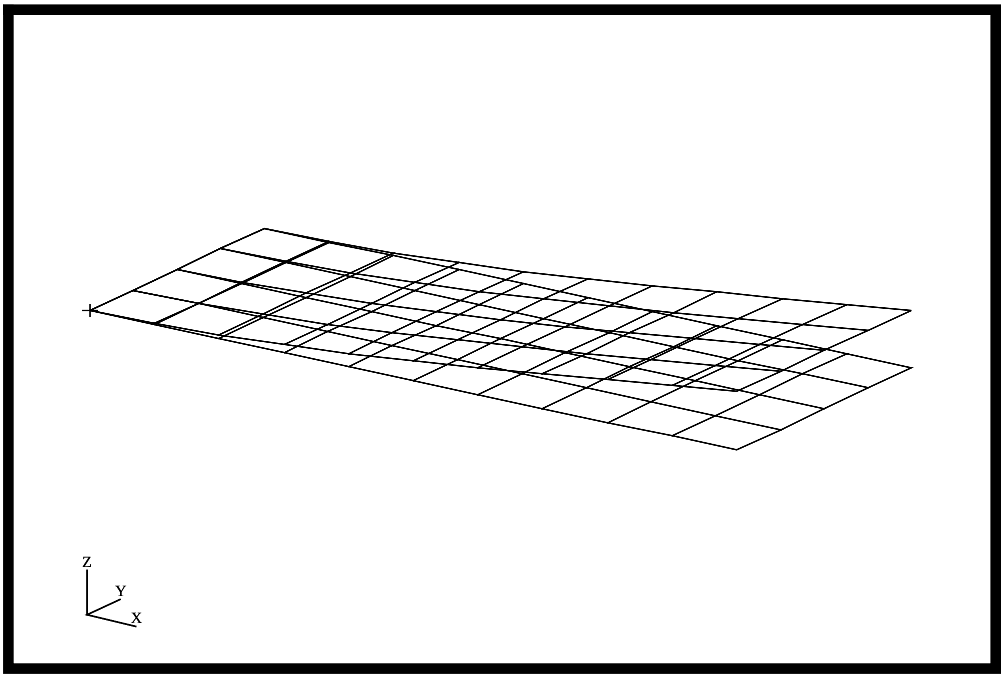
WORKSHOP PROBLEM 4

Modal Transient Response Analysis



Objectives

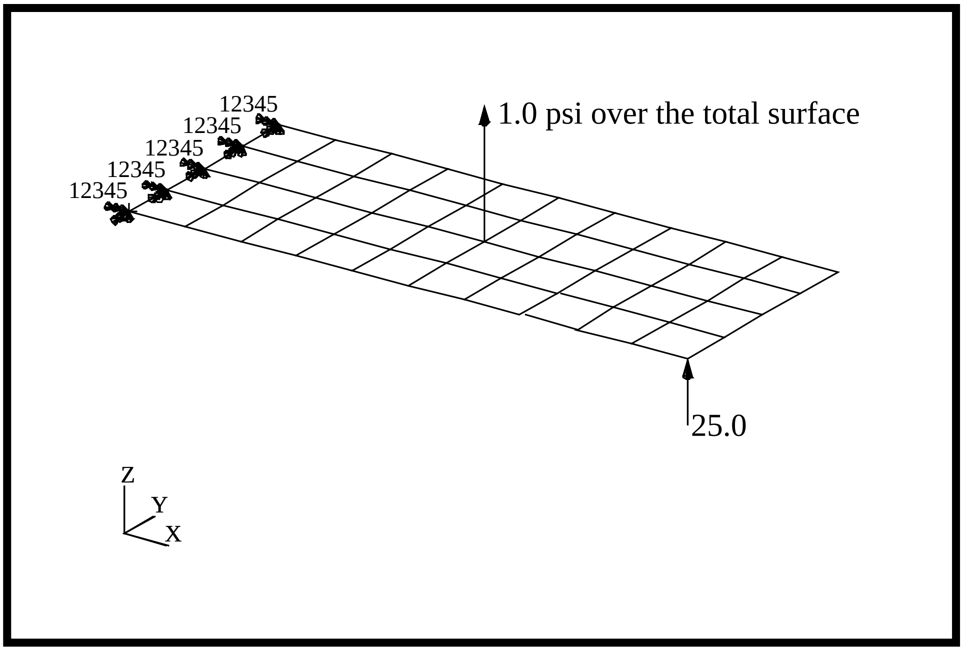
- Define time-varying excitation.
- Produce a MSC/NASTRAN input file from a dynamic math model, created in Workshop 1.
- Submit the file for analysis in MSC/NASTRAN.
- Compute nodal displacements for desired time domain.

