In this course we will cover the theory, examples, and Matlab application scripts for several topics including:

1. The solution of second order and fourth order ordinary differential equations (ODEs);

$$-\frac{d}{dx}\left[K(x)\ \frac{du(x)}{dx}\right] + A(x)\frac{du(x)}{dx} + C(x)\,u(x) - Q(x) = 0 \qquad (8.1\text{-}1)$$

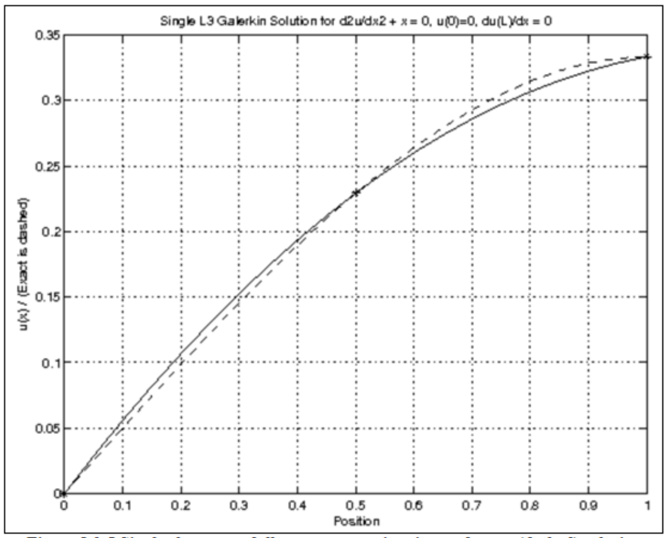


Figure 8.3-5 Single element nodally exact approximation and exact (dashed) solution

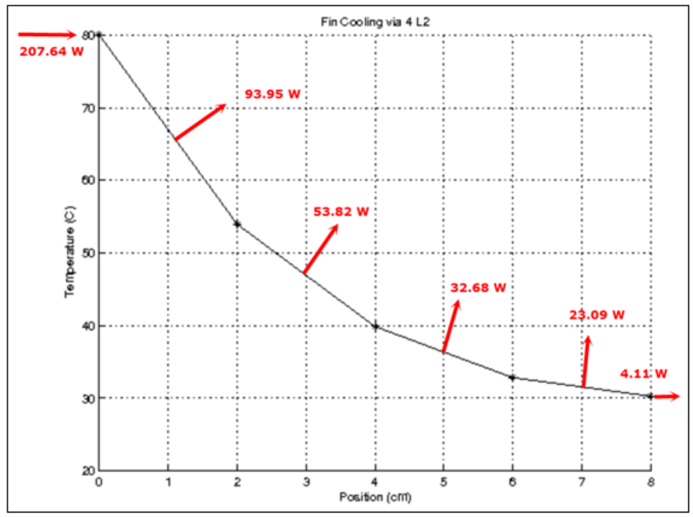


Figure 8.4-1 Heat flow conservation in a cooling fin

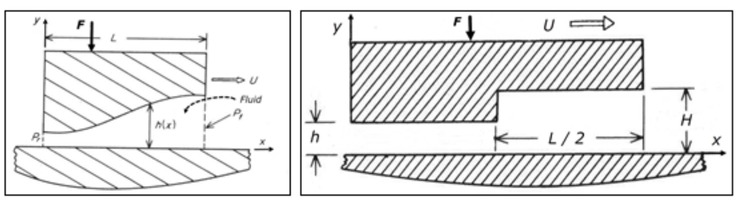


Figure 8.6-5 General and stepped hydrodynamic bearings

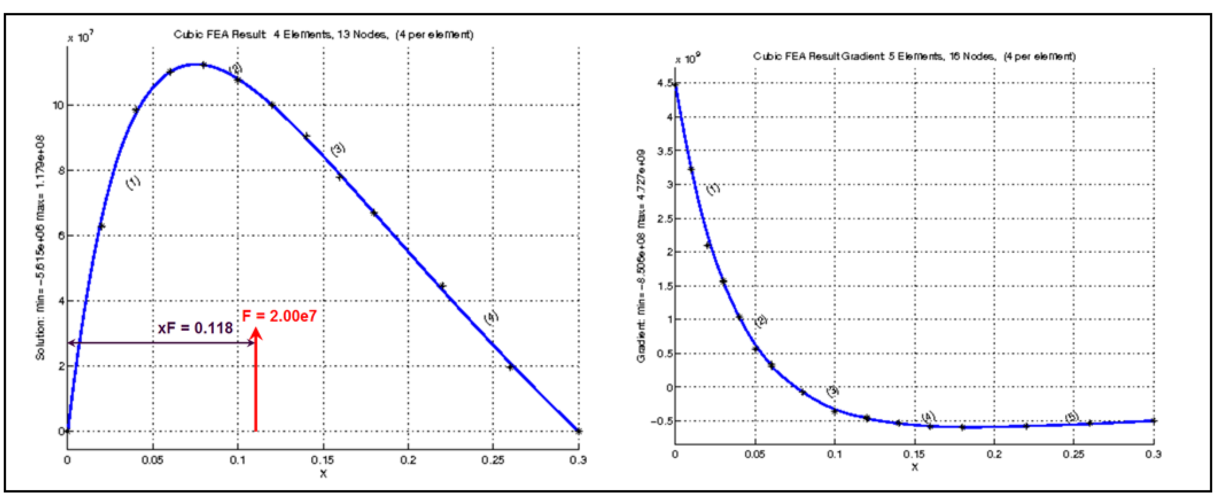


Figure 8.6-6 Bearing pressure, force, and pressure gradient for 4 (top) and 6 L4 elements

