KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE (PHYSICS)

COURSE CODE: SPM 312

COURSE TITLE: MATERIALS TESTING AND EVALUATION

DURATION: 2 HOURS

DATE: 5/12/2023 **TIME: 2:00-4;00PM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.

QUESTION ONE [30 MARKS]

a) What is Fatigue? State three measures that may be taken to extend fatigue life in a material. [4 marks]

b) A piece of copper originally 305 mm long is pulled in tension with a stress of 276Mpa. If the deformation is entirely elastic, what will be the resultant elongation (Young's modulus of copper is $110x10^3$Mpa [4 marks]

c) Differentiate between materials in terms of their properties: metals, ceramics, polymers and composites [4 marks]

d) A relatively large plate of a glass is subjected to a tensile stress of 40 Mpa. If the specific surface energy and modulus of elasticity for this glass are 0.3 J/m^2 and 69 Gpa respectively, determine the maximum length of a surface flaw that is possible without fracture. [3 marks]

e) Using a labeled diagram, describe the three fatigue fracture processes [4 marks]

f) Discuss the following terms as applied to materials, Isotropy, elasticity, malleability and strength. [4 marks]

g) Discuss the Poisson ratio stating the relation with the Young's Modulus of elasticity. [4 marks]

h) State three differences between Brinell hardness and Rockwell hardness [3 marks]

QUESTION TWO [20 MARKS]

a) (i) A 13 mm diameter tensile specimen has a 50 mm gauge length. The load corresponding to the 0.2 % offset is 6800kg and the maximum load is 8400 kg. Fracture occurs at 7300 kg. The diameter after fracture is 8 mm and the gauge length at fracture is 65 mm. calculate the standard properties of the material from the tension test (Take $g = 9.8N/kg$ and $E = 207\ Gpa$). [9 marks]

(ii) If the elongation at maximum load is 22 %, what is the plastic strain at the maximum load? [2 marks]

c) Discuss the mechanical properties of ductility, resilience and toughness [9 marks]

QUESTION THREE [20 MARKS]

a) Discuss any three non - destructive methods of properties of materials [9 marks]

b) Compute the percentage cold work of a cylindrical copper rod if it is cold worked such that the diameter is reduced from 15.2 mm to 12.2 mm [4 marks]

c) A metal column is 3m long and 0.4m diameter. It carries a load of 50MN. Given that the modulus of elasticity is $200Gpa$, calculate the compressive stress and strain and hence determine how much the column is compressed. [7 marks]

QUESTION FOUR [20 MARKS]

a) Discuss the rotating beam fatigue test using a well labeled schematic diagram. [11 marks]

b) Discuss the three theories of fatigue. [9marks]

QUESTION FIVE [20 MARKS]

a) A mild steel wire of radius 0.5 mm and length 3.0 m is stretched by a force of 49N. Calculate the longitudinal stress, longitudinal strain, elongation produced in the body if the Young's modulus of steel is $2.1x10^{11}$N/M. [5 marks]

b) Define true stress and strain. A metal tensile test specimen has a cross sectional area of 100 mm2 and a gauge length of 50 mm, the gradient of the elastic section is $410x10^{3}$N/mm. Determine the modulus of elasticity. [4 marks]

c) Calculate the force needed to shear a pin 8 mm diameter given that the ultimate shear stress is $60Mpa$ [3 marks]

d) An object weighing 10, 000N rests on a horizontal surface at the top of a 6.0m tall vertical pillar. The pillars cross – sectional area is $0.20m^2$ and it is made to granite with a mass density of 270 kgm^{-3}. Find the compressive stress at the cross – section located 3.0m below the top of the pillar and the value of the compressive strain of the top 3.0m segment of the pillar ($g = 9.8\ N/kg$). [8 marks]