

GENERAL CERTIFICATE OF EDUCATION BOARD

Technical and Vocational Education Examination

BUILDING CONSTRUCTION APPLIED MECHANICS 2

7216

JUNE 2022

ADVANCED LEVEL

Specialty Name and Acronym	BUILDING CONSTRUCTION: CE-BC (F4-BA)
Subject Title	BUILDING CONSTRUCTION APPLIED MECHANICS
Subject Code N ^o .	7216
Paper N ^o .	2

Duration: 3 Hours

INSTRUCTIONS TO CANDIDATES

This Paper has **SEVEN Questions**. Answer **FIVE**

All questions carry equal marks.

In all cases involving calculations, you are advised to show all the steps in your working.

Graph Paper will be provided if necessary.

Do not write in pencil except for diagrams and graphs.

Non-Programmable Scientific Calculators and Formulae Booklets may be used.

Where not stated, take $g = 10\text{m/s}^2$.

At the end of your examination, fasten your work together with string.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are advised to read carefully through the question paper, before you begin your answers.

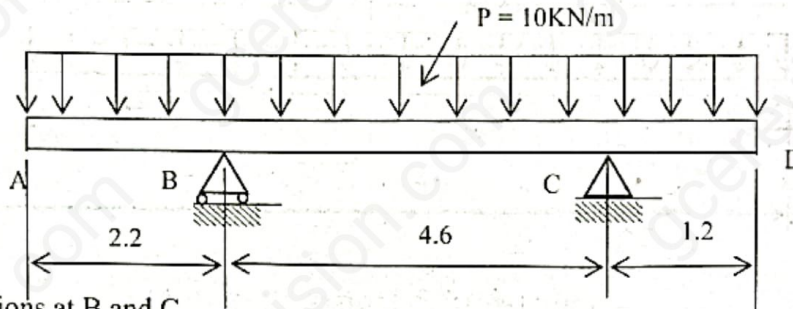
Turn Over

Question 1

Your Village Development Association (VDA) held their annual general assembly to discuss on projects to be carried this year to match the development of the village to modern times. The main project retained for this year was to replace the wooden bridge linking the village to the neighbouring village with a reinforced concrete bridge. The mechanical sketch of the beam carrying the slab of the bridge is simplified as shown below. The characteristics of the materials used for the concrete beam (20x50) cm were as follows:

CONCRETE	STEEL
- Density: 2500 daN/m^3	- Elastic limit; $f_e: 400 \text{ Mpa}$
- Characteristic strength $f_{c28}: 25 \text{ Mpa}$	- Material factor: $\gamma_s: 1.15$
- Material factor: $\gamma_b: 1.5$	- Young's modulus: $2 \times 10^5 \text{ Mpa}$

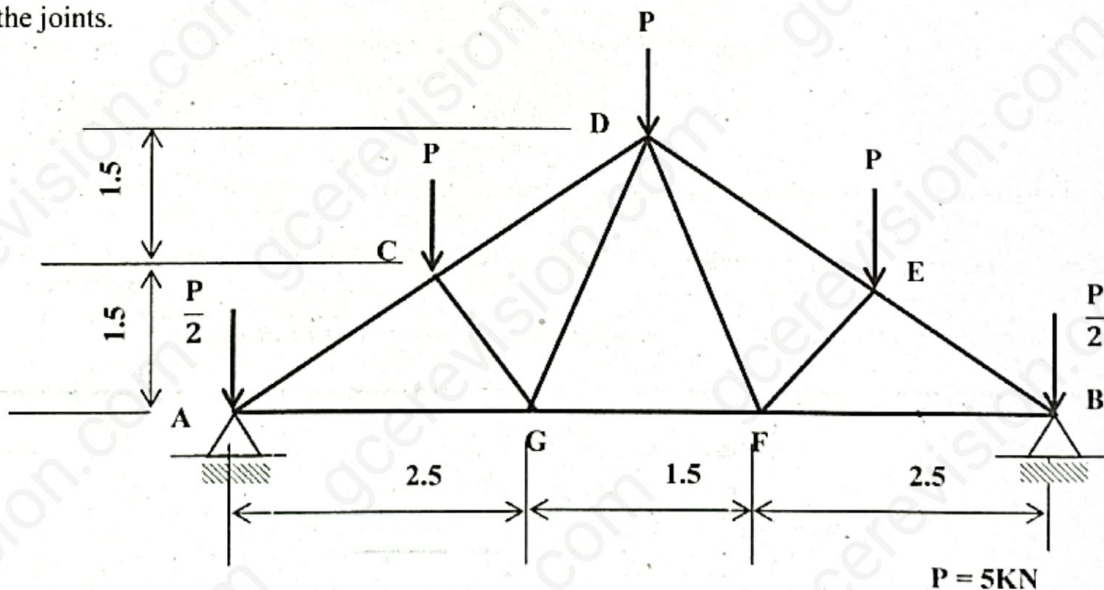
For the purpose of calculation, consider the simplified section given below and ignore the self weight of the beam.



