00272

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX4545/CVX4531/CEX4231 Structural Analysis and Design II**
Academic Year	: 2019/20
Date	: 29th July 2020
Time	: 0930-1230hrs

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Five (5)** pages.
3. Answer any **Five (5)** questions with at least **Two (2)** questions from Each Section. Necessary Extracts from BS 8110 will be provided separately.
4. Answer for each question should commence from a new page.
5. Relevant charts / codes are provided.
6. Closed Book Test **(CBT).**
7. Answers should be in clear hand writing.
8. Do not use red colour pen.

Section A – Structural Analysis

Q1.

(a) State two theorems of **Moment Area Method** using neat sketches. **(4 Marks)**

(b) A cantilevered beam (AB) is uniformly loaded as shown in Figure 1(a). Using **Moment Area Method**, determine the rotation and vertical deflection at end B of the beam. (EI is constant) **(6 Marks)**

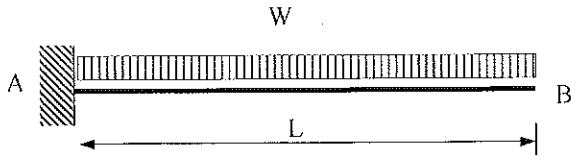

Figure 1(a)

(c) Using the **Theorem of Three Moments Equation**, analyse the continuous beam shown in Figure 1(b) and draw the bending moment diagram. (EI is constant) **(10 Marks)**

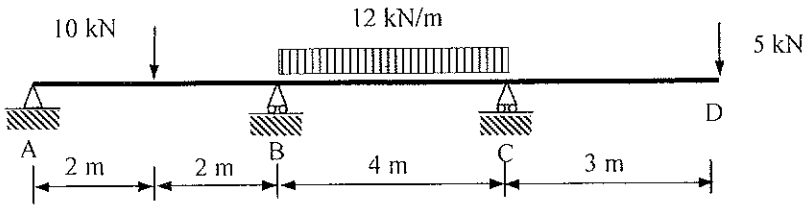

Figure (1b)

Q2.

(a) A fixed end beam (AB) is shown in Figure (2a). If the support B settles down by Δ amount, obtain the resulting bending moments at both ends. Flexural rigidity of the beam is EI. (Hint: You may use Moment Area Method). **(8 Marks)**

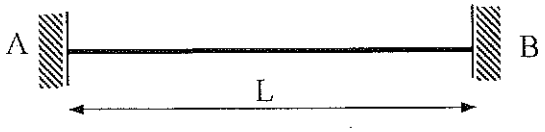

Figure 2(a)

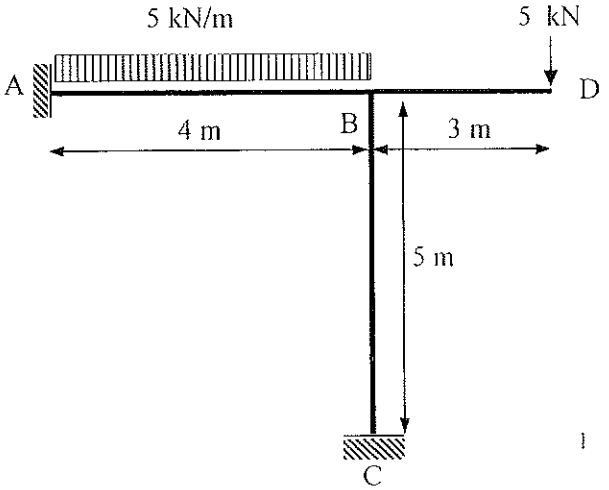

Figure 2(b)

(b) A non-sway frame is shown in Figure 2(b). Second moment of area of the member AB is twice than that of the member BC. Using **Slope Deflection Equations,** analyse the frame and draw the bending moment diagram. **(12 Marks)**

Q3.

(a) Describe following terms used in the **Moment Distribution Method**.

(i) Stiffness factor

(ii) Distribution factor

(iii) Carry over factor **(6 Marks)**

(b) A portal frame structure is loaded as shown in Figure 3. Analyse the structure using **Moment Distribution Method** and draw the bending moment diagram. Second moments of area of members are shown close to respective members in Figure. **(14 Marks)**.

