Ref. No. Ex/CE/5/T/206/2022

B.E. (CIVIL ENGINEERING) SECOND YEAR SECOND SEMESTER EXAM 2022

Subject: THEORY OF STRUCTURES - I

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

No. of Questions		Marks
	Answer any four questions	
Q1.	A simply supported beam of span of **2.4m** is subjected to uniformly distributed load of intensity **1.5N/m** acting vertically downward along the centroidal plane of the beam. The **angle-shaped cross-section** of the beam (shown in Fig. 1) has the following dimensions: width = **80mm.**, depth = **100mm.**, thickness of flange and web = **10mm.** Calculate i) the angle of inclination of principal axes and principal moments of inertia ii) the net vertical and horizontal deflections of the beam at mid-span if E = 2×10^5 N/mm^2 and iii) the stress developed at points P_1 and P_2 (shown in Fig.1) of the cross-section at mid-span.	[25]
Q2.	Analyse the continuous beam **ABC** 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]

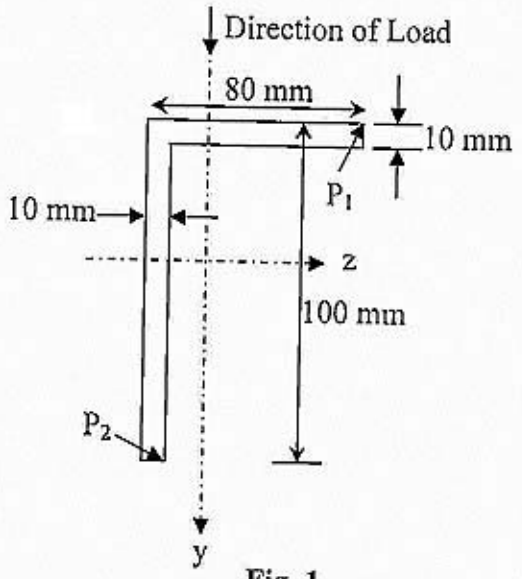

Fig. 1

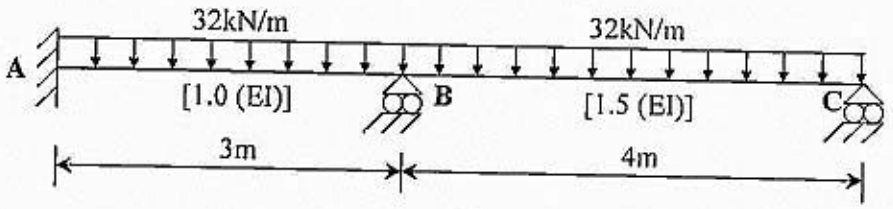

Fig. 2

(Contd. to page 2)

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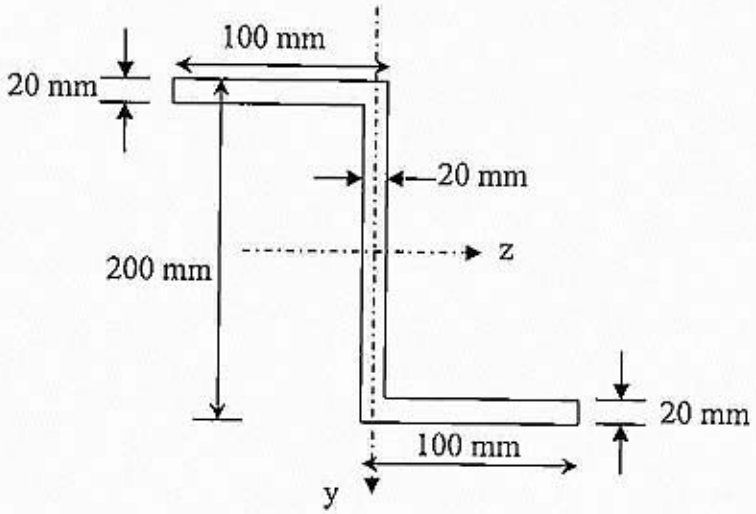
No. of Questions		Marks
	(Contd. from page 1)	
Q3.	a) Define **'kern area' or 'core area'** of short column. b) Derive the **'kern area' or 'core area'** of a **hollow rectangular cross section** (having the following dimensions) of a short column. The **external dimensions** of hollow rectangular cross section are **200mm x 150mm**. The **thickness** of hollow rectangular cross section is **10mm** everywhere. c) Calculate the failure load of a column of length **2.0m** and having **'Z-shaped cross-section'** as shown in Fig.3 if both ends of the column are hinged. Consider $E=2\times10^5$ N/mm^2 and $f_y = 250N/mm^2$. Apply Euler's column theory, if required.	[3+10 +12 = 25]
	 **Fig. 3**	
Q4.	a) A column **3m long** of solid circular cross section with **400mm diameter** is **hinged at both the ends.** The column carries an axial **compressive load of 100kN** at an **eccentricity of 15mm** from the axis of the column. Considering 'Secant Formula', find the maximum and minimum stress developed in the cross-section of column. Consider $E=2\times10^5$ N/mm^2. Also find the maximum eccentricity in order to have no tension anywhere in the cross-section.	[12+13 = 25]
	(Contd. to page 3)	

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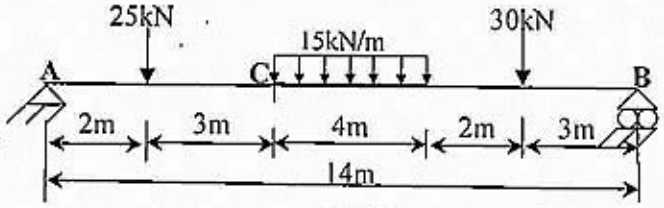
No. of Questions		Marks
	(Contd. from page 2)	
Q4. (contd.)	b) Draw the **influence line diagram** for the support reactions (R_A **and** R_B), shear force (V_C) and bending moment (M_C) at the section C located at the distance **5m** from left end A of the simply supported beam AB of **span 14m**. Using these influence line diagrams, find the magnitude of shear force (V_C) and bending moment (M_C) caused by the given set of non-moving loads as shown in Fig.4.  **Fig.4**	
Q5.	a) What do you mean by 'unsymmetrical bending of beams'? When does it occur? b) "Three moment theorem' is related to the 'statical indeterminancy' of the structure." – Justify. c) Draw 'Euler's column buckling' curve for a slender column. Why it is not applicable for columns having low slenderness ratio? d) Plot the buckled shape of ideal pinned end slender column for 1st mode and 2nd mode of buckling and write the critical loads for that. Mention the utility of the critical load corresponding to 2nd mode of buckling of slender column. e) What do you mean by effective length of column? Write the effective length of column of physical length 'L' if it is hinged at one end and fixed at other end. f) What is 'influence line diagram'? Write some applications of this diagram. = = = E N D = = =	[4+2+ 5+7+4 +3 = 25]