MACHAKOS UNIVERSITY

University Examinations for 2022/2023

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING
SECOND YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM215: ENGINEERING MECHANICS I

DATE: **TIME:**

INSTRUCTIONS:

1.This examination contains **FIVE** questions. Question ONE(1) is compulsory and carries 30 marks. All the other questions carry 20 marks each.
2.Answer question **ONE** and any other **TWO** questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Distinguish between the following terms as used in Engineering mechanics:
   i) Coplanar and Concurrent Forces (2 marks)
   ii) Equillibriant and Resultant force (2 marks)

b) i) Derive the equation for the resultant of two forces A and B, acting at an acute angle Θ between them in both magnitude and direction. (5 marks)

   ii) Find the magnitude of the two forces, such that if they act at right angles to each other, their resultant is $\sqrt{10}$ N, but if they act 60° apart, their resultant is $\sqrt{13}$ N. (5 marks)

c i) State Lamis theorem (3 marks)

iii) A light cable ABCDE as shown in Fig Q1c is fixed at end A and carries two weights W1 and W2 at Band C respectively. It then passes over a frictionless pulley at D carrying a load of 300N at the free end E. In the equillibrium position, BC is horizontal while AB and CD make 150^0 and 120^0 with BC.

Find the Tensions along AB, BC and CD and the magnitudes of the loads W_1 and W_2 (5 marks)

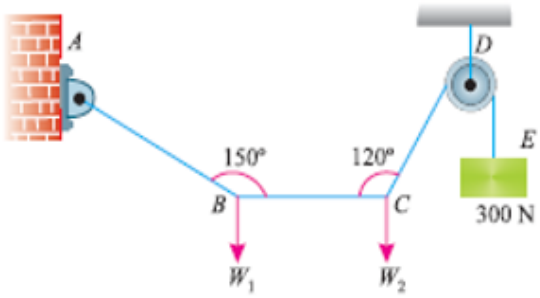

Figure Q1c

d) i) Distinguish between moments and couples (2 marks)

ii) Find the tension required in the operating wire in order to raise the signal through the system of levers as shown inFig. Q1d. All dimensions are in mm.

(4 marks)

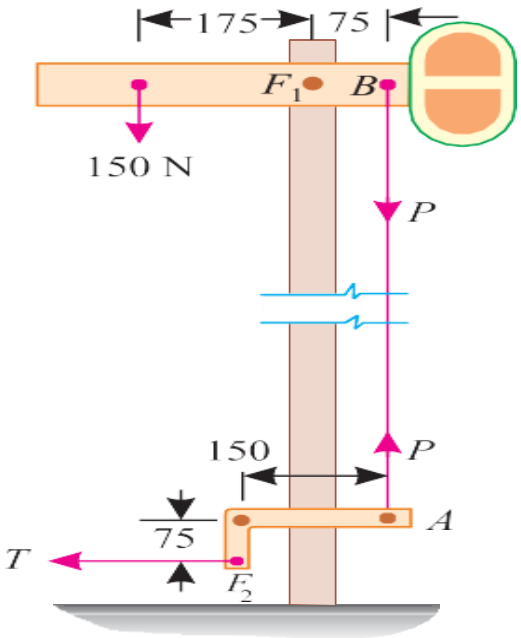

Figure Q1d

QUESTION TWO (20 MARKS)

a i) Distinguish between dynamic and static friction (2 marks)

ii) State three laws of dry friction friction. (3 marks)

iii) Describe briefly two engineering applications of friction (3 marks)

b) A carriage box of mass 450 kg is acted upon by a force P as shown in figure Q2b below.

