















































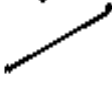
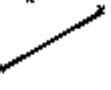


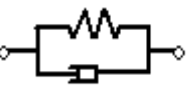




3.2 Pictorial Summary





















3.2.1 Pictorial Summary of Element Types










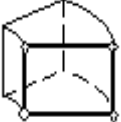

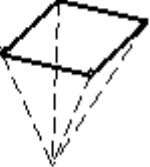
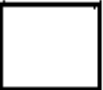







The figures on the next pages graphically summarize the element library for quick reference.





















Structural Point	Structural 2-D Line	Structural 2-D Beam	Structural 2-D Beam	Structural 2-D Beam
Structural Mass  MASS21 1 node 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ	Spar  LINK1 2 nodes 2-D space DOF: UX, UY	Elastic Beam  BEAM3 2 nodes 2-D space DOF: UX, UY, ROTZ	Plastic Beam  BEAM23 2 nodes 2-D space DOF: UX, UY, ROTZ	Offset Tapered Unsymmetric Beam  BEAM54 2 nodes 2-D space DOF: UX, UY, ROTZ
Structural 3-D Line	Structural 3-D Line	Structural 3-D Line	Structural 3-D Beam	Structural 3-D Beam
Spar  LINK8 2 nodes 3-D space DOF: UX, UY, UZ	Tension-Only Spar  LINK10 2 nodes 3-D space DOF: UX, UY, UZ	Linear Actuator  LINK11 2 nodes 3-D space DOF: UX, UY, UZ	Elastic Beam  BEAM4 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ	Thin-Walled Beam  BEAM24 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ
Offset Tapered Unsymmetric Beam  BEAM44 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ	Structural Pipe	Elastic Pipe Tee  PIPE17 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ	Curved Pipe (Elbow)  PIPE18 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ	Plastic Straight Pipe  PIPE20 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ
	Elastic Straight Pipe  PIPE16 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ			



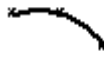


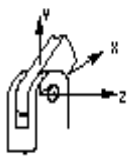



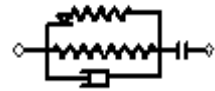
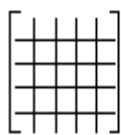

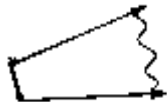





<p>Immersed Pipe</p>  <p>PIPE59 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Plastic Curved Pipe</p>  <p>PIPE60 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p style="text-align: center;">Structural 2-D Solid</p> <p>Triangular Solid</p>  <p>PLANE2 6 nodes 2-D space DOF: UX, UY</p>	<p>Axisymmetric Harmonic Struct. Solid</p>  <p>PLANE25 4 nodes 2-D space DOF: UX, UY, UZ</p>	<p>Structural Solid</p>  <p>PLANE42 4 nodes 2-D space DOF: UX, UY</p>
<p>Structural Solid</p>  <p>PLANE82 8 nodes 2-D space DOF: UX, UY</p>	<p>Axisymmetric Harmonic Struct. Solid</p>  <p>PLANE83 8 nodes 2-D space DOF: UX, UY, UZ</p>	<p>Structural Solid p-Element</p>  <p>PLANE145 8 nodes 2-D space DOF: UX, UY</p>	<p>Triangular Solid p-Element</p>  <p>PLANE146 6 nodes 2-D space DOF: UX, UY</p>	<p style="text-align: center;">Structural 3-D Solid</p> <p>Structural Solid</p>  <p>SOLID45 8 nodes 3-D space DOF: UX, UY, UZ</p>
<p>Layered Solid</p>  <p>SOLID46 8 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Anisotropic Solid</p>  <p>SOLID64 8 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Reinforced Solid</p>  <p>SOLID65 8 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Solid with Rotations</p>  <p>SOLID72 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Solid with Rotations</p>  <p>SOLID73 8 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>
<p>Tetrahedral Solid</p>  <p>SOLID92 10 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Structural Solid</p>  <p>SOLID95 20 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Structural Solid p-Element</p>  <p>SOLID147 20 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Tetrahedral Solid p-Element</p>  <p>SOLID148 10 nodes 3-D space DOF: UX, UY, UZ</p>	<p style="text-align: center;">Structural 2-D Shell</p> <p>Plastic Axisymmetric Shell with Torsion</p>  <p>SHELL51 2 nodes 2-D space DOF: UX, UY, UZ, ROTX</p>

