# Auckland University of Technology

# School of Engineering Computer and Mathematical Sciences

# Department of Mechanical Engineering

# ENME802 Computer Aided Engineering and Analysis 2025

## Project 1: Finite element analysis of Plane Frames

***Due Date: April 11, 2025 (By 5.00 pm)*** ***Weighting: 40%***

### *1. Project description*

Work in groups of three or four and develop a general-purpose Finite Element Program using MATLAB for solving Rigid Plane Frames. Use the FEA code given in the class for solving Pin-jointed Plane Truss problems and modify the same to implement the FEA models used for analysing rigid plane frames. **You must keep the original nomenclature of all variables such as N_nodes, N_element, ncon, etc the same**. Solve for the nodal forces, displacements, and reactions of the members of structures analysed. Use the example plane frame problems shown in Figures 1 to 4 as case studies and solve them using the program developed. Write a report explaining the critical aspects of the development of the code for the numerical implementation and comparing the results of at least one or two of the examples with those obtained by other methods.

### *2. Methodology*

1. Work in groups of four.
2. Use the MATLAB program developed in the class for the 2D trusses as the starting point
3. Make necessary changes to implement the algorithms for analysing the Rigid Plane Frames problems.
4. Develop the code further dividing into functions for specific tasks such as Pre-processor, Assembly, Solution and Postprocessor. **Do not change the names of the key program variables (such as N_nodes, N_element, ncon, etc., )** and keep them the same as used in the class. If any additional names are needed, you may choose appropriate names but following in similar lines.

5. Develop a user interface based on the GUI functions of MATLAB.
6. The GUI should allow the end user to build the data file containing the nodal coordinates, elemental connectivity's etc. Please note: The ease of using the program should reflect in the way the GUI is created. The efforts put in building an effective GUI that allows the end user to easily interact with the program for analysing different problems in rigid plane frames will be rewarded with better marks.
7. The shape of the initial frame must be displayed as the coordinate and connectivity data is provided. Try to improve this display by adding the display of force, moment, and displacement boundary conditions.
8. Also, develop an appropriate scheme to display the end results such as the deformed shape of the frame.
9. Solve the Rigid Frames problems given in Figures 1 to 4 at the end, with appropriate boundary conditions, using the MATLAB program generated.
10. Solve at least a couple of them by any other means and compare the results in the report.
11. Write individual reports discussing the methodology and comparing the results of the MATLAB code and the other methods used.

## *3. Submission*

Each group should **submit** a soft copy of the working program, with all functions and data structures together **by April 11, 2025, by 5.00 pm**. Individual reports have to be submitted through Turnitin on Canvas by the same date and time. A ***written test*** will be done commonly to all in the class in **Week 06 on Tuesday April 08, 2025**, in which a short questionnaire covering the essential elements of the Project 1 will be given to you to answer. I will also alert you during the regular teaching hours as to what aspects are likely to be included in this test. Any missing details, or other instructions as may be needed will be provided on an ongoing basis as part of the discussions in the teaching/tutorial sessions.

## *4. Assessment*

- Literature review, developing logical solutions for implementing the algorithms, and the analysis of rigid plane frames [5 Marks]
- MATLAB coding for the computational implementation of the FE algorithms of rigid plane frames [10 marks]

- GUI for inputting and manipulating data and graphical display of pre-processing and post-processing outcomes [10 marks]
- Individual report [5 marks]
- Written test [10 marks]

