



UNIVERSITY EXAMINATIONS
NJORO CAMPUS

FIRST SEMESTER, 2013/2014 ACADEMIC YEAR

FIFTH YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN
AGRICULTURAL WATER/MANUFACTURING/INSTRUMENTATION ENGINEERING

MENT 226 : STRENGTH OF MATERIALS I

STREAM: BSC (ENGINEERING)

TIME: 2½HRS

DAY: WEDNESDAY 8:30 – 11:00 A.M.

DATE: 22/01/2014

INSTRUCTIONS

Answer any FOUR Questions

Question One

- a) By use of appropriate diagrams differentiate between shear stress and shear strain. **(5 marks)**
- b) If two materials, 1-a low carbon steel and 2- a brittle high carbon steel are subjected to tensile test, how would their stress-strain graphs be like? Sketch the two graphs and explain the difference. **(5 marks)**
- c) In thick shells there are three principal stresses that exist. By use of appropriate diagrams show how these stresses act on a cylindrical shell. **(5 marks)**
- d) Thin shells are used in engineering applications such as in boilers and water pipes. Show that the circumferential stress is twice the axial stress. **(5 marks)**

Question Two

- a) A cantilever beam 6m long carries concentrated loads of 35,32 and 30kN at distances of 2, 3.5 and 5 metres from the fixed end. In addition to this the beam carries a uniformly distributed load of 15kN/m over the entire length of the beam. Draw the S.F. and B.M diagrams. **(10 marks)**

- b) For a solid shaft of radius R and length L , one end is fixed and the other end subjected to a torque T . Show that $\frac{T}{I_p} = \frac{\sigma_s}{R} = \frac{G\theta}{L}$

Where θ = angle of twist

σ_s = Shear stress

G = Modulus of rigidity

I_p = Polar moment of inertia

(10 marks)

Question Three

- a) A solid shaft is to transmit 295kW at 100 r.p.m. If the shear stress is not to exceed 80MPa, find the diameter of the shaft. What percentage saving in weight would be obtained if this shaft is replaced by a hollow one whose internal diameter is 0.6 of the external diameter; the length, material and maximum shear being the same. (11 marks)
- b) A close-coiled helical spring is to have a stiffness of 1.5kN/m of compression under maximum load of 52N and a maximum shearing stress of 136MPa. The solid length of the spring is to be 5.3cm. Find the diameter of the wire, the mean diameter of the coils required. Modulus of rigidity $G = 42\text{GPa}$. (9 marks)

Question Four

- a) Consider a column of length L fixed at end B and free at the end A. Let the horizontal deflection of the end A be e . Show the least buckling load, P is $\frac{\pi^2 EI}{(2L)^2}$. (10 marks)
- b) A steel bar is placed between two copper bars each having the same area and length as the steel bar at 20°C . At this stage they are rigidly connected together at both ends. When the temperature is raised to 351°C the length of the bars increases by 0.178cm. Determine the original length and the final stresses in the bars.

Take $E_s = 201\text{GPa}$

$$\alpha_s = 12 \times 10^{-6}/^\circ\text{C}$$

$$E_c = 100\text{GPa}$$

$$\alpha_c = 17.5 \times 10^{-6}/^\circ\text{C}$$

(10 marks)

Question Five

- a) A cast T-beam has the following dimensions

Overall depth = 170mm

Width of flange = 160mm

Flange thickness = 50mm

Web thickness = 40mm

The beam is simply supported over a span of 2.4 metres placed in the inverted T-position (i.e. flange at the bottom). If the maximum allowance tensile stress in the flange and the compressive stress in the web are limited to 25N/mm^2 and 80N/mm^2 respectively. Find the maximum central load that the beam can safely carry. **(12 marks)**

- b) Compare the weights of two equally strong beams of circular sections made of the same material' one being of solid section and the other of hollow section with inside diameter $2/5$ of the external diameter. **(8 marks)**
