CBCS SCHEME

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15MT51

Fifth Semester B.E. Degree Examination, June/July 2019
Design of Machine Elements

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Briefly explain the classification of machine design. **(06 Marks)**

b. What is stress concentration? Explain the methods of reducing stress concentration. **(04 Marks)**

c. A grooved shaft shown in the Fig.Q1(c) is to transmit 5 KW at 120 rpm. Determine the diameter of the shaft at the groove if it is made of C_{15} steel (σ_y = 235.4 MPa, factor of safety = 2)

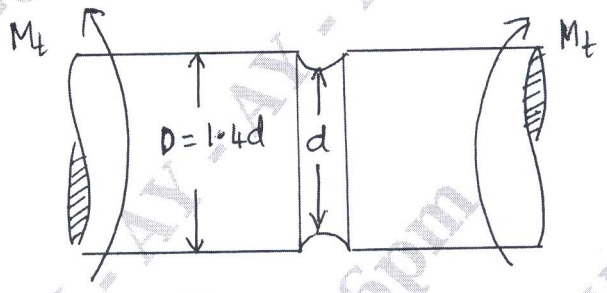

Fig.Q1(c) **(06 Marks)**

OR

2 a. Explain the following theories of failure:
i) Maximum normal stress theory
ii) Maximum shear stress theory
iii) Maximum distortion energy theory **(08 Marks)**

b. A machine element is loaded so that σ_1 = 120 MPa, σ_2 = 0 and σ_3 = –90 MPa; the material has a yield strength in tension and compression of 360 MPa. Find the factor of safety for each of the following theories of failure.
i) Maximum normal stress theory
ii) Maximum shear stress theory
iii) Maximum distortion energy theory **(08 Marks)**

Module-2

3 a. Determine the dimensions of a tapered key to transmit 10 KW at 1000 rpm. Also find the axial force necessary to drive the key home. The permissible shear and compressive stresses in the key material are 60 N/mm^2 and 130 N/mm^2 respectively. [Given μ_1 = 0.25, η = 0.75] **(08 Marks)**

b. A bush pin type flexible coupling has four pins of size M16, made of steel having allowable shear stress of 60 MPa. The outside diameter and length of rubber bush on the pin are 38 mm and 45 mm respectively. The pins are located on pitch circle diameter of 200 mm. The allowable bearing pressure in the rubber bush is 1.0 MPa. If the coupling rotates at 900 rpm, calculate the power that can be transmitted. [Given τ_s = 60 MPa, η = 0.75]. Check whether the size of pin is acceptable for the power transmitted. **(08 Marks)**

OR

4 a. Derive an expression for torque required to lower the load on square threaded screw. **(08 Marks)**

b. A triple threaded power screw is used in a screw jack, has a nominal diameter of 50 mm and a pitch of 8 mm. The threads are square shape and length of the nut is 48 mm. The screw jack is used to lift a load of 7.5 kN. The coefficient of friction at the threads is 0.12 and collar friction is negligible. Calculate:

i) Principal shear stress in the screw rod.
ii) Transverse shear stress in the screw and nut.
iii) Unit bearing pressure for threads
iv) State whether the screw is self locking. **(08 Marks)**

Module-3

5 a. A shaft is required to transmit 1 MW at 240 rpm. The shaft must not twist more than 1° on a length of 15 diameter. If the modulus of rigidity for the shaft materials is 80 kN/mm^2, find the diameter of shaft and shear stress induced. (assume steady load) **(06 Marks)**

b. A shaft is mounted between bearings located 9.5 m apart and transmit 10000 KW at 90 rpm. The shaft weighs 66000 N, has outside diameter = 450 mm and inner diameter = 300 mm. Determine the stress induced in the shaft and the angular deflection between the bearings. Do not neglect the weight of shaft. [Assume steady load: G = 80 GPa] **(10 Marks)**

OR

6 A shaft is supported by two bearings placed 1m apart. A 500 mm diameter pulley is mounted at a distance of 200 mm to the right of left hand bearing and this drives a pulley directly below it with the help of belt having maximum tension of 3000 N. The pulley weigh 1000 N. Another pulley 300 mm diameter is placed 30 mm to the left of right hand bearing is driven with the help of electric motor and the belt which is placed horizontally to the right when viewed from the left bearing. This pulley weighs 500 N. The angle of contact for both the pulleys is 180° and $\mu = 0.24$. Determine the suitable diameter for solid shaft, (assuming torque on one pulley is equal to torque on other pulley. Choose C15 steel (σ_y = 235 MPa, σ_u = 425 MPa) as the shaft material and use ASME Code for the design of shaft. (Assume minor shock condition). **(16 Marks)**

Module-4

7 Two spur gears are to be used for a rock crusher drive and are to be minimum size. The gears are to be designed for the following requirement power to be transmitted is 18 KW. Speed of pinion 1200 rev/min. Velocity ratio 3.5 to 1, tooth profile 20° stub involute. Determine module and face width for strength requirements only. Assume suitable data. **(16 Marks)**

OR

8 a. With a neat sketch obtain the expression for beam strength of helical gears. **(04 Marks)**

b. A pair of mating helical gears have 20° pressure angle in the normal plane. The normal module is 5 mm and the module in the diametral plane is 5.7735 mm. The pitch diameter of the smaller gear is 115.47 mm. If the transmission ratio is 4:1. Calculate :

i) Helix angle
ii) Normal pitch
iii) Transverse pitch
iv) Number of teeth for each gear
v) Addendum
vi) Dedendum
vii) Whole depth
viii) Outside diameter
ix) Centre distance
x) dedendum circle diameter
xi) Base circle diameter **(12 Marks)**

Module-5

9 a. Determine the dimension of bearing and journal to support a load of 7.5 kN at 1000 rpm. The journal is made of hardened steel and the bearings is of babbit material abundance of oil supplied by oil rings. The oil viscosity is 300 say bolt seconds at 40°C and specific gravity is 0.915 at 15.5°C. The operating temperature of the oil is 75°C alloys a clearance of 0.001 mm per mm diameter. Also find the minimum film thickness. Assume suitable data. **(08 Marks)**

b. A 75 mm long full journal bearing of diameter 7.5 mm supports a radial load of 12 kN at the shaft speed of 1800 rev/mn. Assume ratio of diameter to the diameteral clearance is 1000. The viscosity of oil is 0.01 Pas at the operating temperature. Determine the following:
i) Sommerfield number
ii) The coefficient of friction based on Mckee's equation
iii) Amount of heat generated. **(08 Marks)**

OR

10 a. Briefly explain the classification of springs. **(06 Marks)**

b. The spring loaded safety valve for a boiler is required to blow off at a pressure of 1.3 MPa diameter of the valve is 65 mm and maximum lift of the valve is 17.5 mm. Design suitable compression springs for the valve. Assuming spring index to be 6 and providing initial compression of 30 mm. (Take $\tau = 0.45$ GPa and $G = 84$ GPa, squared and ground end) **(10 Marks)**

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