ZIMBABWE

MINISTRY OF HIGHER AND TERTIARY EDUCATION, SCIENCE AND TECHNOLOGY DEVELOPMENT

HIGHER EDUCATION EXAMINATIONS COUNCIL (HEXCO)

NATIONAL CERTIFICATE

IN

CIVIL ENGINEERING/IRRIGATION ENGINEERING

SUBJECT: Applied Mechanics PAPER NO: 313/S04

DURATION: 3 Hours

OCTOBER/NOVEMBER 2014 EXAMINATION

REQUIREMENTS

INSTRUCTIONS TO CANDIDATE

1. Answer any FIVE (5) questions.
2. All questions carry equal marks.
3. Start each question on a new page.

This paper consists of 6 printed pages.

PAPER NO: 313/S04 – APPLIED MECHANICS

QUESTION 1

Fig Q1 shows a cantilever framework supported on frictionless rollers at A and pin pointed at B. The framework supports vertical forces of 45KN at D and 35KN at E and a horizontal force of 25KN at E.

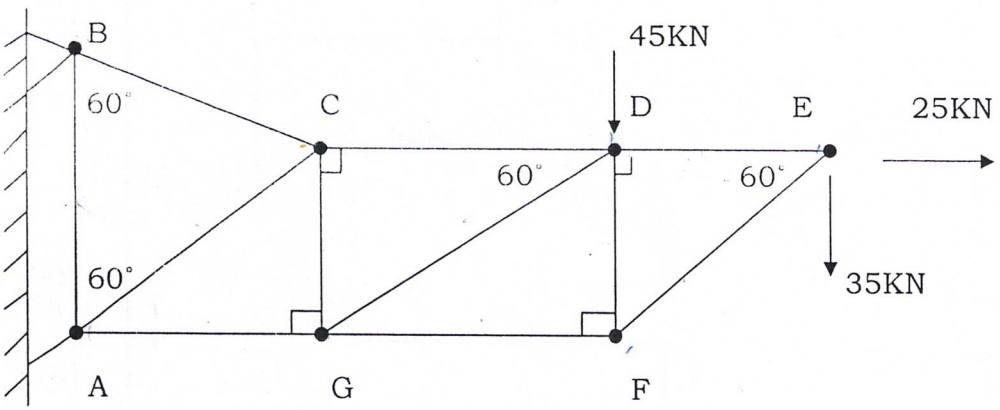

Fig. Q1

a) State an expression in terms of the number of members m, and the number of joints j, which can be used to determine whether the frame is rigid and perfect; non rigid or contains redundant members. (2 marks)

b) Determine the nature and magnitude of the internal forces in all the members of the frame. Tabulate your results indicating struts and/or ties. (15 marks)

c) Calculate the reactions at the supports. (3 marks)

QUESTION 2

For the section shown in Fig Q2:

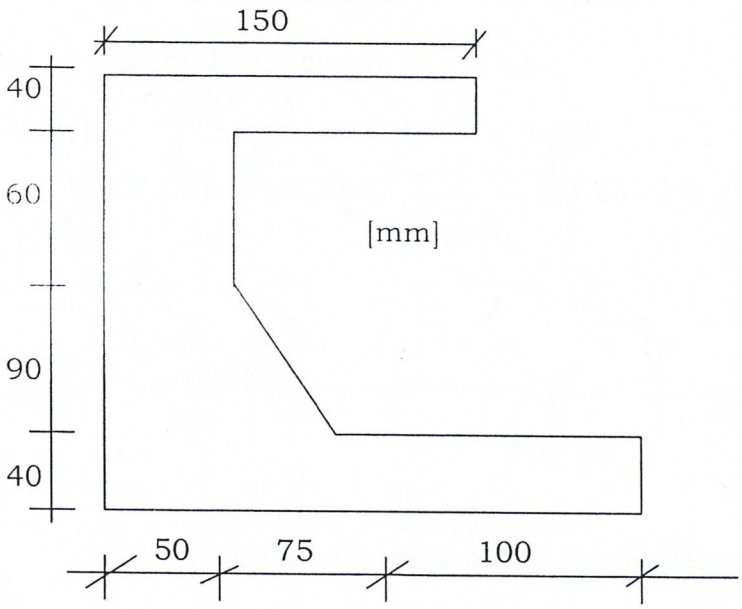

Fig. Q2

a) Determine the position of the centroid. (4 marks)

b) Calculate the second moment of area and the respective radii of gyration about both centroidal axes. (16 marks)