Model Description:

Using the Modal Method, determine the transient response of the flat rectangular plate, created in Workshop 1, under time-varying excitation. This example structure shall be excited by a 1 psi pressure load over the total surface of the plate varying at 250Hz. In addition, a 25 lb force is applied at a corner of the tip also varying at 250Hz but starting 0.004 seconds after the pressure load begins. Both time-dependent dynamics loads are applied only for the duration of 0.008 seconds only. Use a modal damping of $\zeta = 0.03$ for all nodes. Carry out the analysis for 0.04 seconds.

Below is a finite element representation of the flat plate. It also contains the loads and boundary constraints.

Figure 4.1-Loads and Boundary Conditions



Suggested Exercise Steps

- Reference previously created dynamic math model, **plate.bdf**, by using the INCLUDE statement.
- Specify modal damping as a tabular function of natural frequency (TABDMP1).
- Define the time-varying pressure loading (PLOAD2, LSEQ and TLOAD2).
- Define the time-varying tip load (DAREA and TLOAD2).
- Define the time delay term in the equations of the dynamic loading function (DELAY).
- Combine the time-varying loads (DLOAD).
- Specify integration time steps (TSTEP).
- Prepare the model for a modal transient analysis (SOL 112).
- Request response in terms of nodal displacement at grid 11, 33, and 55.
- Generate an input file and submit it to the MSC/NASTRAN solver for normal modes analysis.
- Review the results, specifically the nodal displacements.

```
ID SEMINAR,PROB4

CEND

BEGIN BULK
```

1	2	3	4	5	6	7	8	9	10

1	2	3	4	5	6	7	8	9	10

ENDDATA

Exercise Procedure:

1. Users who are not utilizing MSC/PATRAN for generating an input file should go to Step 11, otherwise, proceed to step 2.

2. Create a new database and named **prob4.db**.

   File/New Database

New Database Name	**prob4**
OK	

   In the *New Model Preference* form set the following:

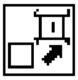
Tolerance	◆ **Default**
Analysis code:	**MSC/NASTRAN**
OK	

3. Create the model by importing an existing MSC/NASTRAN input file, **(plate.bdf)**.

   ◆ **Analysis**

Action:	**Read Input File**
Object:	**Model Data**
Method:	**Translate**
Select Input File	
Select Input File	**plate.bdf**
OK	
Apply	
OK	

4. Activate the entity labels by selecting the Show Labels icon on the tool-bar.

    **Show Labels**

5. Add the pre-defined constraints into a newly defined load case.

◆ **Load Cases**

Action:	**Create**
Load Case Name:	**transient_response**
Load Case Type:	**Time Dependent**
Assign/Prioritize Loads/BCs	
Select Load/BCs to Add to Spreadsheet *(Select from menu.)*	**Displ_spc1.1**
OK	
Apply	

6. Create a time-dependent field for the pressure loading.

◆ **Fields**

Action:	**Create**
Object:	**Non Spatial**
Method:	**Tabular Input**
Field Name:	**time_dependent_pressure**
Options ...	
Maximum Number of t:	**21**
OK	
Input Data ...	
Map Function to Table...	
PCL Expression f'(t):	**sind(90000.*'t)**
Start time:	**0.0**
End time:	**0.008**
Number of Points:	**20**
Apply	
Cancel	

Go back to the ***Time/Frequency Scalar Table Data*** window, go down to row 21, and add the following:

	Time(t)	Value
21	**0.04**	**0.0**

OK

Apply

7. Create a time-dependent field for the nodal force.

 7a. First, define the PCL function manually.

 7b. The text below defines a PCL function called **nodal_force**. Using a text editor, input the text into a file called **prob4.pcl**.

```
Function nodal_force(t)

real t

if (t < 0.004 || t > .012) then
   return 0.0
else
   return sind(90000.*t)
end if
End Function
```

 7c. To compile PCL function, go into the command line and type:

!!input prob4

◆ **Fields**

Action:	**Create**
Object:	**Non Spatial**
Method:	**Tabular Input**
Field Name:	**time_dependent_force**

Options...

Maximum Number of t:	**32**

OK

Input Data...

Map Function to Table...

PCL Expression f'(t):	**nodal_force('t)**
Start time:	**0.000**
End time:	**0.012**
Number of Points:	**31**

Apply

Cancel

Go back to the *Time/Frequency Scalar Table Data* window, go down to row 32, and add the following:

	Time(t)	Value
32	**0.04**	**0.0**

OK

Apply

8. Create the time-dependent pressure.

◆ **Loads/BCs**

Action:	**Create**
Object:	**Pressure**
Type:	**Element Uniform**
New Set Name:	**pressure**
Target Element Type:	**2D**

Input Data...

