me7120 Project 1

wright state university

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Students: Jeremy Geaslen, Mayank Patel, Mohammed Al Rifaie

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Professor: Dr. Joseph Slater

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# Problem Statement

## Finite element code

1. Write a general element code to generate the elemental stiffness and mass matrices for a single three-dimensional rod/torsion-rod/beam linearly tapered element for WFEM.
2. Write an additional routine that returns the coordinate transformation matrix.
3. Obtain the FE matrices (M and K) in global coordinates.
4. Write a subroutine to assemble these elements into the global matrix.

## code validation

Check your code by comparing the results of your code to that of ANSYS for a sufficiently complex problem. Be sure to do at least one mesh convergence study in addition to the following bench marks (See 3 below).

1. Static simple and complex (complicated)
2. Dynamic theoretical: compare to closed-form dynamic mode shapes and natural frequencies
3. Prove that choice of coordinate does not change your answers through rotating your problem a partial angle (less than 90 degrees in all three directions)
4. As least one dynamic case unique to your group validated against ANSYS

# Results and discussion

## Deflections of Uniform beam

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Elements | Closed form | Matlab code | ANSYS | % Error-Matlab | % Error-ANSYS |
| 1 | -1.920477e-04 m | -1.9205e-04 m | -1.568e-04 m | -0.0012 | 18.354 |
| 3 | -1.920477e-04 m | -1.9205e-04 m | -1.919e-04 m | -0.0012 | 0.0769 |
| 5 | -1.920477e-04 m | -1.9205e-04 m | -1.947e-04 m | -0.0012 | -1.3811 |
| 10 | -1.920477e-04 m | -1.9205e-04 m | -1.958e-4 m | -0.0012 | -1.9538 |

## Deflections of Tapered beam

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Elements | Closed form | Matlab code | ANSYS | % Error-Matlab | % Error-ANSYS |
| 1 | -3.854e-04 | -2.7282-04 m | -4.861e-04 m | -29.21 | -26.12 |
| 3 | -3.854e-04 | -3.6754e-04 m | -3.931e-04 m | 4.634 | -1.99 |
| 5 | -3.854e-04 | -3.780e-04 m | -3.8807e-04 m | 1.92 | -0.692 |
| 10 | -3.854e-04 | -3.8257e-04 m | -3.8645e-4 m | 0.734 | -0.272 |
| 20 | -3.854e-04 | -3.8372e-04 m | -3.9267e-04 m | 0.436 | -1.88 |

## Deflections of complex structure (crane)

|  |  |  |
| --- | --- | --- |
| Matlab code | ANSYS | % Error |
| -3.1388e-06 m | -3.087e-06 m | 1.65 |

# Appendix