Department of Applied Mechanics and Biomedical Engineering, Indian Institute of Technology, Madras.

Fundamentals of Finite Element Analysis (AM 5450)

Assignment 2 – Weighted Residual Methods – II and Energy Methods

Submission Date: 2 September 2024

Instructions:

I. Use scientific non-programmable calculator wherever necessary.

II. MATLAB/PYTHON/Python scripts used to prepare plots/figures/results should be attached with your answer.

III. Scan all the pages of your hand-written answers, MATLAB/PYTHON scripts, output results, and figures into a PDF file. Please upload your assignment in Google class room.

1) Consider a plate of length and width of 2 m each and thickness 1 mm. It is subjected to a vertical distributed load of $q = 50$ N/m^2. The bending stiffness of the plate D is given by $D = \frac{Et^3}{12(1-\nu^2)}$, where t is the thickness of the plate and ν is the Poisson's Ratio. The plate is made of aluminum and is simply supported on all the four edges. Use the following governing differential equation.

$$\frac{\partial^4 u}{\partial x^4} + \frac{2\,\partial^4 u}{\partial x^2\,\partial y^2} + \frac{\partial^4 u}{\partial y^4} + \frac{q}{D} = 0$$

a) Obtain the weak form of the governing equation using **Modified Galerkin's** and **Variational** Methods.

b) Write the boundary conditions for this problem. Assume a suitable trial function compatible with the weak form.

c) Determine the displacement field in the plate. Solve using MATLAB/PYTHON and plot the surface and contour plots for the displacement field.

2) Obtain the equivalent functional form $\delta\big(I(u)\big)$ for the following differential equations. Comment on the limitations to obtain the equivalent form.

$(a)\ \dfrac{d^2u}{dx^2} + f(x) = 0$ $\qquad$ $(b)\ \dfrac{d^3u}{dx^3} + 2u = x^2$