Reg. No.

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: BMEE301L – Design of Machine Elements
Class NBR(s): 3777 / 3778 / 3779 / 3780
Slot: A2+TA2+TAA2
Time: Three Hours
Max. Marks: 100

- KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE
- DON'T WRITE ANYTHING ON THE QUESTION PAPER

General Instruction:

i. Use of PSG Design Data Book is permitted
ii. Assume suitable data if necessary

Answer ALL Questions
(10 X 10 = 100 Marks)

1. A C-frame subjected to a force of 15 kN is shown in Fig.1. It is made of grey cast iron FG 300 and the factor of safety is 2.5. Determine the dimensions of the cross-section of the frame.

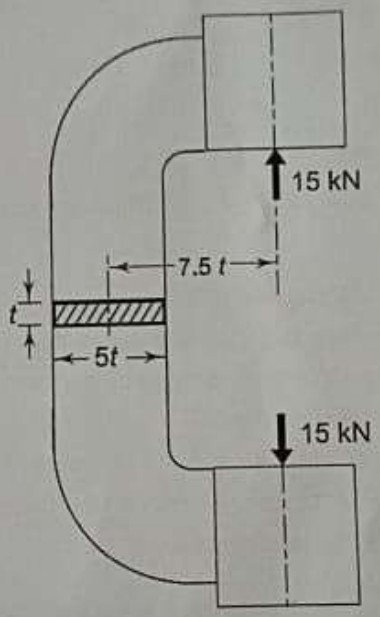

Fig 1

2. A solid circular shaft, 15 mm in diameter, is subjected to torsional shear stress, which varies from 0 to 35 N/mm^2 and at the same time, is subjected to an axial stress that varies from −15 to +30 N/mm^2. The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of steel FeE400 (S_{ut} = 540 N/mm^2 and S_{yt} = 400 N/mm^2) and the corrected endurance limit of the shaft is 200 N/mm^2. Determine the factor of safety.

3. A component machined from a plate made of steel 45C8 (S_{ut} = 630 N/mm²) is shown in Fig. 2. It is subjected to a completely reversed axial force of 50 kN. The expected reliability is 90% and the factor of safety is 2. The size factor is 0.85. Determine the plate thickness t for infinite life. Consider the notch sensitivity factor to be 0.8 and the surface finish factor to be 0.76.

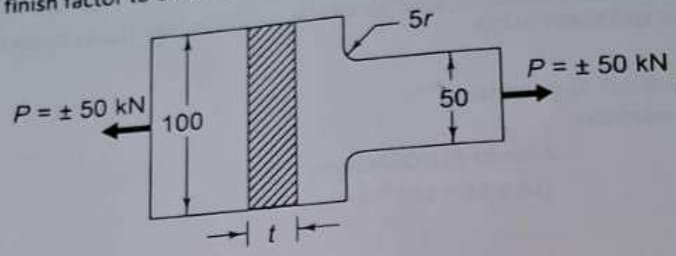

Fig 2

4. Design a leaf spring for the following specifications:

Total load = 140 kN.

Number of springs supporting the load = 4.

Maximum number of leaves = 10.

Span of the spring = 1000 mm.

Permissible deflection = 80 mm.

Take Young's modulus, E = 200 kN/mm² and allowable stress in spring material as 600 MPa.

5. A railway wagon moving at a velocity of 2 m/s is brought to rest by a bumper consisting of two helical compression springs arranged in parallel. The springs are compressed by 150 mm in bringing the wagon to rest. The mass of the wagon is 1000 kg. The spring index can be taken as 6. The springs are made of oil-hardened and tempered steel wire with ultimate tensile strength of 1500 N/mm² and modulus of rigidity of 81370 N/mm². The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength. Design the springs and calculate:

(i) maximum force on each spring.

(ii) wire diameter.

(iii) mean coil diameter, and .

(iv) number of active coils.

6. A solid circular beam, 25 mm in diameter, is welded to a support by means of a fillet weld as shown in Fig. 3. Determine the leg dimension of the weld, if the permissible shear stress is 95 N/mm².