<p>Axisymmetric Harmonic Struct. Shell</p>  <p>SHELL61 2 nodes 2-D space DOF: UX, UY, UZ, ROTZ</p>	<p>Structural 3-D Shell</p> <p>Shear/Twist Panel</p>  <p>SHELL28 4 nodes 3-D space DOF: UX, UY, UZ or ROTX, ROTY, ROTZ</p>	<p>Membrane Shell</p>  <p>SHELL41 4 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Plastic Large Strain Shell</p>  <p>SHELL43 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Elastic Shell</p>  <p>SHELL63 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>
<p>16-Layer Structural Shell</p>  <p>SHELL91 8 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Structural Shell</p>  <p>SHELL93 8 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>100-Layer Structural Shell</p>  <p>SHELL99 8 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Plastic Shell</p>  <p>SHELL143 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Structural Shell p-Element</p>  <p>SHELL150 8 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>
<p>Finite Strain Shell</p>  <p>SHELL181 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Explicit Dynamics</p> <p>Explicit Spar</p>  <p>LINK160 3 nodes 3-D space DOF: UX, UY, UZ, VX, VY, VZ, AX, AY, AZ</p>	<p>Explicit Beam</p>  <p>BEAM161 3 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ, VX, VY, VZ, AX, AY, AZ</p>	<p>Thin Structural Shell</p>  <p>SHELL163 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ, VX, VY, VZ, AX, AY, AZ</p>	<p>Structural Solid</p>  <p>SOLID164 8 nodes 3-D space DOF: UX, UY, UZ, VX, VY, VZ, AX, AY, AZ</p>
<p>Explicit Spring-Damper</p>  <p>COMBI165 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ, VX, VY, VZ, AX, AY, AZ</p>	<p>Explicit Structural Mass</p>  <p>MASS166 1 node 3-D space DOF: UX, UY, UZ, VX, VY, VZ, AX, AY, AZ</p>	<p>Explicit Link</p>  <p>LINK167 3 nodes 3-D space DOF: UX, UY, UZ, VX, VY, VZ, AX, AY, AZ</p>	<p>Hyperelastic Solid</p> <p>Hyperelastic Mixed U-P Solid</p>  <p>HYPER56 4 nodes 2-D space DOF: UX, UY, UZ</p>	<p>Hyperelastic Mixed U-P Solid</p>  <p>HYPER58 8 nodes 3-D space DOF: UX, UY, UZ</p>

<p>Hyperelastic Mixed U-P Solid</p>  <p>HYPER74 8 nodes 2-D space DOF: UX, UY, UZ</p>	<p>Hyperelastic Solid</p>  <p>HYPER84 8 nodes 2-D space DOF: UX, UY, UZ</p>	<p>Hyperelastic Solid</p>  <p>HYPER86 8 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Hyperelastic Mixed U-P Solid</p>  <p>HYPER158 10 nodes 3-D space DOF: UX, UY, UZ</p>	<p style="text-align: center;">Visco Solid</p> <p>Viscoelastic Solid</p>  <p>VISCO88 8 nodes 2-D space DOF: UX, UY</p>
<p>Viscoelastic Solid</p>  <p>VISCO89 20 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Large Strain Solid</p>  <p>VISCO106 4 nodes 2-D space DOF: UX, UY, UZ</p>	<p>Large Strain Solid</p>  <p>VISCO107 8 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Large Strain Solid</p>  <p>VISCO108 8 nodes 2-D space DOF: UX, UY, UZ</p>	<p style="text-align: center;">Thermal Point</p> <p>Thermal Mass</p>  <p>MASS71 1 node 3-D space DOF: TEMP</p>
<p style="text-align: center;">Thermal Line</p> <p>Radiation Link</p>  <p>LINK31 2 nodes 3-D space DOF: TEMP</p>	<p>Conduction Bar</p>  <p>LINK32 2 nodes 2-D space DOF: TEMP</p>	<p>Conduction Bar</p>  <p>LINK33 2 nodes 3-D space DOF: TEMP</p>	<p>Convection Link</p>  <p>LINK34 2 nodes 3-D space DOF: TEMP</p>	<p style="text-align: center;">Thermal 2-D Solid</p> <p>Triangular Thermal Solid</p>  <p>PLANE35 6 nodes 2-D space DOF: TEMP</p>
<p>Thermal Solid</p>  <p>PLANE55 4 nodes 2-D space DOF: TEMP</p>	<p>Axisymmetric Harmonic Thermal Solid</p>  <p>PLANE75 4 nodes 2-D space DOF: TEMP</p>	<p>Thermal Solid</p>  <p>PLANE77 8 nodes 2-D space DOF: TEMP</p>	<p>Axisymmetric Harmonic Thermal Solid</p>  <p>PLANE78 8 nodes 2-D space DOF: TEMP</p>	<p style="text-align: center;">Thermal 3-D Solid</p> <p>Thermal Solid</p>  <p>SOLID70 8 nodes 3-D space DOF: TEMP</p>