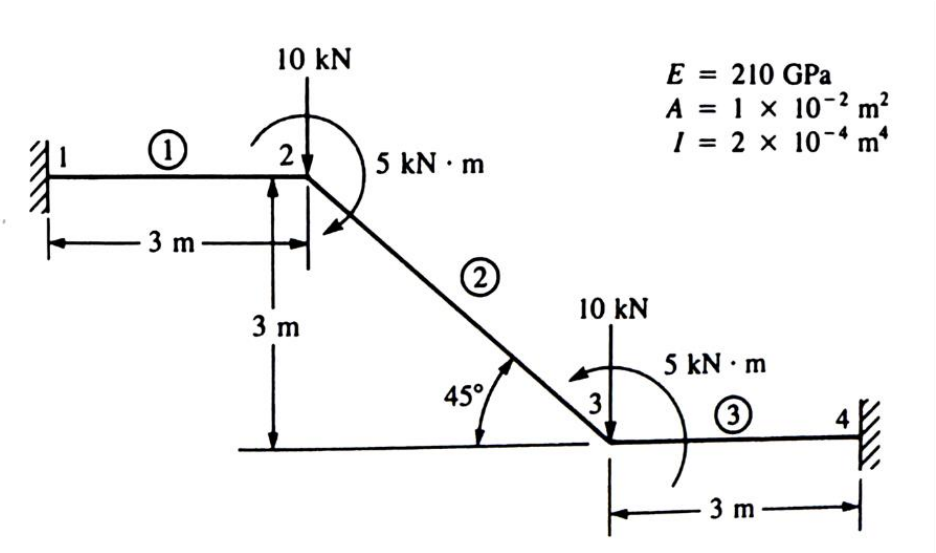


*Figure 1 Example Problem 01*

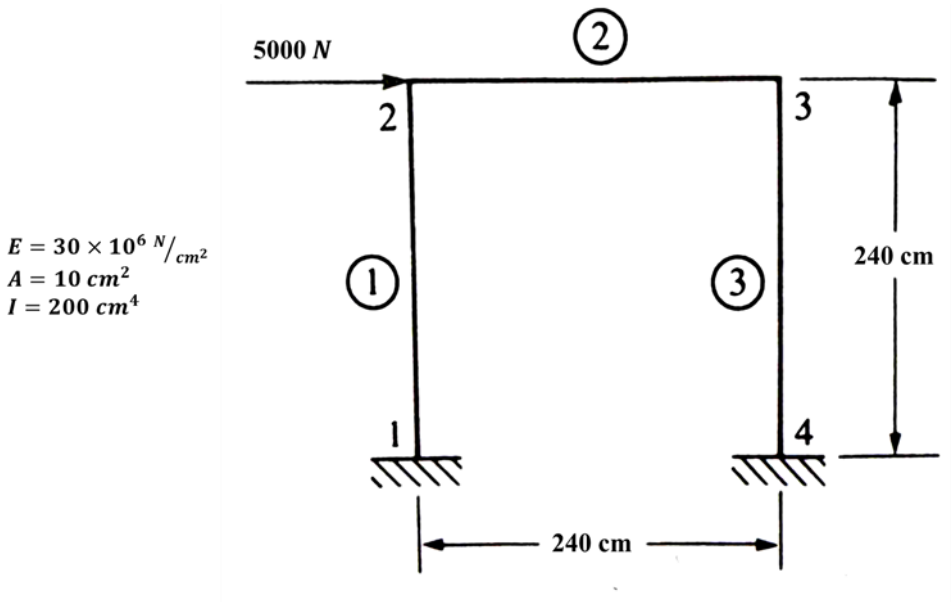


*Figure 2 Example Problem 02*

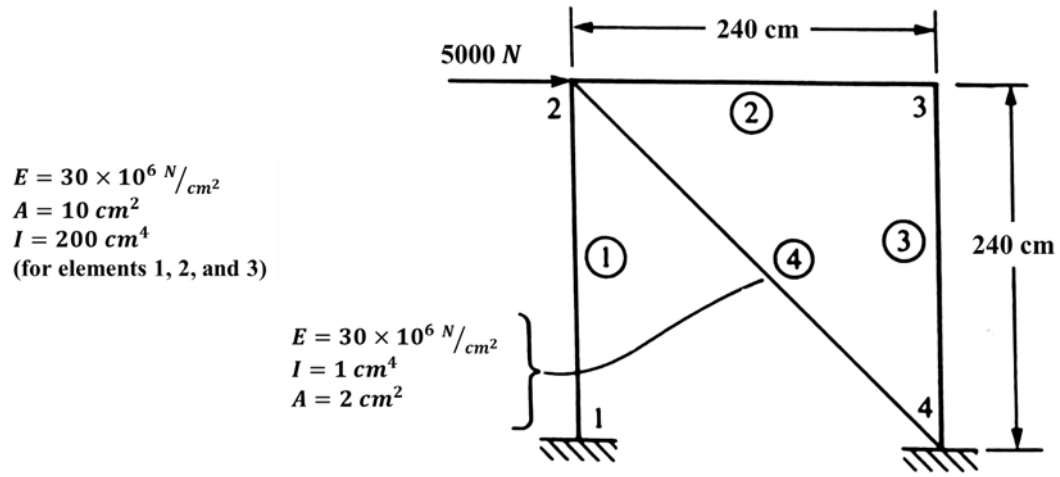


*Figure 3 Example Problem 03*

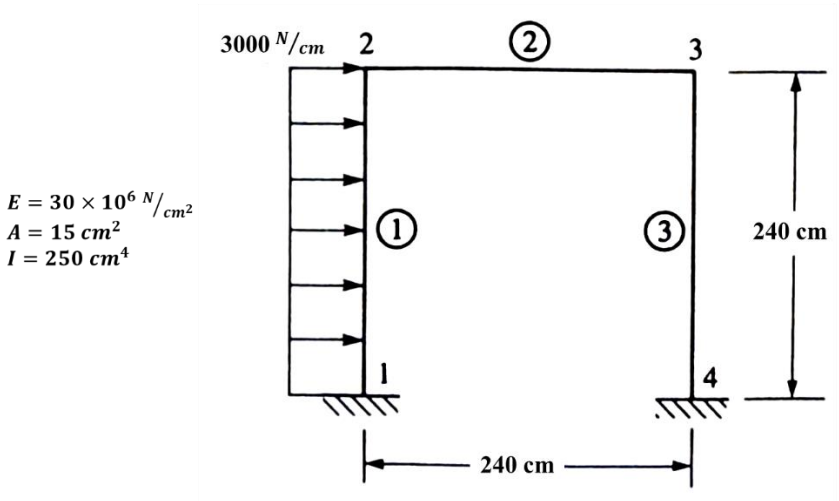


*Figure 4 Example Problem 04*