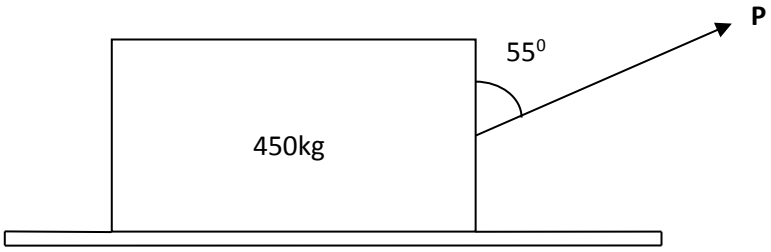

Figure Q2b

i) If **μ** =0.3, determine the value of P when the box is just about to start moving (4 marks)

ii) find the new value of P, if its direction is reversed and **μ** is unchanged (4 marks)

c) Determine the Force which when applied parallel to a plane inclined at 15^0 to the horizontal can just move a body of mass 25 kg up the plane. Take μ =0.3 (4 marks)

QUESTION THREE (20 MARKS)

a) Define the following laws as used in statics

i) Parallelogram law of forces

ii) Polygon law (4 marks)

b) A system of Coplanar concurrent forces is shown in **Figure 3b.** Determine fully the resultant for this system: (6 marks)

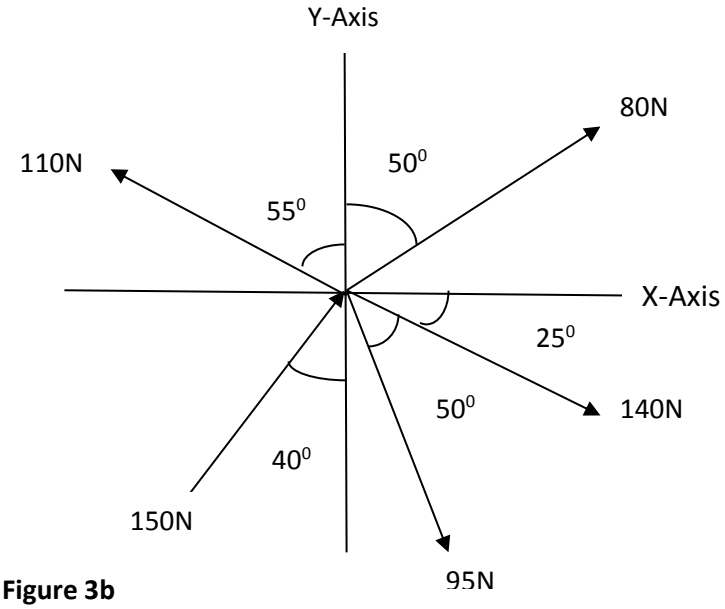

Figure 3b

i) State the principle of moments: (2 marks)

ii) Outline the conditions necessary for a body to be in equilibrium under the action of a system of forces (2 marks)

iii) A beam is simply supported and loaded as shown in **Fig Q3b.** Determine the reactions at the two supports. (6 marks)

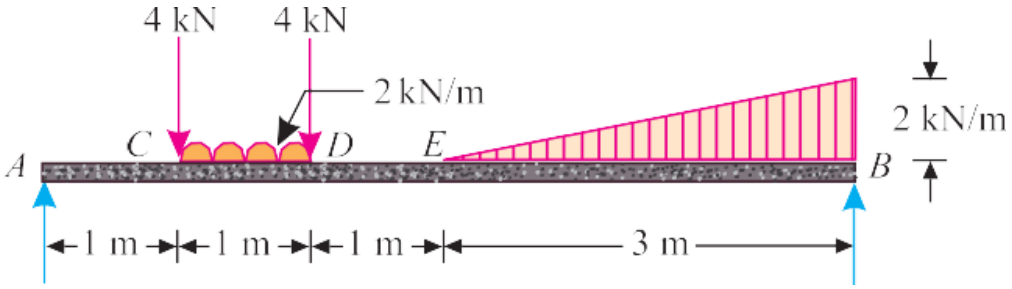

Figure Q3b

QUESTION FOUR (20 MARKS)

a) i) Distinguish between ties and struts as used in frameworks (2 marks)

ii) What are perfect frames? (1 mark)

iii) state three assumptions made in the analysis of frameworks. (3 marks)

b) Determine the magnitude and nature of the forces in all the members of the truss shown in **Fig Q4b**. The truss is fixed to a wall along AE (9 marks)

