KIBABII UNIVERSITY
(KIBU)

UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN PHYSICS

COURSE CODE: **SPM 312**

COURSE TITLE: **MATERIAL TESTING AND EVALUATION**

DATE: 14/12/2022 **TIME:** 2:00-4:00PM

INSTRUCTIONS TO CANDIDATES

TIME: 2 Hours

Answer question ONE and any TWO of the remaining.

Symbols used bear the usual meaning.

KIBU observes ZERO tolerance to examination cheating

Question One (30 marks)

a) State four mechanical properties of materials useful in determining the fabrication and possible practical applications of a material (4 marks)

b) What is the approximate Brinell hardness of a 1040 steel having a yield strength of 690 MPa? (3 marks)

c) Illustrate an applied Load versus strain curve of a typical metallic material showing elastic limit, maximum load, plastic deformation, and fracture (4 marks)

d) A mild steel cable is designed to support struts in a suspension bridge in Likoni, what is the maximum load a single cable of $32mm^2$ gauge can support without fracture (Tensile strength of mild steel $500N/mm^2$ (4 marks)

e) A tungsten tow rope of $40mm^2$ raw gauge and length 3m is used in towing a 1Tonne car, calculate the elongation it experiences during the towing process assuming a uniform load is applied throughout (Modulus of Elasticity of Tungsten $41 \times 10^{10}\ N/m^2$) (4 marks)

f) Differentiate between engineering stress and true stress (2 marks)

g) Discuss the fatigue fracture structure showing all the zones involved (4 marks)

h) State five commonly used tests for hardness (5 marks)

Question Two (20 marks)

a) Describe how stress-strain measurements can be performed in a specimen (6 marks)

b) A cylindrical specimen of steel having an original diameter of 12.8mm is tensile tested to fracture and found to have an engineering fracture strength σ of 460mpa. If its cross-section diameter at fracture is 10.7mm, determine the ductility in terms of percentage reduction in area and the true stress at fracture. (8 marks)

c) A tensile testing apparatus is to be constructed that must withstand a maximum loop of 220000N. The design calls for two cylindrical support posts each of which is to support half of the maximum load, furthermore plain carbon steel ground and polished shafting rounds are to be used, the maximum yield and tensile strength of this alloy are 310Mpa and 565Mpa respectively, determine a suitable diameter for these support posts. (6 marks)

Question Three (20 marks)

a) Proof that the condition for necking to begin in a specimen is that the true strain (ε') becomes equal to strain hardening exponent (n) (8 marks)

b) Discuss the Charpy impact testing method (4 marks)

c) Discuss the four common non-destructive testing techniques (i) Magnetic dust method (ii) Liquid penetration test (iii) Ultrasonic test (iv) Radiography (8 marks)

Question Four (20 marks)

The following data were obtained during a tension test of an aluminium alloy. The initial diameter of the test specimen was 0.505cm and the gauge length was 2.0cm

Load (Kg)	Elongation (cm)	Load (Kg)	Elongation (Kg)
0	0	14000	0.020
2310	0.0022	14400	0.025
4640	0.0044	14500	0.060
6950	0.0066	14600	0.080
9290	0.0088	14800	0.100
11600	0.0110	14600	0.120
12600	0.0150	13600	Fracture

Plot the stress-strain diagram and determine the following mechanical properties (a) Proportional limit (b) Modulus of elasticity (c) Yield point (d) Yield strength at 0.2% offset (e) Ultimate strength and (f) Rupture strength (20 marks)

Question Five (20 marks)

(a) What force is required to punch a 20-mm-diameter hole in a plate that is 25 mm thick? The shear strength is 350 MN/m^2. (4 marks)

(b) A cylindrical steel pressure vessel 400 mm in diameter with a wall thickness of 20 mm, is subjected to an internal pressure of 4.5 MN/m^2.

(i) Calculate the tangential and longitudinal stresses in the steel. (ii) To what value may the internal pressure be increased if the stress in the steel is limited to 120 MN/m^2? (iii) If the internal pressure were increased until the vessel burst, sketch the type of fracture that would occur (9 marks)

(c) A steel rod with a cross-sectional area of 0.25 cm^2 is stretched between two fixed points. The tensile load at 70°C is 1200 Kg. What will be the stress at 0°C? At what temperature will the stress be zero? Assume $\alpha = 6.5 \times 10^{-6}$ cm/(cm·°C) and $E = 29 \times 10^6$ N/m^2 (7 marks)