<p>Tetrahedral Thermal Solid</p>  <p>SOLID87 10 nodes 3-D space DOF: TEMP</p>	<p>Thermal Solid</p>  <p>SOLID90 20 nodes 3-D space DOF: TEMP</p>	<p>Thermal Shell</p>  <p>SHELL57 4 nodes 3-D space DOF: TEMP</p>	<p>Fluid</p> <p>Acoustic Fluid</p>  <p>FLUID29 4 nodes 2-D space DOF: UX, UY, PRES</p>	<p>Acoustic Fluid</p>  <p>FLUID30 8 nodes 3-D space DOF: UX, UY, UZ, PRES</p>
<p>Dynamic Fluid Coupling</p>  <p>FLUID38 2 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Thermal-Fluid Pipe</p>  <p>FLUID66 2 nodes 3-D space DOF: PRES, TEMP</p>	<p>Contained Fluid</p>  <p>FLUID79 4 nodes 2-D space DOF: UX, UY</p>	<p>Contained Fluid</p>  <p>FLUID80 8 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Axisymmetric Harmonic Contained Fluid</p>  <p>FLUID81 4 nodes 2-D space DOF: UX, UY, UZ</p>
<p>Acoustic Fluid</p>  <p>FLUID129 2 nodes 2-D space DOF: PRES</p>	<p>Acoustic Fluid</p>  <p>FLUID130 4 nodes 3-D space DOF: PRES</p>	<p>FLOTRAN CFD Fluid - Thermal</p>  <p>FLUID141 4 nodes 2-D space DOF: VX, VY, VZ, PRES, TEMP, ENKE, ENDS</p>	<p>FLOTRAN CFD Fluid - Thermal</p>  <p>FLUID142 8 nodes 3-D space DOF: VX, VY, VZ, PRES, TEMP, ENKE, ENDS</p>	<p>Thermal Electric</p> <p>Thermal- Electric Solid</p>  <p>PLANE67 4 nodes 2-D space DOF: TEMP, VOLT</p>
<p>Thermal- Electric Line</p>  <p>LINK68 2 nodes 3-D space DOF: TEMP, VOLT</p>	<p>Thermal- Electric Solid</p>  <p>SOLID69 8 nodes 3-D space DOF: TEMP, VOLT</p>	<p>Thermal- Electric Shell</p>  <p>SHELL157 4 nodes 3-D space DOF: TEMP, VOLT</p>	<p>Magnetic Electric</p> <p>Current Source</p>  <p>SOURC36 3 nodes 3-D space DOF: MAG</p>	<p>Magnetic Solid</p>  <p>PLANE53 8 nodes 2-D space DOF: VOLT, AZ</p>