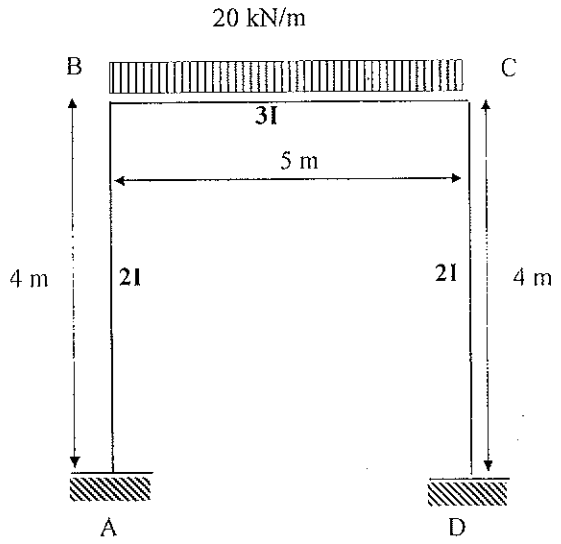

Figure 3

Q4.

(a) State two Castigliano's Theorems. **(6 Marks)**

(b) A cantilevered beam is loaded with **distributed load W** and **central point load P** as shown in Figure 4. Using **Castigliano's first theorem**, determine the rotation and vertical deflection at end B of the beam. **(14 Marks)**

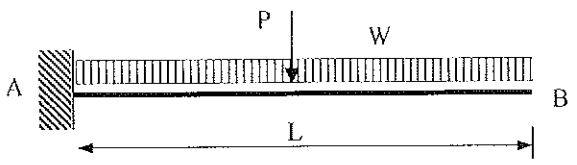

Figure 4

Section B –Design of Structures

All designs are to be done according to the recommendations of the Standard BS8110. For Questions 5, 6 and 7 use data and parameters pertaining to the following structure.

A three storey science laboratory is proposed to be constructed in a school located in Western Province. The design structural engineer has decided on framed reinforced concrete building. Exterior walls which are capable of resisting lateral loads are to be made with masonry block walls. Column and beam arrangement at the first and second floor levels is shown in Figure 5(a). Side elevation of the building is shown in Figure 5(b).

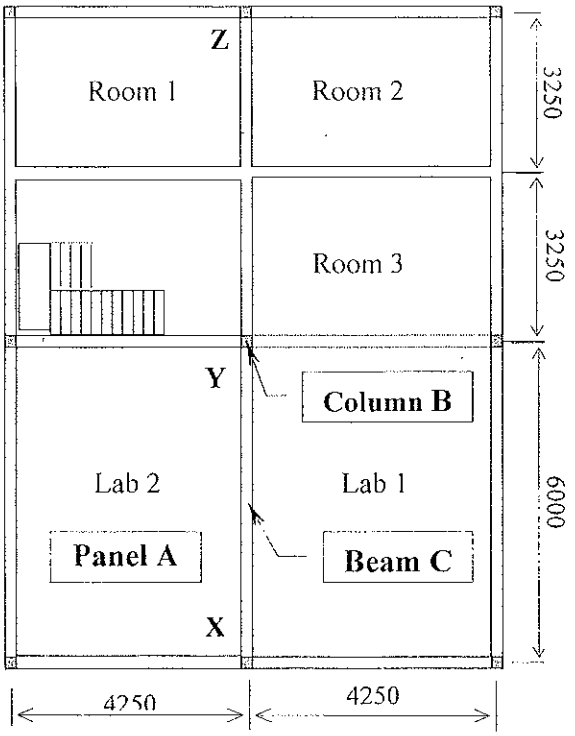

Figure 5(a) Plan of an upper floor slab

Notes:

* All walls are to be of 150 mm thick hollow block masonry.
* Slab is to be 125 mm thick.
* All longitudinal beams are to be 300 x 225, while transverse beams are to be 225 x 225.
* Column positions are as indicated in the plan.
* Columns are to be 150 mm square.
* Beams monolithic with the upper floor slab are to be cast over all walls.
* Roof load is transferred by 9 columns.
* Wall loads may be assumed to be transferred directly down.