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QUESTION 3

a) Discuss the significance of the maximum bending moment and the point of contraflexure in beam design. (2 marks)

b) For the beam shown in Fig. Q3:

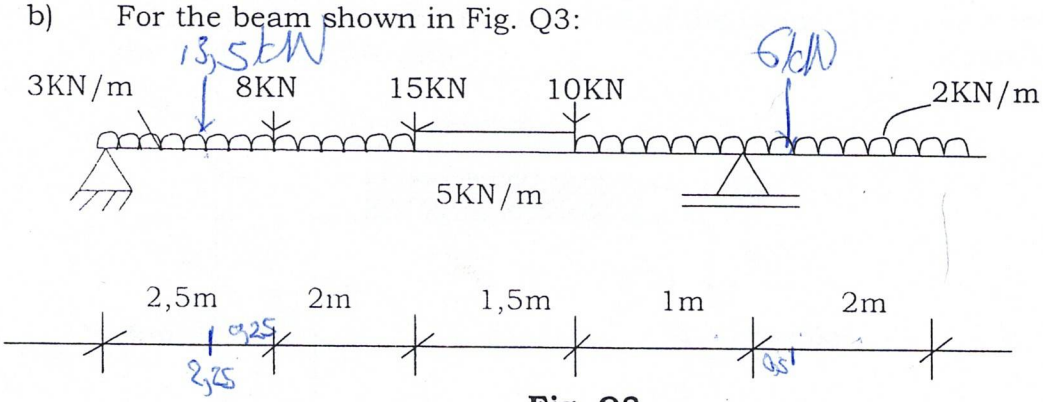

Fig. Q3

i) Draw the free body diagram (1 mark)
ii) Calculate the magnitude of the reactions at the supports. (3 marks)
iii) Draw the shear force diagram. (6 marks)
iv) Draw the bending moment diagram. (5 marks)
v) Determine the value and position of the maximum bending moment. (2 marks)
vi) Calculate the position of the point of contraflexure. (1 mark)

QUESTION 4

a) Explain Newton's three laws of motion. (3 marks)

b) A car passes a certain point using a velocity of 10m/s and a point 1km away with a velocity of 30m/s, the acceleration being uniform.

i) Calculate the average velocity of the car. (1 mark)
ii) Calculate the time taken by the car to travel between the two points. (3 marks)
iii) Determine the acceleration of the car. (2 marks)

c) A uniform ladder 4m long rests with its upper end against a smooth vertical wall and with its lower end on rough ground. The weight of the ladder is 125N. Determine the least coefficient of friction between the ladder and ground for it to be inclined at 60° to the horizontal. (5 marks)

d) A wheel increases its speed from 45 revolutions per minute to 90 revolutions per minute in 30 seconds. Calculate:

i) The angular acceleration of the wheel. (3 marks)
ii) The number of revolutions made by the wheel in these 30 seconds. (3 marks)

QUESTION 5

a) The composite beam shown in Fig Q5A consists of a 300mm x 200mm timber joist strengthened by the addition of two steel plates 180mm steel is 165N/mm² and the modular ratio is 30. Calculate the moment of resistance of the beam. The safe stress in the timber is 5,5N/mm². (8 marks)

