

**QE Topics List: *Structural Mechanics***  
**August 2003**

<b>Mathematical Concepts and Techniques</b>	<b>Mechanics of Solids (Including Concepts from Strength of Materials)</b>
<p><b>Vector and tensor analysis (in Cartesian coordinates):</b>            Indicinal and compact (direct) tensor notation            Vector calculus; divergence and gradient            The divergence theorem            Tensor invariants; change of basis; linear algebra of tensors</p> <p><b>The calculus of variations:</b>            Functionals; directional derivative of a functional            Euler equations            Vainberg's theorem</p> <p><b>Approximate methods for the solution of differential equations:</b>            The Ritz and finite element methods; Fourier series</p> <p><b>Eigenvalue problems:</b>            Eigenvalues and eigenvectors;            Spectral theorem;            Cayley Hamilton theorem</p>	<p><b>Force and stress:</b>            Body forces and surface tractions            Balance of linear and angular momentum            Cauchy's relationship for stress and traction            Measures of stress (Cauchy stress, first and second Piola-Kirchoff stress)</p> <p><b>Motion and strain:</b>            Stretch of lines, change in angles (shear)            The deformation gradient            Measures of strain (Lagrangian or Green strain, engineering strain, Eulerian strain)</p> <p><b>Constitutive models:</b>            Stress-strain-temperature relations;            Hyperelasticity (Hooke's law; nonlinear elasticity)</p> <p><b>Boundary value problems in elasticity</b></p> <p><b>Principles of virtual work and energy principles</b></p> <p><b>Plane stress, plane strain, axisymmetry, and torsion</b></p>
<b>Beam Theory</b>	<b>Static Stability of structures</b>
<p><b>Linear two- and three-dimensional beam theory</b>  <b>Relationship between 3-D solids and beams</b>            Definition of loading and stress and strain resultants            Kinematic hypotheses and constitutive relationships for stress resultants</p> <p><b>Timoshenko beam theory</b>  <b>Boundary value problems and solution methods:</b>            Classical solutions, variational solutions            Essential and natural boundary conditions            Ritz and finite element solutions</p> <p><b>Beams on elastic foundations</b>  <b>Geometrically nonlinear planar beam theory</b></p>	<p><b>Basic concepts of static stability theory</b>  <b>The energy criterion for conservative systems</b>  <b>Bifurcation, limit points, and post-buckling behavior</b>  <b>Linearized buckling eigenvalue problems</b>  <b>Approximate solution methods based on virtual work principles</b></p>