Top Surf Pressure	**-1**
Time Dependence *(Select from the* ***Time Dependent Fields*** *box.)*	**f:time_dependent_pressure**

OK

Select Application Region ...

◆ **FEM**

Select 2D Elements or Edge | **Elm 1:40**
(Select all elements.)

Add

OK

Apply

9. Create the time-dependent nodal force.

◆ **Loads/BCs**

Action:	**Create**
Object:	**Force**
Type:	**Nodal**
New Set Name:	**force**

Input Data ...

Force <F1 F2 F3>	**<0 0 25>**
Time Dependence *(Select from the* ***Time Dependent Fields*** *box.)*	**f:time_dependent_force**

OK

Select Application Region ...

◆ **FEM**

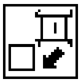
Select Nodes | **Node 11**

Add

OK

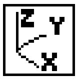
Apply

To simplify the view, turn off the entity labels using the toolbar.



Hide Labels

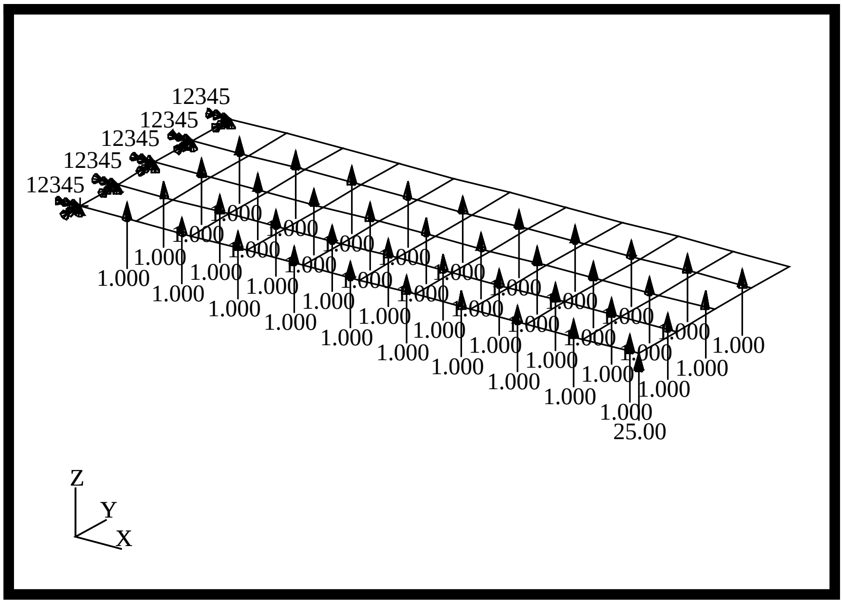
In addition, switch to a 3 view isometric view point.



Iso 3 View

The result should be similar to Figure 4.2.

Figure 4.2



10. Generate the input file.

◆ **Analysis**

Action:	**Analyze**
Object:	**Entire Model**
Method:	**Analysis Deck**
Jobname:	**prob4**
Solution Type...	
Solution Type:	◆ **TRANSIENT RESPONSE**
Solution Parameters ...	
Formulation	**Modal**
Mass Calculation	**Coupled**
Wt.-Mass Conversion	**.00259**
Eigenvalue Extraction...	
Number of Desired Roots	**5**
OK	

OK

OK

Direct Text Input...

◆ **Case Control Section** — **SDAMPING = 100**

◆ **Bulk Data Section** — **TABDMP1, 100, CRIT,**
+, 0., .03, 10., .03, ENDT

(Note that these are two separate lines.)

OK

Subcase Create...

Available Subcases — **transient_response**

(Select from menu.)

Subcase Parameters...

Ending Time = — **.04**

Number of Time Steps = — **100**

OK

Output Requests...

Form Type: — **Advanced**

under *Output Requests*, highlight:

SPCFORCES(SORT1,Real)=ALL FEM

Delete

Output Requests: — select **DISPLACEMENT(...**

Sorting: — **By Freq/Time**

Modify

OK

Apply

Cancel

Subcase Select ...	
Subcases Selected: *(Click to deselect.)*	**default**
Subcases for Solution Sequence: 112 *(Click to select.)*	**transient_response**
OK	
Apply	

An MSC/NASTRAN input file called **prob4.bdf** will be generated. This process of translating your model into an input file is called the Forward Translation. The Forward Translation is complete when the Heartbeat turns green. MSC/PATRAN Users should proceed to step 12.