- Determine the reactions at B and C. (2 marks)
 - Write both the shear force and bending moment equations along the length of the beam. (4 marks)
 - Draw the shear force and bending moment diagrams along the length of the beam. (6 marks)
 - If the maximum bending moment is 49 kNm , calculate the section of the longitudinal reinforcements and draw its disposition on the section. (8 marks)
- Total (20 marks)**

Question 2

The Christian community of your locality contributed money to roof the newly constructed church house. They decided to use the IPE profile for the roof trusses since the building is located in an area where these profiles are being fabricated. You as a future engineer has study and advice the community as to how solid this type of roof element is, compared to the wooden trusses. The mechanical sketch of one of the truss is as shown supporting point loads at the joints.



- Calculate the reactions at the supports A and B. (4 marks)
- Using any method of your choice, determine the magnitude nature of the forces in

- the bars AC, AG, CG and DG considering that $RA = RB = 2P$
 c) Draw the Cremona of the framework.

(10 marks)

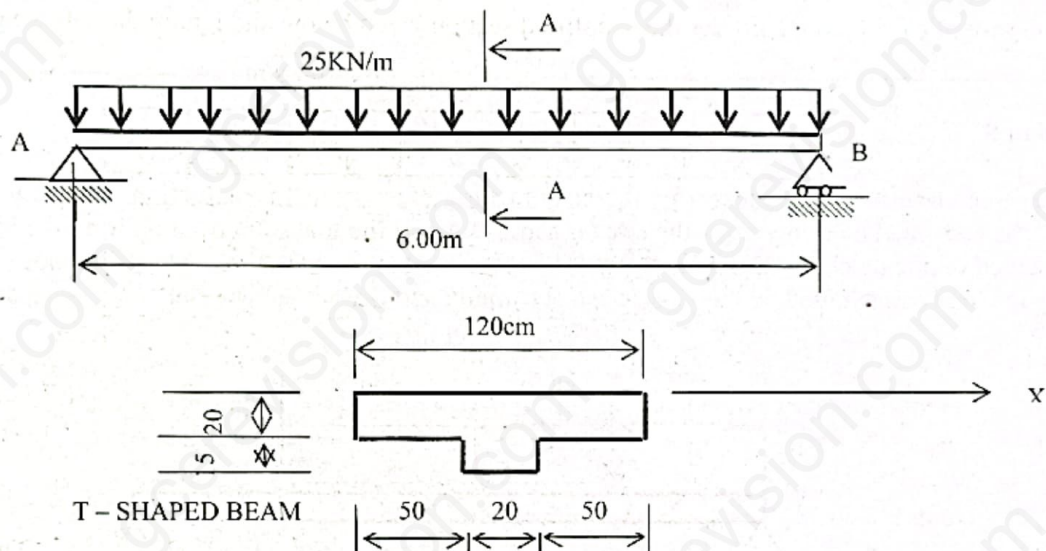
(6 marks)

Total

(20 marks)

Question 3

During the construction of the upper floor of a gymnasium at a sport center, it was concluded that the beams to carry the floor should have a T-shaped section. The load of the floor is considered as being uniformly distributed as indicated on the section below. You are called upon to do the study of this beam and answer the questions below, to assure the project owner that the beams used will carry the floor without failure.