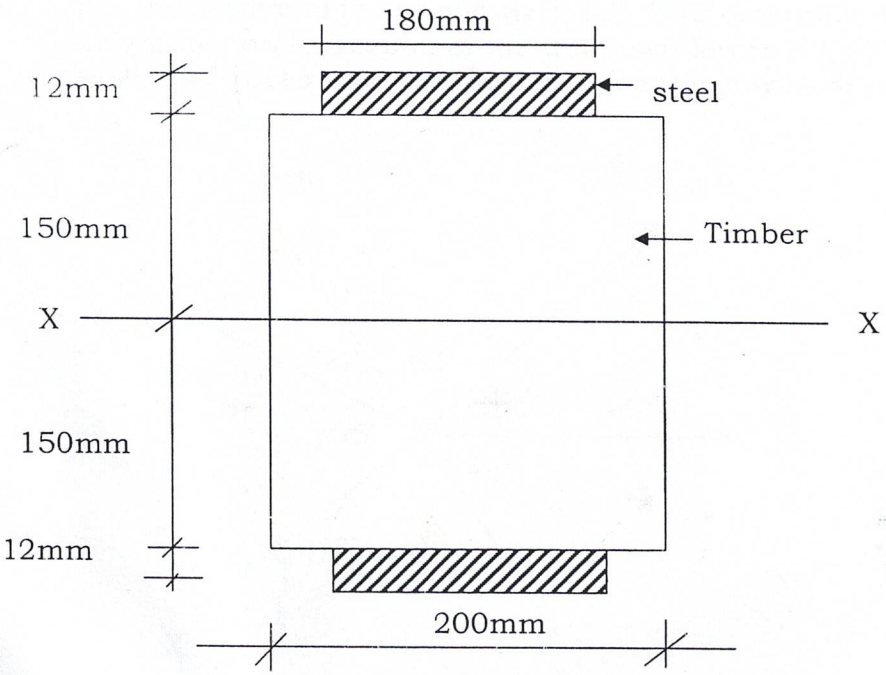

Fig. Q5A

b) A timber joist shown in Fig Q5B is 200mm by 100mm in rectangular cross section and has reinforcing steel flange plates 15mm thick. The composite beam is 4m long, simply supported at each end and carries a total uniformly distributed lateral load of 3,75KN/m. Calculate the maximum bending stresses in the steel and the timber. The modular ratio is 20. (12 marks)

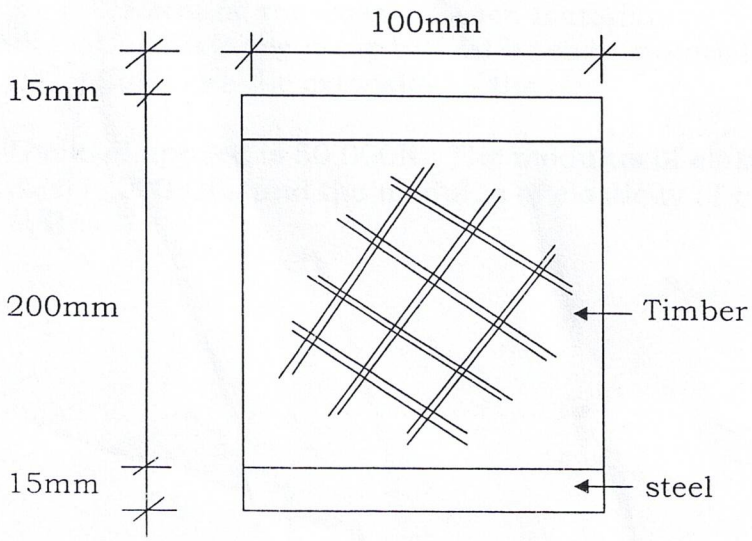

Fig. Q5B

QUESTION 6

a) Explain the following principles:

i) Principle of the parallelogram of forces. (2 marks)
ii) Lami's theorem (2 marks)

b) For the system of forces shown in Fig. Q6B determine the magnitude and direction of the unknown forces X and Y. The system of forces is in equilibrium. Use the graphical method only.

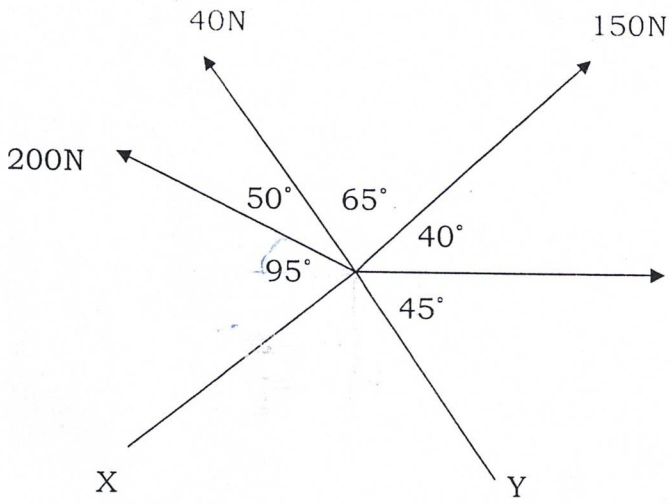

Fig. Q6B

(8 marks)

c) A compound bar 800mm long consists of a mild steel bar 30mm in diameter enclosed by a brass tube 30mm internal diameter and 40mm external diameter. The two materials are rigidly joined together.

i) Determine the stress in each material
ii) Calculate the loads carried by each material
iii) Calculate the extension of the bar.

The load applied is 50 000N. The modulus of elasticity of the mild steel is 200 GPa and the modulus of elasticity of the brass is 90Gpa. (8 marks)

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