boiler is 1m. The maximum pressure is 1.5 N/mm<sup>2</sup>. Design both the joints, using single-V butt weld for both the joints. The permissible tensile stress in the plate material is 70 MPa. Assume the efficiency of welded joint to be 75% and strength of weld and plate are same. (8)
- Q6** Design a journal bearing for a centrifugal pump with the following data- (16)  
 Diameter of the journal = 150 mm  
 Load on bearing = 40 kN  
 Speed of journal = 900 rpm.  
 Take necessary assumptions.