Department of Mechanical Engineering
Indian Institute of Technology Madras

Finite Element Analysis (ME5204)

A5 - Vector valued problem

Date: 4-Nov-2024 Maximum Marks: 50

General instructions:

- Typeset the assignment in LaTeX 2_ε or MS word
- Handwritten document will NOT be accepted unless the assignment specifies
- Upload the code and the report to Google classroom
- Do NOT upload zip files. If zip files are uploaded, the assignments will **NOT** be graded
- Report file name: Rollnumber_A#.pdf (# indicates assignment number)
- Other supporting files should be appropriately named
- Reports/codes found copied, will be assigned '0' marks

1. Despite the delay in submitting the report that details the temperature distribution in the campus, the concerned authorities were satisfied with the overall turn around. The authorities were also glad to see different choices of end conditions that influences the temperature distribution, which is vital to take decisions. Since you have done an extra-ordinary work, they decided to give additional task to you all ☺.

   Based on the consolidated report submitted by the ME5204 class representative to the intelligence unit, it is decided to make some precautionary measures on the D-day, like setting up perimeters, necessary scientific equipments to study the object and also measure the true intensity and the size. For this, a team led by Agent H (as he got time off from MCU), rookie Agent M and the authorities from the government agency are visiting IITM. Due to its sensitive nature, it is decided that they come by helicopter and use one of the water tanks inside IITM as a helipad[1]. They will be flown in from Tambaram air base using single engine light utility helicopter Chetak.

   Of all the available water tanks inside IITM, the intelligence unit here at IITM has zeroed in on two tanks, viz., one near the MSB and one near the Gymkhana as a potential landing spot. Your job as a finite element expert is to assess these two water tanks and identify the one which could be used as a helipad. For this you are required to carry out static and free vibration analysis of these two water tanks. The tasks involved include for both the tanks:

   1. Static analysis to estimate the displacement field and stress field in the tank
   2. Free vibration analysis and estimate the fundamental frequencies and mode shapes

   These tanks are typically symmetrical, and could be modelled as one dimensional domain, however, the course instructor insisted on doing it as a two dimensional problem. You are required to do the same **with and without the weight of the helicopter**. The report to include the following:

   1. Strong form of governing equations along with suitable boundary conditions. [2]
   2. Weak form along with identifying the bilinear/linear and boundary terms. [2]
   3. List of material properties used, include the sources. [2]
   4. Approach on getting the geometry and the mesh details. [2]
   5. Assumptions made along with justification. [5]
   6. Mesh convergence study for both static deflection and free vibration. [7]
   7. Report the location of the maximum stress and the first five fundamental frequencies. [5]
   8. Give a contour plot of displacement field (individual component and displacement magnitude), von-Mises equivalent stress. Note, contour plots to be in paraview. [10]
   9. Plot the first two mode shape of the tanks. [5]
   10. What is the impact on the maximum stress, first fundamental frequency and mode shape due to the helicopter. [5]
   11. Justify your choice of water tank, by taking into consideration the stress, accessibility to the spot, [5]

[1] could have used the Manohar Watsa Stadium, but course instructor ran out of options to give examples from within campus for vector valued problems ☻