Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 70830

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fourth/Fifth/Sixth Semester

Mechanical Engineering

ME 6503 – DESIGN OF MACHINE ELEMENTS

(Common to: Mechanical Engineering (Sandwich), Automobile Engineering, Industrial Engineering, Mechanical and Automation Engineering, Mechatronics Engineering)

(Regulations 2013)

(Also Common to: PTME 6503 – Design of Machine Elements for B.E. (Part-Time) – Mechanical Engineering – Fourth Semester (Regulations – 2014))

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is shock factor and what does it indicate?

2. Differentiate hardness and toughness.

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

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

5. What is the total shear in a double strap butt joint with equal length of straps?

6. What is the bending stress induced in the weld when a circular rod of diameter d, welded to a rigid plate by a circular fillet weld of size t', which is subjected to a bending moment M?

7. Define spring rate.

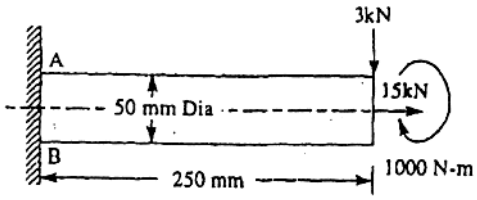
8. Define the term 'fluctuation of speed' and 'fluctuation of energy'.

9. Classify the types of bearings.

10. Define the term Reliability of a Bearing.

PART B — (5 × 13 = 65 marks)

11. (a) A shaft, as shown in Fig.11(a) is subjected to a bending load of 3 kN, pure torque of 1000 N-m and a'n axial pulling force of 15 kN. Calculate the stresses at A and B. (13)



All dimensions in mm

Fig.11(a)

Or

(b) A steel cantilever is 200 mm long. It is subjected to an axial load which varies from 150 N (compression) to 450 N(tension) and also a transverse load at its free end which varies from 80 N up to 120 N down. The cantilever is of circular cross-section. It is of diameter 2d for the first 50mm and of diameter 'd' for the remaining length. Determine its diameter taking a factor of safety of 2. Assume the following values :

Yield stress = 330 Mpa; Endurance limit in reversed loading = 300 Mpa

Correction factors	= 0.7 in reversed axial Loading
	= 1.0 in reversed bending
Stress concentration factor	= 1.44 for bending
	= 1.64 for axial loading
Size effect factor	= 0.85; Surface effect factor = 0.90;
Notch sensitivity index	= 0.90 (13)

12. (a) A bolt is subjected to a direct load of 25 kN and shear load of 15 kN. Considering following theories of failure, determine a suitable size of the bolt if the material of the bolt is C15 having 200 N/mm^2 yield strength. Assume F.O.S. as 2 and also give your comments :

(i) Maximum normal stress theory

(ii) Maximum shear stress theory

(iii) Von misses theory.

Or

(b) A mass of 50 kg drops through 25 mm at the centre of a 250 mm long simply supported beam. The beam has a square cross section. It is made of steel 30C8 (S_{yt} = 400 N/mm^2) and the factor of safety is 2. The modulus of elasticity is 207000 N/mm^2. Determine the dimension of the cross section of the beam. (13)

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 (S_{yt} = 250 N/mm^2) and the factor of safety is 5. Calculate the diameter of the tie rod and the pin. (13)

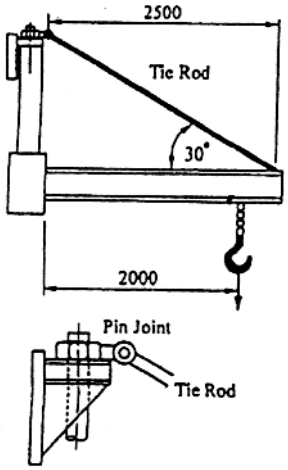


Fig. 13(a)

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)

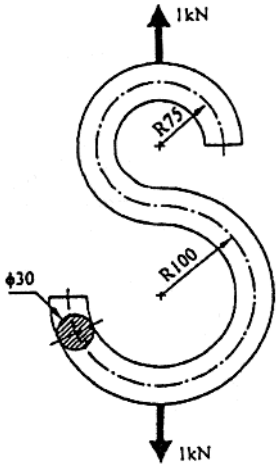


Fig. 13(b)

14. (a) A railway wagon moving at a velocity of 1.5 m/s is brought to rest by bumper 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 MPa and modulus of rigidity of 81.37 GPa. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength. Design the spring and calculate (i) wire diameter (ii) mean coil diameter (iii) number of active coils (iv) total number of coils (v) solid length (vi) free length and (vii) pitch of the coil. (13)

Or

(b) A 5 kW induction motor, running at 960 rpm operates a riveting machine. The flywheel fitted to it, is of mass 120 kg, with radius of gyration equal to 0.35 m. Each riveting takes 1 second and requires 9 kW. Determine (i) the number of rivets formed per hour and (ii) the reduction in speed of the flywheel, after the riveting operation. (13)

15. (a) A ball bearing subjected to a radial load of 5 kN is expected to have a life of 8000 hours at 1450 r.p.m. with a reliability of 99%. Calculate the dynamic load capacity of the bearing so that it can be selected from the manufacturer's catalogue based on a reliability of 90%. (13)

Or

(b) Design a journal bearing for 12 MW, 1000 rpm steam turbine, which is supported by two bearings. Take the atmospheric temperatures as 16°C and operating temperature of oil as 60°C. Assume viscosity of oil as 23 centistokes. (13)

PART C — (1 × 15 = 15 marks)

16. (a) A quantity of air undergoes a thermodynamic cycle consisting of three processes. Process 1 – 2 : Constant volume heating from P_1 = 0.1 MPa, T_1 = 15°C, V_1 = 0.02 m^3 to P_2 = 0.42 MPa. Process 2-3 : constant pressure cooling. Process 3-1 : Isothermal heating to the initial state. Employing the ideal gas model with C_p = 1 kJ/kgK, evaluate the change of entropy for each process. Sketch the cycle on p-v and T-s coordinates. (15)

Or

(b) Air at 80 kpa, 27°C and 220 m/s enters a diffuser at a rate of 2.5 kg/s and leaves at 42°C. The exit area of the diffuser is 400 cm^2. The air is estimated to lose heat at a rate of 18 kJ/s during this process. (15)

Determine :

(i) the exit velocity and

(ii) the exit pressure of the air.

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