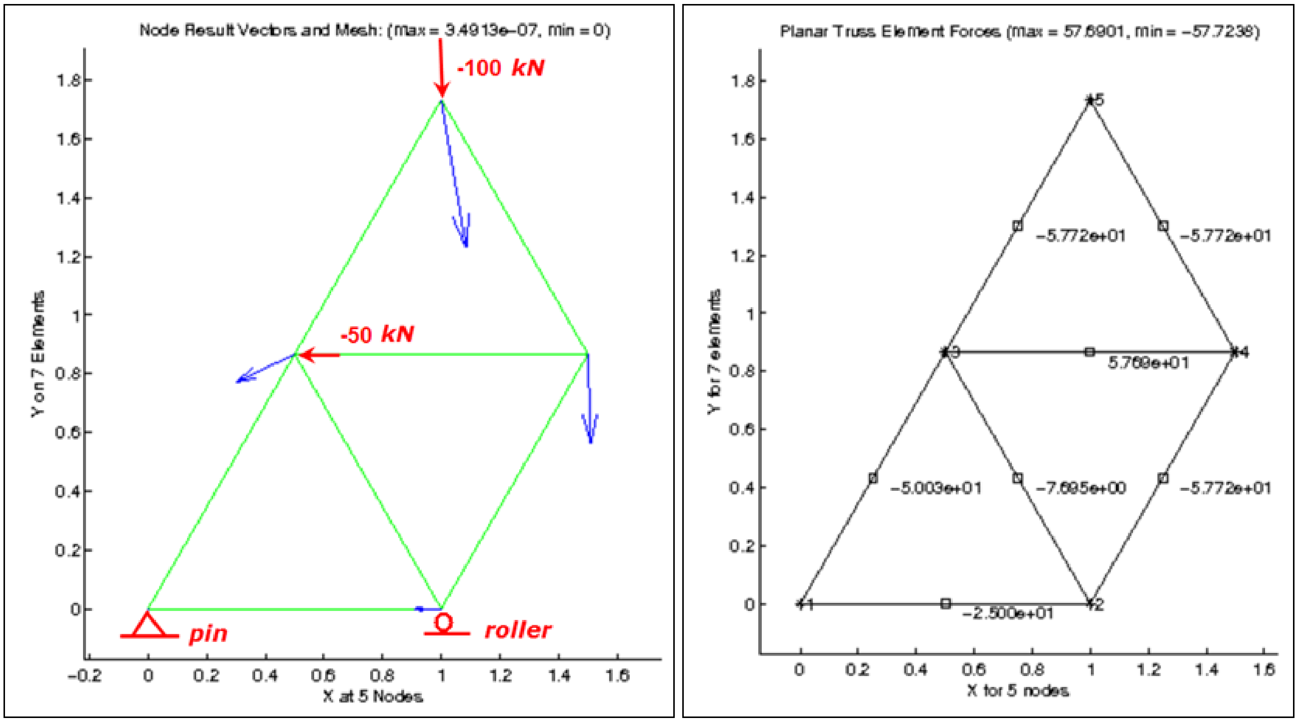


Figure 9.1-6 Displacement vectors (left) and member axial forces in a planar truss

$$\frac{d^2}{dx^2}\left[EI(x)\frac{d^2v}{dx^2}\right] - N(x)\frac{d^2v}{dx^2} - \frac{dN(x)}{dx}\frac{dv}{dx} + k(x)[v - v_\infty] - f(x) = 0. \qquad (10.2\text{-}1)$$

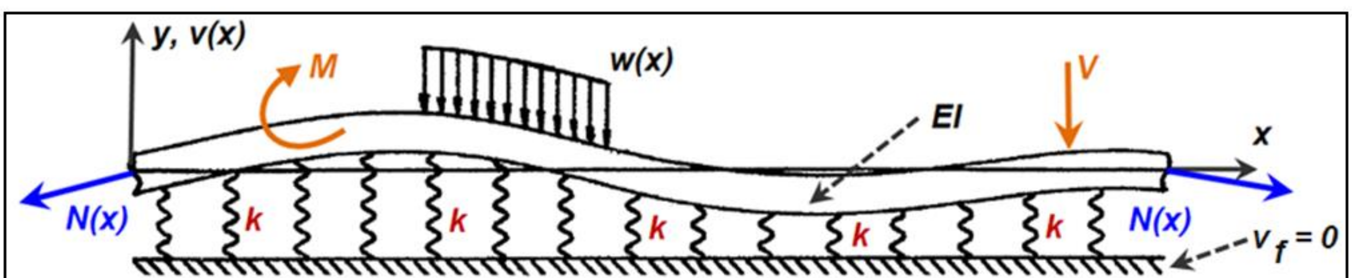


Figure 10.2-1 A beam-column on an elastic foundation

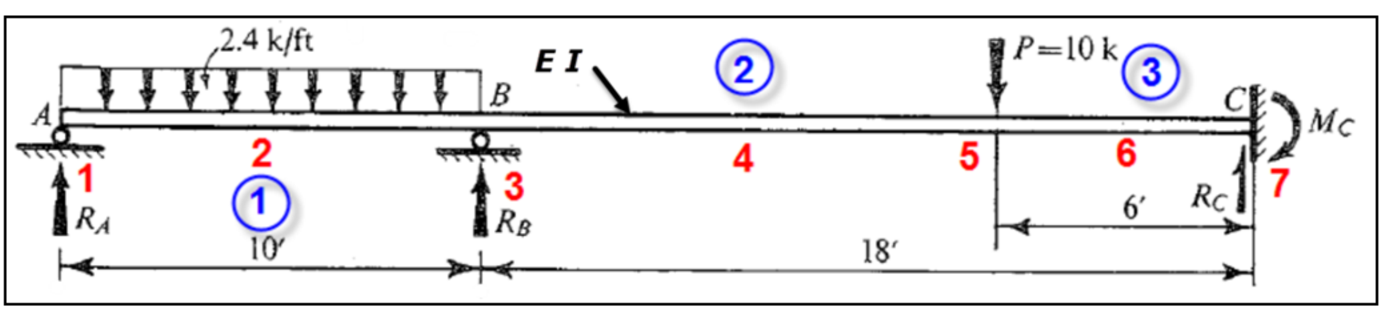


Figure 10.9-1 Two span, constant EI beam

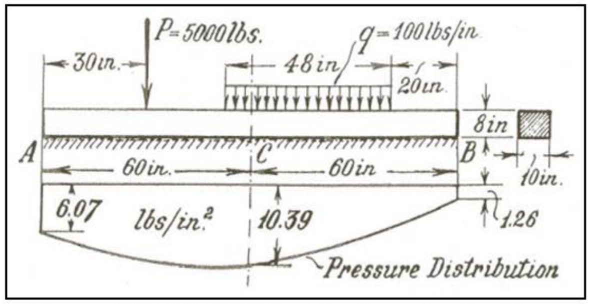


Figure 10.10-3 BOEF with changing loadings

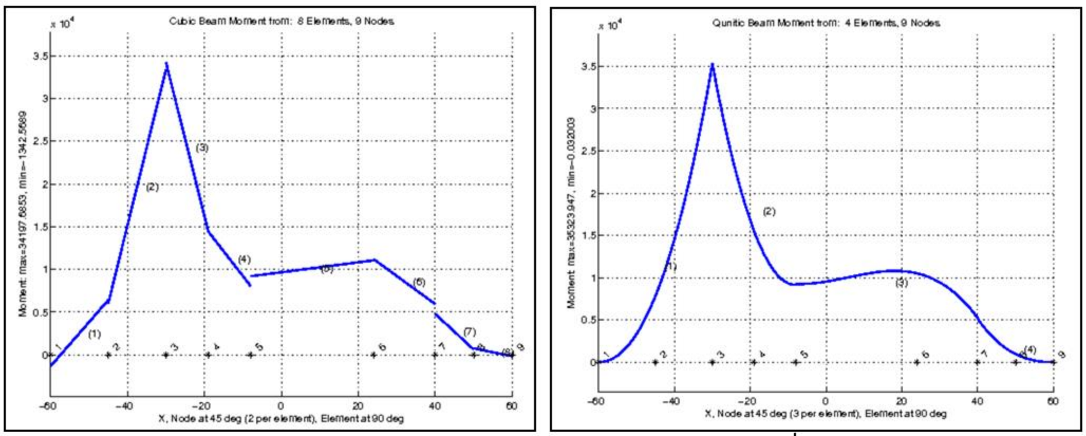


Figure 10.10-4 Moments from cubic (left) and quintic BOEF elements (10 nodes)

