| Reg. No. | | | | | | | | | | | | | | | |
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| Question Paper Code | 13483 |
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**B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2025**

Fifth Semester

**Mechanical Engineering**

**20MEPC504 - DESIGN OF MACHINE ELEMENTS**

Regulations - 2020

(Use of PSG Design *Data Book* is permitted)

Duration: 3 Hours | Max. Marks: 100

**PART - A (MCQ) (10 × 1 = 10 Marks)**

Answer ALL Questions

| | | Marks | K – Level | CO |
|---|---|---|---|---|
| 1. | When tolerance is present on both sides of nominal size, it is termed as<br>(a) Unilateral tolerance (b) Bilateral tolerance<br>(c) Universal tolerance (d) None of the mentioned | 1 | K1 | CO1 |
| 2. | Eccentrically loaded structures have to be designed for _____.<br>(a) Uniaxial force (b) Biaxial force<br>(c) Combined axial force (d) Combined biaxial force | 1 | K1 | CO1 |
| 3. | The phenomenon of decreased resistance of the materials to fluctuating stresses is the main characteristic of _____ failure.<br>(a) Fracture (b) Fatigue (c) Yielding (d) None of the above | | K1 | CO2 |
| 4. | Stress concentration occurs due to,<br>(a) abrupt change in cross-section (b) discontinuities in component<br>(c) internal cracks and flaws (d) any one of the above | 1 | K1 | CO2 |
| 5. | In case of sunk key, power is transmitted by means of,<br>(a) friction force (b) shear resistance of key<br>(c) torsional shear resistance of key (d) tensile force | 1 | K1 | CO3 |
| 6. | A muff coupling is<br>(a) rigid coupling (b) flexible coupling<br>(c) shock absorbing coupling (d) none of the above | 1 | K1 | CO3 |
| 7. | The pin in knuckle joint is subjected to<br>(a) torsional shear stress (b) double shear stress<br>(c) axial compressive stress (d) axial tensile stress | 1 | K1 | CO4 |
| 8. | The weakest plane in a fillet weld is<br>(a) the throat (b) side parallel to the force<br>(c) side normal to the force (d) smaller of two sides | 1 | K1 | CO4 |
| 9. | Bending stress in graduated length leaves are more than that in full length leaves.<br>(a) Yes (b) No (c) In some cases (d) Can't be stated | 1 | K1 | CO5 |
| 10. | Antifriction bearings are<br>(a) oil lubricated bearings (b) bush bearings<br>(c) ball and roller bearings (d) boundary lubricated bearings | 1 | K1 | CO6 |

**PART - B (12 × 2 = 24 Marks)**

Answer ALL Questions

| | | Marks | K – Level | CO |
|---|---|---|---|---|
| 11. | List any two factors that influence the process of machine design. | 2 | K1 | CO1 |
| 12. | Differentiate Hardness and Toughness. | 2 | K2 | CO1 |
| 13. | Define Modulus of resilience and proof resilience. | 2 | K1 | CO2 |
| 14. | Briefly explain why normal stress theory is not suitable for ductile materials? | 2 | K2 | CO2 |
| 15. | State some advantages of hollow shafts over solid shafts. | 2 | K2 | CO3 |
| 16. | Discuss the effect of keyway cut into shaft. | 2 | K2 | CO3 |
| 17. | Name the possible modes of failure of riveting joint. | 2 | K1 | CO4 |

| | | | | | |
|---|---|---|---|---|---|
| 18. | Under what circumstances riveted joints are preferred over welded joints. | | *2* | *K1* | *CO4* |
| 19. | Why Whal's factor is to be considered in the design of helical compression spring? | | *2* | *K1* | *CO5* |
| 20. | State the functions of flywheel. | | *2* | *K1* | *CO5* |
| 21. | Differentiate sliding contact bearing and rolling contact bearing. | | *2* | *K2* | *CO6* |
| 22. | Give two applications where the inner race is rotation and outer race is stationary in rolling contact bearings. | | *2* | *K2* | *CO6* |

**PART - C (6 × 11 = 66 Marks)**

Answer ALL Questions

| | | | | | | |
|---|---|---|---|---|---|---|
| 23. | a) | A hollow shaft of 40 mm outer diameter and 25 mm inner diameter is subjected to a twisting moment of 120 N-m, simultaneously, it is subjected to an axial thrust of 10 kN and a bending moment of 80 N-m. Calculate the maximum compressive and shear stresses. | *11* | *K3* | *CO1* |
| | | **OR** | | | |
| | b) | A Wall bracket as shown in figure 1 is subjected to a pull of 4 kN at 60° to the vertical. The cross-section of the bracket is rectangular having "b = 4t". Determine the dimensions, if the maximum permissible stress induced in the bracket is limited to 30MPa. | *11* | *K3* | *CO1* |

