UNIVERSITY COLLEGE
TATI

# UNIVERSITY COLLEGE TATI (UC TATI)

## FINAL EXAMINATION QUESTION BOOKLET

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| COURSE CODE | : BCE 2243 |
| COURSE | : ENGINEERING MECHANICS |
| SEMESTER/SESSION | : 1-2022/2023 |
| DURATION | : 3 HOURS |

Instructions:

1. This booklet contains 4 questions. Answer **ALL** questions.

2. All answers should be written in answer booklet.

3. Write legibly and draw sketches wherever required.

4. If in doubt, raise your hands and ask the invigilator.

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

**THIS BOOKLET CONTAINS 6 PRINTED PAGES INCLUDING COVER PAGE**

## QUESTION 1

a) A 20 mm diameter rod made of an experimental plastic is subjected to a tensile force of magnitude P = 6kN. Knowing than an elongation of 14mm and decrease in diameter of 0.85 mm are observed in a 150 mm length, determine the modulus of elasticity and the poisson's ratio of material

(10 marks)

b) Figure 1 shows two (2) solid cylindrical rods made of steel are fixed at support A & D. Given $L_{AB}$ = 30 cm, $L_{BC}$ = 20 cm, $L_{CD}$ = 50 cm.

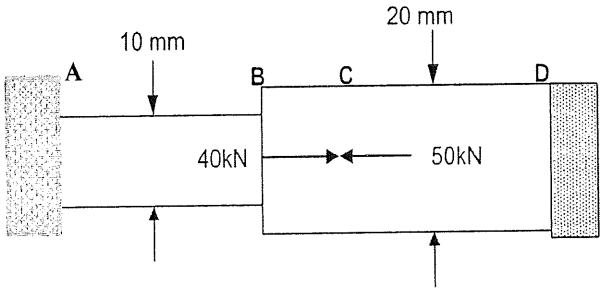


Figure 1

i) Illustrate the free body diagram of the structure (2 marks)

ii) Determine $R_A$ and $R_D$ for the structure in kN (18 marks)

## QUESTION 2

The electric motor exerts a torque of 2.8 kN.m on shaft AB as shown in Figure 2. Knowing that each shaft is solid.

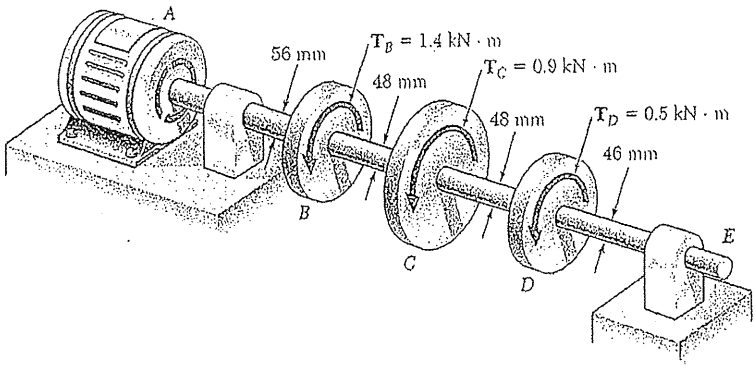


Figure 2

a) Determine the torque value for shaft AB, BC and CD (3 marks)

b) Determine the maximum shearing stress in shaft AB,BC and CD (12 marks)

c) A new design with smaller diameter of shaft BC is being considered to reduce the total of mass of the assembly of shaft structure. Calculate the smallest diameter of shaft BC which the maximum value of the shearing stress in the assembly is unchanged. (5 marks)

## QUESTION 3

The beam shown in Figure 3 is made of nylon for which the allowable stress is 24Mpa in tension and 30Mpa in compression. Determine

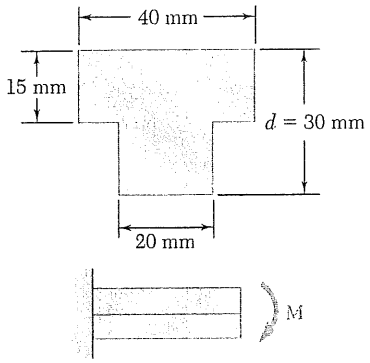


Figure 3

a) The neutral axis for the structure (10 marks)

b) The total inertia for the structure (6 marks)

c) The largest couple M that can be applied to the beam (5 marks)

d) If *d = 40mm,* how it's affect the neutral axis condition (9 marks)

## QUESTION 4

The beam AFB with load acting as shown in Figure 4. The beam is simply supported at A and F and has an overhang from F to B. The load acting as shown in Figure 4.

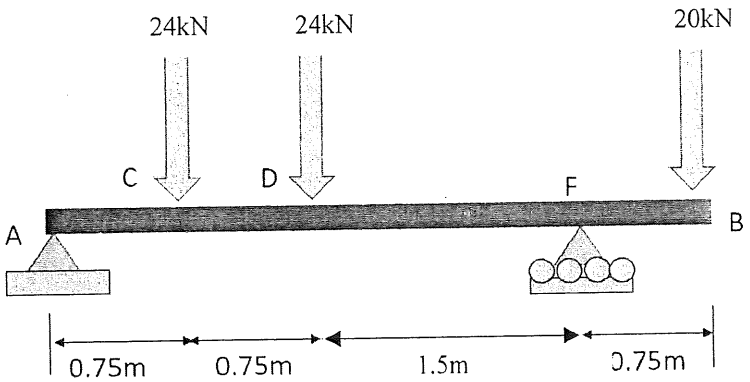


Figure 4

a) Sketch the free body diagram (2 marks)

b) Compute the force at support A and B (4 marks)

c) Construct the shear diagram and bending moment of the structure (10 marks)

d) Determine the max normal stress due to bending, if the beam length is 250mm and wide is 80mm. (4marks)

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

## APPENDIX

### STRESS STRAIN

Normal stress

$$\sigma = \frac{P}{A}$$

Shear stress

$$\tau = \frac{P}{A}$$

Deflection

$$\delta = \frac{PL}{AE}$$

$$\delta = \sum_i \frac{P_i L_i}{A_i E_i}$$

Strain

$$\varepsilon = \frac{\delta}{L}$$

Area

Solid

$A = \pi d^2/4$

Circular/hollow

$A = \pi(d_0^2 - d_i^2)/4$

### TORSION

Maximum shearing stress

$$\tau = \frac{Tc}{J}$$

$$c = \frac{1}{2}D$$

Angle of twist

$$\phi = \frac{TL}{JG}$$

Polar moments of inertia

Solid

$$J = \frac{\pi}{32}D^4$$

Hollow

$$J = \frac{\pi}{32}(D_2^4 - D_1^4)$$

### BENDING STRESS

Centroid

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

Centroidal moments of inertia

$$I_{x'} = \sum\left(\bar{I} + Ad^2\right)$$

2nd moment of area rectangular Shape

$$\bar{I} = \frac{1}{12}bh^3$$

Maximum tensile and compressive stresses

$$\sigma_m = \frac{Mc}{I}$$

Radius of curvature

$$\frac{1}{\rho} = \frac{M}{EI}$$

### SHEAR FORCE AND BENDING MOMENT

The section modulus

$$S = \frac{1}{6}bh^2$$

Maximum normal stress

$$\sigma_m = \frac{|M_B|}{S}$$