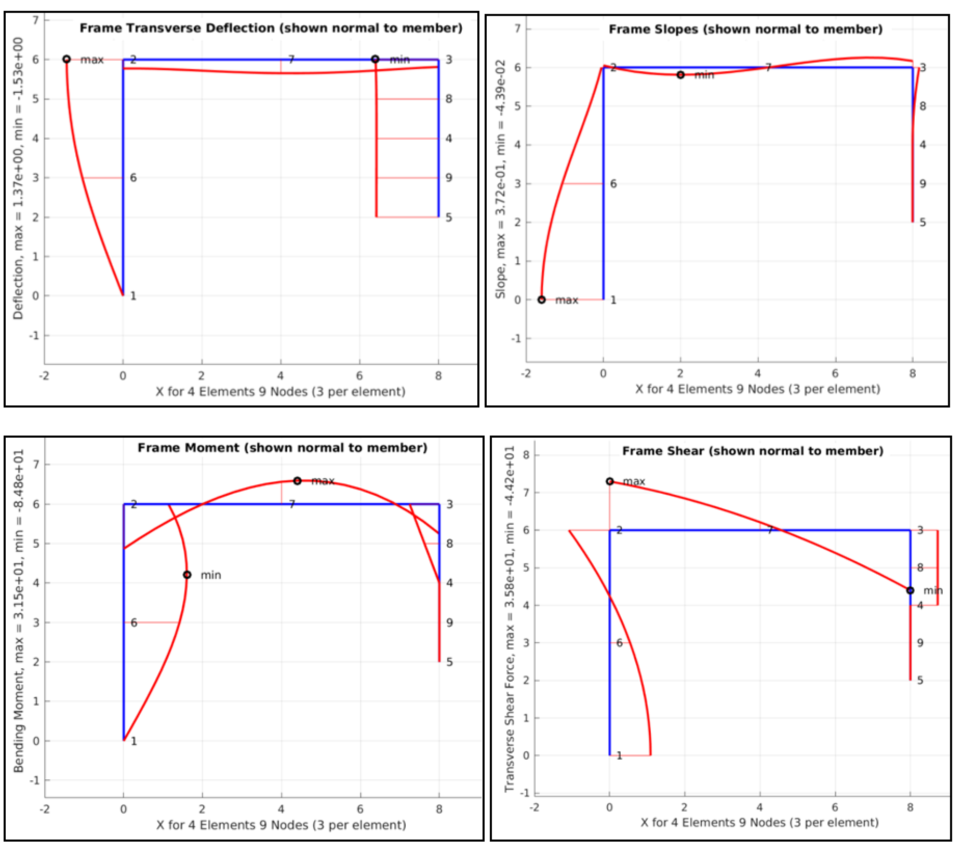


Figure 11.3-1 Enhanced post-processing from cubic/quintic frame members

2. Two-dimensional elliptical partial differential equations (PDEs);

$$\frac{\partial}{\partial x}\left(k_{xx}\frac{\partial u}{\partial x}\right)+\frac{\partial}{\partial y}\left(k_{yy}\frac{\partial u}{\partial y}\right)+m\left(v_x\frac{\partial u}{\partial x}+v_y\frac{\partial u}{\partial y}\right)-au-Q-\rho\,\partial u/\partial\tau=0 \quad (12.2\text{-}1a)$$

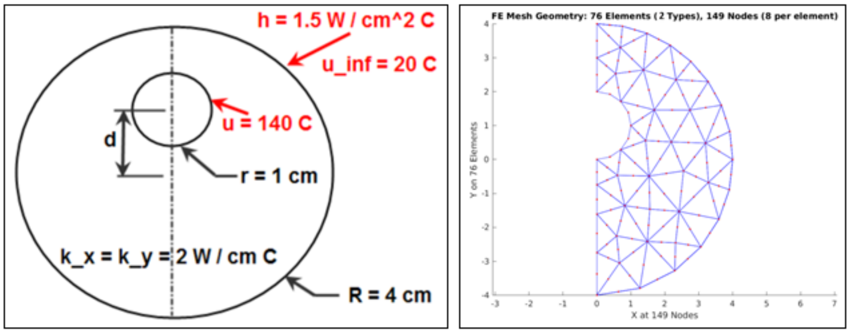
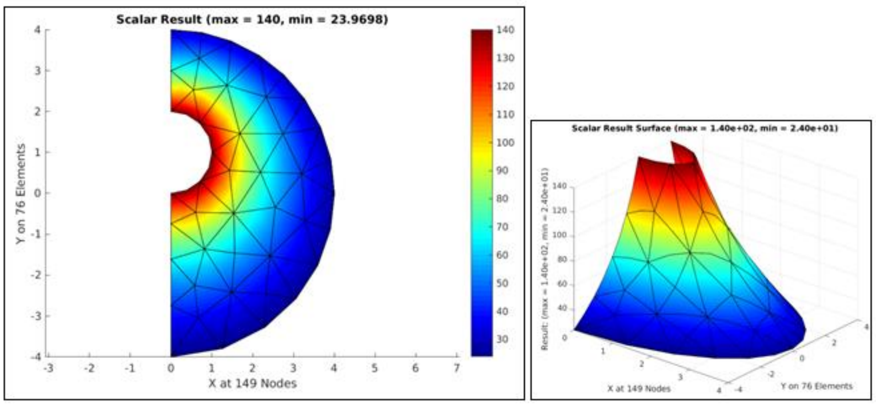


Figure 12.14-4 Symmetric eccentric cylinder with T6 face elements and L3 line elements



