UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET	
COURSE CODE	: DTM 2023
COURSE	: SOLID MECHANICS
SEMESTER/SESSION	: 1 – 2021/2022
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 5 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write and sketch legibly wherever required.
4. Question booklet need to be returned after session ends.
5. If in doubt, raise your hand and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 8 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) The assembly consist of two 10 mm diameter brass rods AB and CD (E_{brass}=193 GPa), a 15 mm diameter stainless steel rod EF ($E_{s.steel}$=101 GPa) and a rigid bar G as shown in Figure 1. **Find**

i. the horizontal displacement of rod EF. (5 marks)

ii. the horizontal displacement of rod AB. (5 marks)

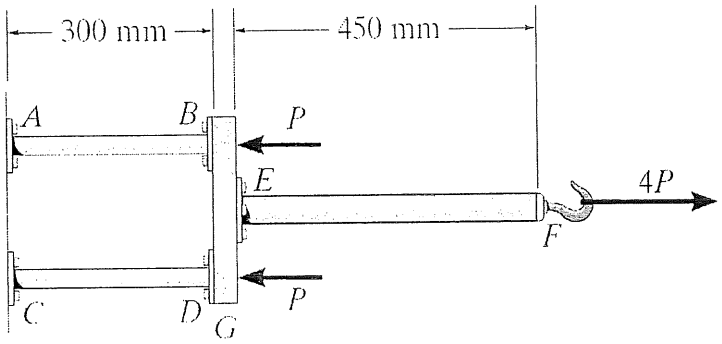

Figure 1

b) The acrylic plastic rod is 200 mm long and 15 mm in diameter shown in Figure 2. If axial load 300 N is applied to it, given it modulus of elasticity, E_p is 2.7 GPa, and Poisson ratio, ν is 0.4. **Compute**

i. the change in its length. (5 marks)

ii. the change in its diameter. (5 marks)

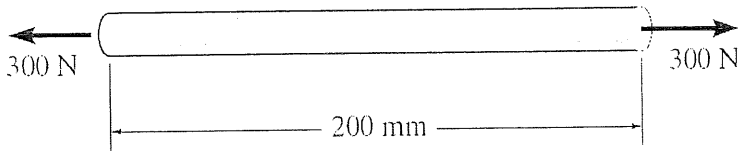

Figure 2

QUESTION 2

The solid shaft is fixed to the support at C and subjected to torsional loadings shown (Figure 3).

a) **Find** Torque, T_A and T_B. Include sketch on your answer. (8 marks)

b) **Find** polar second moment of area, J (4 marks)

c) **Compute** the shear stress at points A and B on the surface (8 marks)

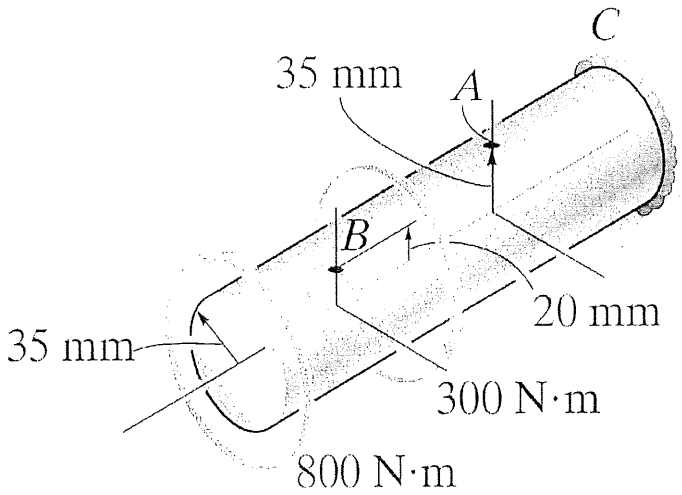

Figure 3

QUESTION 3

Two-point load of 2 kN and 6 kN are applied to the cantilevered strut (Figure 4).

a) **Compute** the centroid of strut cross-section. (6 marks)

b) **Compute** the moment of inertia, I for strut cross-section. (6 marks)

c) **Find** the first moment of area, Q (2 marks)

d) **Determine** the shear stress at point B on the web strut at section a-a. (6 marks)

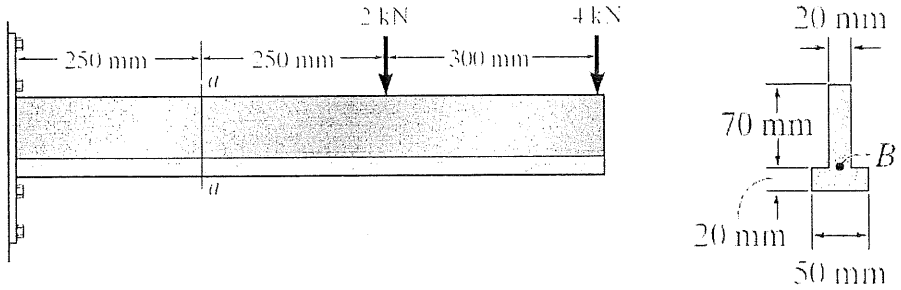

Figure 4

QUESTION 4

The compound beam is fixed at *A*, subjected point load at *B*, and *C*. (Figure 5).

