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Question Paper Code : 72153

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Fourth/Fifth/Sixth Semester

Mechanical Engineering

ME 6503 — DESIGN OF MACHINE ELEMENTS

(Common to Automobile Engineering/Mechanical Engineering (Sandwich)/ Industrial Engineering/Mechanical and Automation Engineering/ Machatronics Engineering)

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Why nonsymmetrical I and T sections are preferred in design of curved beams?

2. Define modulus of resilience and proof resilience. [Pg. No. 11]

3. State the reasons for which the couplings are located near the bearings.

4. List the advantages of cotter joint over threaded joints.

5. Define equivalent torsional moment of a shaft [Pg. No. 38]

6. Why throat is considered while calculating stresses in fillet welds?

7. Sketch the stresses induced in the cross section of a helical spring, considering Wahl's effect.

8. What are the forces acting on connecting rod? [Pg. No. 92]

9. What are anti - friction bearings? [Pg. No. 120]

10. Plot the friction induced in various bearings based on shaft speed.

PART B — (5 × 13 = 65 marks)

11. (a) Design a rectangular key for the following application: A shaft 65 mm diameter transmits power at maximum shear stress of 67 MPa. The shear stress in the key should not exceed 75% of the stress developed in the shaft. The key should be at least 2.5 times strong in crushing compared to shear failure of the key. [Pg. No.144] (13)

Or

(b) Design a muff coupling, which is used to connect two steel shafts transmitting 25 kW power at 360 rpm. The shafts and key are made of plain carbon steel 30C8 $\left(S_{yt} = S_{yc} = 400\text{N/mm}^2\right)$. The sleeve is made of grey cast, iron FG 200 $\left(S_{ut} = 200\text{N/mm}^2\right)$. The factor of safety for the shafts and key is 4. For sleeve, the factor of safety is 6, based on ultimate strength. [Pg. No. 159]

12. (a) A helical compression spring of the exhaust valve mechanism is initially compressed with a preload of 375 N. When the spring is further compressed and the valve is fully opened, the torsional shear stress in the spring wire should not exceed 750 N/mm². Due to space limitations, the outer diameter of the spring should not exceed 42 mm. The spring is to be designed for minimum weight. Calculate the wire diameter and the mean coil diameter of the spring. (13)

Or

(b) A punching machine carries out punching 10 holes per minute. Each hole of 36 mm diameter in 16 mm thick plate requires 7 N-m of energy/mm² of the sheared area. The punch has a stroke of 90 mm. Determine the power of the motor required to operate the machine.

If the total fluctuation of speed is not to exceed 2.5% of the mean speed; determine the mass of the flywheel. The mean speed of the flywheel is 15 m/s. [Pg. No. 154]

13. (a) A wall crane with a pin – joint tie rod is as shown in Fig. 13(a). The crane hook is to take a maximum load 35 kN, when the load is at a distance of 2 m from the wall. The tie rod and pin are made of steel FeG 250 $\left(S_{yt} = 250\,\text{N/mm}^2\right)$ and the factor of safety is 5. Calculate the diameter of the tie rod and the pin. (13)

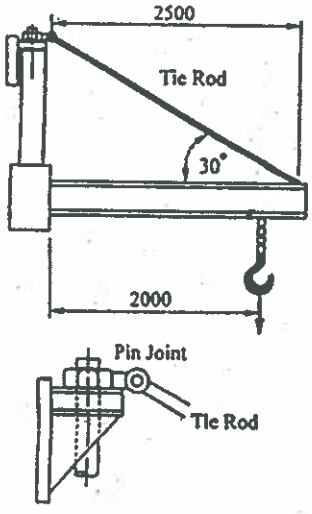

Fig. 13 (a)

Or

(b) A link shaped in the form of a letter S is made up of 30 mm diameter bar, as shown in fig. 13(b). Determine the maximum tensile stress and maximum shear stress in the link. (13)

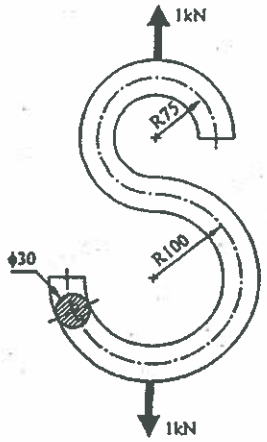

Fig. 13 (b)

14. (a) A bracket is welded to the vertical column by means of two fillet welds as shown in fig. 14(a). Determine the size of the welds, if the permissible shear stress is limited to 70 N/mm². (13)

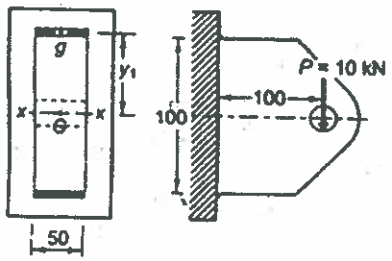

Fig. 14 (a)

Or

(b) A steel plate is subjected to a force of 5 kN and fixed to a channel by means of three identical bolts as shown in fig. 14(b). The bolts are made from 45C8 steel $(S_{yt} = 380\,\text{N/mm}^2)$ and the factor of safety is 3. Specify the size of the bolts. [Pg. No. 145] (13)

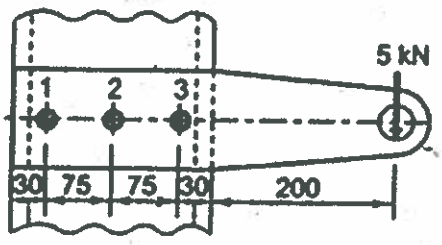

Fig. 14 (b)

15. (a) Design a journal bearing for a 49.9 mm diameter journal. It is ground and hardened and is rotating at 1500 rpm in a bearing of diameter and length both 50 mm. The inlet temperature of oil 65°C. Determine max radial load that the journal can carry and power loss. (13)

Or

(b) A ball bearing is subjected to a radial load of 10 kN and a thrust load of 5 kN. The inner ring rotates at 1000 rpm. The average life is to be 5000 hours. What basic load rating must be used to select a bearing for this purpose? Take $F_a / C_o = 0.5$ and assume service factor 1.5. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A shaft is supported by two bearings placed 1100 mm apart. A pulley of diameter 620 mm is keyed at 400 mm to the right of the left hand bearing and this drives a pulley directly below it with a maximum tension of 2.75 kN. Another pulley of diameter 400 mm is placed 200 mm to the left of the right hand bearing and is driven with a motor placed horizontally to the right. The angle of contact of the pulleys is 180° and the coefficient of friction between the belt and the pulleys is 0.3. Find the diameter of the shaft. Assume $K_b = 3$, $K_t = 2.5$, $S_{yt} = 190\ MPa$, $S_{Ut} = 300\ MPa$. [Pg. No.44] (15)

Or

(b) A solid circular shaft of diameter 45 mm is loaded by bending moment 650 Nm, torque 900 Nm and an axial tensile force of 30 kN. The shaft material is ductile with yield strength of 280 MPa. Determine the factor of safety according to Maximum principal stress, Tresca and Von misses theories of failure. [Pg. No. 137] (15)