# Abaqus tutorial Modal Analysis in 3D

#### Problem

• We will be doing a modal analysis to find the first 7 natural frequencies of a 3D hollow cylinder as shown below, which has one of the ends fixed.



#### Part Module

- Click Create Part with the settings as shown in the figure.
- Create a sketch as shown below. Enter Depth 10.







## Property Module

- Click on Create Material.
- Name it Steel.
- Set General -> Density = 7e3.
- Set Mechanical -> Elasticity -> Elastic, Young's Modulus = 210e9 and Poisson's Ratio = 0.3.

	🜩 Edit Material	×
	Name: Steel	
	Description:	1
	Material Behaviors	
	Density	
	<u>G</u> eneral <u>M</u> echanical <u>T</u> hermal <u>E</u> lectrical/Magnetic <u>O</u> ther	1
	Density	
	Distribution: Uniform	
	Use temperature-dependent data	
	Data	
	Mass Density	
	1 7e3	
🜩 Edit Material	×	
Name: Steel		
Description:	J#	
Material Behaviors		
Density Electic		
<u>G</u> eneral <u>M</u> echanical <u>T</u> herma	al <u>E</u> lectrical/Magnetic <u>O</u> ther	
Elastic		
Type: Isotropic	▼ Suboptions	
Use temperature-dependent o	Jata	
Number of field variables:	0	
Moduli time scale (for viscoelasti	icity): Long-term	
No compression		
No tension		
Data Verret		
Young's Poiss Modulus Rat	on s tio	
1 210e9 0.	3	

## Property Module

- Click on Create Section.
  Select options shown on the right and Click OK.
- Next Click Assign Section. Select the section created and Click OK.



#### Assembly Module

 In Assembly Module, click on Create Instance, select the part, check the Dependent option and click OK.



## Step Module

- In Step Module, click on Create Step.
- Name it Modal.
- Select Procedure type : Linear perturbation and select Frequency.
- Click Continue

	Module:	Step 🗠 Model: 🗘 Model-1		
)÷	•••	💠 Create Step 🛛 🗙		
	Create Step	Name: Modal Insert new step after Initial		
	(XY2) ↓ ↓ ↓	Procedure type: Linear perturbation Buckle		
Static, Linear perturbation Steady-state dynamics, Direct Substructure generation				
		Continue Cancel		

## Step Module

- In the next window, select Lanczos eigensolver.
- Set the "Value" of "Number of eigenvalues requested" to 7.
- Click OK

🜩 Edit Step	<
Name: Modal	
Type: Frequency	
Basic Other	
Description	
	-
Nigeom: Off	
Eigensolver: O Lanczos O Subspace O AMS	
Number of eigenvalues requested: O All in frequency range	
• Value: 7	
Frequency shift (cycles/time)**2:	
Acoustic-structural coupling where applicable:	
Olnclude ○ Exclude ○ Project	
Minimum frequency of interest (cycles/time):	
Maximum frequency of interest (cycles/time):	
Block size: O Default 🔿 Value:	
Maximum number of block Lanczos steps: 🗿 Default 🔘 Value:	
Use SIM-based linear dynamics procedures	
Project damping operators	
Include residual modes	
OK Cancel	

## Load Module

- In load module, select "Boundary Condition Manager".
- Select Step to Initial.
- Select Displacement/Rotation. Click Continue.
- Select a flat circular face. Click Done.
- Check all quantities in the next screen and Click OK.



## Mesh Module

- Click on Part instead of Assembly as shown on the right.
- On the toolbar Mesh -> Control and select Hex with Sweep and click OK.
- In Mesh -> Element Type, Select Hex, 3D Stress, Linear and uncheck reduced integration. Element should be C3D8.





# Mesh Module

- Click on Seed Edges and select the four circles on the flat faces (you should hold Shift key to select multiple edges and Ctrl + Alt + Click to rotate the body) and click Done.
- Set By number and enter Number of elements = 20.
- Click on Mesh Part and select Yes.
- You should get a mesh as shown.







## Job Module

- Click on Create Job. Name it as Modal. Select the model and click Continue.
- In the next screen, click OK.
- Click on Job Manager, select Modal and click on Submit.
- The program will run for a few seconds.



	Jol Mana	ager Job Manager				×
ΗШ		Name	Model	Туре	Status	Write Input
T		Elastodynamics	Model-1	Full Analysis	None	Data Check
						Submit
						Continue
						Monitor
						Results
						Kill
		Create	Edit Copy	Rename	Delete	Dismiss

## Visualization Module

- After the job is completed, right click on the Modal job and select results.
- This will go to the results tab.



## Visualization Module

- To see the current mode, Click on "Animate Harmonic".
- To switch between the modes, stop the current animation by clicking on the "Animate Harmonic" button again.
- Select the Next or Previous buttons on the top right of the screen.
- In "Animation Options", chose Scale Factor/ Harmonic tab and check Full Cycle.
- The animation speed can be set in Player tab of "Animation Options".





## Visualization Module

- You can view the frequency of each mode as well.
- Select Result -> Step/Frame.
- A window which has the Natural frequencies will pop up.

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😑 <u>F</u> ile	<u>M</u> odel	Vie <u>w</u> port	<u>V</u> iew	<u>R</u> esult	<u>P</u> lot	<u>A</u> nimate	Report
! 🗋 🖆	j 🖪 🚔		110 to P	<u>Step</u> <u>A</u> ctiv Secti	/Frame ve Step ion <u>P</u> oi	e s/Frames nts	/lagnit
Model	Results			<u>F</u> ield Histe	l Outpu ory Out	ıt tput	ualizat
Session	Data		✓ \$ 6	 Opti	ons		
1	utput Data	bases (1)			>	LC S	U,
-	Step/Frame					×	
	ep Name Idal	D	escription				
Fran	ne						
[ Ind	lex Descript Increment	ion nt     0: Base State	2				

1: Value = 13641. Freq = 18.588 (cycles/time)

2: Value = 13641. Freq = 18.588 (cycles/time)

3: Value = 2.77761E+05 Freg = 83.879 (cvcles/time)

	ОК	Apply	Field Out	put	Cancel
7	Mode	7: Value = 1.450	14E+06 Freq =	191.66 (	cycles/time)
6	Mode	6: Value = 7.442	76E+05 Freq =	137.31 (	cycles/time)
5	Mode	5: Value = 3.397	89E+05 Freq =	92.774 (	cycles/time)
4	Mode	4: Value = 3.397	89E+05 Freq =	92.774 (	cycles/time)

Mode

Mode

Mode

2

3

#### **Unconstrained Model**

Make a copy of the completed model. In the copy, remove the cantilever displacement boundary condition. Create a new job associated with the new model and re-run the analysis.

When reviewing results, think about the following:

- 1. How do the modal frequencies differ for the unconstrained case?
- 2. Is there a modal frequency and deformation mode in the unconstrained case that closely matches any frequencies associated with the constrained model?