



B.E/B.TECH DEGREE EXAMINATIONS: NOV/DEC 2022

(Regulation 2018)

Fifth Semester

MECHANICAL ENGINEERING

U18MET5003: Design of Machine Elements

(Use of Approved design Databook is permitted)

COURSE OUTCOMES

- CO1:** Apply the concept of steady stresses in design of machine elements subjected to steady loads
- CO2:** Solve problems in machine elements subjected to varying loads
- CO3:** Design shafts and couplings for various applications
- CO4:** Select bearings for specific applications.
- CO5:** Design temporary and permanent joints
- CO6:** Design energy storing springs and flywheel

Time: Three Hours

Maximum Marks: 100

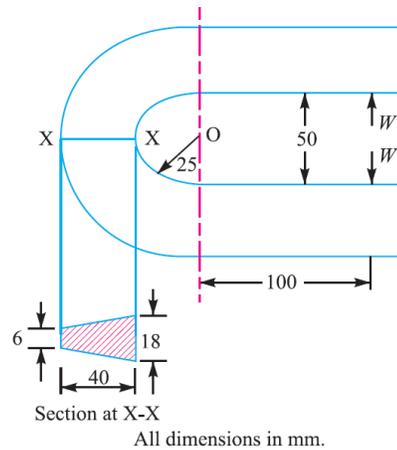
Answer all the Questions:-
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

- | | | |
|--|-----|-------------------|
| 1. List the different phases of design | CO1 | [K ₁] |
| 2. What are preferred numbers?, Specify the significance | CO1 | [K ₂] |
| 3. Define the term 'stress concentration factor'. Also list any two methods that are to be employed to reduce stress concentration in machine elements. | CO2 | [K ₂] |
| 4. Define the critical speed of a shaft. List any two methods used to find the critical speed of shaft. | CO3 | [K ₁] |
| 5. Illustrate the rectangular key with simple sketch. Also show the dimensions of key in terms of shaft diameter, d. | CO3 | [K ₂] |
| 6. Write the Stribeck's equation of rolling contact bearing and state the assumptions. | CO4 | [K ₁] |
| 7. Graphically illustrate the relationship between the bearing characteristics number and the coefficient of friction. Also, the different regions of lubrication. | CO4 | [K ₂] |
| 8. Specify any two methods that are employed to increase the shock absorbing capacity of bolts. | CO5 | [K ₁] |
| 9. List the different types of failure modes in socket and spigot of cotter joint. | CO5 | [K ₂] |
| 10. Define surge in springs and state the effects. | CO6 | [K ₁] |

Answer any FIVE Questions:-
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11. a) The frame of a punch press is shown in Fig. Find the stresses at the inner and outer surface at section X-X of the frame, if $W = 5000$ N.

CO1 [K₂]



8

- b) A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 Nm and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft using the maximum principal stress theory.

CO1 [K₂]

8

12. a) A forged steel bar, 50 mm in diameter, is subjected to a reversed bending stress of 250 N/mm^2 . The bar is made of steel 40C₈ ($\sigma_u = 600 \text{ N/mm}^2$). Calculate the life of the bar for a reliability of 90%.

8

CO2 [K₄]

- b) A hot rolled steel shaft is subjected to varying torsional and an applied bending moment at a critical section. The mean and variable torque are 110 Nm and 220 Nm respectively. The mean and variable bending moment are 110 Nm and 330 Nm respectively. The shaft is of uniform cross-section and no keyway is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MN/m^2 and a yield strength of 410 MN/m^2 . Take the endurance limit as half the ultimate strength, factor of safety of 2, size factor of 0.85 and a surface finish factor of 0.62.

8

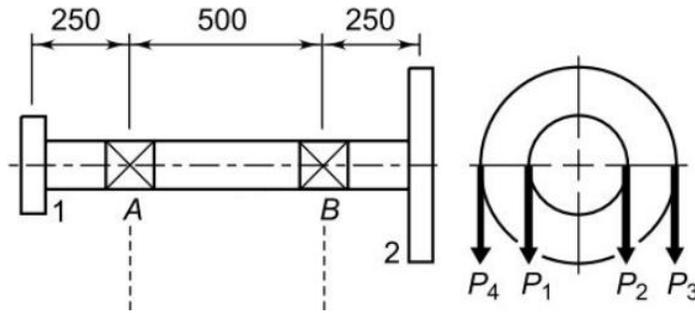
CO2 [K₃]

13. The layout of a shaft carrying two pulleys 1 and 2, and supported on two bearings A and B is shown in Fig. The shaft transmits 7.5 kW power at 360

16

CO3 [K₄]

rpm from the pulley 1 to the pulley 2. The diameters of pulleys 1 and 2 are 250 mm and 500 mm respectively. The masses of pulleys 1 and 2 are 10 kg and 30 kg respectively. Given that, the tension in pulleys are $P_1 = 2652$ N, $P_2 = 1061$ N, $P_3 = 1326$ N and $P_4 = 530$ N respectively. The shaft is made of plain carbon steel 40C₈ and the factor of safety is 3. If the permissible angle of twist is 0.5° per metre length, calculate the shaft diameter on the basis of torsional rigidity. Assume $G = 79.3$ GPa. The linear dimensions shown in Fig. are in mm.

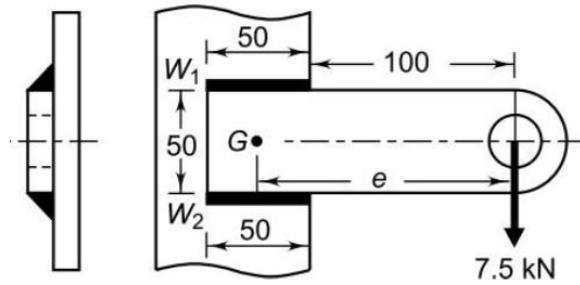


14. A single-row deep groove ball bearing is subjected to a 30 second work cycle 16 CO4 [K₃] that consists of the following two parts:

| Details | Part 1 | Part 2 |
|------------------|--------|--------|
| Duration (s) | 10 | 20 |
| Radial load (kN) | 45 | 15 |
| Axial load (kN) | 12.5 | 6.25 |
| Speed (rpm) | 720 | 1440 |

The static and dynamic load capacities of the ball bearing are 50 kN and 68 kN respectively. Calculate the expected life of the bearing in hours.

15. A welded connection, as shown in Fig. is subjected to an eccentric force of 7.5 16 CO5 [K₃] kN. Determine the size of welds if the permissible shear stress for the weld is 100 N/mm². Assume static conditions. The Dimensions shown in below figure are in mm



16. A railway wagon moving at a velocity of 1.5 m/s is brought to rest by a bumper 16 CO6 [K₃] consisting of two helical springs arranged in parallel. The mass of the wagon is 1500 kg. The springs are compressed by 150 mm in bringing the wagon to rest. The spring index can be taken as 6. The springs are made of oil-hardened and tempered steel wire with ultimate tensile strength of 1250 N/mm² and modulus of rigidity of 81.37 kN/mm². The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength. Design the spring and specify all nomenclature.
