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0800MET201122001

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third Semester B.Tech Degree Examination December 2020 (2019 Scheme)

Course Code: MET201
Course Name: MECHANICS OF SOLIDS

Max. Marks: 100 Duration: 3 Hours

PART A
Answer all questions. Each question carries 3 marks Marks

1		Why is the stress tensor symmetric? Express the stress tensor (3 X 3) for simple axial loading of a rod, with x-axis coinciding with the axis of loading.	(3)
2		What are stress invariants? Why would they remain invariant?	(3)
3		Differentiate between engineering-stress-strain curve and true-stress-strain curve and comment on the applicability of the engineering stress strain curve in the design of mechanical engineering components.	(3)
4		Differentiate between plane–stress and plane-strain by citing suitable example for each case.	(3)
5		State the assumptions involved in deriving Elastic Flexure Formula.	(3)
6		State the assumptions involved in deriving Torsion Formula for circular shafts.	(3)
7		Explain point of inflection and point of contraflexure.	(3)
8		Make a short note on deflection analysis by Castiglianos' method. What is the limitation regarding the material behaviour, while applying this method?	(3)
9		Explain the fundamental difference between the deformation behaviour in (i) bending of beams and (ii) buckling of columns.	(3)
10		State yield criterion as per Max. Normal Strain Theory. Why didn't it get acceptability?	(3)

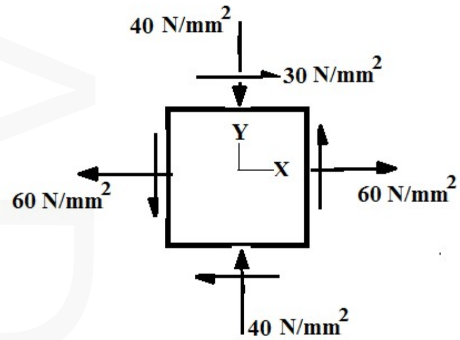
PART B
Answer any one full question from each module. Each question carries 14 marks

Module 1

11	(a)	If the stress tensor at a point is given by σ_{xx}=0, σ_{yy}=0, σ_{zz}=0, τ_{xy}=10, τ_{xz}= -10, τ_{yz}=20, find stress invariants, characteristic equation, principal stresses and the principal plane associated with the maximum principal stress.	(10)
	(b)	If the displacement field is $(3x^2+y)$ **i**+ $(2y^2+z)$ **j**+ $(4z^2+x)$ **k**, obtain the Strain tensor at (2,1,1).	(4)

OR

12 (a) The state of stress is shown in the figure. Using Mohr's circle, determine the Principal stresses, the Maximum shear stress and the Plane of maximum shear stress. (10)

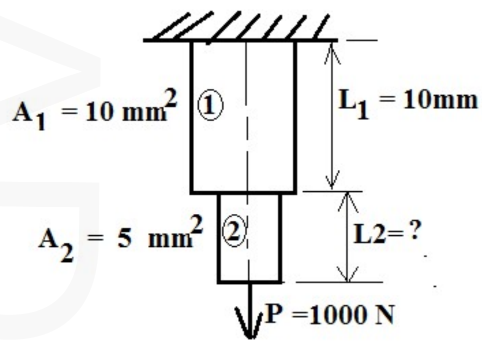


(b) If the stress tensor at a point is given by τ_{xx}=1, τ_{yy}=5, τ_{zz}=6, τ_{xy}=2, τ_{xz}= 3, τ_{yz}=4, find the resultant stress vector on a plane with direction cosines {1/√3, 1/√3, 1/√3} (4)

Module 2

13 (a) Derive expression for extension of a tapered- rod (Young's Modulus is E) of length L tapering from diameter D to d, when loaded by an axial force P. (7)

(b) What should be the length of part-2, if both parts in the figure are to have the same elongation? What is the magnitude of deformation in each part? Use E= 2 X 10^5 N/mm^2 (7)