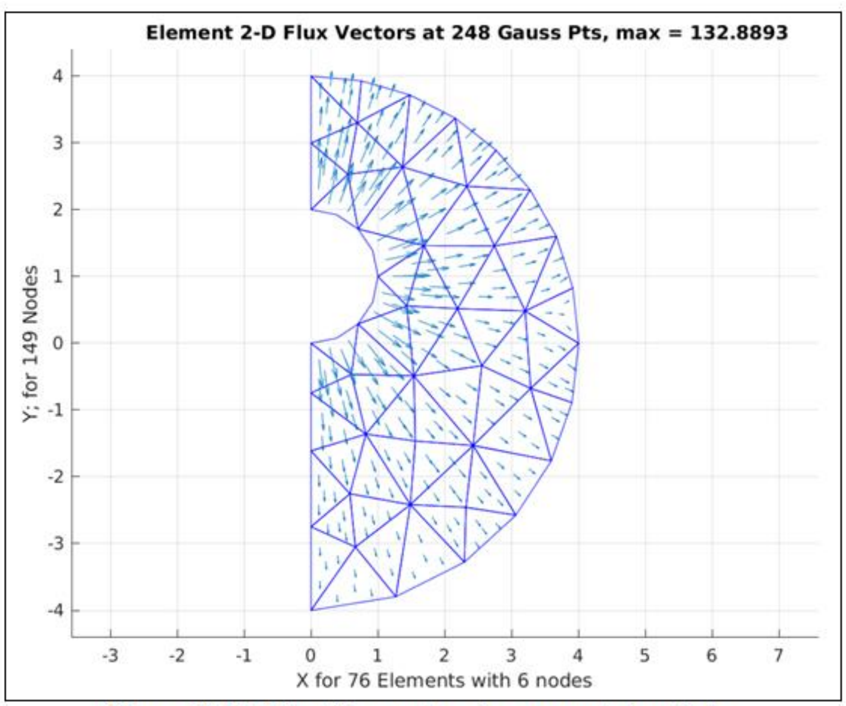


Figure 12.14-9 Heat flux vectors in a symmetric cylinder

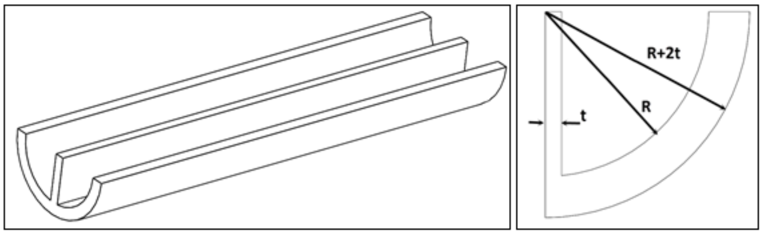


Figure 12.14-26 A symmetric thin-wall channel extrusion subject to torsion

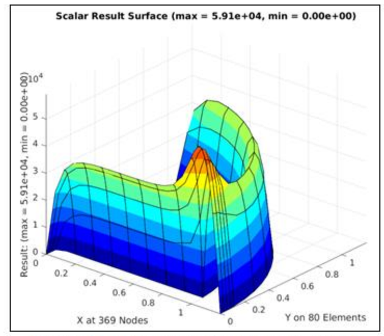


Figure 12.14-30 Stress function carpet plot

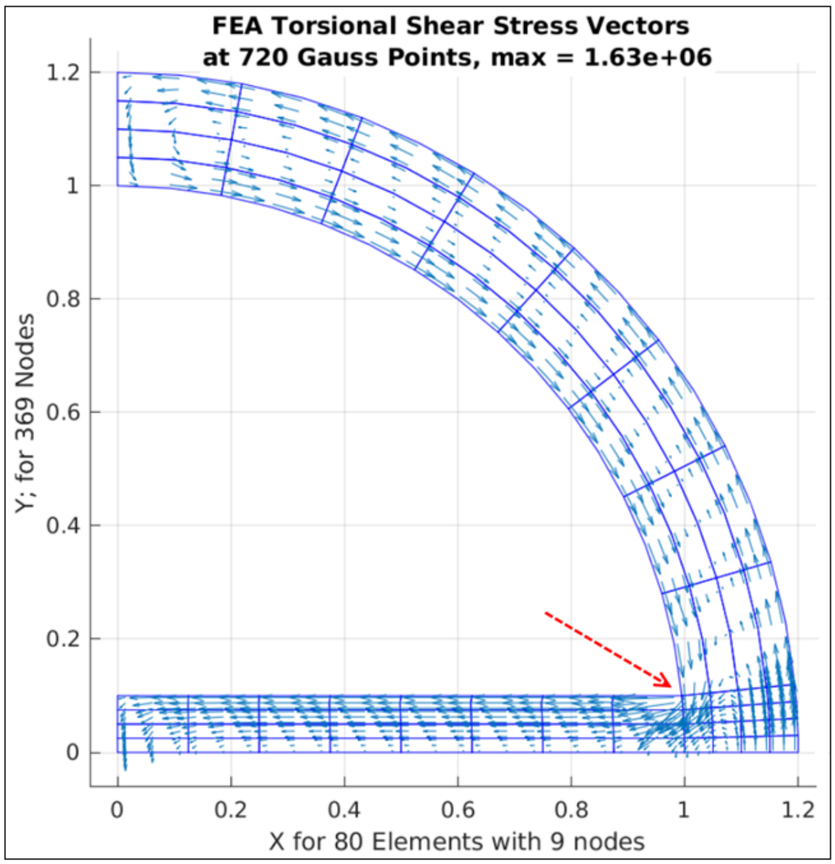


