



**ZIMBABWE**

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,  
SCIENCE AND TECHNOLOGY DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL  
(HEXCO)**

**NATIONAL CERTIFICATE**

**IN**

**CIVIL/ WATER RESOURCES AND IRRIGATION ENGINEERING**

**SUBJECT: Applied Mechanics**

**PAPER NO: 313/13/S04**

**DURATION: 3 Hours**

**OCTOBER/NOVEMBER 2018 EXAMINATION**

**REQUIREMENTS**

Scientific calculator

**INSTRUCTIONS TO CANDIDATE**

- 1) Answer any five (5) questions.
- 2) Start each question on a fresh page.
- 3) Show all working and give answers to 2 decimal places.

QUESTION 1

a) Define the following terms:

- |      |                                  |          |
|------|----------------------------------|----------|
| i)   | Concurrent coplanar forces       | (1 mark) |
| ii)  | A moment and its unit of measure | (1 mark) |
| iii) | Equilibrium                      | (1 mark) |
| iv)  | Fixed support                    | (1 mark) |
| v)   | Point load                       | (1 mark) |

b) The following system of forces shown in fig Q1 is in equilibrium. Determine the magnitude and direction of the unknown forces X and Y. (15 marks)

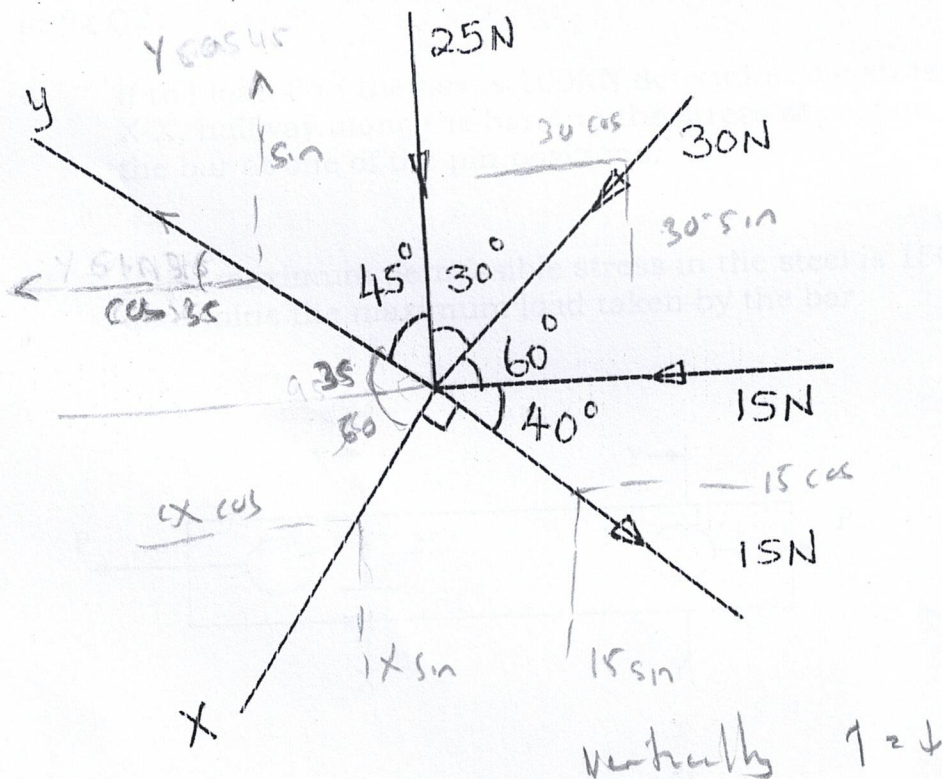


Fig Q1

$$\begin{aligned}
 & \text{Vertically } \uparrow = \downarrow \\
 & Y \sin 35 + 25 + 30 \sin 60 + 15 \sin 40 + X \sin 60 \\
 & = Y \cos 35 \\
 & \leftarrow = \rightarrow \\
 & 30 \cos 60 + Y \cos 35 + X \cos 60 + 15 = 15 \cos 40
 \end{aligned}$$

