

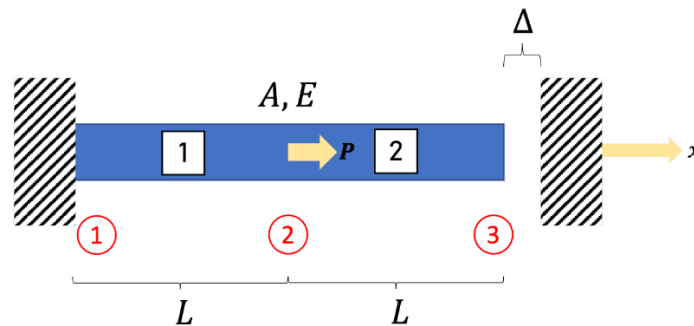


## Computer Lab 2: Axial Loading Analysis using the Finite Element Method (FEM)

Using the Finite Element formulation explained in document “FEM NOTES” develop a program that can solve a general problem of  $n$  bars and  $n+1$  nodes between two walls and find

- The support reaction forces at the two ends of the bar
- Internal forces at each element
- Stresses at each element
- Draw the internal axial force diagram (axial force vs.  $x$ )- this can be done by hand not necessarily with your program.
- Verify your code for the problem below and compare with FEM hand calculations

Verify your code with the problem shown below. It consists of 2 bars (elements) and 3 nodes. A load  $P$  is applied to node 2. Material properties, lengths, load and displacements are given.



Given:

- $A = 250 \text{ mm}^2$
- $L = 150 \text{ mm}$
- $E = 2.0 \times 10^4 \text{ N/mm}^2$
- $P = 6.0 \times 10^4 \text{ N}$
- $\Delta = 1.2 \text{ mm}$



## **MATLAB/PYTHON REPORT Rubric**

Create a code using MATLAB, Python, or other programming language that solves the general n bar problem and verify your code with manual calculations of the 2 bar problem. Present your findings in a TYPED report, which follows the format below. Take care to follow instructions for the report closely.

1. **Cover page and formatting:** Title, author, date, pages numbered. Include a separate title page with the information listed and be sure the report follows the formatting outlined here. Include a table of contents, along with a list of figures and list of tables at the beginning of the report. All figures and tables must be labeled, numbered, and referenced by number in the body of the report. **(5 points)**
2. **Problem statement:** Givens, unknowns, and sketches. This part must clearly define the problem to a reader who is not familiar with the project and should include any images or sketches necessary to explain the original problem. Feel free to use the image included with the original assignment but the explanation of the problem has to be in your own words. **(10 points)**
3. **Theory Manual:** Derive any equations/formulas you used, and number them for reference. Define your variables, draw free body diagrams of the global system and any “cuts” you make, and include anything else that is necessary to explain the solution method. **(20 points)**
  - a. Note that this is a typed report. **All equations and work must be typed and presented in a professional manner.** Hand-drawn figures are fine, provided they are neat and scanned clearly.
4. **Programmer manual:** Explain the logic of your code and the methods used to implement your solution. Things to include Table with variables used and their description, table of user-built functions used and their description, flowcharts, explanations of main program/subroutines, etc. **(10 points)**



5. **Results and Analysis:** Include output figures and calculation results, as well as commentary and physical meaning of results. This should include written explanation and commentary, not just tables or code output. Figures should be referenced and explained in the text as well as the numerical results. Include hand calculations to validate your program. **Use the Finite element method described on the notes document for your hand calculations. (55 points)**
6. **Appendix:** Copy and paste your code here.
7. **Deliverables:** Upload a pdf file and a .m or .py file.

**Other notes:** The best reports are not necessarily the longest; be clear and explain exactly what the reader needs to understand.