2305/303
2307/303
2308/303
STRUCTURES
June/July 2022
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN BUILDING
DIPLOMA IN CIVIL ENGINEERING
DIPLOMA IN HIGHWAY ENGINEERING

STRUCTURES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
- *Answer booklet;*
- *Scientific calculator;*
- *Drawing instruments.*

*Answer any **FIVE** of the following **EIGHT** questions.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
Candidates should answer the questions in English.

This paper consists of 13 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

1. (a) Using the method of moment distribution, analyse the beam shown in **figure 1**, hence sketch the bending moment diagram indicating values at all critical points. Make four distributions. (20 marks)

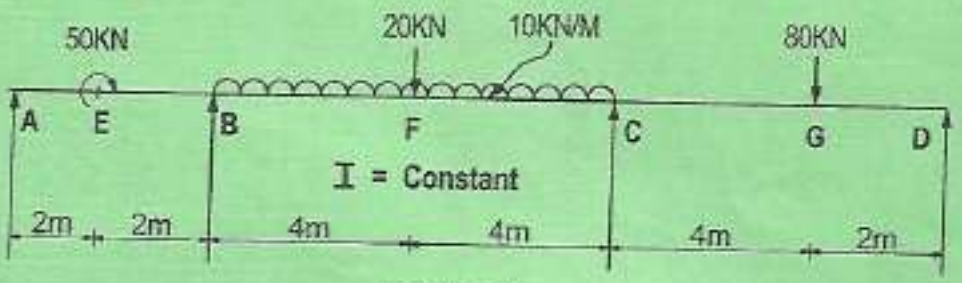

FIGURE 1

2. (a) State **three** assumptions made in the load factor method of design. (3 marks)

(b) Design and detail the plan and section of a reinforced concrete slab of interval dimensions 4.8 m x 6.8 m. The slab is simply supported on a 200 mm thick wall on all the four sides. Use the following information.

$P_s = 230$ N/mm²
$P_{cb} = 7$ N/mm²

Loading:
Imposed load = 2.5 kN/m2
Finishes = 0.8 kN/m2
Unit weight of concrete = 24 kN/m3. (17 marks)

3. Using the three moments theorem, analyse the beam shown in **figure 2**. Plot the shear force and bending moment diagrams indicating values at critical points. (20 marks)

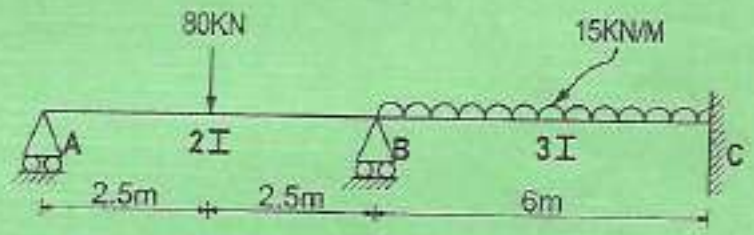

FIGURE 2

4. (a) A steel beam of hollow circular cross-section is of external diameter 300 mm and intend diameter 200 mm. The beam is simply supported on a span of 5.5 m. If the bending stress in the beam is not to exceed 20 N/mm², determine the safe uniformly distributed load that the beam can carry. (8 marks)

(b) **Figure 3** shows a loaded cantilever truss. Using the method of joint resolution, determine the forces in all the members. (12 marks)