Figure 12.14-30 Maximum shear stress 'vectors' with a singular point

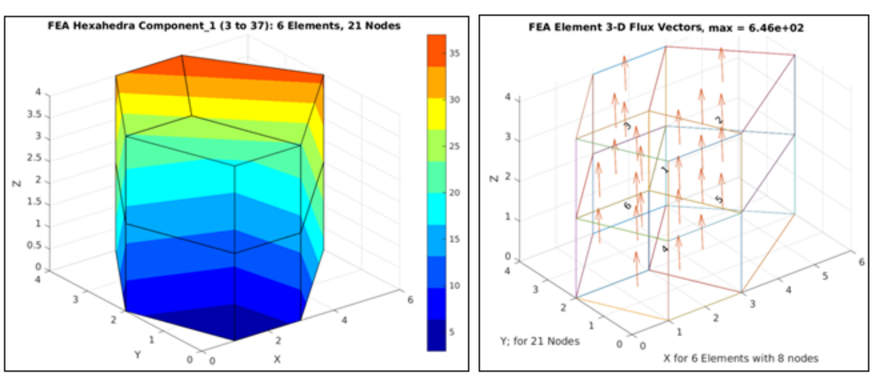
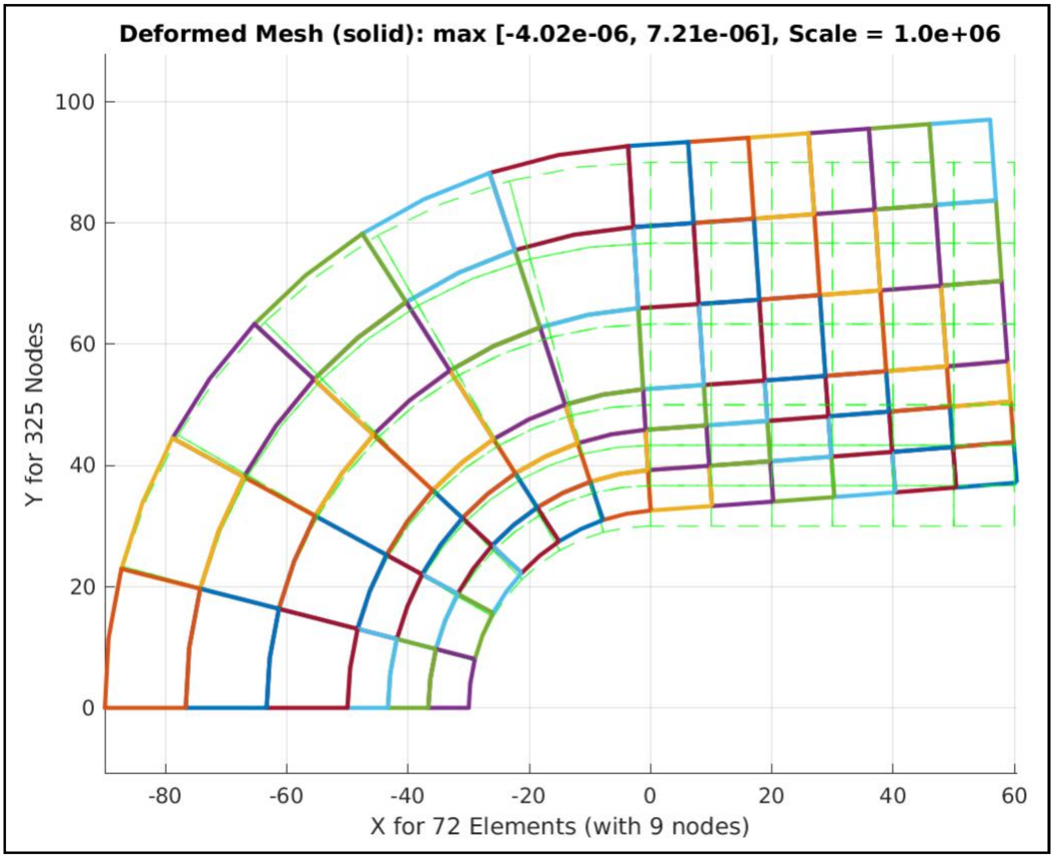
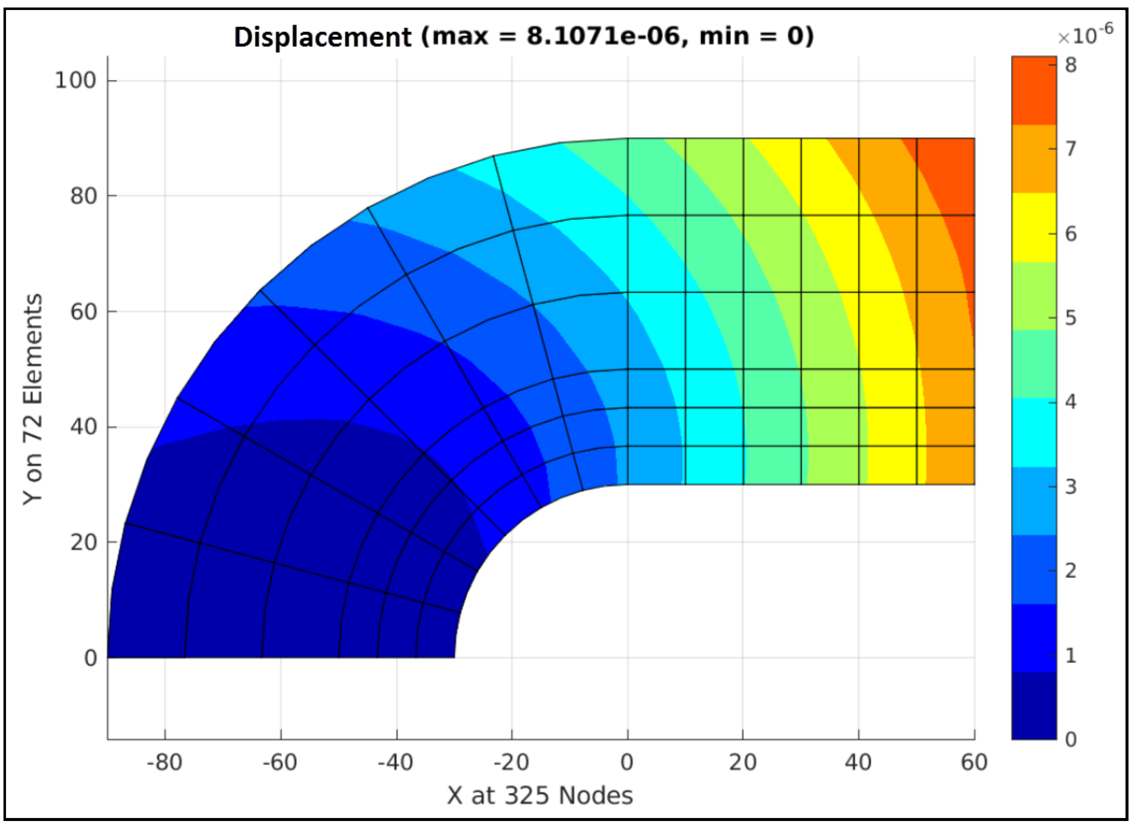
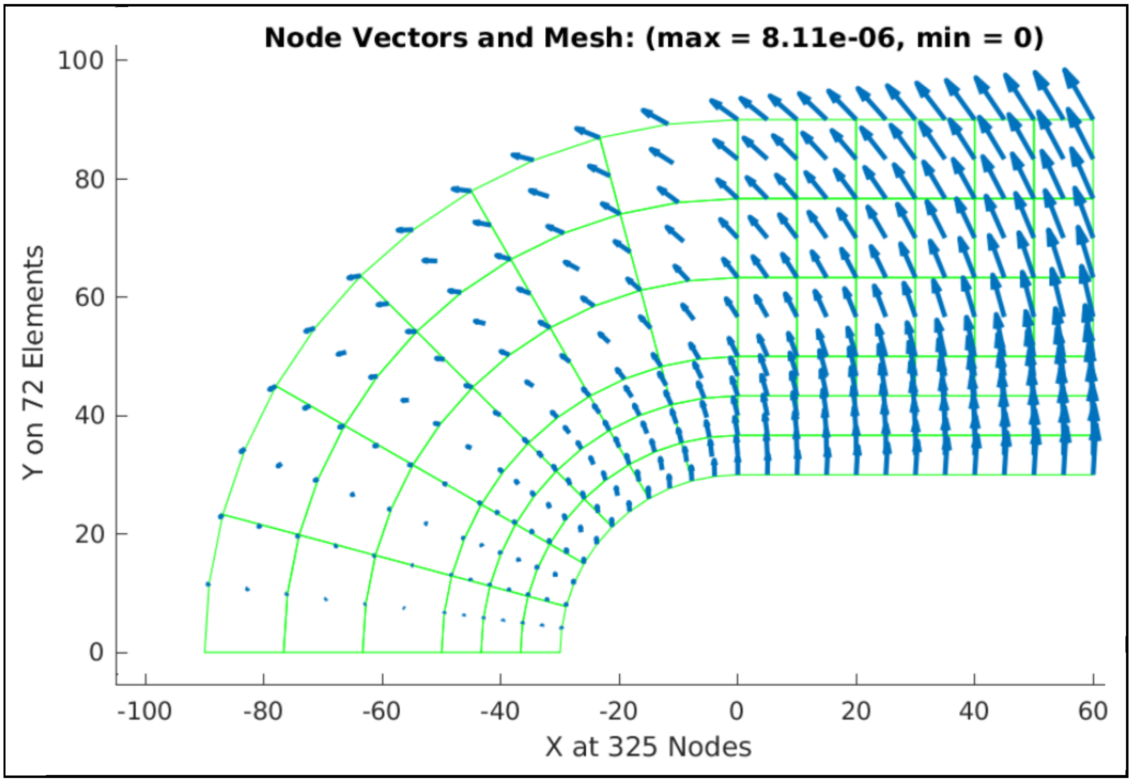


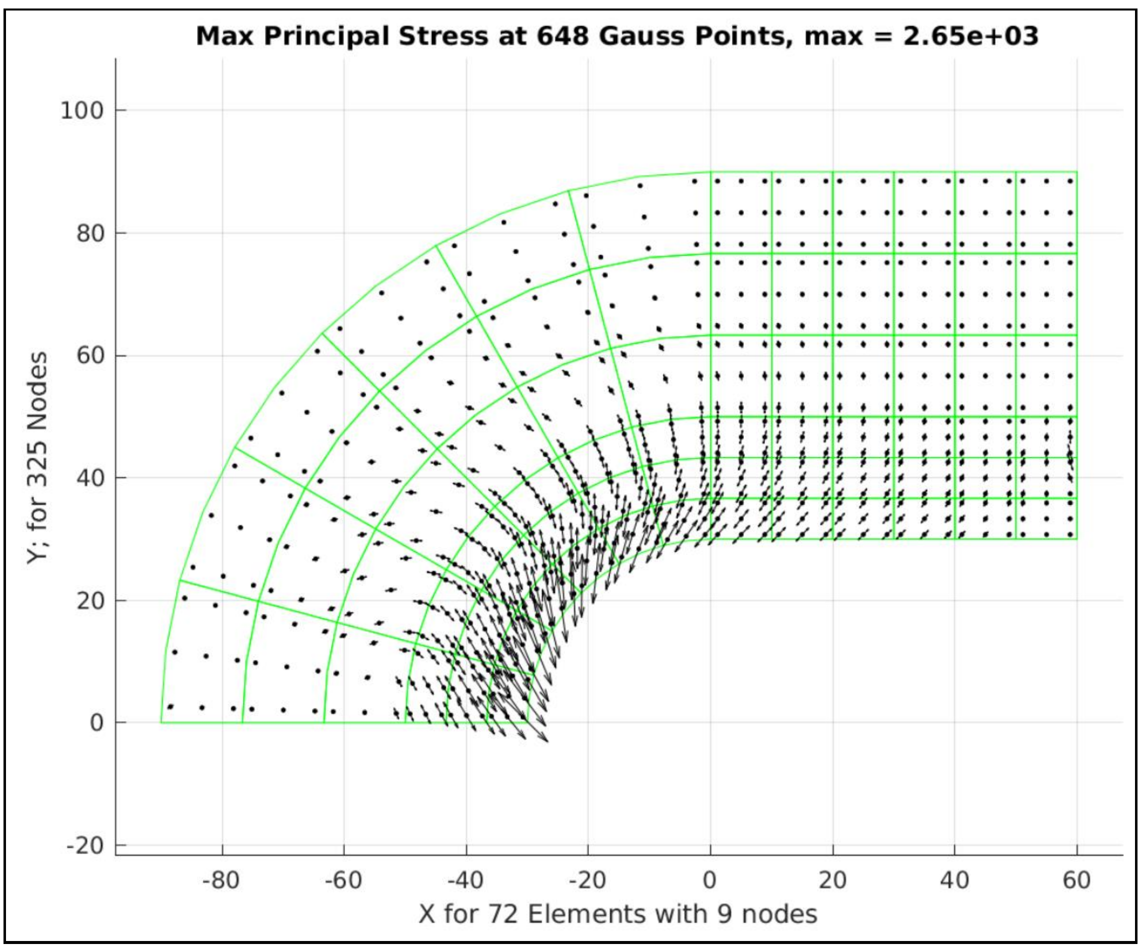
Figure 12.16-2 Linear spatial solution and selected constant flux vectors from patch test