a) **State** numbers cutting sections required? (2 marks)

b) **Compute** shear force and bending moment value along the beam. (12 marks)

c) **Sketch** the shear and moment diagrams for the beam. (6 marks)

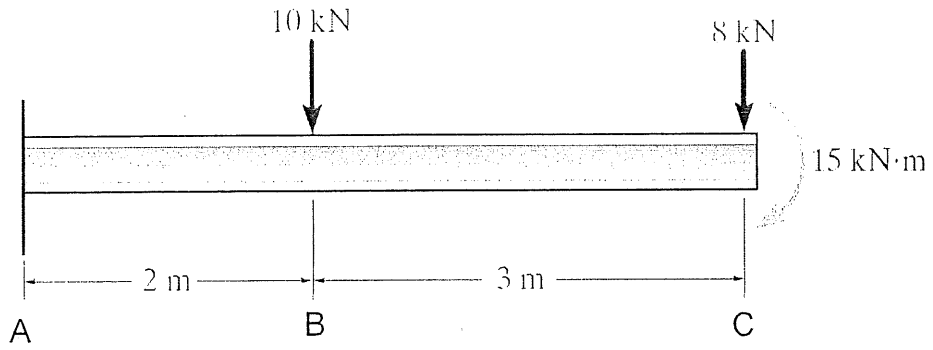

Figure 5

QUESTION 5

For the loading shown, determine (Figure 6).

a) **Formulate** the of the elastic curve for the cantilever beam AB. (16 marks)

b) **Compute** the deflection at the free end (point B). (2 marks)

c) **Compute** the slope free end (point B) (2 marks)

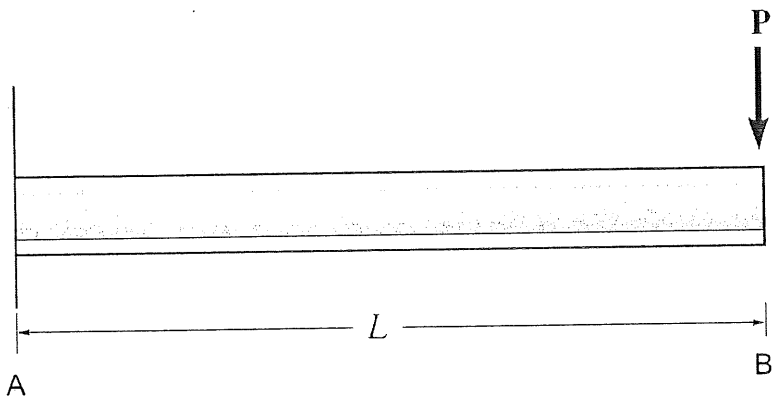

Figure 6

----------End of question----------

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Criteria	Marks
All questions answered will be marked according to answer scheme	/ 100

FORMULA

Math formula

Circle area = $A = \pi r^2$ Circle perimeter = $2\pi r$

Stress Strain

Normal stress $\sigma = \frac{F}{A}$

Shear stress $\tau = \frac{F}{A}$

double shear $\tau = \frac{F}{2A}$

Modulus of Elasticity $E = \frac{FL}{Ax}$

Torsion

$$\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau}{R}$$

Polar second moment of area

$$J_{solid\ shaft} = \frac{\pi D^2}{32} \qquad J_{holl\ \ shaft} = \frac{\pi D^2}{32} - \frac{\pi d^2}{32}$$

Shear Force and Bending Moment

Minimum section Modulus

$$S_{min} = \frac{|M|_{max}}{\sigma_{allowable}}$$

Interpolation

$$Vb - Va = -wx$$

Centroid

$$\bar{Y} = \frac{\sum \bar{y} A}{\sum A}$$

Parallel theorem

$$I_{xx} = I_{xx} + Ad^2$$

Shear stress in Beam

$$\tau = \frac{VQ}{It}$$

Non-Symmetrical Bending

$$\sigma = -\frac{M_z Y}{I_z} + \frac{M_y Z}{I_y}$$

Deflection of Beam

$$EI\frac{d^2y}{dx^2} = M(x)$$

$$Slope = \frac{dy}{dx} = \theta(x)$$

$$deflection = y(x)$$