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Question Paper Code : 41178

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

Fifth Semester

Production Engineering

PR 8551 – DESIGN OF MACHINE ELEMENTS AND TRANSMISSIONS SYSTEMS

(Common to Robotics and Automation)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. How will you find out allowable stress for brittle parts using factor of safety?
2. Distinguish between design synthesis and design analysis.
3. Why is hexagonal head preferred for cap screw instead of square head?
4. What do you understand by efficiency of riveted joints?
5. What are the advantages and disadvantages of Woodruff key over flat key?
6. List any four practical applications of couplings.
7. Why is the pinion weaker than the gear made of same material?
8. Distinguish between open and cross belt drives.
9. Write any four application of concentric springs.
10. Why are ball and roller bearings called 'antifriction' bearings?

PART B — (5 × 13 = 65 marks)

11. (a) A cylindrical shaft made of steel of yield strength 700 MPa is subjected to static loads consisting of bending moment 10 kN-m and a torsional moment 30 kN-m. Determine the diameter of the shaft using two different theories of failure, and assuming a factor of safety of 2. Take E = 210 GPa and poissons ratio = 0.25.

Or

(b) Explain the modified Goodman diagram for bending stresses and torsional shear stresses.

12. (a) A gearbox weighing 7.5 kN is provided with a steel eyebolt for lifting and transporting on the shop floor. The eyebolt is made of plain carbon steel 30C8 (Syt = 400 N/mm²) and the factor of safety is 5. Determine the nominal diameter of the eye bolt having coarse threads if, dc = 0.8d, where dc and d are core and major diameters respectively.

Or

(b) A bracket is welded to the vertical plate by means of two fillet welds as shown in Figure 12(b). Determine the size of the welds, if the permissible shear stress is limited to 70 N/mm².

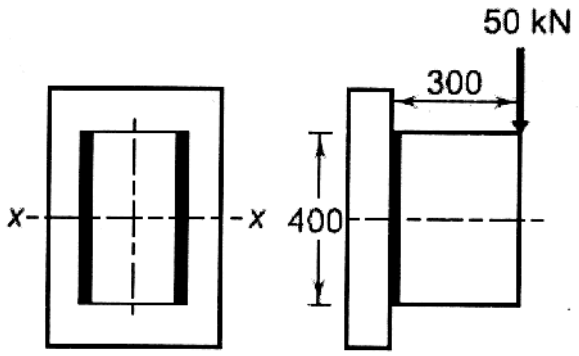

Fig. 12(b)

13. (a) A line shaft supporting two pulleys A and B is shown in Figure 13(a). Power is supplied to the shaft by means of a vertical belt on the pulley A, which is then transmitted to the pulley B carrying a horizontal belt. The ratio of belt tension on tight and loose sides is 3 : 1. The limiting value of tension in the belts is 2.7 kN. The shaft is made of plain carbon steel 40C8 (S_{ut} = 650 N/mm² and S_{yt} = 380 N/mm²). The pulleys are keyed to the shaft. Determine the diameter of the shaft according to the ASME code if, k_b = 1.5 and k_t = 1.0.

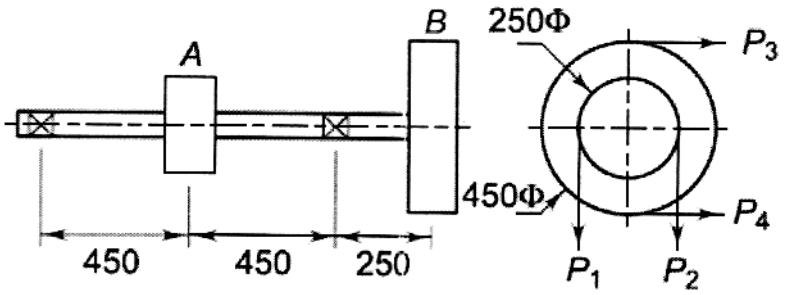

Fig. 13(a)

Or

(b) Design a muff coupling to connect two steel shafts transmitting 25 kW power at 360 rpm. The shafts and key are made of plain carbon steel 30C8 (S_{yt} = S_{yc} = 400 N/mm^2). The sleeve is made of grey cast iron FG 200 (S_{ut} = 200 N/mm^2). The factor of safety for the shafts and key is 4. For the sleeve, the factor of safety is 6 based on ultimate strength.

14. (a) A pair of parallel helical gears consists of an 18 teeth pinion meshing with a 45 teeth gear. 7.5 kW power at 2000 rpm is supplied to the pinion through its shaft. The normal module is6 mm, while the normal pressure angle is 20°. The helix angle is 23°. Determine the tangential, radial and axial components of the resultant tooth force between the meshing teeth.

Or

(b) It is required to select a flat-belt drive to connect two transmission shafts rotating at 800 and 400 rpm respectively. The centre to centre distance between the shafts is approximately 3 m and the belt drive is open type. The power transmitted by the belt is 30 kW and the load correction factor is 1.3. The belt should operate at a velocity between 17.8 to 22.9 m/s. The power transmitting capacity of the belt per mm width per ply at 180° arc of contact and at a belt velocity of 5.08 m/s is 0.0147 kW. Select preferred pulley diameters and specify the belt.

15. (a) A safety valve, 40 mm in diameter, is to blow off at a pressure of 1.2 MPa. It is held on its seat by means of a helical compression spring, with initial compression of 20 mm. The maximum lift of the valve is 12 mm. The spring index is 6. The spring is made of cold drawn steel wire with ultimate tensile strength of 1400 N/mm^2. The permissible shear stress can be taken as 50% of this strength. (G = 81370 N/mm^2). Calculate : (i) wire diameter; (ii) mean coil diameter; and (iii) number of active coils.

Or

(b) A ball bearing is subjected to a radial force of 2500 N and an axial force of 1000 N. The dynamic load carrying capacity of the bearing is 7350 N. The values of X and Y factors are 0.56 and 1.6 respectively. The shaft is rotating at 720 rpm. Calculate the life of the bearing.

PART C — (1 × 15 = 15 marks)

16. (a) A flexible coupling is used to transmit 15 kW power at 100 rpm. There are six pins and their pitch circle diameter is 200 mm. The effective length of the bush (lb), the gap between two flanges and the length of the pin in contact with the right hand flange are 35, 5 and 23 mm respectively. The permissible shear and bending stresses for the pin are 35 and 152 N/mm^2 respectively. Calculate: (i) pin diameter by shear consideration; and (ii) pin diameter by bending consideration.

Or

(b) A semi-elliptic leaf spring consists of two extra full-length leaves and six graduated - length leaves, including the master leaf. Each leaf is 7.5 mm thick and 50 mm wide. The centre-to-centre distance between the two eyes is 1 m. The leaves are prestressed in such a way that when the load is maximum, stresses induced in all the leaves are equal to 350 N/mm^2. Determine the maximum force that the spring can withstand.

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