Reg. No. : [| | | | | | | | | | |]

Question Paper Code : 27372

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fifth Semester

Mechanical Engineering

ME 6503 — DESIGN OF MACHINE ELEMENTS

(Regulations 2013)

(Common to B.E. Automobile Engineering, Mechanical and Automation Engineering, Industrial Engineering and Mechatronics Engineering)

Time : Three hours Maximum : 100 marks

Note: Use of Approved Design Data Book is permitted.
Any required design data can be suitably assumed

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Which theory of failure is suitable for the design of brittle materials?

2. What are the common materials used in mechanical engineering design?

3. What is meant by design of a shaft based on rigidity?

4. What are the possible modes of failure of the pin (bolt) in a flexible coupling?

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. What is the purpose of the flywheel?

8. What type of spring is used to maintain an effective contact between a cam and a reciprocating roller or flat faced follower?

9. What is meant by square journal bearing?

10. Give an example for anti-friction bearing.

PART B — (5 × 16 = 80 marks)

11. (a) A bolt is subjected to an axial pull of 10 kN and a transverse shear force of 5 kN. The yield strength of the bolt material is 300 MPa. Considering a factor of safety of 2.5. Determine the diameter of the bolt, using (i) maximum normal stress theory, (ii) maximum shear stress theory, and (iii) maximum principal strain theory. Take Poisson's ratio as 0.25. (16)

Or

(b) A cantilever rod of length 120 mm with circular section is subjected to a cyclic transverse load; varying from -100 N to 300 N at its free end. Determine the diameter 'd' of the rod, by (i) Goodman method and (ii) Soderberg method using the following data.

Factor of safety = 2; Theoretical stress concentration factor = 1.4; Notch sensitivity factor = 0.9; Ultimate strength = 550 MPa; Yield strength = 320 MPa; Endurance limit = 275 MPa; Size correction factor = 0.85; Surface correction factor = 0.9. (16)

12. (a) The shaft of length 1 m carrying two pulleys 1 and 2 at its left and right ends respectively and it is supported on two bearings A and B which are located 0.25 m from the left end and the same 0.25 m from the right end respectively. The shaft transmits 7.5 kW power at 360 rpm from pulley 1 to pulley 2. The diameters of pulley 1 and 2 are 250 and 500 mm respectively. The masses of pulley 1 and 2 are 10 kg and 30 kg respectively. The belt tension act vertically downward and ratio of belt tensions on tight side to slack sid for each pulley is 2.5:1. The yield strength of the shaft material $\sigma_y = 380$ MPa and factor of safety is 3.

Estimate the suitable diameter of the shaft. (16)

Or

(b) Design a bushed pin type of flexible coupling for connecting a motor and a pump shaft. The following data are provided:

Power transmitted = 20 kW; Speed = 1000 rpm; Diameter of the motor and pump shafts = 50 mm; Allowable bearing pressure in the rubber bush = 0.3 MPa. (16)

13. (a) A steam engine cylinder of 300 mm effective diameter, is subjected to a steam pressure of 1.5 MPa. The cylinder head is connected by means of 8 bolts having yield strength of 30 MPa and endurance limit of 240 MPa. The bolts are tightened with an initial preload of 1.5 times that of steam load. A soft copper gasket is used to make the joint leak proof assuming a fatigue stress concentration factor of 1.4, and factor of safety of 2; determine the size of the bolts required. (16)

Or

(b) Design a knuckle joint to withstand a load of 100 kN. All the parts of the joint are made of the same material with $\sigma_{ut} = \sigma_{uc} = 480$ MPa, and $\tau_u = 360$ MPa. Use factor of safety of 6 on ultimate strength. (16)

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. (16)

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. (16)

15. (a) A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 MPa. The speed of the journal is 900 rpm and the ratio of journal diameter to the diametrical clearance is 1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75°C may be taken as 0.011 kg/m-s. The room temperature is 35°C. Find (i) the amount of artificial cooling required and (ii) the mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10°C. Take specific heat of the oil as 1850 J/kg/°C. (16)

Or

(b) Select a single row deep groove ball bearing for a radial load of 4000 N and an axial load of 5000 N, operating at a speed of 1600 rpm for an average life of 5 years at 10 hours per day. Assume uniform and steady load. (16)

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