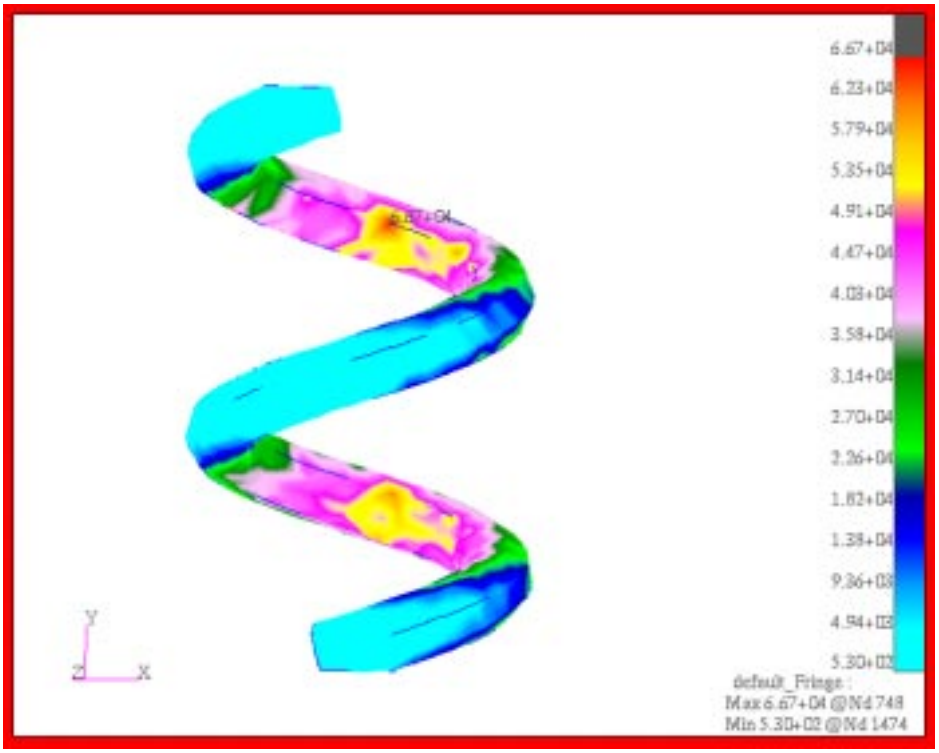
Supplementary Exercise - 6

Helical Spring



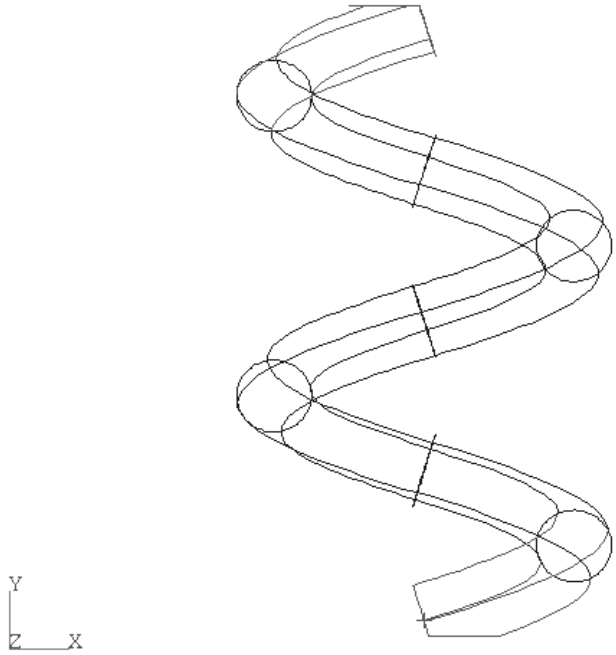
Objective:

- Develop model of a helical spring
- Perform a linear analysis to obtain displacements and stresses.

Helical Spring

Model Description:

In this exercise you will create a simple helical spring model, apply loads to it, and obtain displacements and stresses from a linear static simulation.