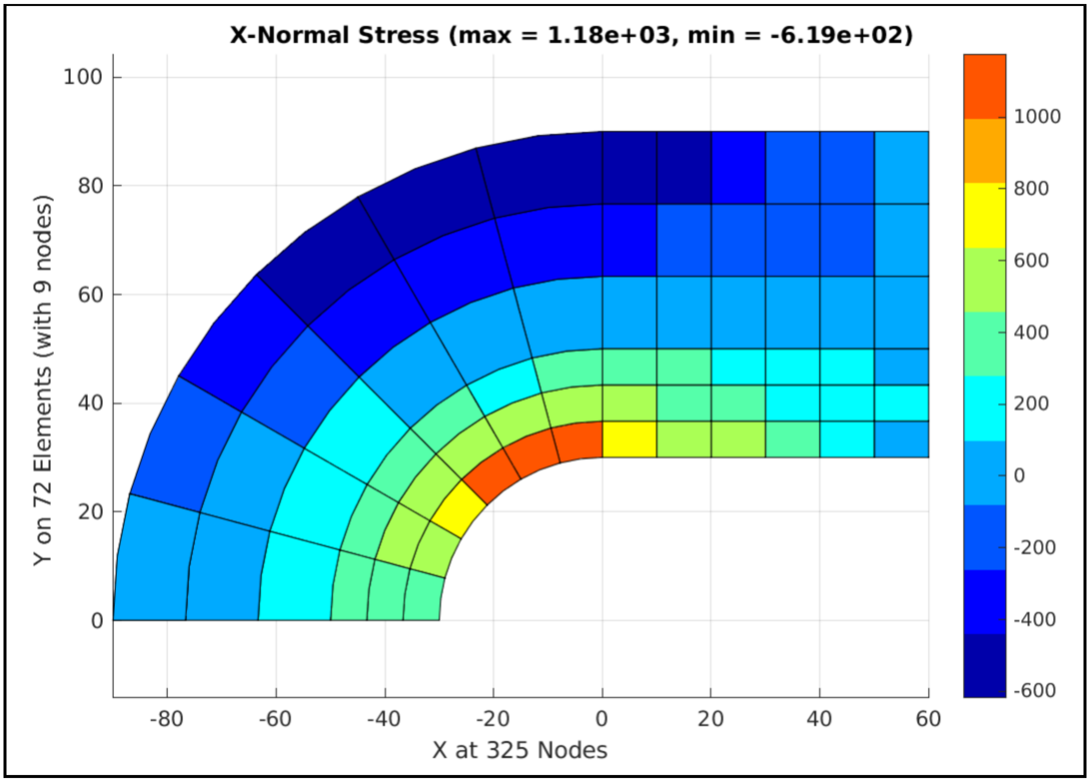
3. Stress Analysis;

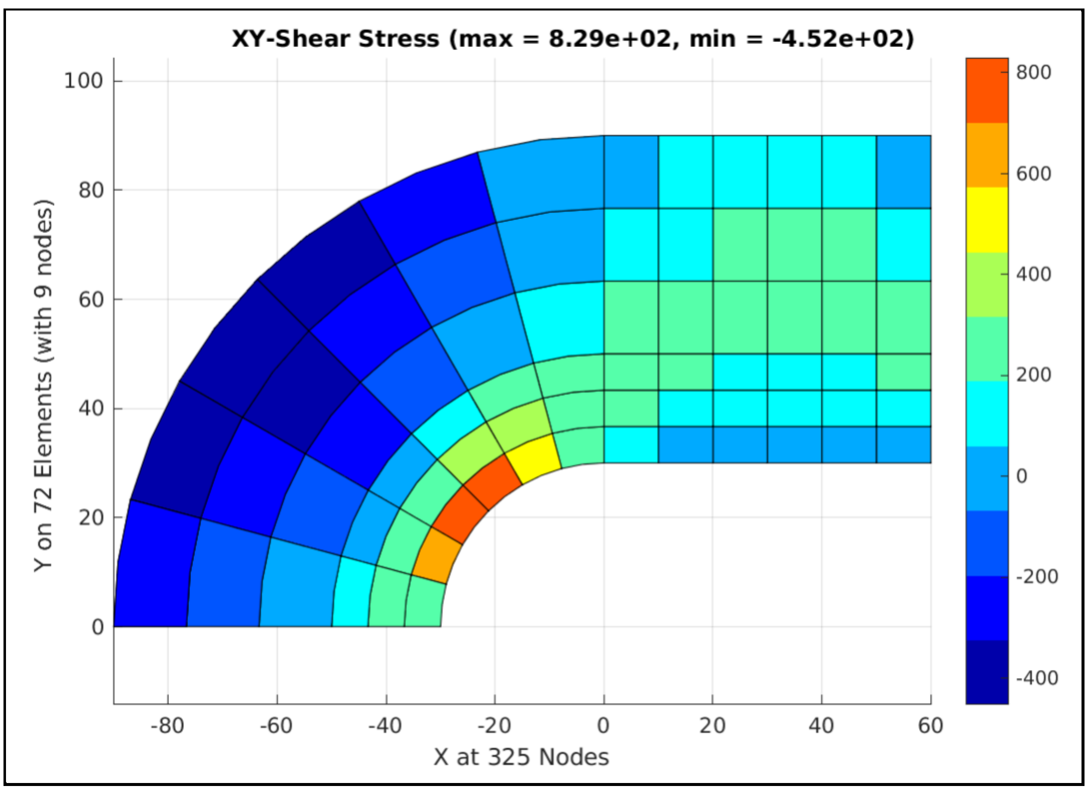





Node Vectors and Mesh: (max = 8.11e-06, min = 0)
Y on 72 Elements
X at 325 Nodes
100
80
60
40
20
0
-100
-80
-60
-40
-20
0
20
40
60


Max Principal Stress at 648 Gauss Points, max = 2.65e+03
Y; for 325 Nodes
X for 72 Elements with 9 nodes
100
80
60
40
20
0
-20
-80
-60
-40
-20
0
20
40
60


X-Normal Stress (max = 1.18e+03, min = -6.19e+02)
Y on 72 Elements (with 9 nodes)
X at 325 Nodes
100
80
60
40
20
0
-80
-60
-40
-20
0
20
40
60
1000
800
600
400
200
0
-200
-400
-600