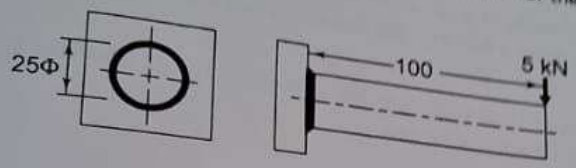

Fig 3

7. A bracket, attached to a vertical column by means of four identical rivets, is subjected to an eccentric force of 25 kN as shown in Fig. 4. Determine the diameter of rivets, if the permissible shear stress is 60 N/mm².

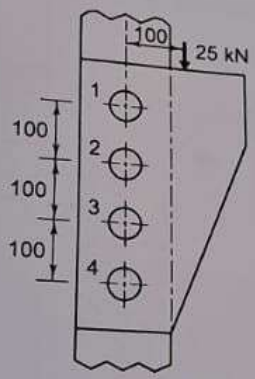

Fig 4

8. Two rods, made of plain carbon steel 40C8 (S_{yt} = 380 N/mm²), are to be connected by means of a cotter joint. The diameter of each rod is 50 mm, and the cotter is made from a steel plate of 15 mm thickness. Calculate the dimensions of the socket end making the following assumptions:

(i) the yield strength in compression is twice of the tensile yield strength; and

(ii) the yield strength in shear is 50% of the tensile yield strength.

The factor of safety is 6.

9.a) A steel shaft (yield stress = 309.9 MPa.) 1.5 m long between bearings carries a 1 kN pulley at midpoint. The pulley is keyed to the shaft and receives 20 kW power at 200 rpm. The belt drive is horizontal, and the ratio of the belt tensions is 3:1. The diameter of the pulley is 600 mm. Calculate the necessary shaft diameter. Take combined shock and fatigue factor applied to bending K_b = 1.75, torsion K_t = 1.25 and factor of safety = 2.

OR

9.b) Design a sleeve muff coupling which is used to connect two steel shafts transmitting 25 kW power at 360 rpm. The shaft is made of plain carbon steel 30C8 (yield stress: 400 MPa) and the sleeve is made of grey cast iron FG200 (ultimate stress: 200 MPa). The factor of safety for the shaft is 4 and for the sleeve, the factor of safety is 6 based on ultimate strength.

10.a) Determine the dimensions of cross-section of the connecting rod as illustrated in Fig. 5 for a diesel engine with the following data:

Cylinder bore = 100 mm

Length of connecting rod = 350 mm

Maximum gas pressure = 4 MPa

Factor of safety = 6

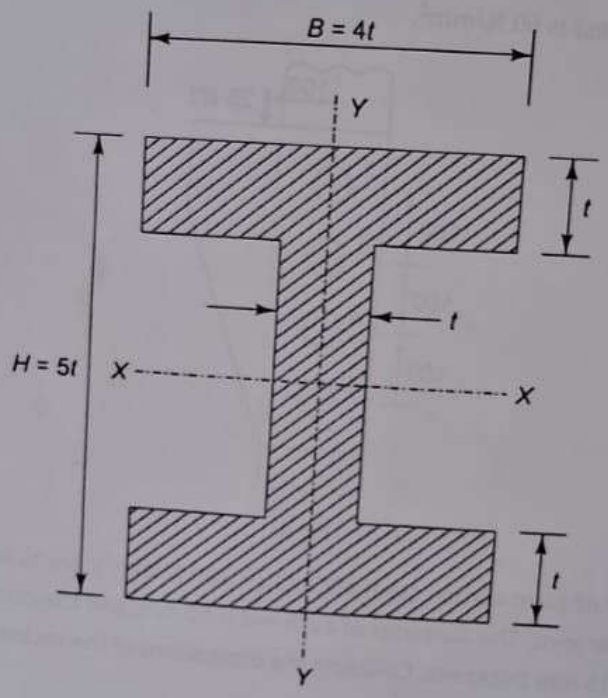

Fig 5

OR

10.b) A single cylinder double acting steam engine delivers 185 kW at 100 rpm. The maximum fluctuation of energy per revolution is 15 per cent of the energy developed per revolution. The speed variation is limited to 1 per cent either way from the mean. The mean diameter of the rim is 2.4 m. Determine the mass of the flywheel and Cross-sectional dimensions of the flywheel rim.

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