BIRLA INSTITUTE OF TECHONOLOGY AND SCIENCE, PILANI

First Semester (2023-2024), Comprehensive Examination

Course: Finite Element Analysis (CE G619)

Date: 15^{th} Dec. 2023 | Total Marks: 80 | Duration: 2:00PM-5:00PM

Q.1. Derive the two coupled differential equations of bending of beam with first order shear deformation theory (FSDT) as shown below. Solve these equations by (i) Collocation method, (ii) Galerkin method and (iii) Ritz method. Take q=1.0. [30]

$$\frac{d}{dx}\left[Gk_sA\left(\theta_x+\frac{dw}{dx}\right)\right]+q=0 \qquad (1)$$

$$\frac{d}{dx}\left[EI\left(\frac{d\theta_x}{dx}\right)\right]-Gk_sA\left(\theta_x+\frac{dw}{dx}\right)=0 \qquad (2)$$

The domain is $(0<x<1)$ and the boundary conditions (simply supported beam) for w and θ_x are,

$w(0)=w(1)=0$ (BC in terms of w)

$\theta_x\,(0.5)=0,\quad \left.\frac{d\theta_x}{dx}\right|_{x=0}=0$ and $\left.\frac{d\theta_x}{dx}\right|_{x=1}=0$ (BC in terms of θ_x)

Solve, these equations, taking 1-parameter solution for w and θ_x, as $w=C_1\emptyset_1$ and $\theta_x=C_2\emptyset_2$.
Determine $\emptyset_1$ considering BC for w and determine $\emptyset_2$ considering BC for θ_x. Take $\emptyset_1$ as the weighting function for Eq.(1) and $\emptyset_2$ as the weighting function for Eq.(2). The collocation point for both Eq. (1) and Eq. (2) is $x=0.5$.

Report, w at $x=0.5$ and report θ_x at $x=0$ and $x=1$ for all methods.

Q.2. Find the value of the following integration by exact method. Find the full value and reduced value of the integration by Gaussian-Quadrature method also. [15]

$$\int_0^5(0.01x^3-0.7x^2+10)\,dx$$

Q.3. A rectangular plain-strain sheet ABCD with thickness of 0.015m along with loading is shown in **Fig.1**. Taking E=70GPa and ν=0.3 find the displacements. The displacement along horizontal direction is restricted at point B and both horizontal and vertical displacements are restricted along AD. Take two 2-D linear triangular elements as marked in the **Fig.1** to solve. [20]

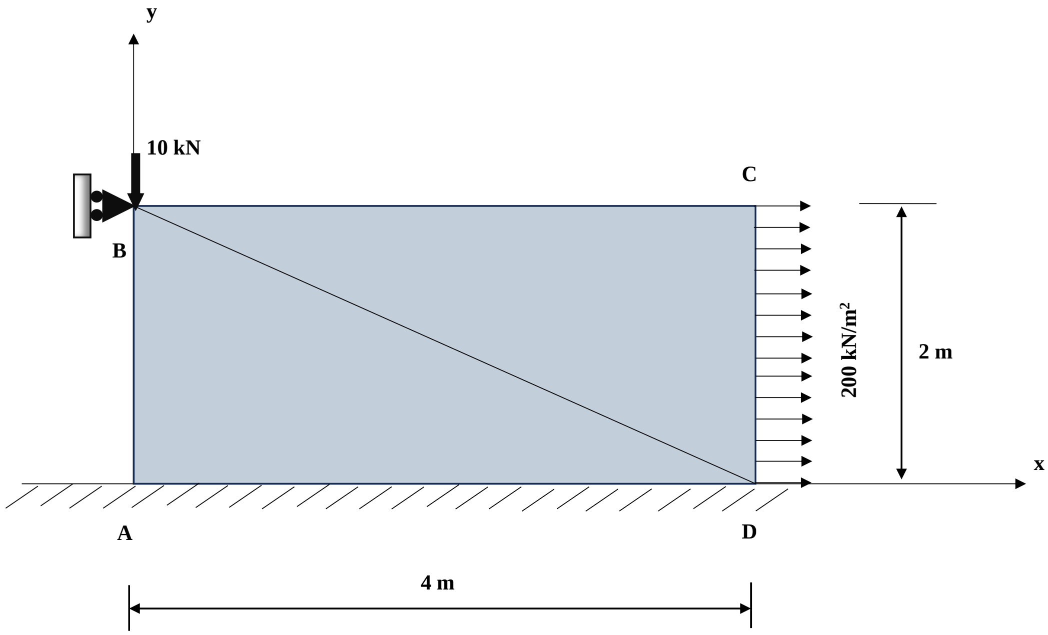

Fig.1 Rectangular sheet

Q.4. A bar shown in **Fig.2** is subjected to a distributed body force in the portion AB only. The bar is restricted on both the ends A and C. Taking E=70GPa and A=0.0004m^2 find the displacement at B and reactions at A and C. Derive the equilibrium equation of the element using isoparametric formulation. [15]

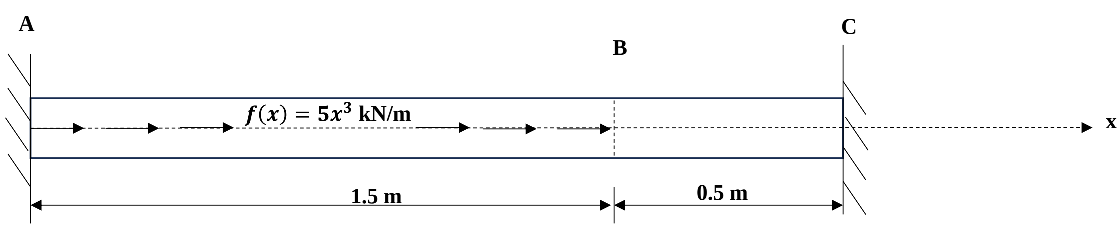

Fig.2 Bar subjected to distributed body force in portion AB