Analysis Code:	MSC/NASTRAN
Element type:	Tet10
Element Global Edge Length:	0.3

Figure 1-1

Suggested Exercise Steps:

- Create a new database named **spring.db**.
- Change the Tolerance to Default and the Analysis Code to MSC/NASTRAN.
- Create the geometry and finite element mesh using the information in Figure 1-1.
- Create boundary conditions restraining one end of the spring model.
- Create loading on the other end of the spring.
- Define spring material named **alum**.
- Define a set property for the Tet10 elements called **spring**.
- Obtain model displacements and stresses, and display them using Patran Results.

Helical Spring

Exercise Procedure:

1. Create a new database and name it **spring.db**.

File/New...

New Database Name | **spring**

OK

2. Change the *Tolerance* to **Default** and the *Analysis Code* to **MSC/NASTRAN**.

New Model Preference

Tolerance | **Default**

Analysis Code: | **MSC/NASTRAN**

OK

3. Create the geometry to represent the helical spring. First, create helical curves to be used as glide curves.

Create a solid

Geometry

Action: | **Create**

Object: | **Curve**

Method: | **XYZ**

Vector Coordinates List | **<0 0.5 0>**

Origin Coordinates List | **[0 0 0]**

Apply

Action: | **Transform**

Object: | **Curve**

Method: | **Translate**

Translation Vector	**<0 0.5 0>**
Repeat Count	**7**
Curve List	**Curve 1**

Apply

Action:	**Create**
Object:	**Curve**
Method:	**2D ArcAngles**
Radius	**1.0**
End Angle	**90.0**
Construction Plane List	**Coord 0.2**
Center Point List	**[0 0 0]**

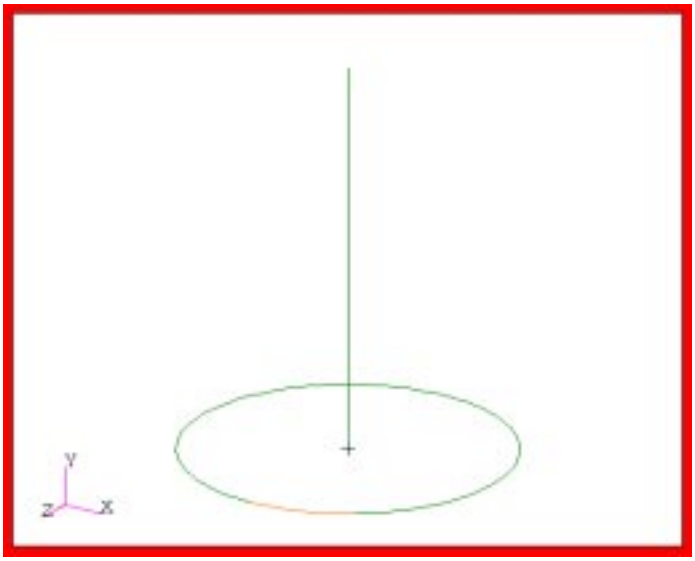
Apply

Action:	**Transform**
Object:	**Curve**
Method:	**Rotate**
Axis	**Coord 0.2**
Rotation Angle	**90.0**
Repeat Count	**3**
Curve List	**Curve 9**

Apply

Helical Spring

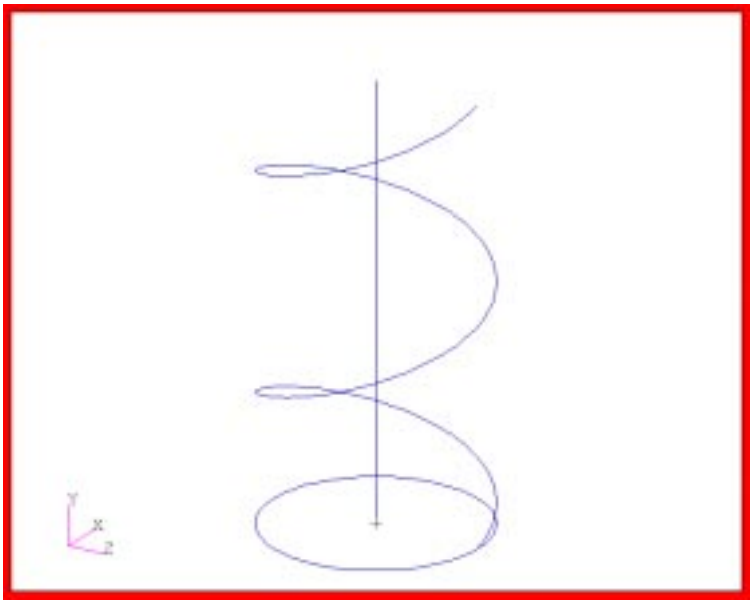
The curves shown below will be used to create the helical glide curves



Action:	**Transform**
Object:	**Curve**
Method:	**Vsum**
Curve 1 List	**Curve 1:8**
Curve 2 List	**Curve 9:12 9:12**

Apply

These are the helical glide curves.