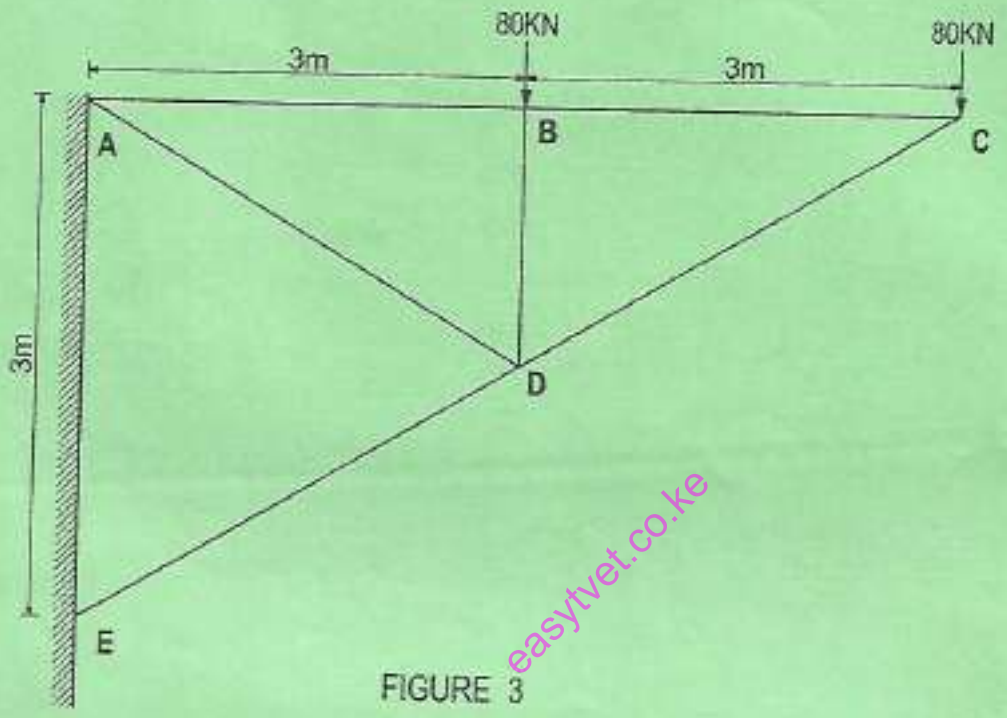

FIGURE 3

5. (a) Using Macaulay's method, determine the slope and deflection at points B and C in terms of EI in the beam shown in **figure 4**. (10 marks)

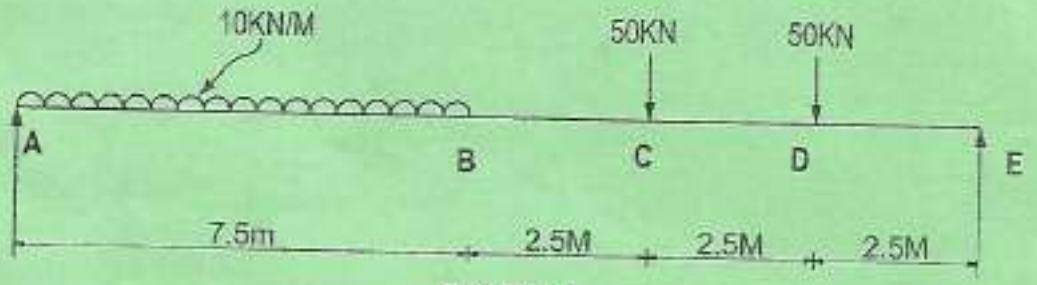

FIGURE 4

(b) **Figure 5** shows a beam section which is subjected to a shear force of 120 kN. Plot the horizontal shear stress distribution diagram across the section indicating values at critical points. (10 marks)

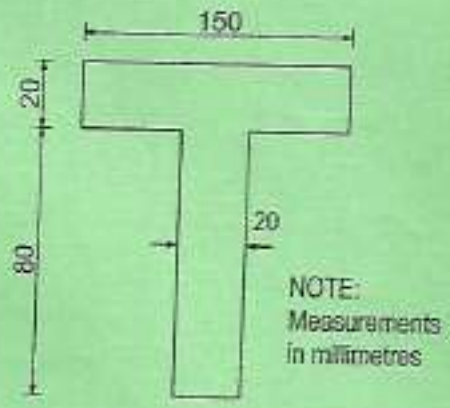

FIGURE 5

6. (a) Define the following terms as applied to structural timber:

(i) basic stress;
(ii) grade stress;
(iii) modification factors;
(iv) permissible stress. (4 marks)

(b) A suspended timber floor of tongue and groove boarding is supported on timber joists spaced at 550 mm centres. The joists are supported on 200 mm thick wall over a clear span of 4.4 m. Design the joist for flexure using class C22 timber and check for shear bearing and deflection given the following information.

Loading:

Dead load due to T&G boarding	=	0.08 kN/m²
Imposed loads	=	1.8 kN/m²
Dead load due to beam's self weight	=	0.1 kN/m
Permissible deflection	=	span / 300
Duration of loading		
Bearing length	=	150 mm

Assume any other information not given. (16 marks)

7. (a) Sketch **three** sections used in stanchion design. (6 marks)

(b) **Figure 6** show the layout plan of a suspended reinforced concrete slab of effective dimensions 10 m x 8 m supported on universal beams. Design the beam marked X using UB section and check for shear and deflection given the following information.

