Mid-Term Presentation

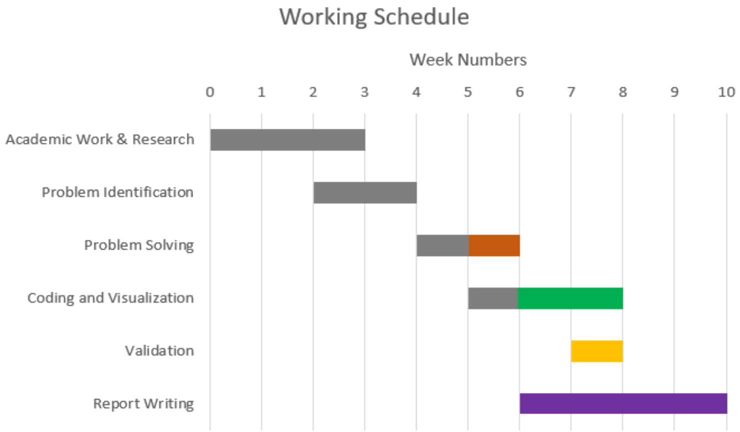
FEM and its application to static structures

Group A

Introduction

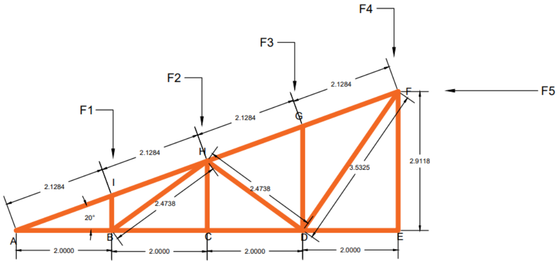
- Finite Element Method (FEM) is a procedure of numerical solution of a domain viewed as the collection of sub-domains.
- FEM on static structures computing the stress and displacement.
- The actual problem will be replaced by simpler ones to find one approximate solution.

Gantt Chart : Progress



Progress so far.

- **Problem Identification**
  Each member came up with various problems where FEM is used and we decided on trusses.



- **Theoretical Background**
  Went through basic ideas about FEM and the new concepts.

Progress so far.

- **Manual and Python Implementation**
  wrote custom classes and procedures for solving the problem in python. Tested code against examples in book and worked on debugging.

```
import math
import numpy as np
import copy
```

```
#import classes for nodes and elements
from node import node
from ele import ele
```

```
#define nodes along with boundary conditions
node1 = node(1,0,0,0,0,np.nan,np.nan)
node2 = node(2,2,0,0,0,np.nan,np.nan)
node3 = node(3,2,2,np.nan,np.nan,1,-2)
```

```
#define elements

ele1 = ele(1,1,1, 1 , 0 , 1 , 2)
ele2 = ele(2,1,1, 1 , math.pi / 2 , 2 , 3)
ele3 = ele(3,1*math.sqrt(2),1, 1, math.pi / 4 , 1 , 3)
```

```
#generating stiffness matrix for all elements

print(ele1.stiff())
print(ele2.stiff())
print(ele3.stiff())
```

```
[[ 1.  0. -1. -0.]
```

Verifying solution

In [15]:
```python
ans_dis = np.linalg.solve(GK_dis , f_dis)
ans_dis
```

Out[15]:
```
array([ 5.82842712, -3.        ])
```

Solution of the Finite Element Equations

Solving Eqs. (4.6.18) for U_5 and U_6, we obtain

$$\boxed{U_3 = (3 + 2\sqrt{2})\frac{PL}{EA} = 5.828\,\frac{PL}{EA}, \quad V_3 = -\frac{3PL}{EA}}$$

and the reaction forces are computed using Eq. (4.6.19)

$$F_{1x} = -P, \;\; F_{1y} = -P, \;\; F_{2x} = 0.0, \;\; F_{2y} = 3P$$

Progress so far.

- **Visualization**
  Worked on visualizing the structure and the deformations in python using the problem data and solution data.

Future Plans

Finalizing Implementation:

- The current version of implementation doesn't work for all cases.
- Determining edge cases and their debugging is needed.

Understanding Theoretical aspects:

- We have been learning the new concepts of FEM and will be getting much better understanding after we implement it ourselves.

Things left

Streamlining Procedure:

- Separate modules have been independently developed to deal with problem definition , solution and visualization
- The streamlining of all these components and compiling into one coherent module is needed.

Report Writing:

- Final report of the project is to be completed and proof read.

Thank You