QUESTION 2

a) Explain the following terms:

- i) Young modulus (1 mark)
- ii) Factor of safety (1 mark)
- iii) Strain (1 mark)

b) Convert the following:

- i) 20MPa to  $\text{N/mm}^2$  (1 mark)
- ii) 50 bars to  $\text{KN/mm}^2$  (1 mark)
- iii) 30GPa to  $\text{KN/mm}^2$  (1 mark)

c) A drawbar between a tractor and a trailer is made up of a length of steel with a rectangular cross-section of 100mm by 12 mm. The load is transmitted to the bar via a pin 25mm in diameter at each end as shown in fig Q2:

- i) If the load P in the bar is 100KN determine the stress at section X-X, halfway along the bar and the stress at section y-y through the bar at one of the pin positions. (10 marks)
- ii) If the maximum permissible stress in the steel is  $150\text{N/mm}^2$ , determine the maximum load taken by the bar. (4 marks)

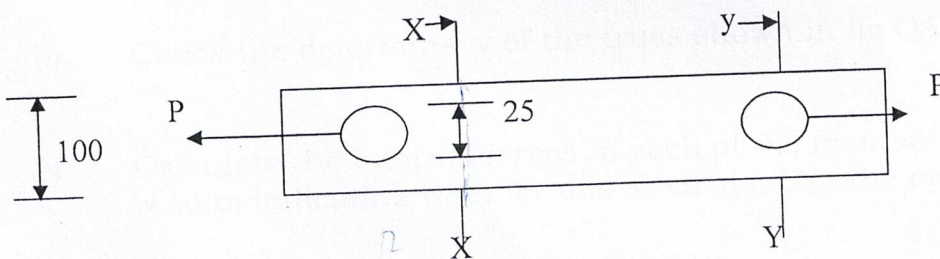


Fig Q2: Dimensions in mm

QUESTION 3

A simply supported beam carries the loading shown in fig. Q3

- a) Determine the reactions at the supports . (6 marks)
- b) Draw the shear force and bending moment diagrams for the beam. (10 marks)
- c) Calculate the value and position of the maximum bending moment. (4 marks)

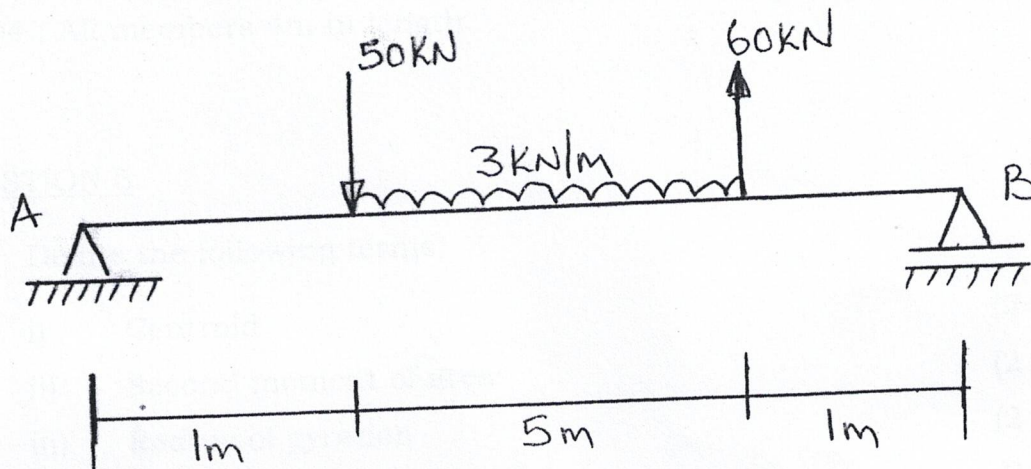


Fig Q3

QUESTION 4

- a) What is your understanding of the term 'determinate truss'? (2 marks)
- b) Check the determinacy of the truss shown in fig Q4. (2 marks)
- c) Calculate the internal forces in each of the members. Tabulate the results indicating whether ties or struts. Use the method of joints. (10 marks)
- d) Determine the forces in members BC, BE and AE using the method of sections. (6 mark)