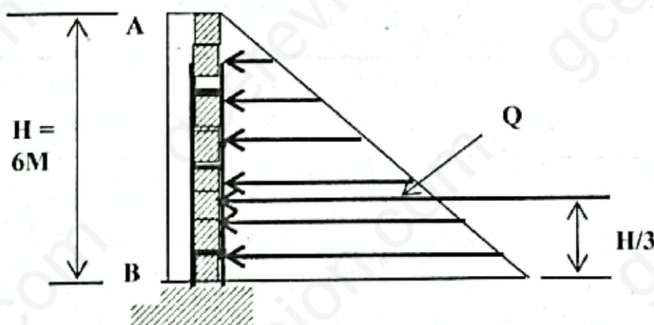
- Determine the contact reactions at the points A and B. (2 marks)
- Write the equations of the shear force and bending moment along AB. (4 marks)
- Draw the shear force and bending moment diagrams and deduce their respective maximum values. (6 marks)
- Determine the second moment of area about the horizontal axis through the centroid of the cross section. (5 marks)
- Determine the maximum compressive stress in the beam due to bending. (3 marks)

Total

(20 marks)

Question 4

The construction of a retaining wall to protect the sides of a roadway from collapsing was agreed upon during a council session for the validation of priority project. In the course of the studies of the project, it was recommended that reinforced concrete pillars will be required to give stability to the retaining wall. Considering that the pressure at the base of the pillar is $P_B = 50000 \text{ N/mm}^2$ and that the pillar can be considered as a beam which is embedded at the point B and simply supported at A as shown;

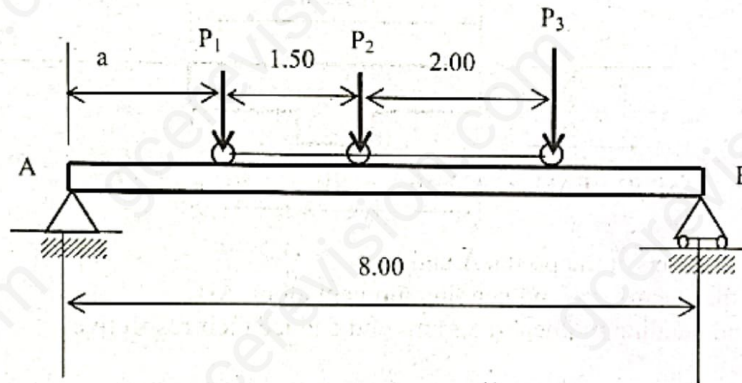


- a) Determine the load at the base $q_b = P_{scr} = P_u$ knowing that $c = 0.8m$. (4 marks)
- b) Considering that the moment at B is $M_B = 1/3 \times Q \times H$ and $Q = H/2 \times P_u$, calculate the reactions at A and B at the ULS ($P_u = 40 \text{ kN}$) (4 marks)
- c) Write the equations of the shear force and bending moment and draw their diagrams. (8 marks)
- d) Given the value of $M_u = 60 \text{ kNm}$ and the section of the pillar to be $20 \times 20 \text{ cm}$, calculate the section of the reinforcement rods (A_{st}) needed. (6 marks)
- Take: $\mu b d^2 f_{bu} = M_u$, $A_{st} = Z \square st \geq M_u$ and $\alpha = 1.25(1 - \sqrt{1 - 2\mu})$

Total (20 marks)

Question 5

A trailer truck transporting cement from the manufacturing factory to a construction site had to cross a stream in order to deliver the cement. The bridge over the stream had to support the loads imposed on it by the wheels of the moving truck as presented on the mechanical sketch below. The distances between the three wheels are not variable and therefore there no way the loads transmitted by the wheels can act simultaneously at a given point.