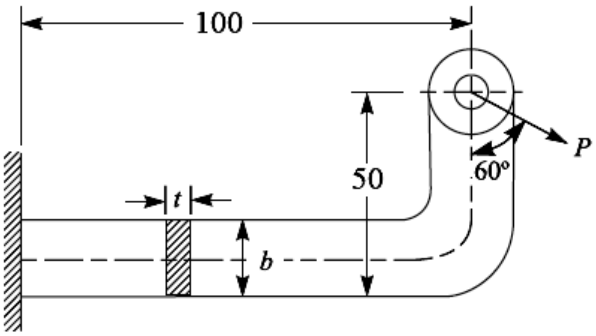


Figure 1

| | | | | | |
|---|---|---|---|---|---|
| 24. | a) | Determine the diameter of a tensile member of a circular cross-section using Goodman Equation. The following data is given:<br>Maximum tensile load = 10 kN;<br>Maximum compressive load=5kN;<br>Ultimate tensile strength = 600 MPa;<br>Yield point = 380 MPa;<br>Endurance limit=290 MPa;<br>Factor of safety = 4;<br>Stress concentration factor = 2.2. | *11* | *K3* | *CO2* |
| | | **OR** | | | |
| | b) | A rotating shaft of 16 mm diameter is made of plain carbon steel with a yield stress of 400 N/mm$^2$. It is subjected to an axial load of 4500 N, a steady torque of 50 Nm and maximum bending moment of 75 Nm. Calculate the factor of safety based on Maximum shear stress theory. | *11* | *K3* | *CO2* |
| 25. | a) | Design a muff coupling to connect two shafts transmitting 40 kW at 120 rpm. The permissible shear and crushing stress for the shaft and key material are 30 N/mm$^2$ and 80 N/mm$^2$ respectively. The material for muff is CI ($\tau_{CI}$ = 15 N/mm$^2$). Assume the maximum torque transmitted is 25% more than the mean torque. | *11* | *K3* | *CO3* |
| | | **OR** | | | |

b) Design a CI flange coupling for a MS shaft 90 kW at 250 rpm. The allowable shear in the shaft is 40 N/mm$^2$. The allowable shear stress in the coupling bolt is 30 N/mm$^2$. *11 K3 CO3*

26. a) A welded joint, as shown in figure 2, is subjected to an eccentric load of 2500 N. Find the size of the weld, if the maximum shear stress in the weld is not to exceed 50 N/mm$^2$. *11 K3 CO4*

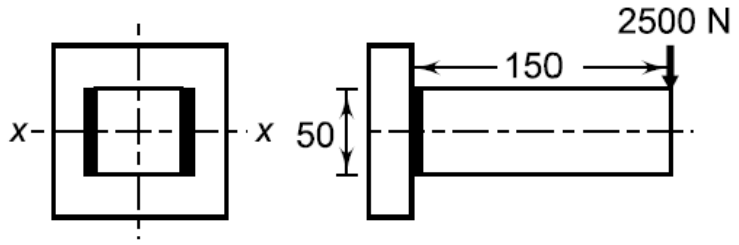


Figure 2

**OR**

b) Design a Knuckle joint to connect two circular rods subjected to an axial tensile force of 50kN. Select a suitable material with a factor of safety of 4. *11 K3 CO4*

27. a) Design a helical spring for a spring loaded safety valve for the following conditions: Operating pressure = 1 N/mm$^2$; Maximum pressure when the valve blows off freely = 1.075 N/mm$^2$; Maximum lift of the valve when the pressure is 1.075 N/mm$^2$ = 6 mm; Diameter of valve seat = 100 mm; Maximum shear stress = 400 MPa; Modulus of rigidity = 86 kN/mm$^2$; Spring index = 5.5. *11 K3 CO5*

**OR**

b) Design a cast iron flywheel for a four stroke cycle engine to develop 110 kW at 150 r.p.m. The work done in the power stroke is 1.3 times the average work done during the whole cycle. Take the mean diameter of the flywheel as 3 metres. The total fluctuation of speed is limited to 5 per cent of the mean speed. The material density is 7250 kg/m$^3$. The permissible shear stress for the shaft material is 40 MPa and flexural stress for the arms of the flywheel is 20 MPa. *11 K3 CO5*

28. a) Design a suitable Journal Bearing for a centrifugal pump from the following data: Load on the Bearing = 13.5kN; Diameter of the Journal = 80mm; Speed=1440rpm; Bearing characteristic number at the working temperature (75°C) = 30; Permissible bearing pressure intensity = 0.7 N/mm$^2$ to 1.4 N/mm$^2$; Average atmospheric temperature = 30°C. Increase in temperature of oil is 10°C. *11 K3 CO6*

**OR**

b) A single-row deep groove ball bearing is subjected to a radial force of 8 kN and a thrust force of 3 kN. The shaft rotates at 1200 rpm. The expected life of the bearing is 20,000 hours. The minimum acceptable diameter of the shaft is 75 mm. Select a suitable ball bearing for this application. *11 K3 CO6*