CBCS SCHEME

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21ME63

Sixth Semester B.E./B.Tech. Degree Examination, June/July 2025
Machine Design

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of design data hand book is permitted.
3. Assume missing data suitably.

Module-1

1 a. Explain the following:
i) Elasticity
ii) Plasticity
iii) Ductility
iv) Brittleness
v) Factor of safety. **(10 Marks)**

b. Determine the required thickness of the steel bracket at section A-A when loaded as shown in Fig.Q.1(b) in order to limit the tensile stress to 100 N/mm^2. **(10 Marks)**

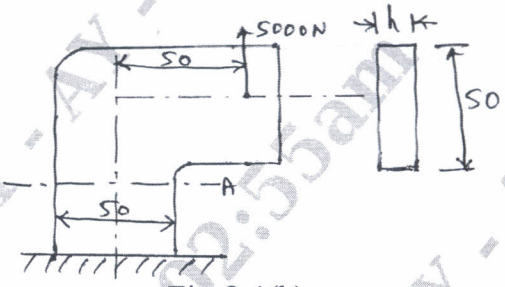

Fig.Q.1(b)

OR

2 a. A notched flat plate shown in Fig.Q.2(a) is subjected to bending moment of 10 N.m. Determine the maximum stress induced in the member by taking the stress concentration into account. **(10 Marks)**

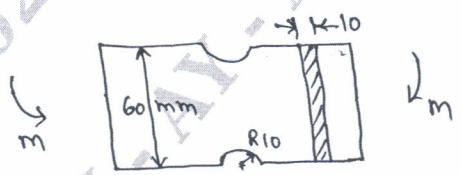

Fig.Q.2(a)

b. Derive an equation for impact stress induced in a member subjected to axial impact loading. **(10 Marks)**

Module-2

3 a. With usual notations prove that a hollow shaft is always stronger than a solid shaft of the same material, weight and length when subjected to simple torque and hence deduce that

$$\frac{\text{Torque on hollow shaft}}{\text{Torque on solid shaft}} = \frac{1+k^2}{\sqrt{1-k^2}} > 1, \text{ where } k = \frac{D_i}{D_o}$$ **(14 Marks)**

b. A shaft is required to transmit 1 MW at 240 rpm. The shaft must not twist more than 1° on a length of 15 diameters. If the modulus of rigidity for the shaft material is 80 kN/mm^2, find diameter of the shaft. **(06 Marks)**

OR

4 a. Write design procedure for flange coupling. **(08 Marks)**

b. Design a value spring for an automobile engine, when the value is closed, the spring produces a force of 45 N and when it opens, produces a force of 55 N. The spring must fit over the value bush which has an outside diameter of 20 mm and must go inside a space of 35 mm. The lift of the value is 6 mm. The spring index is 12. The allowable stress may be taken as 0.33 GPa, modulus of rigidity 80 Gpa. **(12 Marks)**

Module-3

5 a. Sketch and explain failure modes of riveted joints. **(08 Marks)**

b. A double riveted lap joint is to be made between 9 mm plates, if the safe working stresses in tension, crushing and shear are 80 N/mm^2, 120 N/mm^2 and 60 N/mm^2 respectively, design the riveted joint. **(12 Marks)**

OR

6 a. A plate of 80 mm wide and 10 mm thick is to be welded to another plate by means of two parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of weld so that maximum stress does not exceed 50 N/mm^2. Consider the joint under static loading and then under dynamic loading. **(10 Marks)**

b. A flat circular plate is used to close the flanged end of a pressure vessel of internal diameter 300 mm. The vessel carries a fluid at a pressure of 0.7 N/mm^2. A soft copper gasket is used to make the joint leak proof. Twelve bolts are used to fasten the cover plate onto the pressure vessel. Find the size of bolts so that the stress in the bolts is not to exceed 100 N/mm^2. **(10 Marks)**

Module-4

7 A pair of carefully cut spur gears with 20° full depth involute profile is used to transmit 12 kW at 1200 rpm of pinion. The gear has to rotate at 300 rpm. The material used for both pinion and gear is medium carbon steel whose allowable bending stress may be taken as 230 MPa. Determine the module and face width of spur pinion and gear. Suggest suitable hardness. Take 24 teeth on pinion, modulus of elasticity may be taken as 210 GPa. **(20 Marks)**

OR

8 a. Derive an equation for formative or virtual or equivalent number of teeth for bevel gear. **(08 Marks)**

b. Following data refer to a worm and worm gear drive centre distance 200 mm, PCD of worm 80 mm, number of start 44, axial module 8 mm, transmission ratio 20, worm gear is phosphor bronze with σ_{au} 55 MPa, worm is of hardened ground steel, tooth form 20° FD involute. Determine following:
Number of teeth on worm gear, lead angle face width of worm gear to transmit 15 kW of power at 1750 rpm of worm based on the beam strength of worm gear. **(12 Marks)**

Module-5

9 a. Determine the power transmitted by a single pair plate clutch assuming uniform pressure distribution. The friction surfaces have an outside diameter of 350 mm and an inner diameter of 280 mm. The co-efficient of friction is 0.25 and the maximum allowable pressure is 0.85 MPa. **(10 Marks)**

b. A single block brake is shown in Fig.Q.9(b). The drum diameter is 250 mm. The contact angle is 90°. If an operating force of 700 N is applied at the end of the lever and the coefficient of friction is 0.35, determine the torque that may be sustained by the brake. **(10 Marks)**

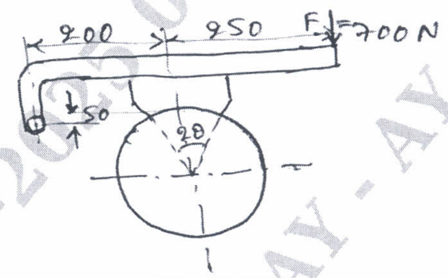

Fig.Q.9(b)

OR

10 a. Explain hydrodynamic theory of lubrication with sketch. Pressure distribution in bearing and graph showing variation of friction with speed. **(10 Marks)**

b. A single row deep groove ball bearing has a specific dynamic capacity of 46.3 kN. The actual radial load F_r = 9 kN. The speed of rotation is 1800 rpm. What is the life in i) Cycles of operation ii) in hours iii) What is average life? **(10 Marks)**

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