CBCS SCHEME

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15MA54

Fifth Semester B.E. Degree Examination, Jan./Feb. 2021
Elements of Machine Design

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 following theories of failure :
i) Maximum principal stress theory ii) Maximum shear stress theory. **(06 Marks)**

b. A round rod of diameter 1.2d has semicircular groove of diameter 0.2d. The rod is subjected to a bending moment of 10kN-m. The material of the rod is C 30 steel (σ_y = 294 N/mm^2). Determine the safe value of 'd' by considering stress concentration into account. Take factor of safety = 2. **(10 Marks)**

OR

2 a. Derive an expression for Instantaneous stress due to axial impact. **(06 Marks)**

b. A cantilever beam of width 50mm, depth 150mm is 1.5m long. It is struck by a weight of 1000N that falls from a height of 10mm at its free end. Determine the following :
i) Impact factor ii) Instantaneous maximum deflection
iii) Instantaneous maximum stress iv) Instantaneous max load. Take E = 206 GPa. **(10 Marks)**

Module-2

3 A steel cantilever member shown in Fig. Q3 is subjected to a transverse load at its end, that varies from 45N (up) to 135N (down) and axial load varies from 450N (tension) to 110N(compression). Determine the required diameter at the change of section for infinite life using a factor safety 2. The strength properties of the material are σ_u = 550 MPa , σ_y = 470 MPa , σ_{-1} = 275 MPa. **(16 Marks)**

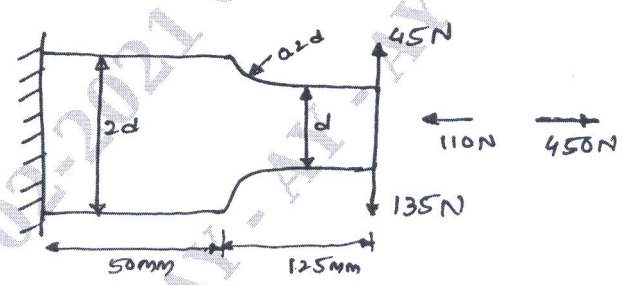

Fig. Q3

OR

4 A solid steel shaft running at 600rpm is supported on bearings of 600mm apart. The shaft receives 40kN through a 40mm diameter pulley weighting 400N located 300mm to the left bearing by a vertical flat belt drive. The power is transmitted from the shaft through another pulley of diameter 600mm weighing 600N located at 200mm to the right of right bearing. The belt drives are at right angle to each other and ratio of belt tension is 3. Determine the size of the shaft necessary, if the allowable shear stress is the shaft material is 40MPa and the loads are steady. **(16 Marks)**

Module-3

5 Design a bronze spur geat 81.4 N/mm^2 and mild steel pinion 101N/mm^2 to transmit 5kW at 1800 rpm. The velocity ratio is 3.5:1. Pressure angle is 14 ½^0 , number of teeth on pinion is 16. Determine the module and face width. Also suggest suitable hardness for the weaker member based on dynamic and wear consideration. **(16 Marks)**

OR

6 Design a pair of bevel gears to connect two shafts at 60^0. The gears are alloy steel of case hardened and precision cut with form cutters. The gear ratio is 5:1. The power transmitted is 30kW at 900rpm of the pinion. The 24 teeth pinion is of 20^0 fall depth. Suggest suitable surface hardness for the gear pair. **(16 Marks)**

Module-4

7 a. Design the assembly of a cotter joint to connect two rods subjected to an axial pull of 600kN. The material selected for the joint has the following permissible stresses : 300MPa in tension , 220MPa in shear and 450MPa in crushing. **(08 Marks)**

b. Design the assembly of a knuckle joint to connect two mild steel rods subjected to an axial pull of 100kN. The allowable stress for rods are 100MPa ,130MPa and 60MPa in tension, crushing and shear respectively. The bending of the pin is prevented by selection of proper fit. **(08 Marks)**

OR

8 a. The standard cross section of a flat key, which is fitted on a 50mm diameter shaft is 16mm × 10mm. The key is transmitting 475 N-m torque from the shaft to the rub. The key is made of commercial steel for which yield strength in both tension and compression may be taken as 230N/mm^2. Determine the minimum length of key required if the factor of safety is 3. **(06 Marks)**

b. Design a rigid flange coupling to transmit 18kW at 1440 rpm. The allowable shear stress in the cast iron flange is 4MPa. The shaft and keys are made of AISI 1040 annealed steel with ultimate and yield strength values as 518.3MPa and 353.4MPa respectively. **(10 Marks)**

Module-5

9 a. Derive an expression of Petroff's equation. **(06 Marks)**

b. A 75mm journal bearing of diameter 75mm supports a load of 15kN. The ratio of $\frac{d}{c} = 1000$ and the viscosity of the oil is 25 × 10^{-3} pas. The heat generated in the bearing is 442 watts. Determine the maximum speed of the journal using Mackee's equation. **(10 Marks)**

OR

10 a. Briefly explain the properties of good lubricant. **(06 Marks)**

b. A 75mm long full journal bearing of diameter 75mm supports a load of 12kN at the shaft speed of 1800 rpm. Assume the ratio of diameter to diametral clearance is 1000. The viscosity of oil is 0.01 Pas at the operating temperature. Determine the following :

i) Sommer field number.
ii) Coefficient of friction based on Mackee's equation.
iii) Amount of heat generated. **(10 Marks)**

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