



MACHAKOS UNIVERSITY

University Examinations for 2020/2021 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM 210: ENGINEERING MECHANICS I

DATE: 25/3/2021

TIME: 8.30-10.30 AM

INSTRUCTIONS

Answer question ONE and any other TWO questions

QUESTION ONE (COMPULSORY-30 MARKS)

- a) Define the following terms as used in Engineering Mechanics
- Particle
 - Inertia
 - Rigid body
 - Mechanical Advantage
 - Mechanical efficiency (5 marks)
- b) i) Derive the equation for the resultant of two concurrent forces acting at an angle θ between them
- ii) Determine fully the Resultant of two forces of magnitudes 145 N and 275N acting at an angle of 110° from each other (8 marks)
- c) A simple lifting machine has a velocity ratio of 22. On test, it was found that an effort of 75N will lift a load of 1100N, and that an effort of 120N will lift a load of 2000N. Determine;
- the law of the machine
 - the effort and efficiency at a load of 2800N (10 marks)
- d) i Distinguish between kinetic and potential Energy
- ii State the principle of conservation of energy.

- iii A block of mass 2.5kg falls freely from a height of 25m above the ground. Determine its velocity at the instant it strikes the ground (7 marks)

QUESTION TWO (20 MARKS)

- a) Describe the following terms as used in statics
- coplanar forces
 - concurrent forces
 - Triangular law
 - Polygon law
- (6 marks)
- b) Determine analytically, the resultant of the system of forces shown in **Figure 2b** (7 marks)

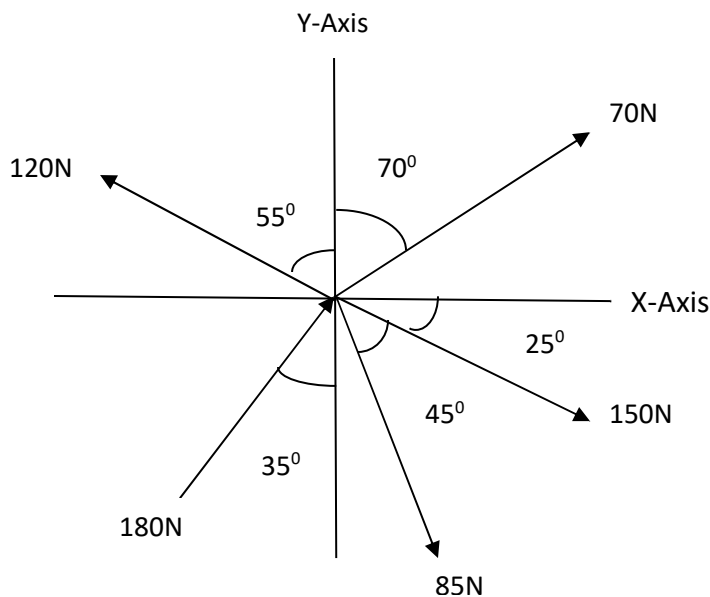


Figure 2b

- c) i) State the principle of moments
- ii) A beam is simply supported and loaded as shown in **Figure 2c**. Determine the reactions at the two supports

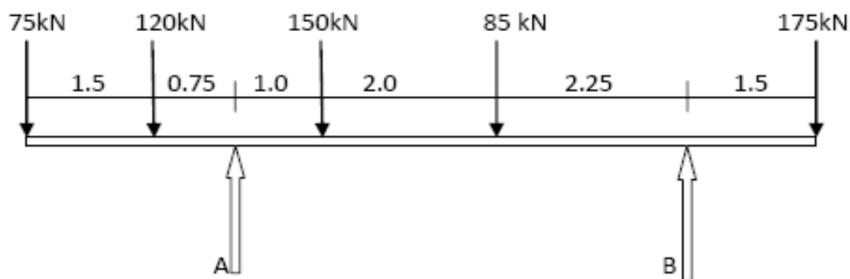


Fig.2c; All length dimensions in m

(7 marks)

QUESTION THREE (20 MARKS)

- a) i Distinguish between ties and struts as used in frameworks
ii state three assumptions made in the analysis of trusses. (5 marks)
- b) Determine the magnitude and nature of the forces in all the members of the truss shown in Figure 3. The truss is fixed to a wall along AE (15 marks)