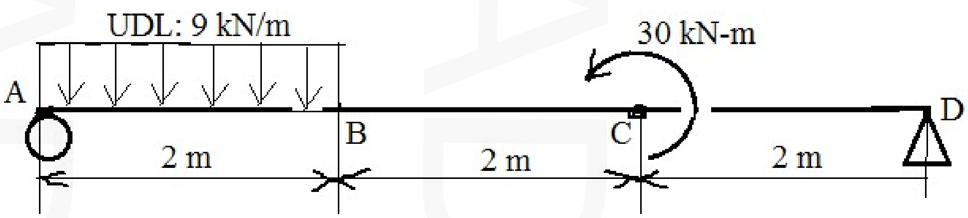
OR

14 (a) A steel rod 20mm in diameter screwed at the ends passes through a copper tube of inner diameter 25 mm and outer diameter 30mm. The temperature of the assembly was at 115°C when they were assembled and was relieved of all stresses. Find the stresses in the rod and the tube when the temperature has fallen to 15°C. E_{steel} = 2.1 X 10^5 N/mm^2, E_{copper} = 1.0 X 10^5 N/mm^2 , α_{steel} =0.000012/deg.C and α_{copper} =0.0000175/deg.C . (9)

(b) Formulate Generalized Hooke's law equations for a tri-axial state of stress in Cartesian coordinates, starting from consideration of Hooke's law for an elastic solid and Poisson's ratio. (5)

Module 3

15 (a) Draw Shear Force and Bending Moment Diagram for the beam shown: (10)



(b) Find the maximum bending stress induced in a horizontal simply supported beam made of steel of length 2m, with square cross section of side 10mm, loaded by a vertically downward force of 200N at mid-span. $E_{steel} = 2.1 \text{ X } 10^{5}$ N/mm^2 (4)

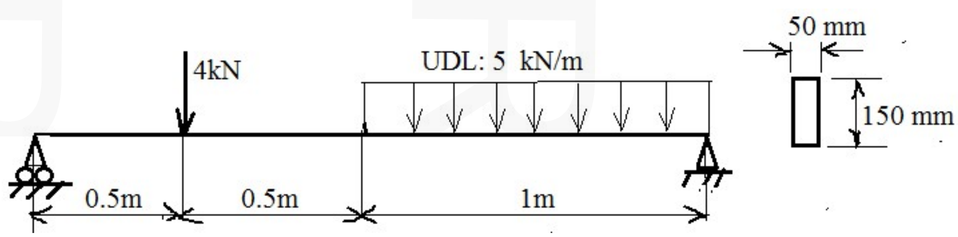
OR

16 (a) A solid shaft is proposed to be replaced by a hollow shaft (of the same length and the same material) for transmitting a torque of 30 kNm. If the allowable shear stress of the material used is 100 N/mm^2, find the ratio of the weight of hollow shaft to the solid one, if the inner diameter for hollow one is to be 0.5 times its outer diameter. (8)

(b) A beam is loaded by a load distribution acting in the transverse direction. Derive differential equations connecting the Load, Shear Force and Bending Moment. (6)

Module 4

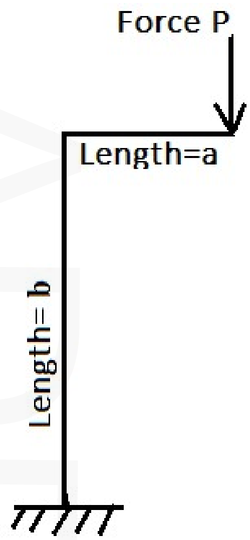
17 (a) Find deflection at the mid-span, if E=12GPa and cross section as shown (10)



(b) Sate Reciprocal Relation and demonstrate its applicability in an engineering problem. (4)

OR

18 (a) A structure as shown is loaded by a vertically downward force 'P at the free end'. Find deflection at the free end, in the direction of the load using Castigliano's method. Consider strain energy due to Bending Moment Alone (Neglect other effects). Use a=2m, b=4m, P=30 X 10^3N, EI (applicable for both legs) is 30 X 10^6 Nm^2. (8)



(b) Derive strain energy expressions in terms of the geometry, material property and load during (i) Bending and (ii) Torsion. (6)

Module 5

19 (a) Using the expression for Euler's critical buckling load, formulate an expression for Rankine's Crippling load in terms of Rankine's constant(α) (6)

(b) A column has a square cross-section of 40 mm side. If it has to carry a load of 89,600 N, what should be its limiting length if both ends are assumed to be pinned. Rankine constant α = 1/1600, and compressive strength is 560 N/mm^2. (8)

OR

20 (a) Formulate an expression for the yield criterion according to von-Mises' theory (5)

(b) If the principal stresses at a point are: $\{\sigma_1, \sigma_2, \sigma_3\} = \{10, 0, -4\}$ MPa and if the yield strength of the material under consideration is 40 MPa, find the factor of safety in design as per (a) Max. Normal Stress Theory (b) Max. Shear Stress Theory and (c) Max. Distortion Energy Theory. (9)

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