Create the surface to be glided to create the solids. Create a curve normal to the first glide curve.

Action:	**Create**
Object:	**Curve**
Method:	**2D Normal**
Input Length	**0.25**
Construction Plane List	**Coord 0.2 0.3**
Point List	**Point 10**
Curve List	**Curve 13**

Apply

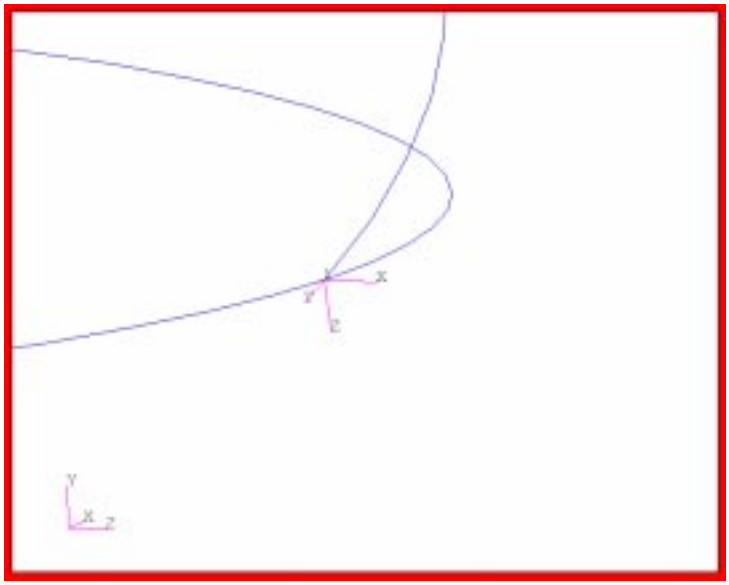
Create local coordinate system for revolving a point to make an arc.

Action:	**Create**
Object:	**Coord**
Method:	**3 Point**
Origin	**Point 10**
Point on Axis 3	**Point 22**

Helical Spring

Point on Plane 1-3	**Point 23**

Apply



Create a 90 degree arc.

Action:	**Create**
Object:	**Curve**
Method:	**Revolve**
Axis	**Coord 1.2**
Total Angle	**90.0**
Point List	**Point 22**

Apply

Create three more arcs to complete a circle.

Action:	**Transform**
Object:	**Curve**
Method:	**Rotate**
Axis	**Coord 1.2**
Rotation Angle	**90.0**
Repeat Count	**3**
Curve List	**Curve 23**

Apply

Create a circular surface from the four 90 degree arcs.

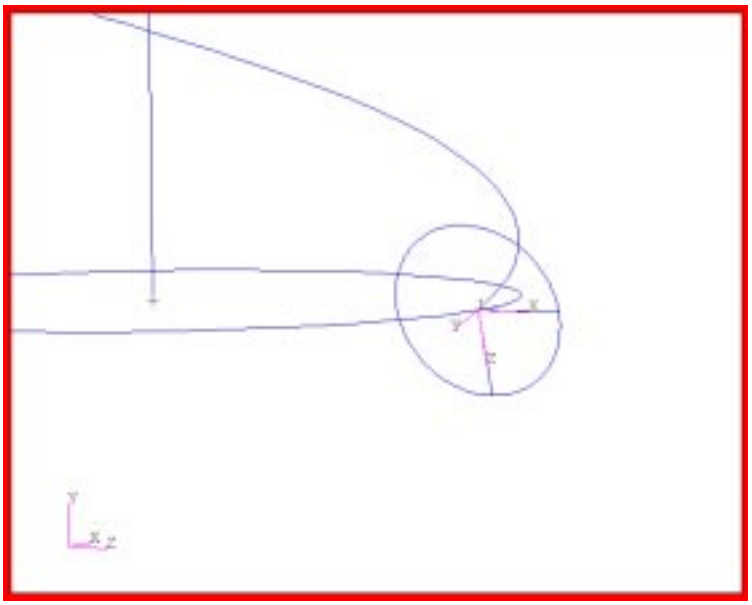
Action:	**Create**
Object:	**Surface**
Method:	**Edge**
Option:	**4 Edge**
Surface Edge 1 List	**Curve 23**
Surface Edge 2 List	**Curve 24**
Surface Edge 3 List	**Curve 25**
Surface Edge 4 List	**Curve 26**

