	ii.	A hollow shaft of external diameter 120 mm transmits 300 kW power at 200 rpm. Determine the maximum internal diameter if the maximum stress in the shaft is not to exceed 60 MPa.	**8**
OR	iii.	Determine the diameter of solid shaft which will transmit 300 kW at 250 rpm. The maximum shear stress not to exceed 30 MPa and twist should not be more than 1^o in a shaft length of 2 m. Take modulus of rigidity for the material of the shaft as 100 GPa.	**8**
Q.6	i.	Why Rankine theory of column's preferred over Euler's theory?	**2**
	ii.	Find the expression with proper assumptions for Crippling load P at which a column of length l with both the ends of the column is hinged.	**8**
OR	iii.	The external and internal diameter of a hollow cast iron are 5 cm and 4 cm respectively. If the length of this column is 3 m and both of its ends are fixed, determine the crippling load using Rankine's formula. Take the value of σ_c = 550 MPa and α = 1/1600 in Rankine's formula.	**8**

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Total No. of Questions: 6 *Total No. of Printed Pages:4*

Enrollment No.....

Faculty of Engineering

End Sem (Odd) Examination Dec-2018

AU3CO02/FT3CO02/ME3CO02 Strength of Materials

Programme: B.Tech. Branch/Specialisation: AU/FT/ME

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1	i.	A rod, 120cm long and of diameter 3.0 cm is subjected to an axial pull of 18 kN. The stress in N/mm^2 is. (a) 22.57 (b) 23.47 (c) 24.57 (d) 25.47	**1**
	ii.	A rod 3 m long is heated from 10°C to 90°C. Find the expansion of rod. Take Young's modulus = 100 GPa and coefficient of thermal expansion = 0.000012/°C (a) 0.208 cm (b) 0.288 cm (c) 0.348 cm (d) 0.168 cm	**1**
	iii.	If the principal stresses in a plane stress problem are σ_1= 100 MPa, σ_2= 40MPa, the magnitude of the maximum shear stress (in MPa) will be (a) 60 (b) 50 (c) 30 (d) 20	**1**
	iv.	The tensile stresses at a point across two mutually perpendicular planes are 120 MPa and 60 MPa. The value of normal stress on a plane inclined at 30^o to the axis of minor stress in MPa is (a) 75 (b) 90 (c) 30 (d) 105	**1**
	v.	The neutral axis of the cross-section a beam is that axis at which the bending stress is (a) Zero (b) Minimum (c) Maximum (d) Infinity	**1**
	vi.	The point of contraflexure occurs in (a) Cantilever beams (b) Simply supported beams (c) Overhanging beams (d) Fixed beams	**1**

vii. Two shafts 'A' and 'B' are made of same material. The shaft 'A' is solid and has diameter D. The shaft 'B' is hollow with outer diameter D and inner diameter D/2. The strength of hollow shaft in torsion is _____ as that of solid shaft. **1**

(a) 1/16 (b) 1/8 (c) 1/4 (d) 15/16

viii. The torsional rigidity of a shaft is given by **1**

(a) T/J (b) T/r (c) T/θ (d) T/G

ix. According to Euler's column theory, the crippling load for a column of length (*l*) with one end fixed and the other end free is _____ the crippling load for a similar column hinged at both the ends. **1**

(a) Equal to (b) Less than (c) More than (d) All of these

x. The slenderness ratio is the ratio of **1**

(a) Area of column to least radius of gyration

(b) Length of column to least radius of gyration

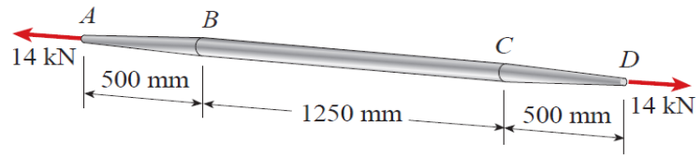
(c) Least radius of gyration to area of column

(d) Least radius of gyration to length of column

Q.2 i. A steel plate has a modulus of elasticity as 200 GPa and Poisson's ratio as 0.3. What is the value of Bulk modulus for the steel plate? **2**

ii. A compound tube consists of a steel tube 170 mm external diameter and 10 mm thickness and an outer brass tube 190 mm external diameter and 10 mm thickness. The two tubes are of same length. The compound tube carries an axial load of 1 MN. Find the stresses and the load carried by each tube and the amount by which it shortens. Length of each tube is 0.15 m Assume E_s = 200 GPa and E_b = 100 GPa. **8**

OR iii. Calculate the elongation of a copper bar of solid circular cross section with tapered ends when it is stretched by axial loads of magnitude 14 kN (see figure). The length of the end segments is 500 mm and the length of the prismatic middle segment is 1250 mm. Also, the diameters at cross sections *A*, *B*, *C*, and *D* are 12, 24, 24 and 12 mm, respectively, and the modulus of elasticity is 120 GPa. **8**



