(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS

2021/2022 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE IN MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE CODE: MIE 322

COURSE TITLE: SOLID MECHANICS IV

DATE: 29-04-2022 **TIME: 15:00-17:00**

INSTRUCTIONS TO CANDIDATES

1. This paper consists of **FOUR** questions
2. Answer Question **ONE (Compulsory)** and any other **TWO** Questions
3. All symbols have their usual meaning

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 5 Printed Pages. Please Turn Over

QUESTION ONE (compulsory) [30 MARKS]

(a) Prove that in case of a rotating hollow cylinder, the radial stress is maximum at radius = $\sqrt{[R_1 X R_2]}$ and is given by

$$\sigma_r = (3+\nu)\frac{\rho\omega^2}{8}[R_1-R_2]^2 \qquad \textbf{[10 marks]}$$

(b) According to the theory of maximum shear stress, determine the diameter of a bolt which is subjected to axial pull of 10 KN together with a transverse shear stress of 5 KN. Elastic limit in tension is 250 MPa, factor of safety = 3 and Poison's ratio = 0.3. **[12 marks]**

(c) The shear force acting on a section of a beam is 50 *KN*. The section of the beam is of T-shaped of dimensions *100 mm X 100 mm X 20 mm* as shown in **FIG Q 1 (c).** The moment of inertia about the horizontal neutral axis is 314.221 X 10^{-8} m^4, Calculate the shear stress at the neutral axis and at the junction of the web and the flange And show graphically on the figure. **[8 marks]**

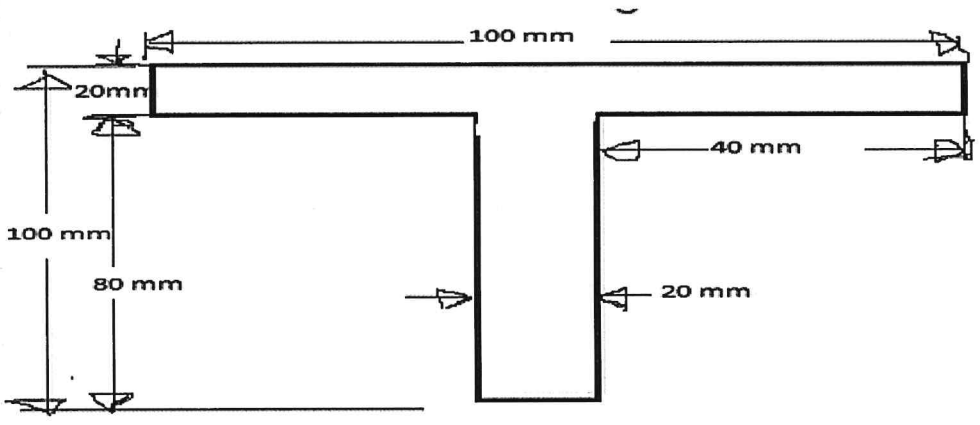

FIG Q 1 (c)

QUESTION TWO (20 MARKS)

An element of steel (E = 200 GPa, $\nu = 0.30$) in the form of a rectangular parallelepiped (see figure Q2) of dimensions a = 250 mm, b = 200 mm, and c = 150 mm is subjected to triaxial stresses $\sigma_x = -80$ MPa, $\sigma_y = -60$ MPa, and $\sigma_z = -30$ MPa acting on *the x, y, and z* faces, respectively. Determine the following quantities:

(a) the maximum shear *stress* τ_{max} in the material; **[5 marks]**

(b) the changes, Δa, Δb , and Δc in the dimensions of the element;

[5 marks]

(c) the change ΔV in the volume; and **[5 marks]**

(d) the strain energy U stored in the element. **[5 marks]**

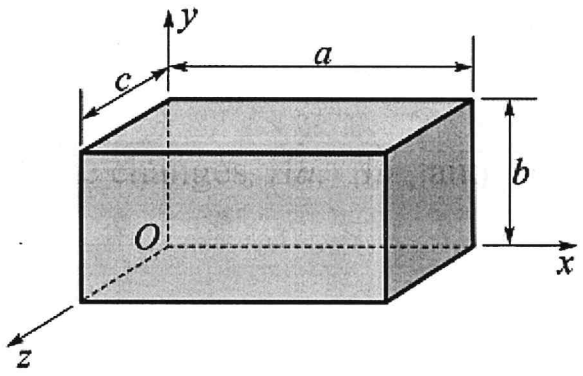

FIG Q2

QUESTION THREE (20 MARKS)

An unloaded steel cylinder has internal and external diameters of 204 mm and 304 mm respectively. Determine the circumferential thermal stresses at the inner and outer surfaces where the steady temperatures are 200°C and 100°C respectively.

Take E = 207 GN/m^2, $\alpha = 11 \times 10^{-6}$ per °C and Poisson's ratio = 0.29

The temperature distribution through the wall thickness may be regarded as follows:

$T = a + b \log_e r$, *where a and b are* constants

With this form of temperature distribution, the radial and circumferential thermal stresses at ***radius r*** where the temperature ***is T*** are obtained from

$$\sigma_r = A - \frac{B}{r^2} - \frac{E\alpha T}{2(1-v)} \quad \text{and} \quad \sigma_H = A + \frac{B}{r^2} - \frac{E\alpha T}{2(1-v)} - \frac{E\alpha b}{2(1-v)}$$ **[20 marks]**

QUESTION FOUR (20 MARKS)

A beam having the cross-section shown in FIG Q4 is constructed from material having a constant thickness of 1.3 mm.

(i) Calculate the length e (shear centre), through which the vertical load Q be applied in order that there shall be no twisting of the section.

(ii) Using neat graph paper to Sketch the shear stress distribution.

[20 marks]

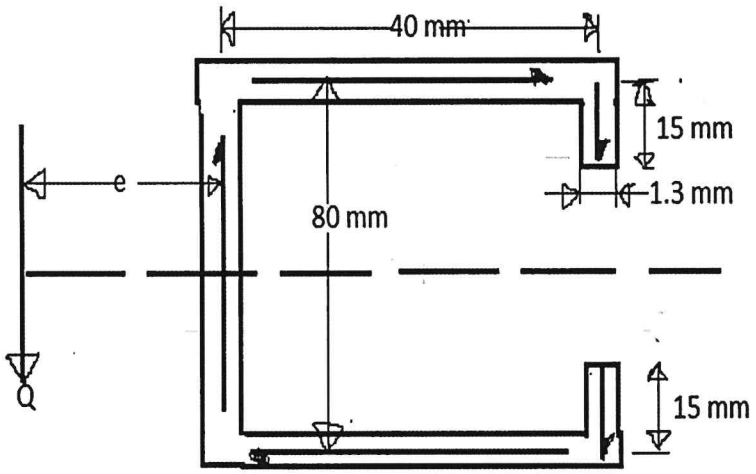

FIG Q4