THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

((A Constituent College of JKUAT)

(A Centre of Excellence)

Faculty of Engineering & Technology

DEPARTMENT OF BUILDING & CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECE 2204: STRENGTH OF MATERIALS I

END OF SEMESTER EXAMINATION
SERIES: AUGUST 2012
TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer Booklet*
- *Pocket Calculator*

This paper consists of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **TWO** printed pages

Question One (20 Marks)

a) Define the following terms as they apply to properties of engineering materials.

i) Toughness
ii) Hardness
iii) Malleability
iv) Ductility
v) Elasticity **(5 marks)**

b) With the aid of a labeled sketch, illustrate typical force-extension graph of a tensile test carried out on mild steel standard specimen. Show the main extension zones that the specimen undergoes and sketch the shapes of the specimen at each extension zone. **(7 marks)**

c) A metallic specimen whose original diameter and gauge length was 25mm and 225mm respectively was tested in tension until failure and the following results obtained:

- Final length at failure = 250mm
- Yield load = 85KN
- Maximum load = 135KN
- Extension at 12KN load = 0.036mm
- Diameter of the neck at failure = 12.5mm

Determine the following:

i) Yield stress
ii) Ultimate stress
iii) Percentage elongation
iv) Percentage reduction in area. **(8 marks)**

Question Two (20 marks)

a) Write down the general expression that gives the shear stress at a point in the cross section of abeam and show that the maximum shear stress in a rectangular cross-section is one and a half times the average stress. **(10 marks)**

b) A timber beam of rectangular section is simply supported on a span of 4.5m and is required to carry a uniformly distributed load of 8KN/m on its entire span. Determine suitable cross-sectional dimensions for the beam if the maximum allowable values for stresses for beam are $7.5N/mm^2$ in bending and $0.7N/mm^2$ in shear. **(10 marks)**

Question Three (20 marks)

a) From first principles, derive an expression for the moment of resistance of a rectangular beam section subjected to bending. **(6 marks)**

b) Figure Q3 (b) shows a loaded beam and its cross-section. Determine the maximum tensile and compressive bending stresses developed in the section due to the given loading. **(14 marks)**

Question Four (20 marks)

a) Show that the maximum value of shear stress in a complex stress system is numerically equal to one half of the difference between the given normal stresses and occurring on planes at 45^o to the given planes. **See figure Q4(a)** **(10 marks)**

b) At a point of a material, the two-dimensional state of stress is shown in figure Q4 (b). Determine the τ_1, τ_2, θ *and* τ following: by the Mohr's circle of stress method. **(10 marks)**

Question Five (20 marks)

a) The piston of a hydraulic ram is 400mm in diameter and the piston rod is 60mm in diameter. The water pressure is 1N/mm2. Determine the stress in piston rod and the elongation of a length of 1m of the rod when the piston is under pressure from the piston – rod side. Take Modulus of elasticity, E = $200 \times 10^3 KN/mm^2$ **(10 marks)**

b) A steel bar having a rectangular cross-section of 75 x 25mm, carries an axial load of 180KN. Estimate the decrease in the length of the sides of the cross-section if the modulus of elasticity, $E = 200 \times 10^3$ KN/mm^2 and the Poisson's ratio is 0.3. **(10 marks)**