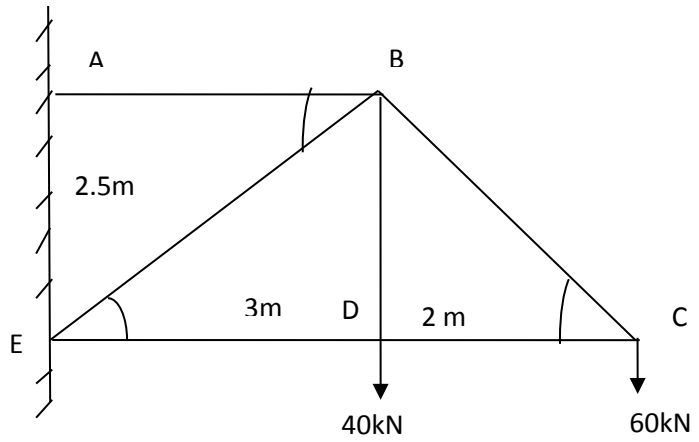

Figure Q4b

c) i) Distinguish between equilibrium and stability (2 marks)
ii) Illustrate the various forms of stability (3 marks)

QUESTION FIVE (20 MARKS)

a) i) Distinguish between the terms **centroid** and **centre of gravity** (2 marks)
ii) Derive from first principles the moment of inertia of a triangular section of base '**b'** and height '**h'** about its centroidal axis (5 marks)

b) The cross section of a model commemoration plaque is shown in **Fig.Q5b**

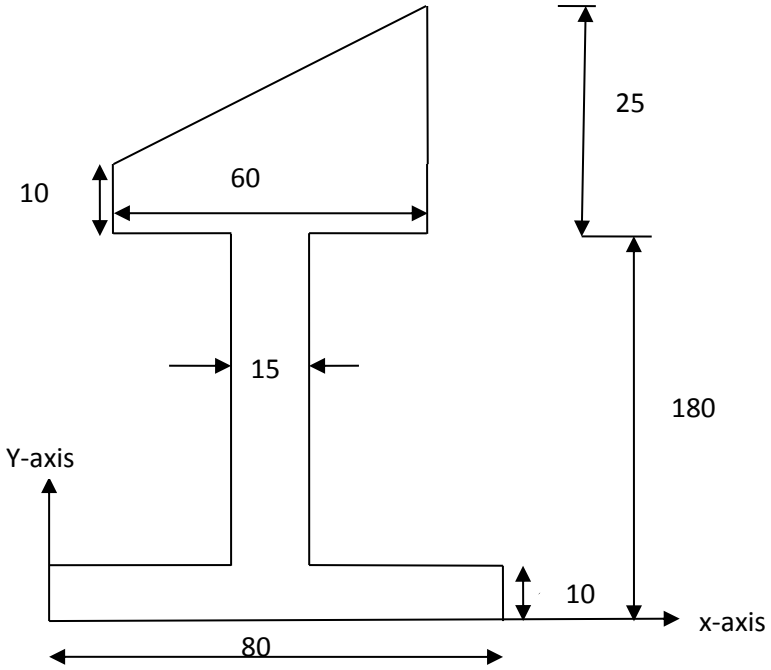

Figure Q5b: All dimensions are in mm

Determine :

i) the centroid of this section with reference to the base: (3 marks)

ii) the moment of inertia of the section about the centroidal axis parallel to the base. (4 marks)

c i) State the Principle of virtual work (2 marks)

ii) A simply supported beam AB of span 5 m is loaded as shown in Fig Q5c. Using the principle of virtual work, determine the reactions at A and B (4 marks)

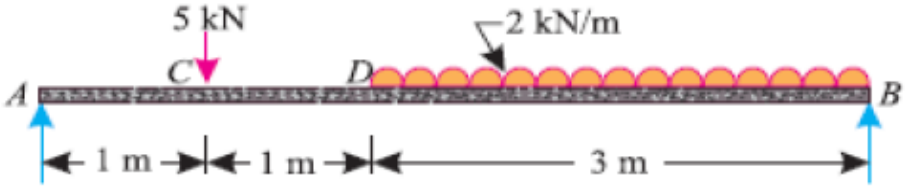

Figure Q5c