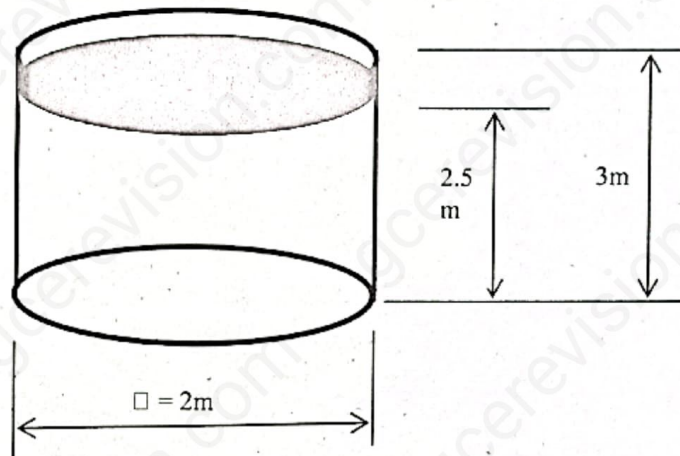


- a) Calculate the value and position of the resultant of the three forces. (3 marks)
- b) Determine the maximum bending under each wheel. (6 marks)
- c) Calculate the bending under P_3 when P_1 is at the point A. (3 marks)
- d) Calculate the bending under P_1 when P_1 is at the point B. (3 marks)
- e) Draw the envelope curve produce by the trailer truck along the bridge. (5 marks)
- Take: $P_1 = 2 \text{ kN}$, $P_2 = 5 \text{ kN}$, $P_3 = 3 \text{ kN}$ and $a = 1.25 \text{ m}$

Total (20 marks)

Question 6

A business tycoon decided to isolate himself from the community and constructed his resident where there is water scarcity. Being very rich, he opted for boreholes to supply his house with water. A circular tank in aluminum was bought and placed at a height 6m from the ground. The diameter of the tank is 2m, the height is 3m. The study is concentrated on the tank and it's contain as shown in the diagram below.



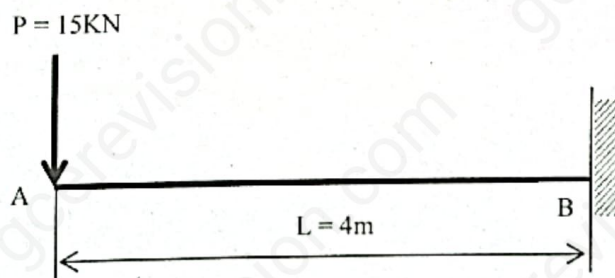
Considering that the density of water is 1000kg/m^3 , the acceleration due to gravity is 10m/s^2 and the height of water in the tank is 2.5m; consider the tank to be closed.

- Calculate the highest pressure in the tank. (5 marks)
- Calculate the pressure at the bottom of the tank. (5 marks)
- Draw the diagram of the pressure exerted on the walls of the tank. (6 marks)
- Determine the pressure exerted by water at 2m from the bottom of the tank. (4 marks)

Total (20 marks)

Question 7

The mechanical sketch below shows the loading of a cantilever beam on the upper floor of a church hall. During ceremonies in the church hall, some special guests reserved this section of the hall for entertainment. This beam is embedded at one end and supporting a point load (P) at the free end.



- Determine the vertical force at the point B and the embedded moment. (4 marks)
- Write the shear and bending moment equations along the length of the beam. (4 marks)
- Write the equation of deflection between the interval $0 \leq x \leq L$ (8 marks)
- Deduce the value of the deflection at the point $L/2$ in function of EI . (4 marks)

Total (20 marks)