Ref. No. Ex/CE/5/T/206/2023

B.E. (CIVIL ENGINEERING) SECOND YEAR SECOND SEMESTER EXAM 2023

Subject: THEORY OF STRUCTURES - I

Time: Three hours **Full Marks: 100**

No. of Questions		Marks

Answer any four questions

Q1. A cantilever beam of span of **1.5m** is subjected to one concentrated load of magnitude **5N** acting vertically downward along the centroidal plane of the beam. The '**Z-shaped cross-section**' of the beam (shown in Fig. 1) has the following dimensions: width = **60mm.**, depth = **120mm.**, thickness of flange and web = **8mm**. Calculate [25]

i) the angle of inclination of principal axes and principal moments of inertia

ii) the net vertical and horizontal deflections of the beam at free end if E = $2x10^5$ N/mm^2 and

iii) the stress developed at points P_1 and P_2 (shown in Fig.1) of the cross-section at fixed end.

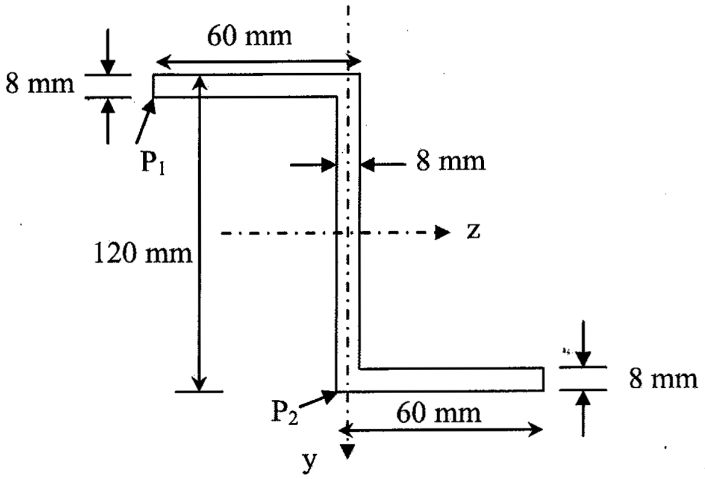

Fig. 1

Q2. Analyse the continuous beam **ABCD** as shown in Fig.2 by using '**Three Moment Theorem**' and calculate the support reactions. Also draw the bending moment diagram and shear force diagram for this beam. [25]

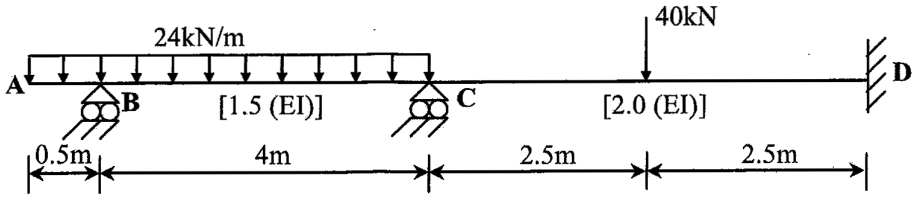

Fig. 2

(Contd. to page 2)

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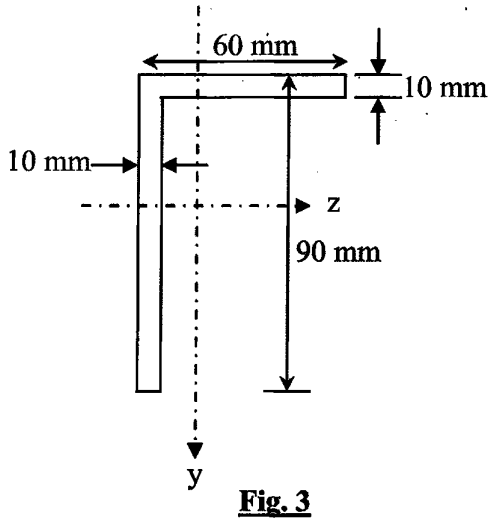
No. of Questions		Marks
	(Contd. from page 1)	
Q3.	a) Define **'kern area' or 'core area'** of short column. b) Derive the **'kern area' or 'core area'** of a **hollow circular cross section** of a short column. The hollow circular cross section has **external diameter = 120mm** and the **thickness = 15mm.** c) Calculate the failure load of a column of length **3.0m** and having **'angle-shaped cross-section'** as shown in Fig.3 if both ends of the column are **fixed.** Consider $E=2x10^5$ N/mm^2 and $f_y = 250$N/mm^2. Apply Euler's column theory, if required.  **Fig. 3**	[3+10 +12 = 25]
Q4.	a) A column **2.5m long** of **hollow rectangular** cross section of **external dimensions 400mm x 300mm** and uniform **thickness of 20mm** is **hinged at both the ends.** The column carries an axial **compressive load of 75kN** at an **eccentricity of 25mm** from the axis of the column. Considering 'Secant Formula', find the maximum and minimum stress developed in the cross-section of column. Consider $E=2x10^5$ N/mm^2. Also find the maximum eccentricity in order to have no tension anywhere in the cross-section. (Contd. to page 3)	[12+13 = 25]

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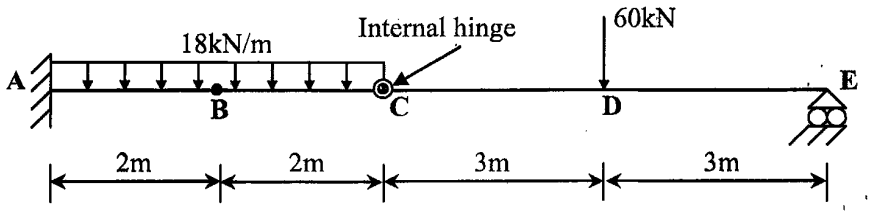
No. of Questions		Marks
	(Contd. from page 2)	
Q4. (contd.)	b) Draw the **influence line diagram** for the support reactions (R_A **and** R_E), shear force (V_B) and bending moments (M_A **and** M_B) of the propped cantilever beam AE as shown in Fig.4. There is an **internal hinge at point C** as shown in figure. Using these influence line diagrams, find the magnitude of above mentioned forces and moments i.e. R_A, R_E, V_B, M_A **and** M_B caused by the given set of non-moving loads as shown in Fig.4.  **Fig. 4**	
Q5.	a) What are the principal axes of the cross-section? How is 'unsymmetrical bending of beam' related with principal axes of the cross-section of beam? b) Why does the bending of beams of circular cross-section always become 'symmetrical' in nature? c) What is the minimum number of spans of the beam required for the analysis of the beam by "Three moment theorem"? d) Write the assumptions in Euler's buckling theory of column. e) Plot the buckled shape of ideal **fixed-free** slender column for 1st mode and 2nd mode of buckling and write the critical loads for that. f) What is 'influence line diagram'? What are uses of this diagram?	[6+2+ 2+6+6 +3 = 25]

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