Generating an input file for MSC/NASTRAN Users:

MSC/NASTRAN users can generate an input file using the data previously stated. The result should be similar to the output below.

11. MSC/NASTRAN input File: **prob4.dat**

```
ID SEMINAR, PROB4
SOL 112
TIME 30
CEND
TITLE = TRANSIENT RESPONSE WITH TIME DEPENDENT PRESSURE AND POINT LOADS
SUBTITLE = USE THE MODAL METHOD
ECHO = UNSORTED
SPC = 1
SET 111 = 11, 33, 55
DISPLACEMENT(SORT2) = 111
SDAMPING = 100
SUBCASE 1
METHOD = 100
DLOAD = 700
LOADSET = 100
TSTEP = 100
$
OUTPUT (XYPLOT)
XGRID=YES
YGRID=YES
XTITLE= TIME (SEC)
YTITLE= DISPLACEMENT RESPONSE AT LOADED CORNER
XYPLOT DISP RESPONSE / 11 (T3)
YTITLE= DISPLACEMENT RESPONSE AT TIP CENTER
XYPLOT DISP RESPONSE / 33 (T3)
YTITLE= DISPLACEMENT RESPONSE AT OPPOSITE CORNER
XYPLOT DISP RESPONSE / 55 (T3)
$
BEGIN BULK
PARAM, COUPMASS, 1
PARAM, WTMASS, 0.00259
$
$ PLATE MODEL DESCRIBED IN NORMAL MODES EXAMPLE PROBLEM
$
INCLUDE 'plate.bdf'
$
$ EIGENVALUE EXTRACTION PARAMETERS
$
```

```
EIGRL, 100, , ,5
$
$ SPECIFY MODAL DAMPING
$
TABDMP1, 100, CRIT,
+, 0., .03, 10., .03, ENDT
$
$ APPLY UNIT PRESSURE LOAD TO PLATE
$
LSEQ, 100, 300, 400
$
PLOAD2, 400, 1., 1, THRU, 40
$
$ VARY PRESSURE LOAD (250 HZ)
$
TLOAD2, 200, 300, , 0, 0., 8.E-3, 250., -90.
$
$ APPLY POINT LOAD (250 HZ)
$
TLOAD2, 500, 600,610, 0, 0.0, 8.E-3, 250., -90.
$
DAREA, 600, 11, 3, 1.
DELAY, 610, 11, 3, 0.004
$
$ COMBINE LOADS
$
DLOAD, 700, 1., 1., 200, 25., 500
$
$ SPECIFY INTERGRATION TIME STEPS
$
TSTEP, 100, 100, 4.0E-4, 1
$
ENDDATA
```

Submitting the input file for analysis:

12. Submit the input file to MSC/NASTRAN for analysis.

    12a. To submit the MSC/PATRAN **.bdf** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran prob4.bdf scr=yes**. Monitor the run using the UNIX **ps** command.

    12b. To submit the MSC/NASTRAN **.dat** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran prob4 scr=yes**. Monitor the run using the UNIX **ps** command.

13. When the run is completed, use **plotps** utility to create a postscript file, **prob4.ps**, from the binary plot file **prob4.plt**. The displacement response plots for Grids 11, 33 and 55 are shown in figures 4.3, 4.4, and 4.5**.**

14. When the run is completed, edit the **prob4.f06** file and search for the word **FATAL**. If no matches exist, search for the word **WARNING**. Determine whether existing WARNING messages indicate modeling errors.

15. While still editing **prob4.f06**, search for the word:

    D I S P L (spaces are necessary)

    Displacement at Grid 11.

    Time T3

    .0064= ___________

    .0092= ___________

    .02 = ___________

    Displacement at Grid 33.

    Time T3

    .0068= ___________

    .0092= ___________

    .02 = ___________

Displacement at Grid 55.

