MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF SCIENCE IN CIVIL ENGINEERING

SUPPLEMENTARY EXAMINATION

ECV 203: STRENGTH OF MATERIALS I

DATE: 1/9/2017 **TIME: 2:00 – 4:00 PM**

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 ONE (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 moduluswith respect to x-axis in Figure 1 below. (10 marks)

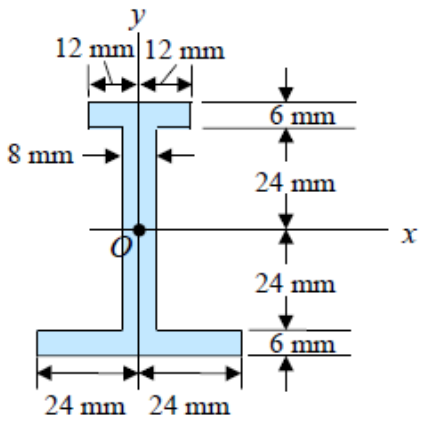


Figure 1

QUESTION TWO (20 MARKS)

a) In figure 2 below, determine the maximum shear stress and rate of twist of the given shaft if a $T = 30kNm$ 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 $\tau_{allow} =$ 100MPa, what is the maximum torque that the shaft can transmit? Let G = 90 GPa, D = 90mm. (16 marks)

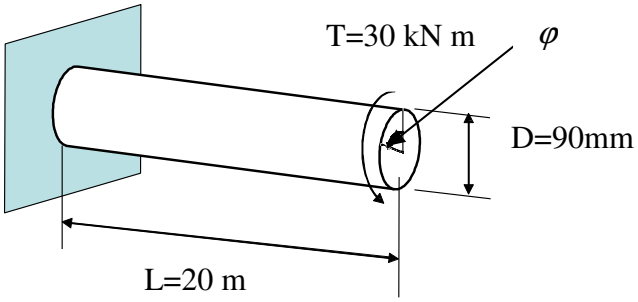


Figure 2

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

QUESTION THREE (20 MARKS)

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. (7 marks)

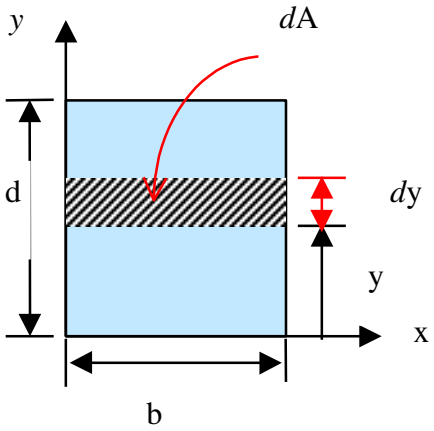


Figure 3

c) Consider the axis parallel to the x axis and passes through the centroid say gg. Find the second moment of thearea about the centroid say I_{gg}. (7 marks)

d) Using the answers obtained in b and c prove the parallel axis theorem. (3 marks)

QUESTION FOUR (20 MARKS)

a) State the assumptions used in deriving the Euler buckling/Crippling load for columns. (7 marks)

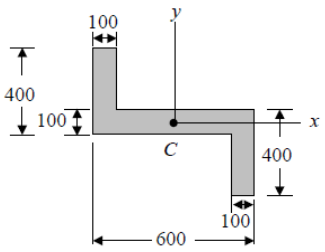
b) Derive an expression foe Euler crippling load for;

i) A column with pinned support at both ends. (7 marks)

ii) A hollow mild steel tube 6 m long 4 cm internal diameter and 6 mm thick is used asa strut with both ends hinged. Find the crippling load and safe load taking factor of safety as 3. Take E = 2 x 10^5 N /mm. (6 marks)

QUESTION FIVE (20 MARKS)

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 Figure5.Using direct integration, find an expression of the second moment of area about the y axis, say I_{yy} in terms b and d. (4 marks)

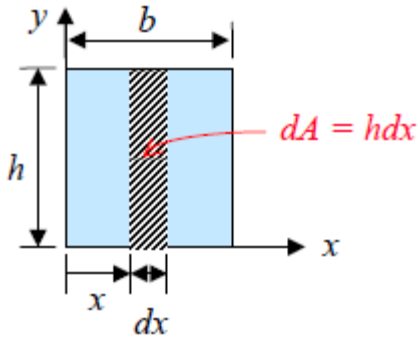


Figure 5

c) Assuming b=200mm and h= 300mm. Provide the value of the expression in b above. (2 marks)

d) Consider the axis parallel to the y axis and passes through the centroid say $I_{y\acute{y}'}$as in figure 6 below.Find the second moment of the area about the centroid say $I_{y\acute{y}'}$. (4 marks)

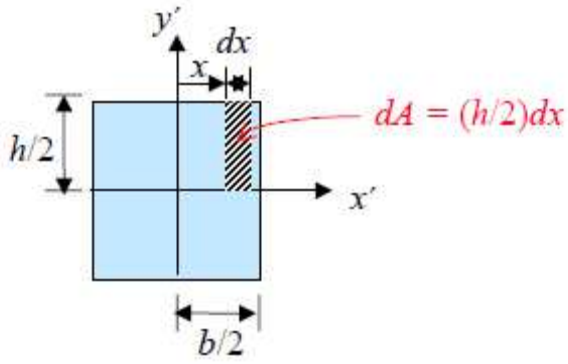


Figure 6

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}. (5 marks)