Apply

Helical Spring

Turn on the geometric display lines using toolbar icon.

This four edged surface does not have any degenerate edges, as a circular surface created by revolving a curve 360 degrees would.

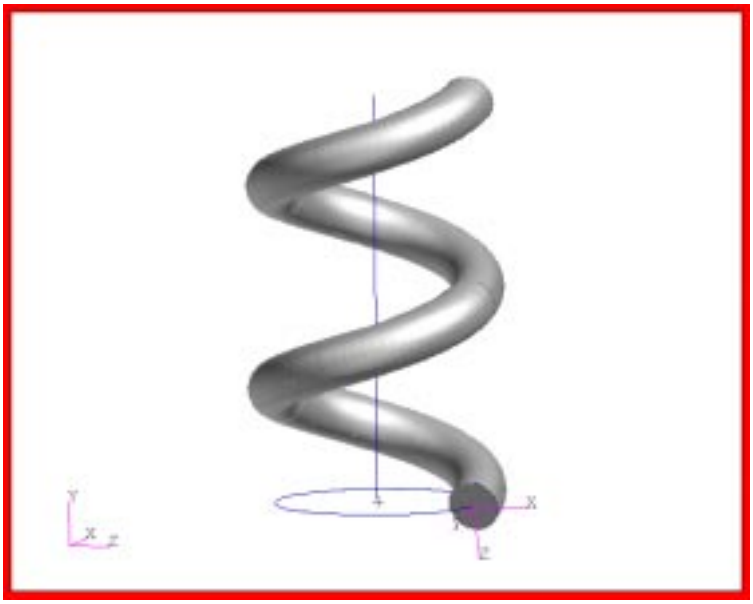


Create parametric solids by gliding the surface.

Action:	**Create**
Object:	**Solid**
Method:	**Glide**
◆ ***Normal Project Glide***	
Director Curve List	**Curve 13:20**
Base Surface List	**Surface 1**

Apply

These solids do not have any degenerate faces.



Trim the bottom and top solids to create flat surfaces on the spring.

Action:	**Create**
Object:	**Plane**
Method:	**Vector Normal**
Plane Offset Distance	**-0.1**
Vector List	**Coord 0.2**

Apply

Plane Offset Distance	**4.1**
Vector List	**Coord 0.2**

Apply

Helical Spring

Action:	**Edit**
Object:	**Solid**
Method:	**Break**
Option:	**Plane**
☐ ***Delete Original Solids***	
Solid List	**Solid 1 8**
Break Plane List	**Plane 1 2**