Loading:

Line load	=	3.5 kN/m²
Partitions	=	1.2 kN/m²
Finishes	=	0.8 kN/m²

Slab thickness	=	150 mm
Unit weight of concrete	=	24 kN/m3
Allowable deflection	=	$\frac{1}{360}$ x span
P_{bc}	=	165 N/mm²
Allowable shear stress	=	100 N/mm²

(14 marks)

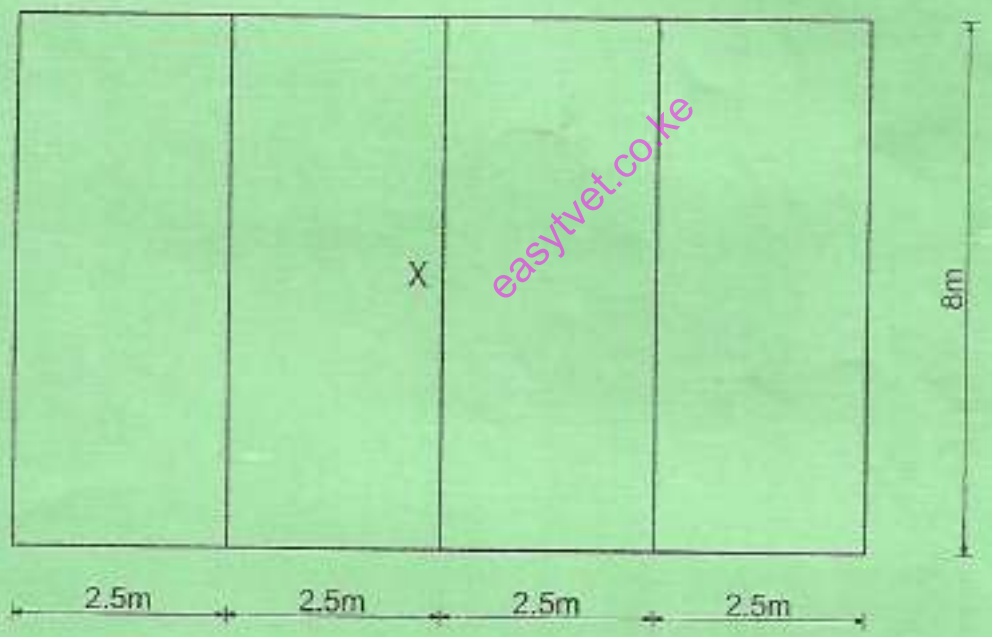

FIGURE 6

8. (a) With the aid of sketches, explain four modes of failure of bolted connections. (8 marks)

(b) A stanchion carries loads as shown in **figure 7**. Calculate the stresses at points A, B, C, D using the following properties of the section.

$A = 9290\ mm^2$
$Zxx = 894500\ mm^3$
$Zyy = 305000\ mm^3$

(12 marks)

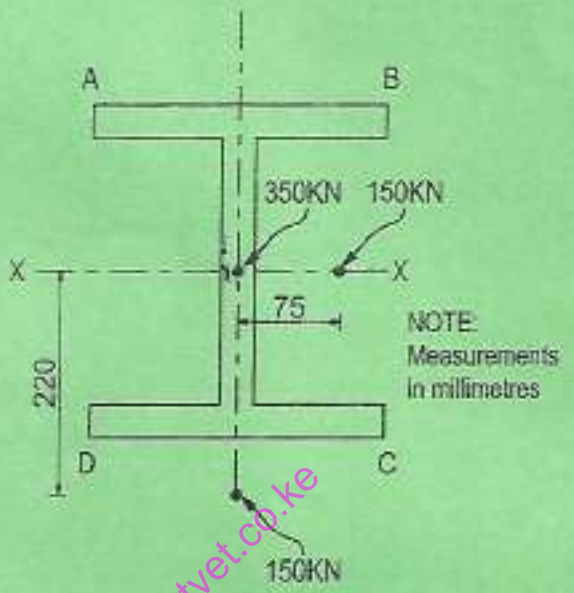

FIGURE 7