Total No. of Questions : 8]

SEAT No. :

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[Total No. of Pages : 5

[6002]-203

S.E. (Mechanical/Automobile) (Automation & Robotics) (Mechanical Sandwich)

SOLID MECHANICS

(2019 Pattern) (Semester-III) (202041)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Answer Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.***
2) ***Figures to the right indicate full marks.***
3) ***Use graph paper for Graphical Solution.***
4) ***Use of electronic pocket calculator is allowed.***
5) ***Assume suitable data if necessary.***

Q1) a) A square beam 20mm × 20mm in section and 2 m long is supported at the ends. The beams fails when a point load of 400 N is applied at the centre of the beam. What uniformly distributed load per meter length will break a cantilever of the same material 40 mm wide, 60 mm deep and 3m long? **[9]**

b) A simply supported beam of span 4 m carries a central point load 100 kN. The beam is I-section of unequal flange as shown in Figure 1. Calculate shear stress at neutral axis and also draw shear stress distribution over the depth of the section. **[9]**

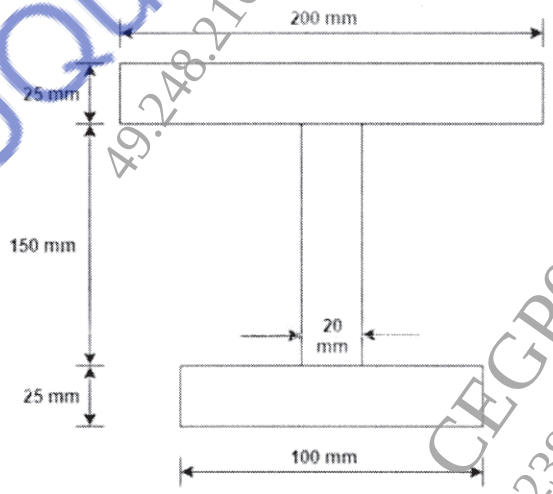

Figure 1

OR

P.T.O.

Q2) a) A T section of flange180 mm × 30 mm and web 200 mm × 30 mm is simply supported at the both ends. It carries two concentrated loads of 110 kN each acting 2 m distance from each support. Span of the beam is 10 m. Determine the maximum bending stress induced in the beam and draw bending stress distribution diagram and also find bending stress at the layer 110 mm from the bottom. **[9]**

b) A simply supported beam of span 8m is subjected to point loads' of 60 kN, 80 kN and 50 kN at 2 m, 4 m and 6 m from left support respectively. Determine slope at left support and deflection under 60 kN and 80 kN loads. Take EI = 2.668×10^9 kNm^2. **[9]**

Q3) a) A hollow shaft with diameter ratio 3 / 5 is required to transmit 450 kW at 120 rpm with a uniform twisting moment The shearing stress in the shaft must not exceed 60 N/mm^2 and the twist in a length of 2.5 m must not exceed 1º. Calculate the external diameter of the shaft satisfying these conditions. Take the modulus of rigidity is 8×10^4 N/mm^2. **[9]**

b) A 4m length of a tube has a buckling load of 2kN when used as a column hinged at both ends. Calculate buckling load for 4.5 m length of the same tube when used as column if **[8]**

i) Both ends are fixed

ii) One end fixed and other is hinged

iii) One end is fixed and the other free.

OR

Q4) a) A composite shaft consist of copper rod of 20 mm diameter enclosed in a steel tube of 60 mm external diameter and 20 mm thick. The shaft is required to transmit to torque of 1200 Nm. Determine the shear stresses developed in the copper and steel if both the shaft have equal length and welded to a plate at each end so that their twists are equal take modulus of rigidity for steel as twice that copper. **[9]**

b) Calculate the critical load for a strut which is made up of a bar circular in section, 1.2 m long and which is hinged at one end and fixed at the other end. The same bar when freely supported at its ends gives the central deflection of 3mm, when a load of 100 N is placed at its centre. Also find the safe load taking factor of safety is 3. **[8]**

Q5) a) At a point in a strained material, there are two mutually perpendicular stresses of 30 MPa and 70 MPa, both tensile. They are accompanied by a shear stress of 20 MPa. Determine principal plane and principal stresses. Use Mohr's stress circle method only. **[9]**

b) A solid circular shaft is subjected to a bending moment of 45 kNm and a torque of 15 kNm. Design the diameter of the shaft according to: **[9]**

i) Maximum principal stress theory

ii) Maximum shear stress theory

iii) Maximum strain energy theory

Take $\mu = 0.25$, Stress at elastic limit = 200 MPa and factor of safety is 2.

