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**Question Paper Code: U5704**

B.E./B.Tech. DEGREE EXAMINATION, NOV 2023

Fifth Semester

Mechanical Engineering

**21UME504 DESIGN OF MACHINE ELEMENTS**

(Regulations 2021)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

- In cyclic loading, stress concentration is more serious in CO1- U  
(a) brittle materials (b) ductile materials  
(c) brittle as well as ductile materials (d) elastic materials
- The largest permissible size for a dimension is known as CO1- U  
(a) lower limit (b) upper limit (c) basic size (d) actual size
- If the diameter of a solid shaft is increased two times, the torque transmitted will CO1- U  
be  
(a) two times (b) four times (c) eight times (d) sixteen times
- The basic shaft is one CO1- U  
(a) whose lower deviation is zero (b) whose upper deviation is zero  
(c) whose lower and upper deviation is zero (d) none of the above
- The crest diameter of a screw thread is same as CO1- U  
(a) Major diameter (b) Minor diameter (c) Pitch diameter (d) None of the above
- Transverse fillet welded joints are designed for CO1- U  
(a) Tensile strength (b) Compressive strength  
(c) Bending strength (d) Torsional strength

7. The springs made in the form of a cone disk to carry a high compressive force is called as CO1- U
- (a) helical spring      (b) Belleville spring      (c) Leaf spring      (d) none of these
8. The deflection in a helical coiled spring under axial load is CO1- U
- (a) directly proportional to load      (b) directly proportional to spring index
- (c) inversely proportional to square of wire      (d) inversely proportional to number of coils
9. Which one of the following is a criterion in the design of hydrodynamic journal bearings? CO1- U
- (a) Sommerfeld number      (b) rating life
- (c) Specific dynamic capacity      (d) Rotation factor
10. The ball bearings are provided with a cage CO1- U
- (a) to reduce friction
- (b) to facilitate slipping of balls
- (c) to prevent the lubricant from flowing out
- (d) to maintain the balls at a fixed distance apart

PART – B (5 x 2= 10Marks)

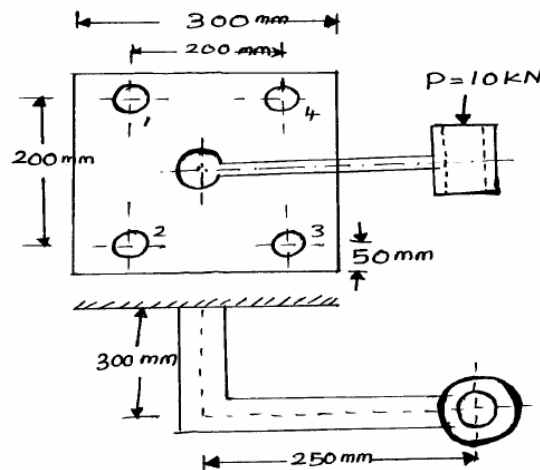
11. Explain about factor of safety? List the factors to be considered while deciding the factor of safety. CO1- U
12. Why hollow shaft has greater strength and stiffness than solid shaft of equal weight? CO1- U
13. Differentiate with a neat sketch the fillet weld subjected to parallel loading and transverse loading. CO1- U
14. When two concentric springs of stiffness 100N/mm respectively are subjected to an axial load of 750 N, what will be the deflection of each spring? CO2- App
15. List any six types of bearing materials. CO1- U

PART – C (5 x 16= 80Marks)

16. (a) A Cantilever of span 200 mm and 60 mm diameter carries a vertical downwards load of 3 kN at free end along with a torque of 104 kN-m and an axial pull force of 12 kN. Calculate the maximum normal stress at the bottom face of the fixed end. CO2- App (16)

Or

- (b) A shaft of 200 mm length is cantilever rod of circular section. It is subjected to a cyclic transverse load that varies from -50 to 150 kN. Determine the diameter of the shaft assuming a factor of safety of 2, size correction factor of 0.85 and surface correction factor of 0.9. The material properties are ultimate strength = 550 MPa; yield strength = 320 MPa and endurance limit = 275 MPa. Theoretical stress factor = 1.4, Notch sensitivity factor = 0.9. CO2- App (16)
17. (a) Design a knuckle joint for a tie rod of a circular cross section to sustain a maximum pull of 70 kN. The ultimate strength of the material of the rod against tearing is 420 MPa. The ultimate tensile and shearing strength of the pin material are 510 MPa and 396 MPa respectively. Determine the tie rod section and pin section. Take factor of safety=6. CO3- App (16)
- Or
- (b) Design a bushed-pin type flexible coupling to connect a pump shaft to a motor shaft transmitting 32 kW at 960 rpm. The overall torque is 20% more than mean torque. The material properties are as follows: The allowable shear and crushing stress for the shaft and key material is 40 MPa and 80 MPa respectively. The allowable shear stress for cast iron is 15 MPa. The allowable bearing pressure for rubber bush is 0.8 N/mm<sup>2</sup>. The material of the pin is same as that of shaft and key. CO3- App (16)
18. (a) A rigid steel bracket subjected to a vertical force of 10 kN is shown in fig. It is fastened to a vertical sanction by means of four identical bolts. Determine the size of the bolts by maximum shear stress theory. The maximum permissible shear stress in any bolts is limited to 50 N/mm<sup>2</sup>. CO2- App (16)



Or

- (b) A plate 100 mm wide and 12.5 mm thick is to be welded to another plate by means of two parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that maximum stress does not exceed  $56 \text{ N/mm}^2$ . CO2- App (16)
19. (a) Design a close-coiled helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm. Assume a spring index of 5. The permissible shear stress intensity is 420 MPa and modulus of rigidity  $84 \text{ kN/mm}^2$ . Neglect the effect of stress concentration. CO3- App (16)
- Or
- (b) Design a CI flywheel for a four stroke engine developing 150 kW at 200 rpm. Calculate the mean diameter of the flywheel if hoop stress is not to exceed 4 MPa. Total fluctuation of speed is to be 4% mean speed. Work done during power stroke is 1.5 times average work done during the cycle. Density of CI is  $7200 \text{ kg/m}^3$ . CO3- App (16)
20. (a) Design a journal bearing for a centrifugal pump from the following data: Load on the journal=20000 N, Speed of the journal=900 rpm, Type of oil is SAE10, for which the absolute viscosity at  $55^\circ\text{C}$  is  $0.017 \text{ kg/m-s}$ , Ambient temperature of oil =  $15.5^\circ\text{C}$ , Maximum bearing pressure for the pump= $1.5 \text{ N/mm}^2$ . Also calculate the mass of the lubricating oil required for artificial cooling, if the rise of temperature of oil be limited to  $10^\circ\text{C}$  and heat dissipation coefficient is  $1232 \text{ W/m}^2/^\circ\text{C}$ . CO3- App (16)
- Or
- (b) Select a suitable ball bearing for a drilling machine spindle of diameter 40 mm rotating at 3000 rpm. It is subjected to radial load of 200 N and axial thrust of 1000 N. It is to work for 45 hours a week for one year. CO3- App (16)