



MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

EMM210 ENGINEERING MECHANICS I

DATE: _____ **TIME:** _____

Instructions to candidates:

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) co-planer forces and concurrent forces (2 marks)
 - ii) Resultant and equilibrant (2 marks)
- b) State the following laws as applied in statics:
- i) parallelogram law of forces (2 marks)
 - ii) polygon law of forces (2 marks)
- c) i) Two forces A and B act at an angle θ between them. If $\theta = 0^\circ$ and $A=B$, Show from first principles that their resultant $R = 2A = 2B$ (5 marks)
- ii) Two coplanar concurrent forces act simultaneously on a particle at an angle of 140° between them. The bigger force is 60N and the resultant is perpendicular to the smaller one. Find the magnitude of the smaller force. (6 marks)

- d) i) State the conditions required for a system of forces to be in equilibrium (2 marks)
- ii) Determine the support reactions at A and B for the beam shown in Fig Q1d (5 marks)

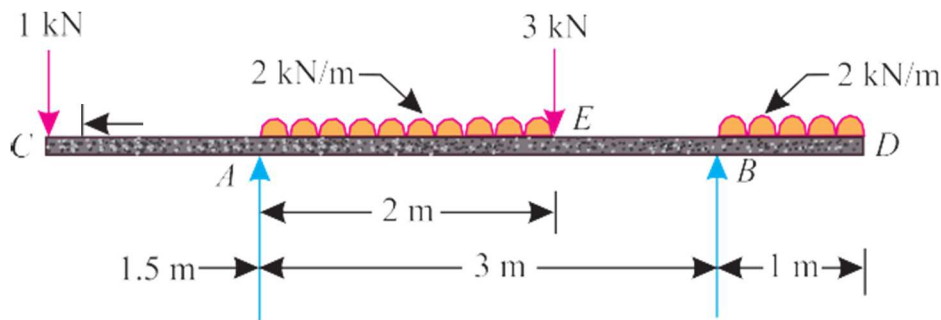


Figure Q1d

- iii) With the aid of suitable sketches, distinguish between stable and neutral equilibrium (4 marks)

QUESTION TWO (20 MARKS)

- a) i) Discuss any two practical applications of belt drives (2 marks)
- ii) With the aid of suitable sketches, distinguish between an open and a crossed belt drive showing clearly the tight and slack sides of the belt in each case (4 marks)
- b) Two pulleys of diameter 900 mm and 300 mm respectively are fixed on two parallel shafts 6 m apart and connected by means of a crossed belt. The larger pulley is connected to a motor shaft while the smaller one drives a machine spindle.
- i) determine the length of the belt. (4 marks)
- ii) if the optimal power transmitted is 1500W at the motor speed of 1200rpm, determine the slack side tension when the tight side tension is 80N (4 marks)
- c) i) Distinguish between Kinetic energy and potential energy (2 marks)
- ii) A 12tonne truck travelling at 1.6m/s^2 impacts onto a buffer spring stopper whose stiffness is 2.15 mm/kN . Find the maximum compression of the buffer spring (4marks)

QUESTION THREE 20 MARKS

- a) i) Distinguish between centre of gravity and centroid. (2 marks)
- ii) State the two theorems of area moment of inertia. (4 marks)
- b) i) Determine the area moment of inertia for a triangular section of base b and height h :
about the base. (4 marks)
- ii) about a centroidal axis $x-x$ parallel to the base (3 marks)
- c) Determine the moment of inertia of the section shown in Figure Q3(c) about an horizontal axis passing through its centroid. (7 marks)