XY-Shear Stress (max = 8.29e+02, min = -4.52e+02)
Y on 72 Elements (with 9 nodes)
X at 325 Nodes
100
80
60
40
20
0
-80
-60
-40
-20
0
20
40
60
800
600
400
200
0
-200
-400

$$\nabla^2 u(x,y,t) + \lambda\, u(x,y,t) = 0 \qquad (14.1\text{-}1)$$

4. Vibrations and eigen-problems;

$$[\boldsymbol{K} - \lambda_j\, \boldsymbol{M}]\boldsymbol{\delta}_j = 0,\ \ j = 1,2, \ldots \qquad (14.2\text{-}3)$$

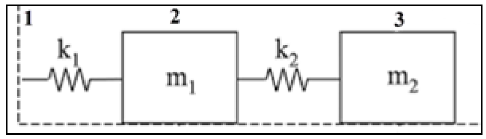


Figure 14.3-1 A two DOF spring-mass system

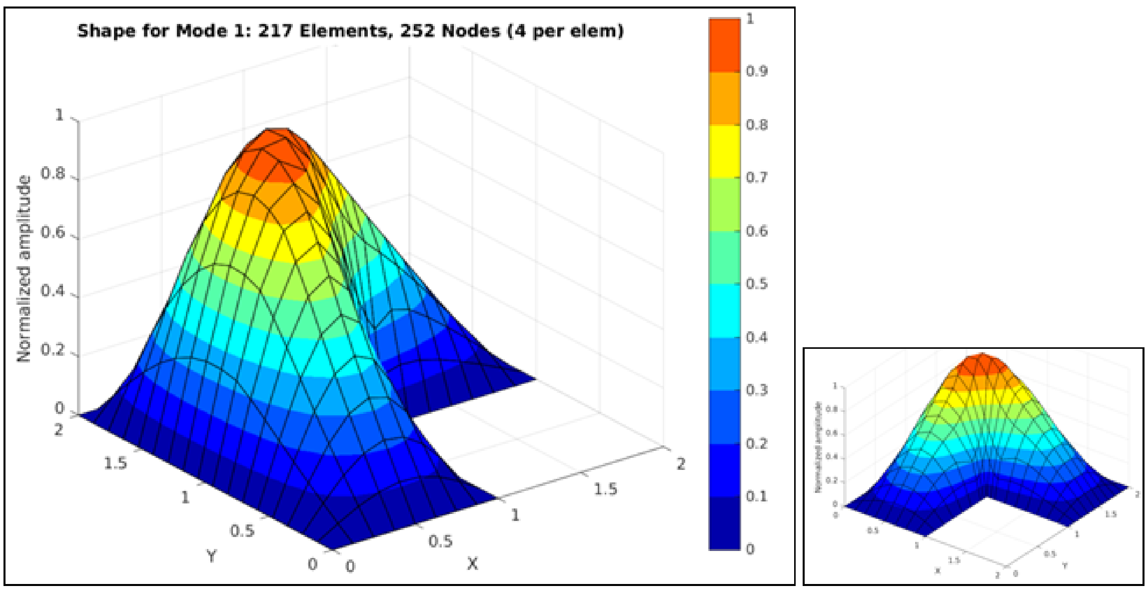


Figure 14.7-1 L-shaped membrane first mode of vibration with Q9 and Q4 elements

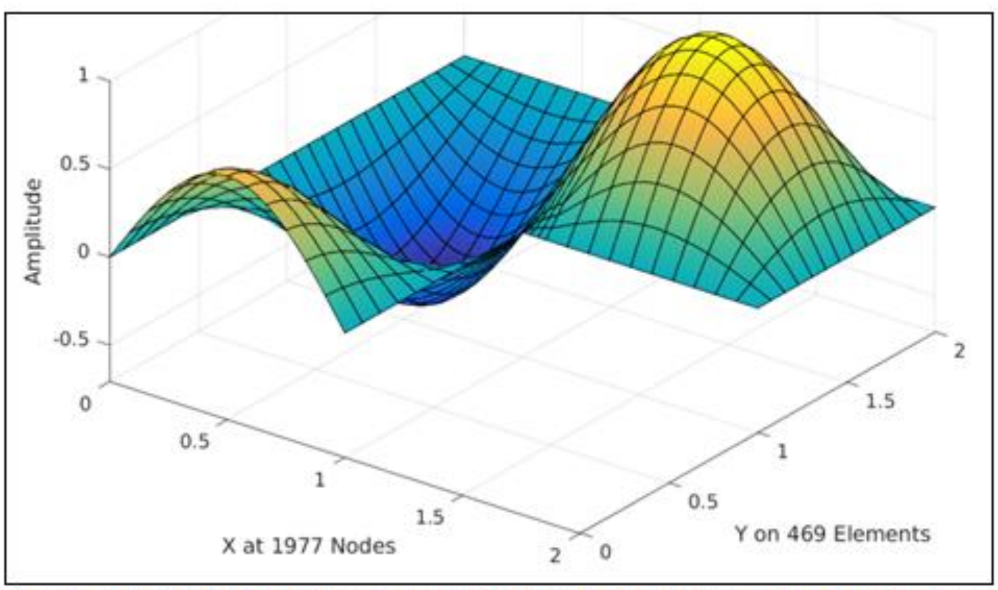


Figure 14.7-3 First three symmetric modes of U-shaped membrane

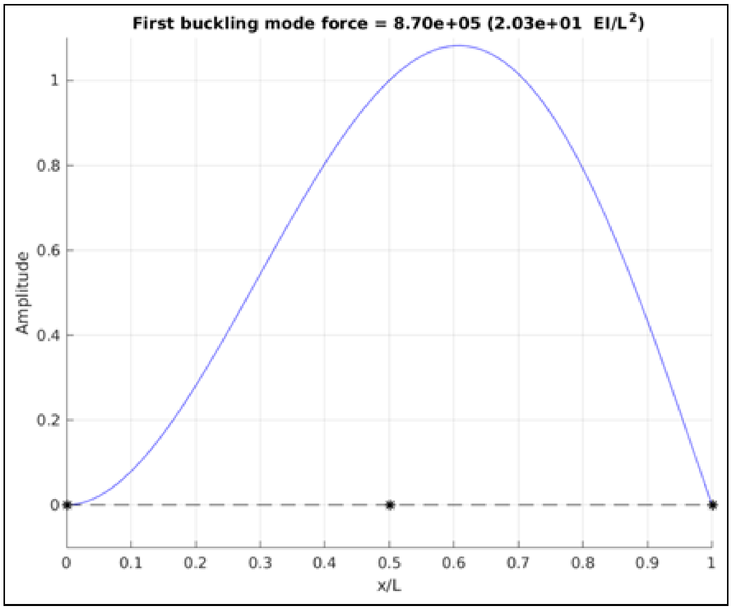


Figure 14.8-4 Linear buckled mode shape estimate of fixed-pinned column

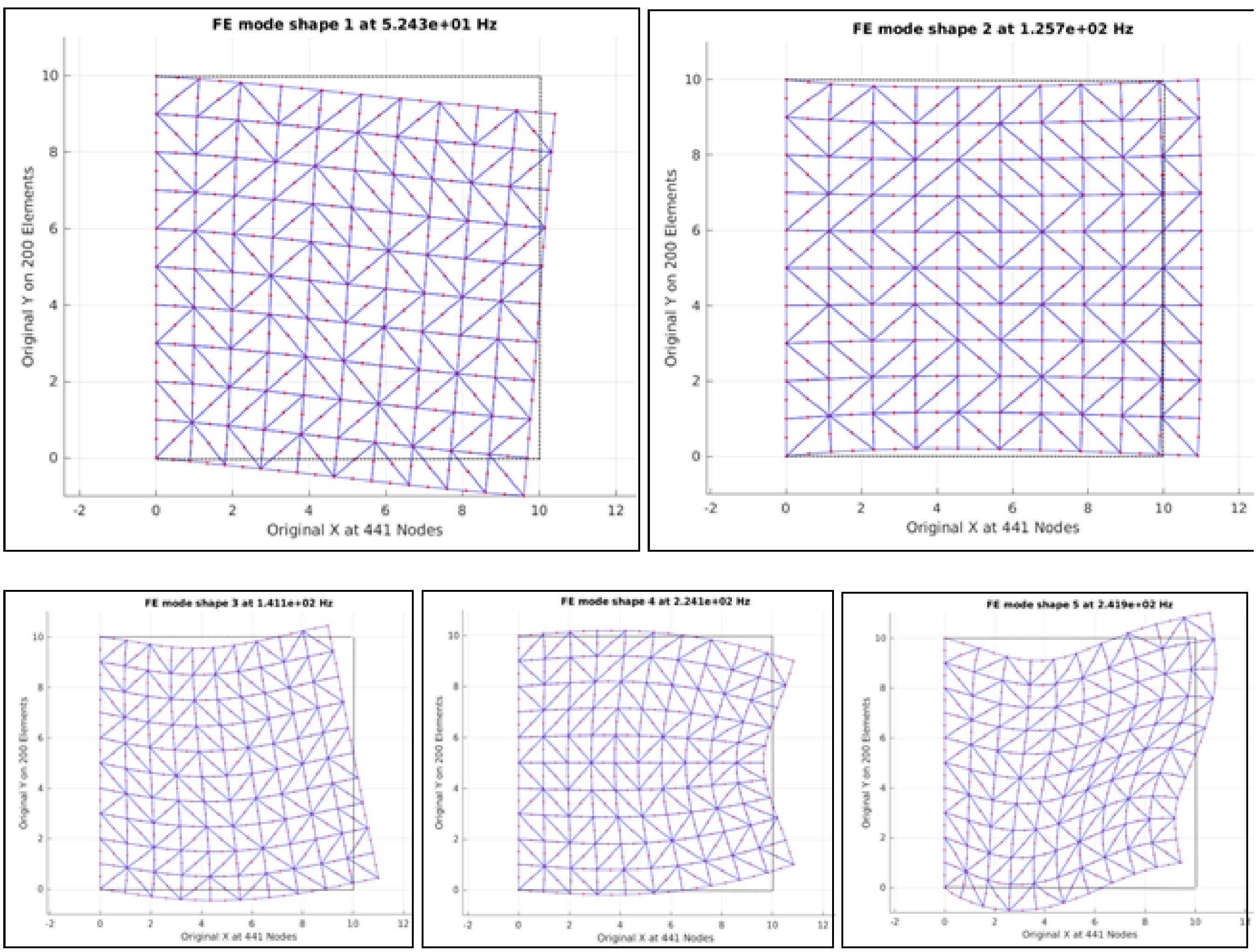