All Dimensions are in 'mm'

Material and Load Properties:

Concrete grade - C30
Grade of Steel fy HT steel - 460 N/mm^2
MS - 250 N/mm^2

Unit weight of concrete - 24 kN/m^3
Unit weight of block masonry – 18 kN/m^3
Dead load by floor finishes - 0.5 kN/m^2
Dead load by the roof - 1.0 kN/m^2
Imposed load on floors- 4.0 kN/m^2
Exposure condition - mild
Fire protection required - 1 hr

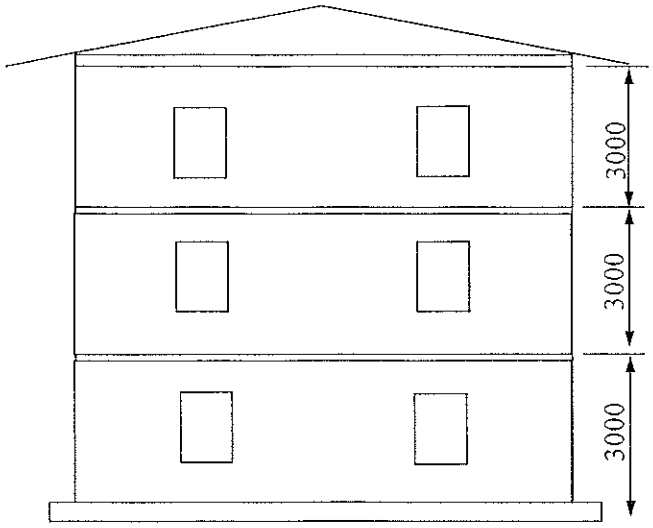

Figure 5(b) Side elevation

Q5. Using given data, design the **Panel A**, of the second floor assuming all loads are uniformly distributed. Follow the design steps given below.

(a) Decide on **nominal cover** for SLS durability and SLS fire resistance, calculate **characteristic** (dead and imposed loads due to nominal loads) and **design load** on the panel as area loads. **(2 Marks)**

(b) Identify the span conditions, end conditions and evaluate appropriate mid pan and over the support moments for **ULS of flexure**. You may use the factors from Table given in the handout. **(5 Marks)**

(c) Design reinforcement against **ULS of flexure** to resist the bending moments at mid spans and over supports for the slab panel. (You may use 10 mm HYS for main reinforcements). **(5 Marks)**

(d) Check against **SLS of deflection** for the slab panel and if necessary, propose suitable modifications. **(4 Marks)**

(e) Sketch the reinforcement arrangement on a plan and one cross section of the slab panel using the **standard method of detailing**. (Not necessary to indicate curtailment lengths) **(4 Marks)**

Q6. Using data given pertaining to the structure given above, design the **Beam C (XYZ)** (there are no walls along the beam), and following the steps (assume that effective beam section is rectangular and all loads are transferred to the beam are uniformly distributed).

(a) Evaluate the **characteristic dead and imposed loads** transferred on to the beam and the maximum **design load** as linear loads. **(2 Marks)**

(b) Calculate design bending moments and shear forces at the mid spans and support sections of the beam and sketch **bending moment** and **shear force diagrams**. **(5 Marks)**

(c) Design reinforcement for **ULS of flexure** at the critical sections (support and mid spans) of the beam. **(4 Marks)**

(d) Check for **ULS of shear** at critical sections of the beam and provide shear reinforcements of necessary. (You may assume two or four legged 6mm MS shear stirrups) **(5 Marks)**

(e) Check against **SLS of deflection** of the beam based on conditions at the mid spans. Only propose modifications if this check fails. **(4 Marks)**

Q7. Using the data pertaining to the structure given above, design the **Column Segment** from 1st floor to 2nd floor at location C, along the following steps,

(a) Determine the **type** of the column segment (braced/unbraced) about its two principal axes of the bending and state your reasons for such selection. **(2 Marks)**

(b) Evaluate the **effective heights** and the **slenderness ratios** of the column segment and determine the slenderness condition (short/slender), about both principal axes. Give logical reasons. **(4 Marks)**

(c) Evaluate the **characteristic loads** and calculate **design axial loads** and **design axial bending moments** (If any) acting on the column segment. You should pay due consideration to the moments created by eccentricity of loading and possibility of slenderness buckling in evaluating these values. **(4 Marks)**

(d) Determine the column reinforcement against **ULS of Compression and flexure** and shear links arrangement. **(6 Marks)**

(e) Produce a detailed reinforcement **sketch** with column in elevation and required cross sections, using the standard method of detailing. **(4 Marks)**