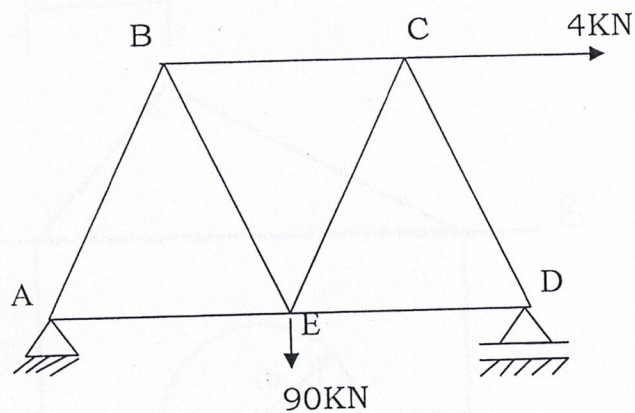


Fig Q4 : All members 4m in length

### QUESTION 5

a) Define the following terms:

i) Centroid

(2 marks)

ii) Second moment of area

(2 marks)

iii) Radius of gyration

(2 marks)

iv) Parallel axis theorem

(2 marks)

b) For the area shown in fig Q5 determine:

i) The position of the centroid

(5 marks)

ii) The second moment of area about the axis AB.

(5 marks)

iii) The radius of gyration of the area about the axis AB.

(2 marks)

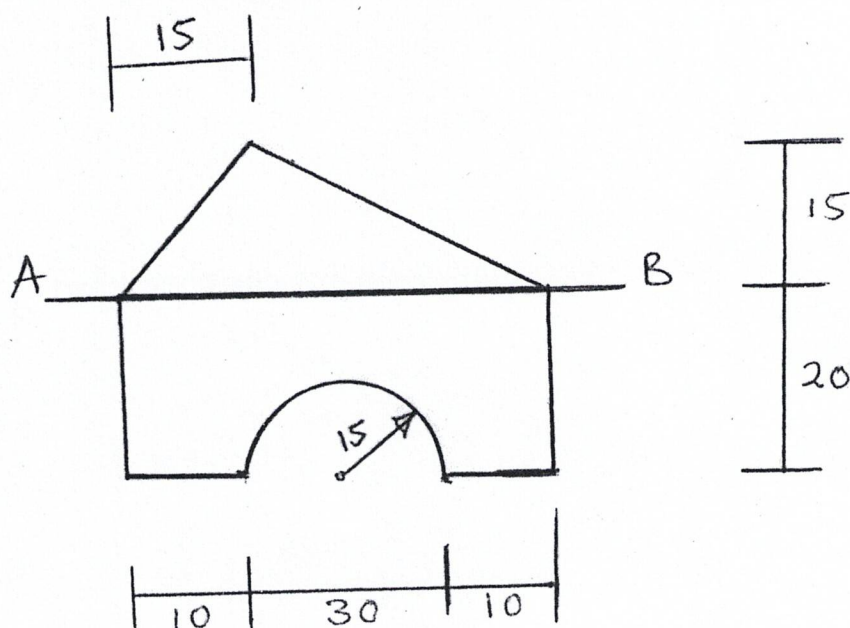


Fig Q5

QUESTION 6

- a)
  - i) State Newton's Laws of motion. (3 marks)
  - ii) Define the term 'Coefficient of friction'. (1 mark)
- b) A uniform ladder 8m long weighs, 220N, rests on rough ground and is propped against a vertical rough wall at an angle  $\theta$  to the horizontal. If the coefficient of friction  $\mu = 0.4$  for the ground and the wall surfaces, find  $\theta$  when slip is about to take place. (6 marks)
- c) A train accelerates uniformly from rest to reach 54km/h in 200 seconds, after which the speed remains constant for 300 seconds. At the end of this time the train decelerates to rest in 150 seconds:
  - i) Show the motion on a velocity-time graph. (4 marks)
  - ii) Calculate the total distance travelled. (6 marks)

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