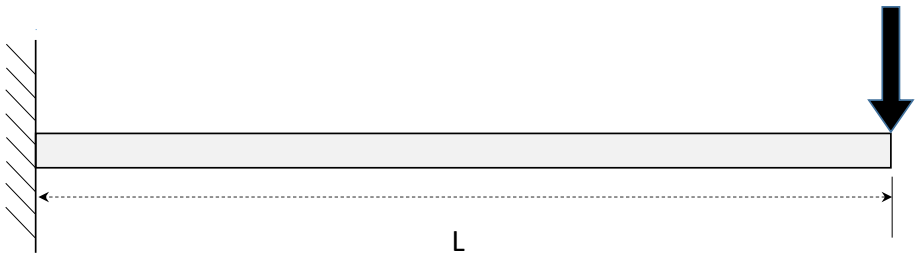
CE422

Finite Element Methods

Take Home Midterm Examination – October 26, 2021

This is your take home midterm examination. This is an open book / open notes examination. Of course, you must work alone and should not discuss the exam with anyone else. The exam is due Tuesday, November 2, 2021. If you have any questions, please contact me at any time. As this is a take home exam, there is no time limit other than the due date itself.

1) (20 points) A cantilever beam is subjected to a point load at the end of the Bernoulli-Euler, as illustrated below

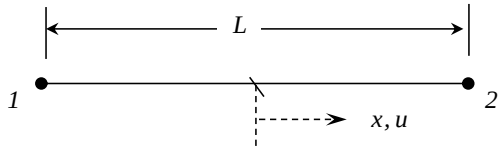


Find the deflection (i.e., displacement), rotation, moment, and shear for the linear elastic Bernoulli Euler beam using the Rayleigh Ritz method assuming a third degree polynomial.

2) (20 points) State the convergence criteria for the Rayleigh-Ritz Method and how it relates to the Finite Element Method.

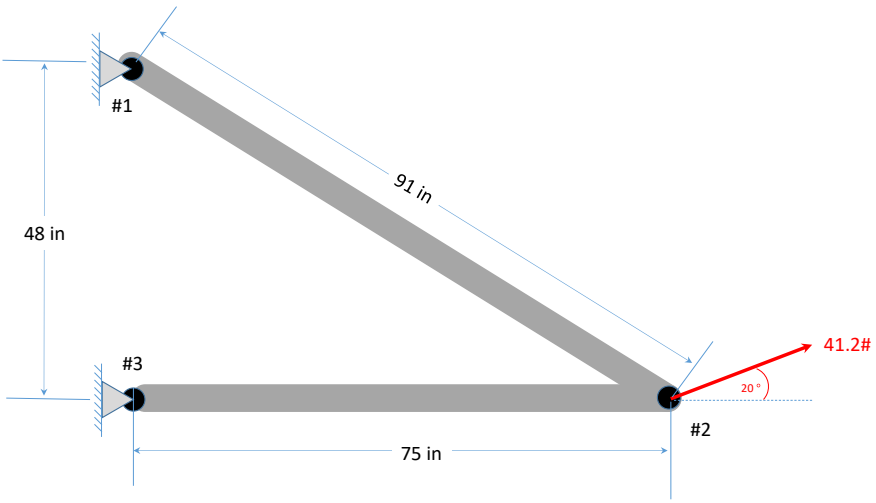
3) (20 points) Imagine that stresses in the *xy* plane are reported to be $\sigma_x = -6a_1x^2$, $\sigma_y = 9a_1x^2$, and $\tau_{xy} = 9a_1y^2$, where a_1 is a constant. If body forces are zero, is this state of stress in fact possible? Explain.

4) (20 points) Assume that the axial displacement field of a uniform bar has the following form: $u = a_1x + a_2x^2$.



Express u in terms of the nodal degrees of freedom u_1 and u_2, by developing the shape function matrix, $[N]$. Then determine the strain-displacement matrix, $[B]$ and the element stiffness matrix, $[K]$ in terms of A, E, and L. What deficiencies do you see in these results? To what do you attribute these deficiencies?

5) (20 points) A two-member truss with cross sectional properties, area, A, and elastic modulus, E, is subjected to a load of 41.2 lbs at node #2.



Determine the deflection of node #2 and the reaction at node #3 using the stiffness method.