<p>Magnetic-Scalar Solid</p>  <p>SOLID96 8 nodes 3-D space DOF: MAG</p>	<p>Magnetic Solid</p>  <p>SOLID97 8 nodes 3-D space DOF: VOLT, AX, AY, AZ</p>	<p>Magnetic Interface</p>  <p>INTER115 4 nodes 3-D space DOF: AX, AY, AZ, MAG</p>	<p>Magnetic Edge Solid</p>  <p>SOLID117 20 nodes 3-D space DOF: AZ</p>	<p>Magnetic-High Frequency</p>  <p>HF119 4 nodes 3-D space DOF: AX</p>
<p>Magnetic-High Frequency</p>  <p>HF120 20 nodes 3-D space DOF: AX</p>	<p>Electrostatic Solid</p>  <p>PLANE121 8 nodes 2-D space DOF: VOLT</p>	<p>Electrostatic Solid</p>  <p>SOLID122 20 nodes 3-D space DOF: VOLT</p>	<p>Tetrahedral Electrostatic Solid</p>  <p>SOLID123 10 nodes 3-D space DOF: VOLT</p>	<p>General Circuit</p>  <p>CIRCU124 2-6 nodes 3-D space DOF: VOLT, CURR, EMF</p>
Coupled-field				Contact
<p>Coupled-field Solid</p>  <p>SOLID5 8 nodes 3-D space DOF: UX, UY, UZ, TEMP, VOLT, MAG</p>	<p>Coupled-field Solid</p>  <p>PLANE13 4 nodes 2-D space DOF: UX, UY, TEMP, VOLT, AZ</p>	<p>Coupled-field Solid</p>  <p>SOLID62 8 nodes 3-D space DOF: UX, UY, UZ, AX, AY, AZ, VOLT</p>	<p>Tetrahedral Coupled-field Solid</p>  <p>SOLID98 10 nodes 3-D space DOF: UX, UY, UZ, TEMP, VOLT, MAG</p>	<p>Point-to-Point</p>  <p>CONTACT12 2 nodes 2-D space DOF: UX, UY</p>
<p>Point-to-Ground</p>  <p>CONTACT26 3 nodes 2-D space DOF: UX, UY</p>	<p>Point-to-Surface</p>  <p>CONTACT48 3 nodes 2-D space DOF: UX, UY, TEMP</p>	<p>Point-to-Surface</p>  <p>CONTACT49 5 nodes 3-D space DOF: UX, UY, UZ, TEMP</p>	<p>Point-to-Point</p>  <p>CONTACT52 2 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Contact</p>  <p>TARGE169 3 nodes 2-D space DOF: UX, UY</p>

<p>Contact</p>  <p>TARGE170 3 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Contact</p>  <p>CONTA171 2 nodes 2-D space DOF: UX, UY</p>	<p>Contact</p>  <p>CONTA172 3 nodes 2-D space DOF: UX, UY</p>	<p>Contact</p>  <p>CONTA173 4 nodes 3-D space DOF: UX, UY, UZ</p>	<p>Contact</p>  <p>CONTA174 8 nodes 3-D space DOF: UX, UY, UZ</p>
Combination				
<p>Revolute Joint</p>  <p>COMBIN7 5 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Spring-Damper</p>  <p>COMBIN14 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ, PRES, TEMP</p>	<p>Control</p>  <p>COMBIN37 4 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ, PRES, TEMP</p>	<p>Nonlinear Spring</p>  <p>COMBIN39 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ, PRES, TEMP</p>	<p>Combination</p>  <p>COMBIN40 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ, PRES, TEMP</p>
Matrix		Infinite		
<p>Stiffness, Mass or Damping Matrix</p>  <p>MATRIX27 2 nodes 3-D space DOF: UX, UY, UZ, ROTX, ROTY, ROTZ</p>	<p>Superelement</p>  <p>MATRIX50 2-D or 3-D space DOF: Any</p>	<p>Infinite Boundary</p>  <p>INFIN9 2 nodes 2-D space DOF: AZ, TEMP</p>	<p>Infinite Boundary</p>  <p>INFIN7 4 nodes 3-D space DOF: MAG, TEMP</p>	<p>Infinite Boundary</p>  <p>INFIN110 4 nodes 2-D space DOF: AZ, VOLT, TEMP</p>
<p>Infinite Boundary</p>  <p>INFIN11 8 nodes 3-D space DOF: MAG, AX, AY, AZ, VOLT, TEMP</p>	Surface		<p>Surface Effect</p>  <p>SURF22 8 nodes 3-D space DOF: UX, UY, UZ, TEMP</p>	
<p>Surface Effect</p>  <p>SURF19 3 nodes 2-D space DOF: UX, UY, TEMP</p>				