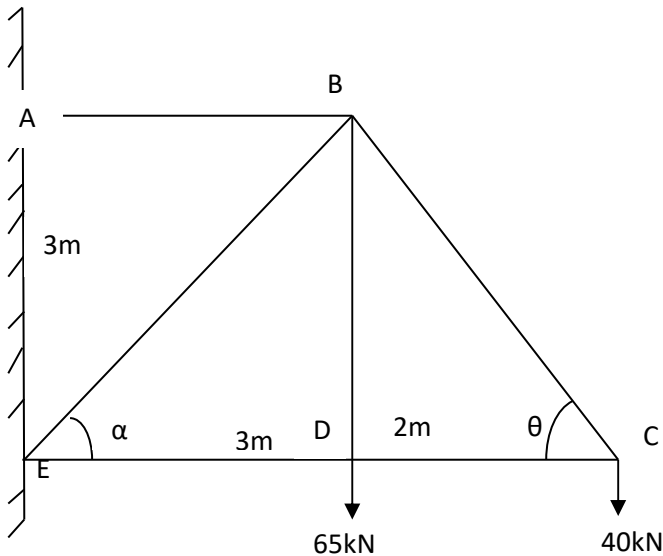


Figure 3

QUESTION FOUR (20 MARKS)

- a) i Distinguish between the terms **centre of gravity** and **centroid**
ii Show that the moment of inertia I_{xx} of a rectangular section of width **b** and depth **d** about its centroidal axis parallel to the width is given: $I_{xx} = \frac{bd^3}{12}$ (7 marks)
- b) State the following theorems of area moment of inertia:
i. Perpendicular axes theorem
ii. Parallel axes theorem (4 marks)
- c) The cross section of a symmetrical I-beam is shown in **Fig.4c**

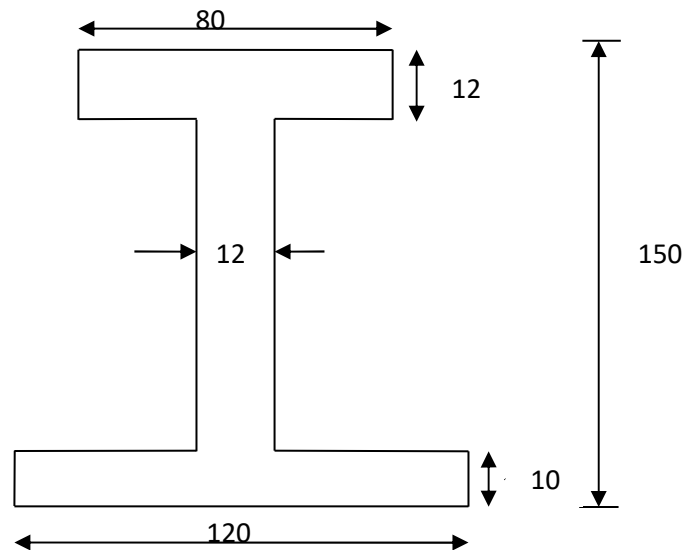


Fig.4c: All dimensions are in mm

Determine for this section:

- the centroid with reference to the base
- area moment of inertia of the section about a centroidal axis parallel to the base

(9 marks)

QUESTION FIVE (20 MARKS)

- State three laws of dry friction friction. (3 marks)
- A carriage box of mass 250 kg is acted upon by a force P as shown in figure 5b below.

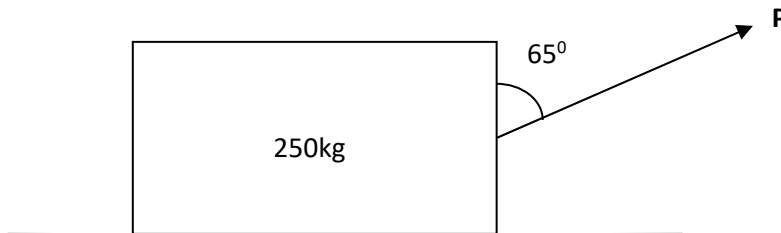


Figure 5b

- If $\mu = 0.3$, determine the value of P when the box is just about to start moving.
 - find the new value of P , if its direction is reversed and μ is unchanged (8 marks)
- c) i) With the aid of suitable sketches, distinguish between open and closed belt drives, showing clearly the tight and slack sides of each drive.
- ii) A countershaft has a pulley 1200mm diameter keyed to it and it is to have a speed of 200 rev/min. It is to be driven by an electric motor which has a speed of 1000 rpm. What is the diameter of the pulley that should be fitted to the electric motor?

(9 marks)