



MACHAKOS UNIVERSITY

University Examination 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

ECV 203 STRENGTH OF MATERIALS 1

DATE: 25/7/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS:

1. *Non programmable calculators may be used.*
2. *Clearly state the assumptions used if any.*
3. *Diagrams MUST be clearly labeled and symbols used MUST be defined.*
4. *Answer **question 1** and any other **2 questions**.*

QUESTION 1 (COMPULSORY)

- a) Discuss the following; (10 marks)
- i. Euler crippling load
 - ii. Second moment of area
 - iii. Radius of gyration
 - iv. Section modulus
 - v. Slenderness ratio
- b) Calculate the second moment of area, the radius of gyration and the section modulus with respect to x-axis in Figure 1 below. (10 marks)

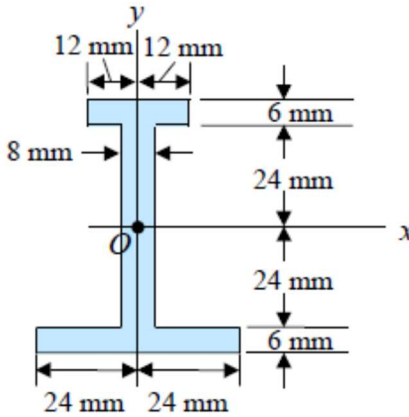


Figure 1

QUESTION 2

a) In figure 2 below, determine the maximum shear stress and rate of twist of the given shaft if a $T = 30 \text{ kNm}$ torque is applied to it; b) if the length of the shaft is 20 m, how much would it rotate by? c) if the maximum shear stress level is restricted within $\tau_{allow} = 100 \text{ MPa}$, what is the maximum torque that the shaft can transmit? Let $G = 90 \text{ GPa}$, $D = 90 \text{ mm}$. **(16 Marks)**

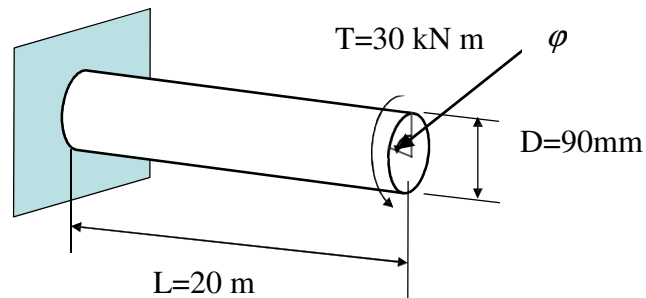


Figure 2

b) State the assumptions used to derive the formula for torsion in circular shafts. **(4 Marks)**

QUESTION 3

a) State the parallel axis theorem. **(3 Marks)**

b) Consider a rectangular cross section of breadth, b and depth, d as shown in the figure below.

Using direct integration, find an expression of the second moment of area about the x axis, say I_{xx} in terms b and h . **(7Marks)**

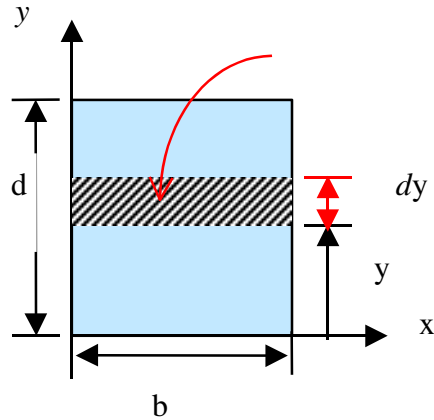


Figure 3

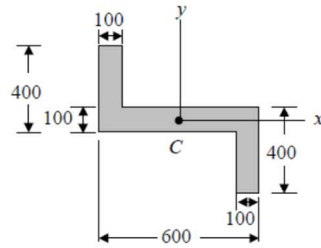
- c) Consider the axis parallel to the x axis and passes through the centroid say gg. Find the second moment of the area about the centroid say I_{gg} . **(7Marks)**
- d) Using the answers obtained in b and c prove the parallel axis theorem. **(3 Marks)**

QUESTION 4

- a) State the assumptions used in deriving the Euler buckling/Crippling load for columns. **(7Marks)**
- b) Derive an expression for Euler crippling load for;
 - i) A column with pinned support at both ends. **(7Marks)**
 - ii) A hollow mild steel tube 6 m long 4 cm internal diameter and 6 mm thick is used as a strut with both ends hinged. Find the crippling load and safe load taking factor of safety as 3. Take $E = 2 \times 10^5 \text{ N / mm}^2$. **(6Marks)**

QUESTION 5

- a) Calculate the second moment of area, the radius of gyration and the section modulus with respect to y-axis for the figure 4 shown **(3 marks)**



Dimension in mm

Figure 4

- b) Consider a rectangular cross section of breadth, b and depth, h as shown in the Figure 5. Using direct integration, find an expression of the second moment of area about the y axis, say I_{yy} in terms b and d . **(4Marks)**

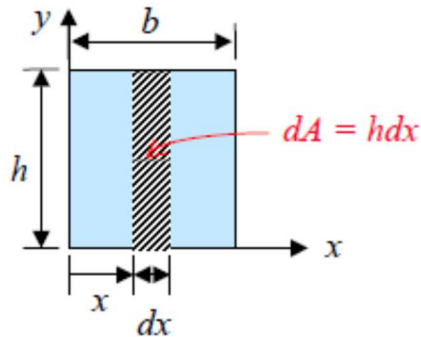


Figure 5

- c) Assuming $b=200\text{mm}$ and $h= 300\text{mm}$. Provide the value of the expression in b above. **(2Marks)**
- d) Consider the axis parallel to the y axis and passes through the centroid say $I_{yy'}$ as in figure 6 below. Find the second moment of the area about the centroid say $I_{yy'}$. **(4Marks)**

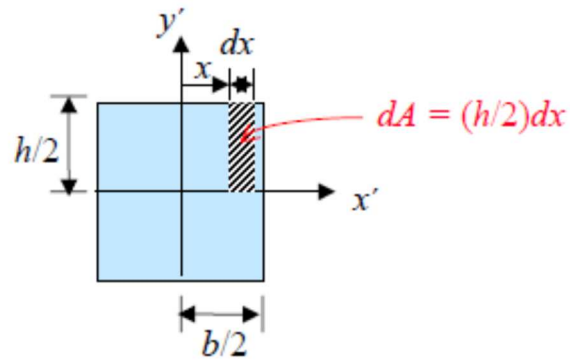


Figure 6

- e) Considering the dimensions in c, provide the numerical value of the expression in d above.
(2 Marks)
- f) Prove the parallel axis theorem from the answers above and calculate the radius of gyration, k_{xx} .
(5Marks)