Q.3 i. Define Principal Plane and Principal Stresses **2**

ii. The principal tensile stress at a point across two perpendicular planes is 120 MPa and 60 MPa. Find the normal and tangential stress and the resultant stress and its obliquity on a plane at 20° with the major principal plane. Also find the intensity of stress which acting alone can produce the same maximum strain. Take Poisson's ratio = 0.25. **8**

OR iii. Obtain an expression for the major and minor principal stress on a plane, when body is subjected to direct stress in two mutually perpendicular directions followed by a shear stress. **8**

Q.4 Attempt any two:

i. Derive Bending Equation with usual notations and proper assumptions. **5**

ii. An I-section has the following dimensions: **5**

Flanges:150 mm x 20 mm ; Web: 30 mm x 10 mm

The maximum shear stress developed in the beam is 16.8 MPa. Find the shear force to which the beam is subjected.

iii. A beam of length 6 m is simply supported at its ends and carries two point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Find the deflection under each load. Take E = 200 GPa& I = 85 x 10^6 mm^4 **5**

Q.5 i. Which is, shaft is better Hollow or solid for the same external diameter and why. **2**

Marking Scheme

AU3CO02/FT3CO02/ME3CO02 Strength of Materials

Q.1	i.	A rod, 120cm long and of diameter 3.0 cm is subjected to an axial pull of 18 kN. The stress in N/mm^2 is. (d) 25.47	**1**
	ii.	A rod 3 m long is heated from 10°C to 90°C. Find the expansion of rod. Take Young's modulus = 100 GPa and coefficient of thermal expansion = 0.000012/°C (b) 0.288 cm	**1**
	iii.	If the principal stresses in a plane stress problem are σ_1= 100 MPa, σ_2= 40MPa, the magnitude of the maximum shear stress (in MPa) will be (c) 30	**1**
	iv.	The tensile stresses at a point across two mutually perpendicular planes are 120 MPa and 60 MPa. The value of normal stress on a plane inclined at 30^o to the axis of minor stress in MPa is (d) 105	**1**
	v.	The neutral axis of the cross-section a beam is that axis at which the bending stress is (a) Zero	**1**
	vi.	The point of contraflexure occurs in (c) Overhanging beams	**1**
	vii.	Two shafts 'A' and 'B' are made of same material. The shaft 'A' is solid and has diameter D. The shaft 'B' is hollow with outer diameter D and inner diameter D/2. The strength of hollow shaft in torsion is _____ as that of solid shaft. (d) 15/16	**1**
	viii.	The torsional rigidity of a shaft is given by (a) T/J	**1**
	ix.	According to Euler's column theory, the crippling load for a column of length (l) with one end fixed and the other end free is _____ the crippling load for a similar column hinged at both the ends. (b) Less than	**1**
	x.	The slenderness ratio is the ratio of (b) Length of column to least radius of gyration	**1**
Q.2	i.	K = 166.67 GPa	**2**
	ii.	Stress in steel 127.34 MPa & in brass 63.67 MPa — 3 marks Load in steel 0.64 MN and in brass 0.36 MN — 3 marks Deformation 0.096 mm — 2 marks	**8**
OR	iii.	Formula — 2 marks Deformation 0.838 mm — 6 marks	**8**
Q.3	i.	Principal Plane definition — 1 mark Principal Stresses definition — 1 mark	**2**
	ii.	Normal stress = 112.98 MPa — 2 marks Tangential stress = 19.28 MPa — 2 marks Resultant stress = 114.6 MPa — 2 marks Obliquity = 9.4^o — 1 mark Intensity of stress = 105 MPa — 1 mark	**8**
OR	iii.	Major principal stress expression — 4 marks Minor principal stress expression — 4 marks	**8**
Q.4		Attempt any two:	
	i.	Assumptions — 2 marks Derivation — 3 marks	**5**
	ii.	Moment of Inertia in mm^4 — 2 marks Maximum shear force = 50 kN — 3 marks	**5**
	iii.	Creating deflection equation — 1 mark Deflection at C = -9.019 mm — 2 marks Deflection at D = - 16.7 mm — 2 marks	**5**
Q.5	i.	Which is, shaft is better Hollow or solid for the same external diameter and why.	**2**
	ii.	Torque calculation = 14323900 N-mm — 2 marks Internal dia = 88.5 mm — 6 marks	**8**
OR	iii.	Calculating Torque T = 11459000 N-mm — 2 marks D based on strength = 124.5 mm — 3 marks D based on Rigidity = 107.5 mm — 2 marks Selection of diameter = 124.5 mm — 1 mark	**8**
Q.6	i.	Rankine theory of column's preferred over Euler's theory	**2**

	ii.	Assumptions	2 marks	**8**
		Expression	6 marks	
OR	iii.	Calculating I = 57656π mm4	1 mark	**8**
		Calculating k = 25.625 mm	1 mark	
		Calculating P = 123750 N	3 marks	
		Rankine formula	2 marks	
		Correct equivalent length	1 mark	

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