TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY
Department of Building & Civil engineering
UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING
TCV 4215: STRENGTH OF MATERIALS

END OF SEMESTER EXAMINATION
SERIES: AUGUST 2024

Instructions to Candidates:

1. You should have an answer booklet for this examination.
2. This paper contains FOUR questions.
3. Answer question ONE or any TWO questions.
4. Marks for each question are indicated in the parenthesis.
5. Examination duration is **2 Hours.**
   Graph paper is required.

Question One (20 marks)

a) With aid of illustrations ,define the following terms as used in strength of materials
   i) Dead loading
   ii) Poisson's ratio
   iii) Distributed loads
   iv) Young's modulus
   v) Modulus of rigidity **[5 marks]**

b) A circular bar 40 mm diameter carries an axial tensile load of 100kN. What is the value of the shear stress on the planes on which the normal stress has a value of 50 MN/m2 tensile [4 marks]

c) The coupling shown in **Figure Q1c** is constructed from steel of rectangular cross-section and is designed to transmit a tensile force of 50kN. If the bolt is of 15mm diameter, calculate the shear stress in the bolt, the direct stress in the plate and the direct stress in the forked end of the coupling.

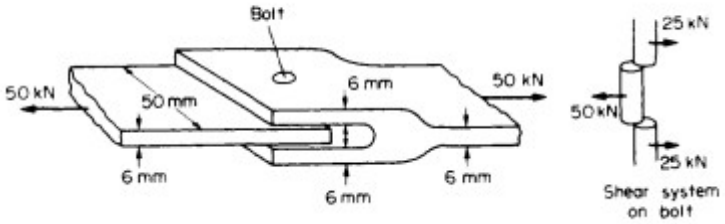

Figure Q1c [6 marks]

d) Consider the rectangular element of unit depth shown in **Figure Q1d** subjected to a system of two direct stresses,Show that

i. $\sigma_\theta = \frac{1}{2}(\sigma_x + \sigma_y) + \frac{1}{2}(\sigma_x - \sigma_y)\cos 2\theta$

ii. $\tau_\theta = \frac{1}{2}(\sigma_x - \sigma_y)\sin 2\theta$

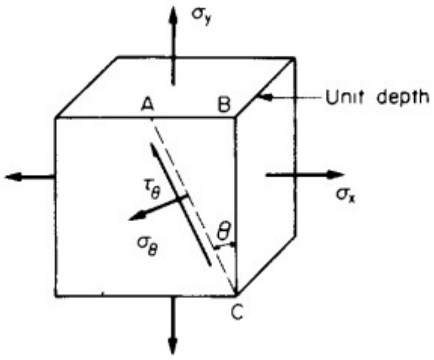

Figure Q1d

Question Two (20 marks)

(a) A 25 mm diameter bar is subjected to an axial tensile load of 100kN. Under the action of this load a 200mm gauge length is found to extend 0.19 x 10^-3 mm. Determine the modulus of elasticity for the bar material. [4 marks]

(b) If, in order to reduce weight whilst keeping the external diameter constant, the bar is bored axially to produce a cylinder of uniform thickness, what is the maximum diameter of bore possible given that the maximum allowable stress is 240MN/m^2? The load can be assumed to remain constant at 100kN. [8 marks]

(c) What will be the change in the outside diameter of the bar under the limiting stress quoted in (b)? (E = 210GN/m^2 and v = 0.3). [8 marks]

Question Three (20 marks)

A material is subjected to two mutually perpendicular direct stresses of 80 MN/m^2 tensile and 50MN/m^2 compressive, together with a shear stress of 30 MN/m^2. The shear couple acting on planes carrying the 80 MN/m^2 stress is clockwise in effect. Calculate:

i. The magnitude and nature of the principal stresses;
ii. The magnitude of the maximum shear stresses in the plane of the given stress system;
iii. The direction of the planes on which these stresses act.

Confirm your answer by means of a Mohr's stress circle diagram, and from the diagram determine the magnitude of the normal stress on a plane inclined at 200 counterclockwise to the plane on which the 50 MN/m' stress acts. **[20 Marks]**

Question Four (20 marks)

(a) A uniform T-section beam is 100 mm wide and 150 mm deep with a flange thickness of 25 mm and a web thickness of 12 mm. If the limiting bending stresses for the material of the beam are 80 MN/m2 in compression and 160 MN/m2 in tension, find the maximum u.d.1. That the beam can carry over a simply supported span of 5 m. **[8 Marks]**

(b) A flitched beam consists of two 50 mm x 200 mm wooden beams and a 12 mm x 80 mm steel plate. The plate is placed centrally between the wooden beams and recessed into each so that, when rigidly joined, the three units form a 100 mm x 200 mm section as shown in below. Determine the moment of resistance of the flitched beam when the maximum bending stress in the timber is 12 MN/m2.What will then be the maximum bending stress in the steel? **[12 Marks]**

For steel $E = 200\ GN/m^2$; for wood $E = 10\ GN/m^2$.