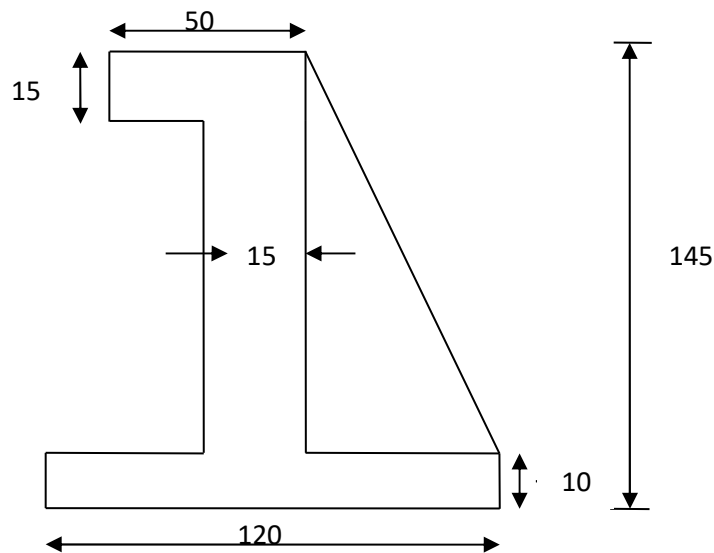


Figure Q3(c)

QUESTION FOUR 20 MARKS

- a) i) Distinguish between redundant and deficient frameworks (2 marks)
 ii) State three assumptions made in the analysis of trusses. (3 marks)
- b) Figure Q4b shows a Warren girder freely supported at its end points. The girder is loaded as shown and comprises seven members of length 3m each which are pin-jointed at their ends. Find the magnitude of the forces in all the members and state their nature (Tabulate your results)

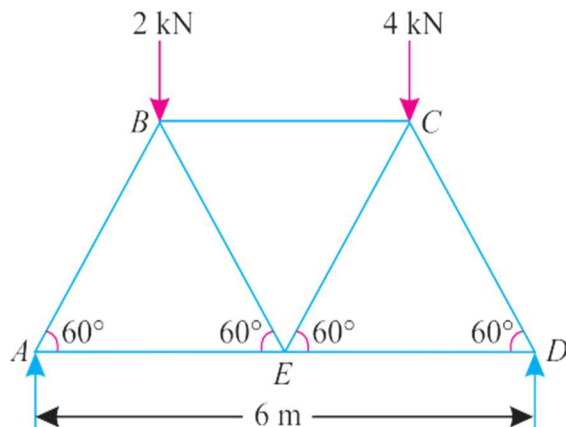


Figure Q4b

(8 marks)

- c) i) State Lami's Theorem. (2 marks)
 ii) Two men lift a 3kN load using two ropes fixed to the load. One rope is inclined at 40° and the other 35° to the vertical. Determine the tension in each rope (5 marks)

QUESTION FIVE 20 MARKS

- a) i) Distinguish between static and dynamic friction (2 marks)
- ii) Explain two applications of friction in engineering (2 marks)
- iii) A force of 200N acting parallel to a plane which is inclined at 15° to the horizontal is required to just move a certain body up the incline. When the same plane is then inclined at 20° to the horizontal, the force applied parallel to the plane is found to be 230 N. Determine the weight of the body and the coefficient of friction between the surfaces involved. (8 marks)
- b) i) State the principle of virtual work as applied in mechanics. (2 marks)
- ii) A block of weight W resting on a smooth surface inclined at 20° to the horizontal is supported and maintained at equilibrium by an effort P , suspended from a pulley as shown in Fig Q5b. Using the principle of virtual work, determine P if $W=120\text{N}$ (6 marks)

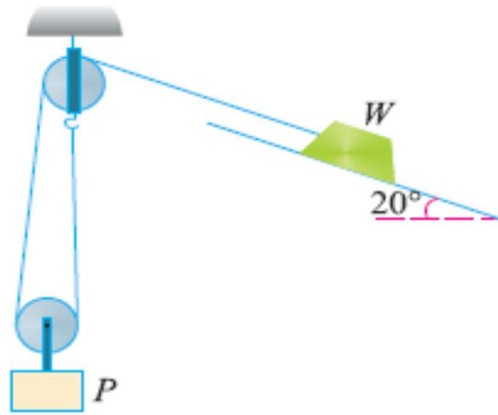


Fig Q5b