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);

\[-\frac{d}{dx} \left[ K(x) \frac{du(x)}{dx} \right] + A(x) \frac{du(x)}{dx} + C(x) \ u(x) - Q(x) = 0 \]  \hspace{1cm} (8.1-1)
Figure 9.1-6 Displacement vectors (left) and member axial forces in a planar truss

\[
\frac{d^2}{dx^2} \left[ EI(x) \frac{d^2v}{dx^2} \right] - N(x) \frac{d^2v}{dx^2} - \frac{dN(x)}{dx} \frac{dv}{dx} + k(x)[v - v_0] - f(x) = 0. \quad (10.2-1)
\]

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);

\[
\frac{\partial}{\partial x} \left( k_x \frac{\partial u}{\partial x} \right) + \frac{\partial}{\partial y} \left( k_y \frac{\partial u}{\partial y} \right) + m \left( \nu_x \frac{\partial u}{\partial x} + \nu_y \frac{\partial u}{\partial y} \right) - au - Q - \rho \frac{\partial u}{\partial t} = 0 \tag{12.2-1a}
\]

Figure 12.14.4 Symmetric eccentric cylinder with T6 face elements and I3 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)

Max Principal Stress at 648 Gauss Points, max = 2.65e+03
4. Vibrations and eigen-problems:

\[ V^2 u(x,y,t) + \lambda \ u(x,y,t) = 0 \]  \hspace{1cm} (14.1-1)

\[
[K - \lambda_j M] \delta_j = 0, \ j = 1,2,... 
\]  \hspace{1cm} (14.2-3)

**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;

\[-D(x,t) \frac{\partial^2 u(x,t)}{\partial x^2} + A(x,t) \frac{\partial u(x,t)}{\partial x} + C(x,t) u(x,t) + F(x,t) = G(x,t) \frac{\partial u(x,t)}{\partial t}\]  \hspace{1cm} (15.1-1)

\[[S]\{T(t)\} + [M]\{T'(t)\} = \{c(t)\} - \{c_{EBC}(t)\} \equiv \{p(t)\}\]  \hspace{1cm} (15.1-4)

\[\begin{align*}
[S]\{\delta(t)\} + [D]\{\delta'(t)\} + [M]\{\delta''(t)\} &= \{f(t)\}, \quad \{\dot{\}\} = \partial\{\}\partial t
\end{align*}\]  \hspace{1cm} (15.4-1)

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

Etc.