CBCS SCHEME

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15AU53

Fifth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Design of Machine Elements – I

Time: 3 hrs. Max. Marks: 80

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 if any suitably.

Module-1

1 a. Draw the stress-strain diagrams for a ductile and brittle materials and show the salient points on them. **(06 Marks)**

b. The load F on C-clamp shown in Fig.Q.1(b) is 37.5 kN. Determine the dimensions b and h, if allowable stress is 100MPa, b = 3h and e = 200mm. **(10 Marks)**

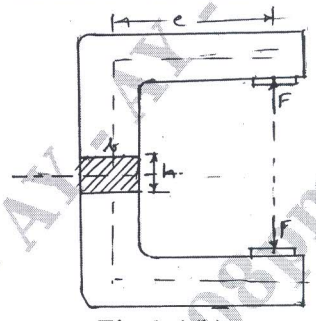

Fig.Q.1(b)

OR

2 a. Define factor of safety, list the factors which effect on factor of safety. **(04 Marks)**

b. A shaft is made up of steel having yield strength 700MPa. It is subjected to combined load of bending moment 10kN-m and twisting moment of 30kN-m. Determine the diameter of shaft according to

i) Max normal stress theory of failure.
ii) Max shear stress theory of failure.

Assuming factor of safety as 2 and $\mu = 0.25$. **(12 Marks)**

Module-2

3 a. A flat plate subjected to a tensile force of 5 kN is as shown in Fig.Q3(a), σ_u = 200 MPa for the material used. Determine thickness of plate. If factor of safety is 2.

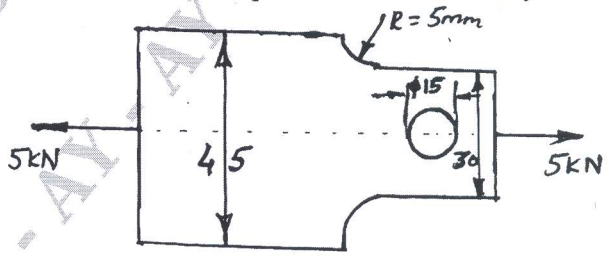

Fig.Q3(a) **(08 Marks)**

b. An unknown weight fall through 20 mm on to a collar rigidly attached to the lower end of vertical bar 2m long and 500 mm^2 section. If the maximum instantaneous extension is known to be 2 mm, what is the corresponding stress and the value of unknown weight? Take E = 200 GPa. **(08 Marks)**

OR

4 A cantilever beam made up of cold drawn carbon steel (σ_u = 55 MPa, σ_y = 470 MPa, σ_{-1} = 275 MPa) of circular cross-section is subjected to load which varies from –F to 3F. Determine the maximum load that member can withstand for on infinite life. FOS 2. [Refer Fig.Q4]

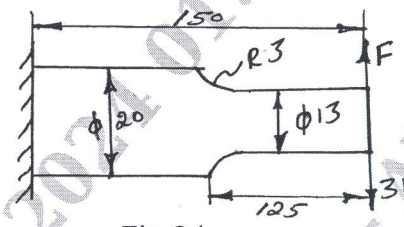

Fig.Q4 **(16 Marks)**

Module-3

5 a. A flange coupling is used to connect two co-axial shafts of diameter 50mm. The allowable shear stress in the steel shaft is 40MPa. Determine :

i) shear stress induced in the key

ii) shear stress induced in the four M16 × 1.5 bolts located on the bolt circle diameter of 150mm and

iii) shear stress induced in the cast iron flange of 20mm thick and the hub diameter of 100mm. **(08 Marks)**

b. Design a knuckle joint to connect two mild steel rods to sustain an axial pull of 150kN. The pin and the rods are mode of some material. Assume the working stresses in the material as 80MPa in tension, 40MPa in shear and 120MPa in crushing. **(08 Marks)**

OR

6 A section of steel shaft of 2m long supported between bearings running at 1000rpm carries a 20° involute spur gear of pitch diameter 200mm at its mid point. The gear delivers 20kN power to its mating gear located directly above the shaft. If the shaft material selected has an allowable shear stress of 40MPa, determine the diameter of the shaft. Assume the loads are steady. **(16 Marks)**

Module-4

7 a. Explain failures of riveted joint. **(06 Marks)**

b. Design a triple riveted lap joint of zig-zag type for pressure vessel of 1.5m diameter. The maximum pressure is 1.5MPa. Allowable stresses in tension, crushing and shear are 100MPa, 125MPa and 75MPa respectively. **(10 Marks)**

OR

8 a. Derive an expression for strength of double parallel single transverse welded joint. **(06 Marks)**

b. Determine the size of weld for a welded joint loaded as shown in Fig.Q.8(b). The permissible shear stress for the weld material is 75MPa. **(10 Marks)**

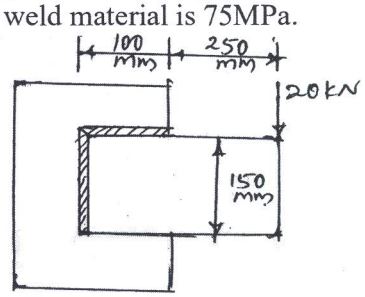

Fig.Q.8(b)

Module-5

9 a. The cylinder head of a steam engine is subjected to a steam pressure of 0.7 MPa. It is held in position by means of 12 bolts. A soft copper gasket is used to make the joint leak-proof. The effective diameter of cylinder is 300 mm. Find the size of the bolts so that the stress in the bolts is not to exceed 100 MPa. **(06 Marks)**

b. The structural connection shown in Fig.Q9(b) subjected to an eccentric load P of 10 kN with an eccentricity of 500 mm. The centre distance between bolts at 1 and 3 is 150 mm and the centre distance between bolts at 1and 2 is 200 mm. All bolts are identical. The bolts are made of plain carbon steel having $\sigma_y = 400$ MPa and FOS = 2.5. Determine size of bolts.

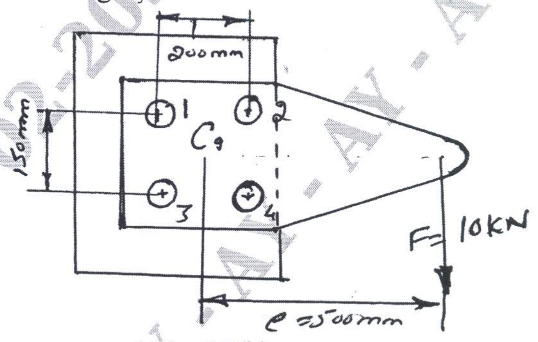

Fig.Q9(b) **(10 Marks)**

OR

10 a. Explain overhauling of screws. **(04 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 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 the collar friction is negligible. Calculate:

(i) Principle shear stress in the screw rod
(ii) Transverse shear stresses in screw and nuts
(iii) Unit Bearing Pressure for threads
(iv) State whether the screw is self locking **(12 Marks)**

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