THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of JKUAT)
Faculty of Engineering and Technology

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN CIVIL ENGINEERING (YR II, SEM II)

ECE 2214: THEORY OF STRUCTURES II

END OF SEMESTER EXAMINATION

SERIES: DECEMBER 2011
TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer booklet*
- *Battery Powered Programmable Calculators may be used.*

This paper consists of **FIVE** questions
Answer question **ONE (COMPULSORY)** from **SECTION A** and any other **TWO** questions from **SECTION B**
Maximum marks for each part of a question are clearly shown
This paper consists of **FOUR** printed pages

SECTION A (COMPULSORY)

Question 1 (20 marks)

a) The cross-section of a composite beam made of Aluminium and Steel is shown in figure 1. The moduli of elasticity are $E_a = 70Gpa$ and $E_s = 2100Gpa$. Under the action of bending moment that produces a maximum stress of 60Mpa in the aluminum, what is the maximum stress σ_s in the steel? (13 marks)

b) A strut is made of a hollow tube of external diameter 75 mm and wall thickness of 3 mm. if the strut is fixed at both ends and the compressive stress is 149.5N/mm2 when it begins to buckle, $E = 210Gpa$ calculate the Euler Buckling load if both ends of the strut were pinned. Take (13 marks)

c) List **FOUR** ways by which a gravity retaining wall may fail (4 marks)

SECTION B (Answer any TWO questions from this section)

Question 2 (20 marks)

a) (i) State the **THREE** assumptions made in the analysis of torsion of circular bars? (3 marks)

(ii) Show that the power, P, transmitted by a circular shaft is given by, $P = \frac{2\pi nT}{60}$, where n = number of revolutions per minute and T = the applied Torque (5 marks)

b) A solid circular shaft rotating at 2Hz is required to transmit 150kW. What is the mimimum required shaft diameter d if the allowable shear stress is 40MPa? Determine the angle of twist θ per unit length for this diameter. Take G = 80Gpa (12 marks)

Question 3 (20 marks)

A simply supported composite beam with an effective span of 4 m is loaded with a uniformly distributed load of 2.5KN/m. The beam is constructed of a wood member 100 mm wide x 200 mm deep reinforced on its lower side by a steel bar 8mm thick x 100mm wide. By transforming the beam section into an equivalent wood section find the maximum bending stresses σ_s and σ_w in the steel

$E_w = 10GPa$ $E_s = 210GPa$
and wood respectively. If the modulus of elasticity for wood and for steel. Also sketch the variation of the bending stress across the section giving numerical values
(20 marks)

Question 4 (20 marks)

a) For a thin walled tube subjected to torsion define the following terms giving any formula where necessary.
   (i) The shear flow, q (1 mark)
   (ii) The torsion constant, J (1 mark)
   (iii) The Torsional Rigidity (1 mark)

b) Show that for a thin-walled circular tube the torsional constant $J = 2\pi r^3 t$, where t is the wall thickness and r is the median radius (4 marks)

c) Calculate the shear stress τ and the angle of twist θ for a steel tube (G = 76GPa) having the cross-section shown in figure 3. The tube has a length L = 1.5, and it is subjected to a torque T = 10KN/m (13 marks)

Question 5 (20 marks)

The retaining wall shown carries a surcharge of 24KN/m. The soil in front and behind the wall (SOIL 1) is cohesionless and has a unit weight of 18KN/m^3 and an angle of internal friction of 32^o. The soil beneath the base (SOIL 2) has a cohesion of 40KN/m^2, a unit weight of 20KN/m^3 and angle of internal friction of 35^o. Analyze the wall for overturning and sliding stability. Ignore the weight of soil above the toe. Comment on your answers (20 marks)