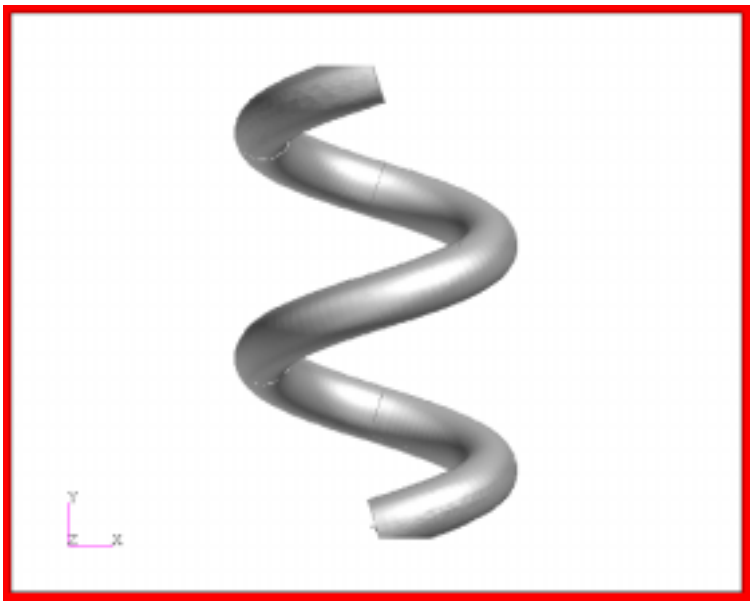
Apply

Action:	**Delete**
Object:	**Solid**
Solid List	**Solid 9 12**

Apply

Delete Curves and both planes as they are not needed to continue.

The final step in creating the geometry (trimming the bottom and top solids) can require that the bottom and top solids have no degenrate faces before trimming.



Mesh the model

4. Now create the tetmesh for the model.

◆ ***Finite Elements***

Action:	**Create**
Object:	**Mesh**
Type:	**Solid**
Global Edge Length	**0.3**
Mesher:	◆ ***Tet Mesh***
Element Topology:	**Tet10**
Input List	**Solid 2:7 10 11**

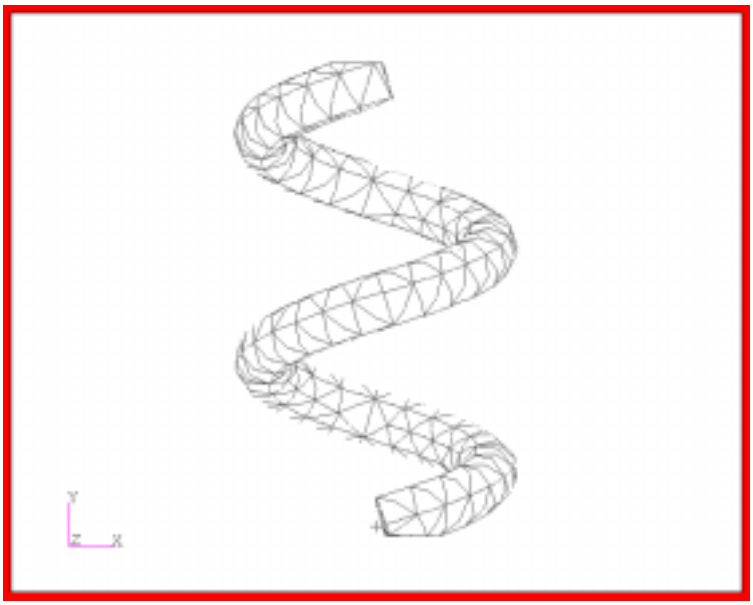
Apply

Action:	**Equivalence**
Object:	**All**
Method:	**Tolerance Cube**

Apply

Helical Spring

Your finite element model should look like the one shown in the figure below.