OR

Q6) a) A rectangular block of material is subjected to a tensile stress of 110 N/mm^2 on one plane and a tensile stress of 60 N/mm^2 on a plane at right angles, together with shear stresses of 70 N/mm^2 on the faces. Find the following terms: **[9]**

i) The magnitude of principal stresses

ii) The magnitude of greatest shear stress

iii) The location of principle plane

iv) The location of plane containing maximum shear stress.

b) An axial pull of 25 kN along with a shear force of 20 kN is applied to a circular bar of 20 mm diameter. The elastic limit of the bar material is 250 MPa and Poisson's ratio, $\mu = 0.3$. Determine the factor of safety against failure based on: **[9]**

i) Maximum shear stress theory

ii) Maximum strain energy theory

iii) Maximum principal strain energy theory

iv) Maximum shear strain energy theory

Q7) a) A segment of a generator shaft is subjected to a torque T and an axial force P, as shown in the figure 2. The hollow shaft having outer diameter d_2=280 mm and inner diameter d_1=230 mm and delivers 1800 kW at 4.0Hz. If the compressive force, P=525 kN. What are the maximum tensile, compressive and shear stresses in the shaft? **[9]**

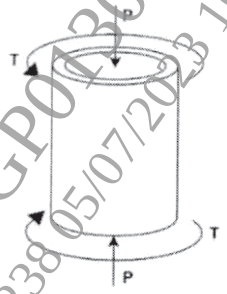

Figure 2

b) A hollow rectangular section is having external size 600 mm × 550 mm and internal size 500 mm× 450 mm. It carries a vertical load of 110 kN at the outer edge of the column on X-axis. Calculate maximum and minimum intensities of stress in the section. Assume 600 mm side horizontal. **[8]**

OR

Q8) a) The bar has a diameter of 40mm. if it is subjected to the two force components at its end as shown in figure3. Determine the state at point A and B and show the results on a different volume element located at this point. **[9]**

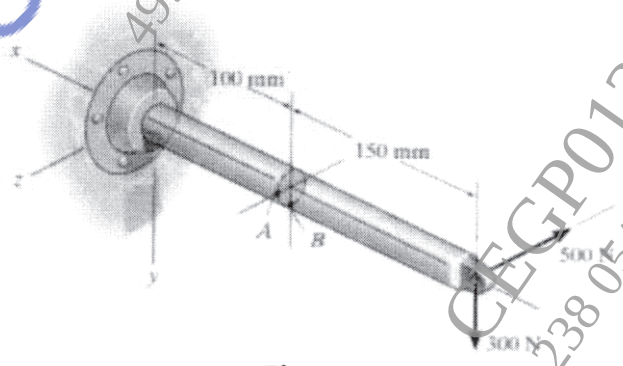

Figure 3

b) Determine the stress resultant at four corners of Column subjected to eccentric load of 500 kN, as shown in Figure.4 **[8]**

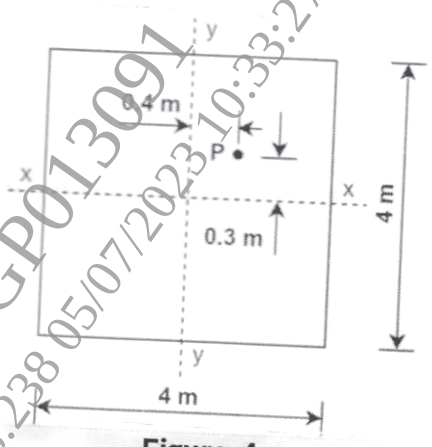

Figure. 4