Ref. No. ***Ex/PG/CIV/PC/T/112B/2025***

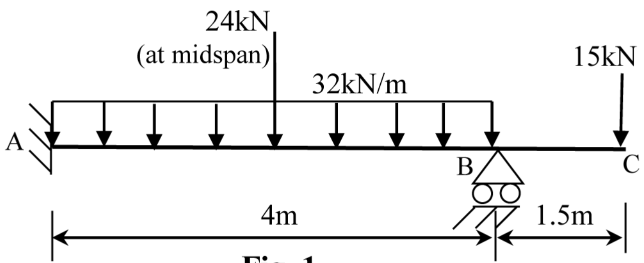
M. E. CIVIL ENGINEERING 1ST YEAR 1ST SEMESTER … EXAMINATION, ***2025***

SUBJECT … ***COMPUTATIONAL METHODS & FINITE ELEMENT ANALYSIS***…

Full Marks 100
(40 marks for this part)

Time: **Three hours**

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
	Answer Q.1 and any ONE questions from the rest	
1. [CO:1]	Analyse the beam ABC as shown in Fig.1 by '**Stiffness Method**' assuming that support **B** *settles down* by **1.0mm**. Also calculate the support reactions and draw BMD and SFD. Given, $E = 200 \times 10^6$ kN/m^2, $I = 350 \times 10^{-6}$ m^4.  **Fig. 1**	[20]
2. [CO:3]	a) Derive the shape functions for a **two-noded** one dimensional element of length 'L' in Cartesian coordinate system. b) Using these shape functions, derive the stiffness matrix of an one dimensional **two-noded** element of length 'L' if it is used in 'uniaxial problem'. Assume relevant data. c) A bar of length 'L', cross-sectional area 'A' is suspended from the top and subjected to an axial load 'P' at the free end at bottom. Determine the end deformation, strain and stress developed in the bar considering **the external load and its self-weight**. Discretize the bar using a **single three-noded one dimensional element**. Assume any other data, if required.	[2+5+13 = 20]

[Turn over

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SUBJECT … ***COMPUTATIONAL METHODS & FINITE ELEMENT ANALYSIS*** …

Full Marks 100
(40 marks for this part)

Time: **Three hours**

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
3. [CO:3]	a) Derive the shape functions for a **three-noded triangular element** having the coordinates of the vertices as **(9,4)**, **(12,4)** and **(12,8)**. All values are in mm. b) Using these shape functions, form the **strain-displacement matrix** for the above element having two degrees of freedom (u,v) per node in '**plane-stress condition**'. c) Form the **constitutive relationship matrix** of this element if it is used in '**plane-stress condition**'. Consider $\mathbf{E = 2.1x10^5\ N/mm^2}$ and $\boldsymbol{\nu = 0.2}$. Assume any other relevant data, if required. d) Write the properties of shape functions of **three-noded triangular element**. Why is this element named as 'constant strain triangular (CST) element'?	[10+5 +2+3 = 20]
4. [CO:3]	a) What is the utility of shape functions in finite element analysis? b) Write short note on 'importance of natural coordinate system' in finite element analysis. c) Write the difference among isoparametric, sub-parametric and super-parametric finite element formulation. d) Using the basic properties of the shape functions, derive the shape functions of **four-noded rectangular element** in '**natural coordinate system**'. e) Using the shape functions of above-mentioned four-noded element, calculate the elements of the '***Jacobian matrix***' of a **four-noded 'quadrilateral element'** having the nodal coordinates **(2,5)**, **(9,4)**, **(7,10)**, and **(1,8)** [All values are in mm] to be used in plane stress condition.	[2+3+ 3+4+8 = 20]

Ref.: Ex/PG/CIV/PC/T/112B/2025

M.C.E. 1ST YEAR1ST SEMESTER EXAM 2025
SUBJECT: Computer Methods and Finite Element Analysis
Full Marks 100
(30 marks for part II)

No. of Question	PART – II	No.
	Questions 1 and 4 are compulsory.	
1. a)	Compare between weighted residual method and variational method.	
b)	Write advantage of Boundary Element Method over Finite Element Method.	
c)	Derive the governing differential equation for a steady state heat conduction problem. [CO1]	4+3+3
2.	Obtain approximate deflection at the free end of a cantilever beam of length L, subjected to a concentrated load P using the Ritz method. The governing differential equation is [CO2] $$EI\frac{d^4y}{dx^4} = 0$$	10
	OR	
3.	Obtain the approximate solution to the following problem using the Method of lease square and collocation method using quadratic trial solution. [CO2] $$\frac{d^2y}{dx^2} + x^2 = 0$$ Given boundary conditions, $y(0) = 0; \frac{dy}{dx} + 2y = 1$ at $x=1$.	10
4.	The inside of a 1.0m thick wall is maintained at a constant temperature 250° C, while the outside is insulated. There is a uniform heat source inside generating 500W/m^3. The thermal conductivity K=25.0W/m-°C. Find the temperature distribution at 1/3rd points in the wall. [CO3]	10

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Ref. No. : Ex/PG/CIV/PC/T/112B/2025

M.E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER EXAMINATION 2025

SUB: COMPUTATIONAL METHODS & FINITE ELEMENT ANALYSIS (PART-III)

Total Time: Three Hours | Full Marks: 100 (40+30+30)

Part – III (30 Marks)

1.	**(a)** List the different methods used to model the interface element. **(b)** Describe in detail the methodology for determining the stiffness matrix of the interface element using the oldest method. **(c)** State the limitations of the above method. **(d)** Write the stress-strain relationship for joint element. Describe how the value of the constitutive matrix is assigned/determined in modeling the joint element.	1+7+2+5 **[CO4]**
2.	**(a)** What is roll of mapping function and shape function in determining the stiffness matrix of an infinite element? **(b)** Derive the mapping function for a 4-nodded quadrilateral element. **(c)** Write true or false and justify your claim. i. The stiffness matrix of an infinite element will be higher than that of similar sized finite element. ii. The nodal variable of the node situated at infinite distance can easily be determined using mapped infinite element. iii. The self-weight of an infinite element should always be less than that of finite element.	2+5+3 **[CO4]**
3.	For two-point Gauss-Quadrature determine the locations and its corresponding weight factors.	5 **[CO3]**