5. Create Loads and Boundary Conditions.

Create Loads and BCs

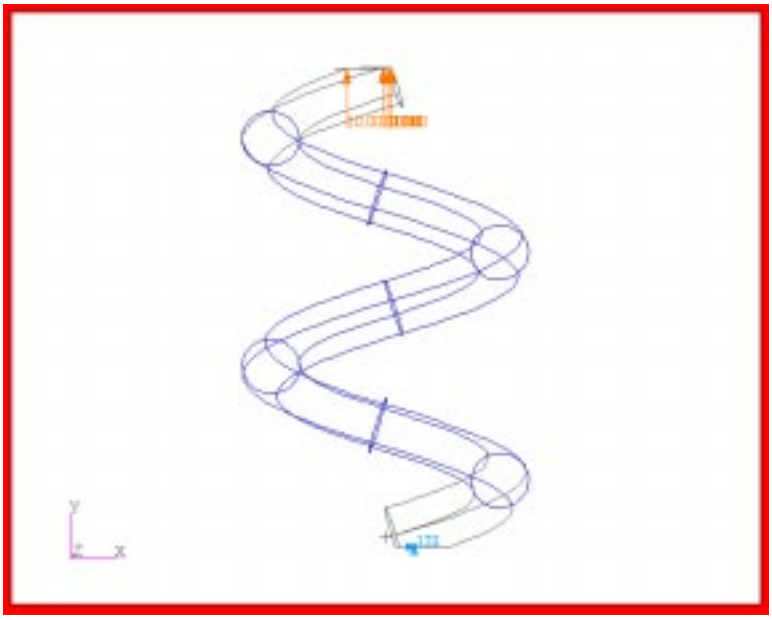
◆ ***Loads/BCs***

Action:	**Create**
Object:	**Displacement**
Type:	**Nodal**
New Set Name	**fixed_end**
Input Data...	
Translations	**< 0 0 0 >**
OK	
Select Application Region...	
Select Geometry Entities	**Solid 10.7 (select solid face at bottom of model)**
Add	
OK	
Apply	

Action:	**Create**
Object:	**Force**
Type:	**Nodal**
New Set Name	**force_up**
Input Data...	
Force	**< 0 10 0 >**
OK	
Select Application Region...	
Select Geometry Entities	**Solid 11.4 (select solid face at top of model)**
Add	
OK	
Apply	

Helical Spring

The corresponding loads and boundary conditions are displayed below:



6. Create a material for aluminum called **alum**.

Create Material

◆ ***Materials***

Action:	**Create**
Object:	**Isotropic**
Method:	**Manual Input**
Material Name	**alum**
Input Properties...	
Elastic Modulus	**10e6**
Poisson Ratio	**0.3**
Density	**0.000259**

Apply

Cancel

Create Property

7. Define tet10 element property set called **spring**.

◆ ***Properties***

Action:	**Create**
Object:	**3D**
Type:	**Solid**
Property Set Name	**spring**
Input Properties...	
Material name	**m:alum**
OK	
Select Members	**Solid 2:7 10 11**
Add	
Apply	

8. Analyze the model

◆ ***Analysis***

Action:	**Analyze**
Object:	**Entire Model**
Method:	**Full Run**
Apply	

9. Read the results into the Patran database.

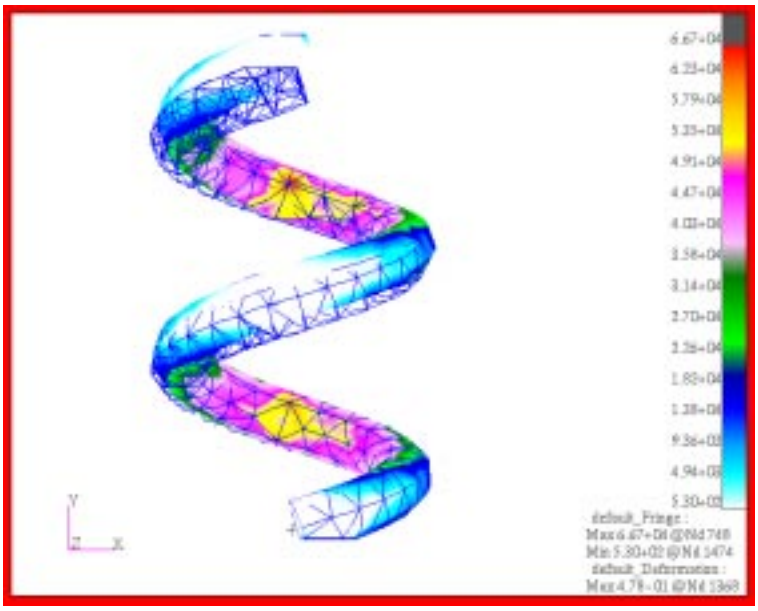
Action:	**Read Output2**
Object:	**Result Entities**
Method:	**Translate**
Select Results File...	
Selected Results File:	**spring.op2**
OK	
Apply	

In Results, use quick plot and choose stress tensor for your fringe result and displacements for deformation results.

◆ ***Results***

Action:	**Create**
Object:	**Quick Plot**
Select Result Cases:	**Default, Static Subcase**
Select Fringe Result:	**Stress, Tensor**
Select Deformation Result:	**Displacements, Translational**
Apply	

The following shows both the displacement and stresses.



10. When completed with this exercise, close the database.

File/Quit...