ME311 FINITE ELEMENT METHOD July -December 2025

Assignment I Weighted Residual Methods and Ritz Method

Issued on: 30-07-2025 **Deadline:07-08-2025 in the regular class time**

Instructions

Each student should submit the assignment in the form of hardcopy and the submission should contain the following

- Step by step solution of the problem with manual calculation
- Print out of the CODE with the outputs as per the question
- Plots without proper caption, axes title, etc., will not be considered.

Problem 1:

Consider a differential equation given below which governs the axial deformation behaviour of a structural member subjected to self-weight. The limit varies between 0 to 1.

$$-\frac{d}{dx}\left[A(x)E\frac{du}{dx}\right] = \rho A(x)g$$

Boundary Condition 1: **u(0)=0** and **u(1)=0**

Boundary Condition 2**: u(0)=0** and **AE du/dx=0** at **x=1**

Assume that the cross-sectional area varies as **A(x) = 100(x^2-2x+1) mm^2;**

E=210 GPa; density = 7800 kg/m^3; g=9.81 m/s^2;

Solve the problem **manually** using

- Two point Collocation
- Method of Least Squares with TWO TERM approximation
- Galerkin approach with TWO TERM approximation
- Ritz method with TWO TERM approximation
- Write a **computer code** and **show the convergence** by using a greater number of points/terms in the above methods.

Plot the results on a same graph for each approach and compare the converged results in each method on a same graph.

Problem 2:

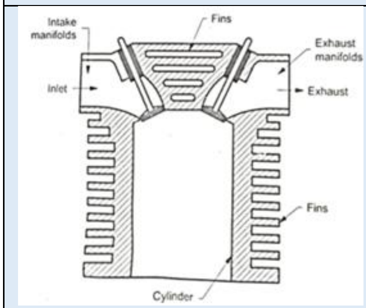
Consider a differential equation given below which governs the heat transfer through fin in an IC engine, a schematic diagram is given. Compare the temperature distribution through the fin for the fin with uniform cross-section, linearly decreasing cross-section, and quadratically decreasing cross-section.

$$-\frac{d}{dx}\left[kA(x)\frac{du}{dx}\right]+hP(x)(T-T_{\infty})=0; \quad 0<x<L$$

$$T(x=0)=100^{0}C \quad and \quad \left[kA\frac{dT}{dx}\right]_{x=L}=0$$

Assume

$$k=300\frac{W}{mC}; \quad h=100\frac{W}{m^{2}C}; \quad T_{\infty}=20^{0}C; L=100cm$$



Uniform square cross section:

$$A(x)=100mm^{2}$$

Linearly decreasing square cross-section:

$$A(x)=100\left[1-\left(\frac{x}{L}\right)\right]mm^{2}$$

Parabolically Decreasing square cross-section:

$$A(x)=100\left[\left(\frac{x}{L}\right)^{2}-2\left(\frac{x}{L}\right)+1\right]mm^{2}$$

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