Figure 14.11-5 First five modes of planar vibration validation problem

5: Transient and dynamic time histories;

$$-D(x,t)\frac{\partial^2 u(x,t)}{\partial x^2} + A(x,t)\frac{\partial u(x,t)}{\partial x} + C(x,t)\,u(x,t) + F(x,t) = G(x,t)\frac{\partial u(x,t)}{\partial t} \qquad (15.1\text{-}1)$$

$$[\boldsymbol{S}]\{\boldsymbol{T}(t)\} + [\boldsymbol{M}]\{\dot{\boldsymbol{T}}(t)\} = \{\boldsymbol{c}(t)\} - \{\boldsymbol{c}_{\boldsymbol{EBC}}(t)\} \equiv \{\boldsymbol{p}(t)\} \qquad (15.1\text{-}4)$$

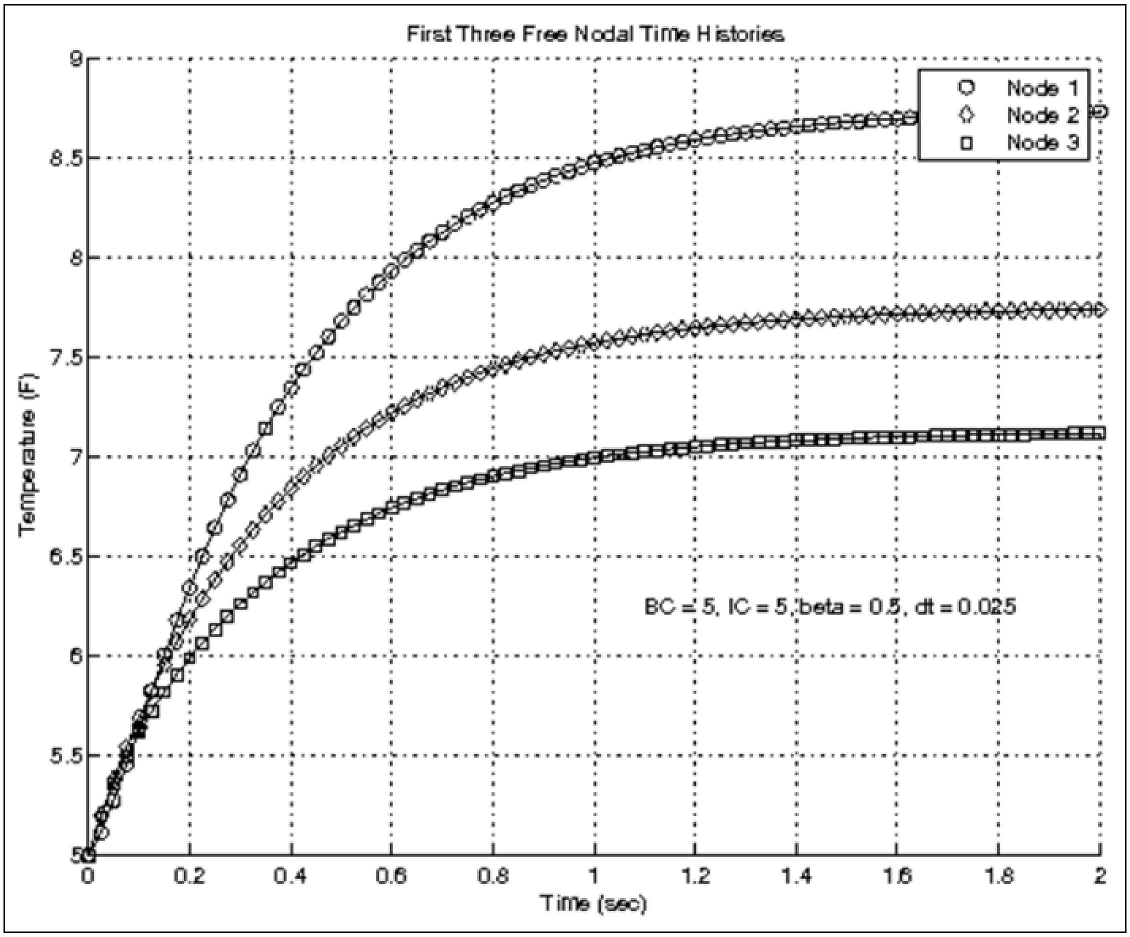


Figure 15.2-2 Transient history of a square with heat generation

$$[\boldsymbol{S}]\{\boldsymbol{\delta}(t)\} + [\boldsymbol{D}]\{\dot{\boldsymbol{\delta}}(t)\} + [\boldsymbol{M}]\{\ddot{\boldsymbol{\delta}}(t)\} = \{\boldsymbol{f}(t)\},\ \{\dot{\ }\} = \partial\{\ \}/\partial t \qquad (15.4\text{-}1)$$

Etc.