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21/2/22 2021

B.Tech. 5th Semester End-Term Examination

ME

MACHINE DESIGN – 1

(New Regulation & New Syllabus)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No. 1 and any *four* question from the rest.

[Use of Design Data Handbook Allowed]

[Required data may be assumed from Design Data Handbook]

1. (a) What are the factors that are to be considered in deciding factor of safety in machine design?

   (b) What are the functions of couplings?

   (c) On what factors in a belt drive the efficiency of power transmission depends?

   (d) What are the different modes of failure of riveted joints?

   (e) Name some applications where Cotter and Knuckle joints are used.

   $(5 \times 2 = 10)$

2. A solid shaft made of steel is subjected to a moment of 3.75 KNm and a torque of 9.20 KNm. The yield strength of the shaft material is 285 MPa. Assuming a suitable factor of safety, estimate the required shaft diameter using:

   (a) Maximum normal stress theory and

   (b) Maximum shear stress theory. $(2 \times 7\frac{1}{2} = 15)$

[Turn over

3. A tie bar in a bridge 200mm wide and 12.5 mm thick has to be connected to a gusset plate of same thickness by a double cover butt joint. Design the joint if the design stresses are as follows:

σ_t= 105 N/mm^2

τ_s= 70 N/mm^2

σ_c= 150 N/mm^2 (15)

4. Find the diameter of a solid steel shaft to transmit 20 kW at 200 rpm. The ultimate shear stress for the steel may be taken as 360 MPa and a factor of safety as 8. If a hollow shaft is to be used in place of the solid shaft, estimate the inside and outside diameter when the ratio of inside to outside diameters is 0.5. (15)

5. Design a Cotter Joint to support a load of 40 kN in tension and 40 kN in compression. The design stresses for the material of the joint are σ_c = 90 MPa, σ_t = 50 MPa and τ_s= 35 MPa. Check the design for all types of possible failures. (15)

6. A solid shaft is transmitting 50 kW at 900 rpm. A pulley of 400 mm diameter is mounted to the shaft using a rectangular sunk key which uses a belt drive to transmit power. Selecting suitable material of the shaft and the key, design the key considering all possible modes of failure of the key. (15)

7. Design a Cast Iron Flange coupling to transmit 4.5 MW at 800 rpm. The design stresses are as follows:

   (a) Shear stress for Shaft, Bolt and Key Material = 60 N/mm^2

   (b) Crushing Stress for the bolt and the key material = 80 N/mm^2

   (c) Permissible Shear Stress for Cast Iron = 8 N/mm^2 (15)

8. Design a flat belt drive to transmit 100 kW for a system consisting of two pulleys of diameters 0.90 m and 1.45 m, centre distance of 5m, a belt speed 24 m/s, coefficient of friction 0.30, a slip of 1.15% at each pulley and 2% friction loss at each shaft, 12% overload. (15)

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