# EXAM 1   MEEM 4405   Oct. 6th, 2004

Answers to questions 1 and 2 are at the end.

1.   (a) For the beam shown determine one parameter Rayleigh-Ritz solution using the approximation for the bending displacement given below. (b) For two parameter solution calculate the elements of the stiffness matrix and load vector. Do not solve for the parameters but show the equations in matrix form. Assume bending rigidity EI is a constant. The solution will be in terms of w, L, E, and I. Please be methodical.

$$v(x) \ = \ \sum_{i=1}^{n} C_i x^{i+1}$$

$C_1 = \text{----------------}$
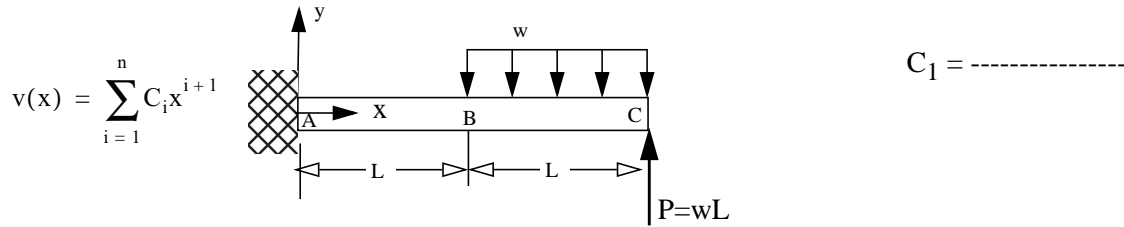
2.   The axial rod shown has an axial rigidity $EA = 15 \, (10^6)$ lbs. The rod is to be modelled using a linear element for AB and a linear element for BC. (a) Write the global stiffness matrix before incorporating loads or boundary condition. (b) Determine the displacement at point B using FEM. (c) Write the FEM equation for determining the reaction force at A and then solve for it. Please be methodical.

$u_B = \text{----------------}$

$R_A = \text{----------------}$
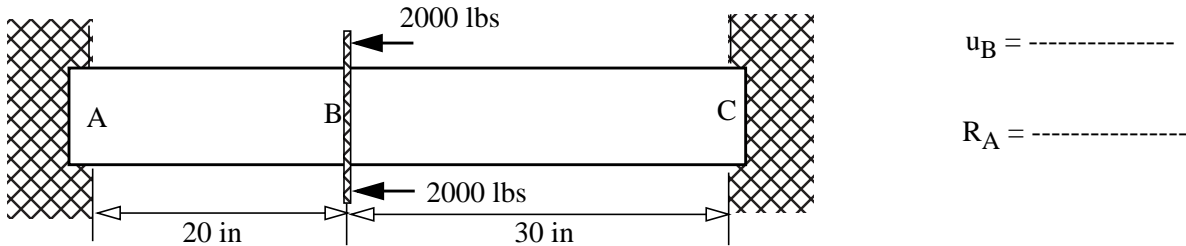
3.   (a) For the beam shown determine a kinematically admissible displacement function using coordinate shown.
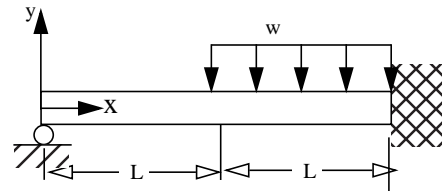
(b) For a cubic Lagrange polynomial sketch the approximate interpolation function ($\mathcal{L}_3$) associated with node 3.
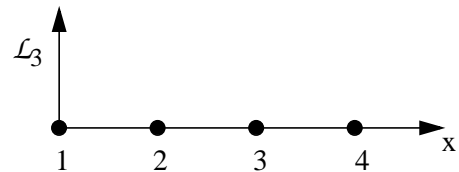
(c) What is h-method of mesh refinement?
(d) What is p-method of mesh refinement?
(e) What is r-method of mesh refinement?

<div align="center">(f--o) Circle the correct answer True or False</div>

(f) The stiffness matrix in FEM is always symmetric.   TRUE / FALSE

(g) The stiffness matrix is singular before boundary conditions are imposed.   TRUE / FALSE

(h) The total potential energy of a structure increases with mesh refinement.   TRUE / FALSE

(i) The total strain energy of a structure increases with mesh refinement.   TRUE / FALSE

(j) When displacements are approximated by Lagrange polynomial the stress will always show discontinuity at element end.

TRUE / FALSE.

(k) In Unigraphics the software allows the user to directly place loads and boundary conditions on the nodes.

TRUE / FALSE

(l) Unigraphics allows the user to specify the number of modes that will be calculated in a buckling analysis.

TRUE / FALSE

(m) In Unigraphics the value defined as Eigen in a buckling analysis is always the critical buckling load.

TRUE / FALSE.

(n) In Unigraphic the units of displacements in the results are inches   TRUE / FALSE

(o) In Unigraphics the units of stress in the results are Newton/millimeter^2 TRUE / FALS

ANSWERS

1. $C_1 = \dfrac{5}{24}\dfrac{wL^2}{EI}$

2. $u_B = -0.0032$ in $R_A = 2400$ lb