NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF INDUSTRIAL AND MANUFACTURING ENGINEERING

SOLID MECHANICS I

TIE 2103

First semester Main Examination Paper

December 2014

This examination paper consists of 3 printed pages

Time Allowed: 3 hours

Total Marks: 100

Special Requirements: None

Examiner's Name: Nicholas Tayisepi

INSTRUCTIONS AND INFORMATION TO CANDIDATE

1. Answer any four (4) questions.
2. Each question carries 25 marks.
3. Use of calculators is permissible.

MARK ALLOCATION

QUESTION	MARKS
1.	**25**
2.	**25**
3.	**25**
4.	**25**
5.	**25**
6.	**25**
TOTAL MARKS ATTAINABLE BY CANDIDATE	**100**

Question One

A beam AC 6m long is simply supported at R_A at the extreme left hand end and at R_C, 5 m from R_A. It carries a 5 kN point load at position E, 1 m from R_A, a 10 kN load, 4m from R_A and a 5 kN point load at the other end C. It also carries a Uniformly Distributed Load (UDL) of 6 kN/m for a length of 5 m starting from end R_A.

a) Draw the shear force diagram. **[9]**

b) Draw the bending moment diagram. **[10]**

(c) Determine the position of any point of contraflexture. **[6]**

Question Two

Determine the total number of rivets in double shear and diameter 8 mm required to withstand a 400 kN load without failure if the ultimate shear stress for the rivet material is 250 MN/m^2. **[25]**

Question Three

Compute the inner and outer diameters of a hollow shaft with a diameter ratio of 2:3 when transmitting 90 kW at 240 revolutions per minute. The maximum shear stress is limited to 80 MN/m^2 and angle of twist to 4°C over a length of 4 m. Take G = 80 GN/m^2 for the shaft material. **[25]**

Question Four

A close coiled helical spring, constructed from an 8 mm diameter wire and with a mean coil diameter of 50 mm, is used to join two shafts which transmit 1.2 kilowatts of power at 360 revolutions per minute. If the number of turns of the spring is 10 and the modulus of elasticity of the spring material is 210 GN/m^2, determine:

(a) The relative angle of twist between the two ends of the spring, **[13]**

(b) The maximum stress set up in the spring material. **[12]**

Question Five

(a) Determine the shortening (δ) of the component bar shown in the Figure QU5 below, under the action of two forces P_1 and P_2 if the bar is made up of material with modulus of elasticity E and the diameter varies from small diameter d_1 at the free end to a larger d_2 at the fixed end. **[13]**

(b) Evaluate δ, of the component shown on the Figure QU5, given that: P_1 = 9.2 kN, P_2 = 6.8 kN, d_1 = 22 mm, d_2 = 30 mm, E = 70 GPa and the two sections of the bar have equal lengths $L_1 = L_2$ = 300 mm. **[12]**

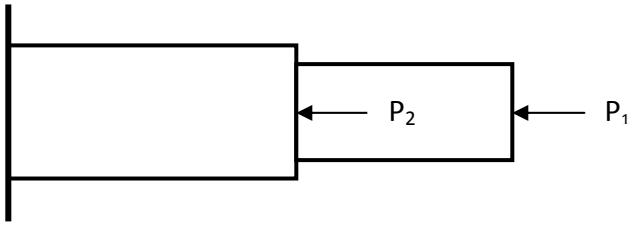

Figure QU5

Question Six

(A) A copper bar diameter 10 mm and length 1 m carries a 150 kg load and it is found to extend by 2.5 mm. Determine, for the bar, the value of:

(i) the stress, **[6]**

(ii) the strain, **[4]**

(iii) the Young's Modulus of Elasticity. **[3]**

(B) Determine the maximum plate thickness that can be punched from a copper plate using a diameter 12 mm punch if the maximum force available at the punch is 150 kN. Use an ultimate shear stress of 360 MN/m^2 for the plate material. **[12]**

……End of Examination……