Time T3

.0068= ___________

.0092= ___________

.02 = ___________

Comparison of Results

16. Compare the results obtained in the **.f06** file with the results on the following page:

POINT-ID = 11

D I S P L A C E M E N T   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	R3
.0	G	.0	.0	.0	.0	.0	.0
4.000000E-04	G	3.138503E-15	5.333171E-15	1.873720E-04	-6.340404E-06	5.161942E-05	.0
5.999999E-03	G	9.901832E-13	2.054362E-12	1.177721E-01	3.009433E-03	-3.418436E-02	.0
6.399998E-03	G	1.301660E-12	2.610037E-12	1.495051E-01	6.088505E-03	-4.068905E-02	.0
6.799998E-03	G	1.361787E-12	2.701773E-12	1.469920E-01	1.272909E-02	-3.955902E-02	.0
8.799998E-03	G	-1.399555E-12	-2.778663E-12	-1.534481E-01	-1.183270E-02	4.150834E-02	.0
9.199998E-03	G	-1.565439E-12	-3.143368E-12	-1.692225E-01	-1.568289E-02	4.710494E-02	.0
9.599999E-03	G	-1.396290E-12	-2.830759E-12	-1.533197E-01	-1.109114E-02	4.241555E-02	.0
2.000000E-02	G	1.762308E-13	3.609815E-13	2.043042E-02	1.705799E-04	-5.402198E-03	.0
3.959996E-02	G	5.328810E-14	1.099402E-13	6.485358E-03	-1.067494E-05	-1.817145E-03	.0

POINT-ID = 33

D I S P L A C E M E N T   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	R3
.0	G	.0	.0	.0	.0	.0	.0
4.000000E-04	G	-1.482405E-15	5.013036E-15	1.835858E-04	-3.682543E-14	5.086755E-05	.0
5.999999E-03	G	-7.504724E-13	1.795108E-12	1.207052E-01	2.766146E-03	-3.436569E-02	.0
6.399998E-03	G	-9.796515E-13	2.269019E-12	1.556774E-01	6.135463E-03	-4.140196E-02	.0
6.799998E-03	G	-1.045427E-12	2.321332E-12	1.599741E-01	1.308315E-02	-4.083382E-02	.0
7.199998E-03	G	-8.759517E-13	1.829195E-12	1.278863E-01	1.804037E-02	-3.306541E-02	.0
8.799998E-03	G	1.073612E-12	-2.391129E-12	-1.655026E-01	-1.212454E-02	4.270243E-02	.0
9.199998E-03	G	1.217997E-12	-2.696051E-12	-1.851369E-01	-1.596580E-02	4.844051E-02	.0
2.000000E-02	G	-1.280910E-13	3.184533E-13	2.059413E-02	1.496853E-04	-5.411018E-03	.0
3.959996E-02	G	-3.946867E-14	9.686225E-14	6.468208E-03	-2.682333E-05	-1.813416E-03	.0

POINT-ID = 55

D I S P L A C E M E N T   V E C T O R

TIME	TYPE	T1	T2	T3	R1	R2	R3
.0	G	.0	.0	.0	.0	.0	.0
4.000000E-04	G	-4.974573E-15	5.435887E-15	1.873720E-04	6.340404E-06	5.161942E-05	.0
6.399998E-03	G	-2.151553E-12	2.189475E-12	1.615714E-01	5.634375E-03	-4.218743E-02	.0
6.799998E-03	G	-2.229502E-12	2.212659E-12	1.728057E-01	1.248924E-02	-4.215589E-02	.0
7.199998E-03	G	-1.757434E-12	1.697970E-12	1.456460E-01	1.736620E-02	-3.459810E-02	.0
8.799998E-03	G	2.297826E-12	-2.283533E-12	-1.773652E-01	-1.152392E-02	4.395273E-02	.0
9.199998E-03	G	2.561482E-12	-2.555566E-12	-2.007833E-01	-1.524836E-02	4.984966E-02	.0
9.599999E-03	G	2.290908E-12	-2.331874E-12	-1.754856E-01	-1.067918E-02	4.413952E-02	.0
2.000000E-02	G	-2.917673E-13	3.108817E-13	2.072625E-02	1.192453E-04	-5.428383E-03	.0
3.959996E-02	G	-8.886282E-14	9.431532E-14	6.432103E-03	-4.190110E-05	-1.814187E-03	.0

17. MSC/NASTRAN Users have finished this exercise. MSC/PATRAN Users should proceed to the next step.

18. Proceed with the Reverse Translation process, that is importing the **prob4.op2** results file into MSC/PATRAN. To do this, return to the Analysis form and proceed as follows:

◆ **Analysis**

Action:	**Read Output2**
Object:	**Result Entities**
Method:	**Translate**
Select Results File...	
Select Results File	**prob4.op2**
OK	
Apply	

When the translation is complete bring up the **Results** form.

◆ **Results**

Form Type:	**Advanced**
Select Results Case *(Select all.)*	
Get Results	
Select Result	**1.1 Displacements, Translational**
Plot Type	**XY Plot**
Plot Type Options...	
Global Variable	
Global Variables:	**1. Time**
Apply	
Result (Y)	
Results:	**1.1 Displacements, Translational**
Vector Component	❐**X** ❐**Y** ■**Z**

OK

Node IDs **Node 11**

Apply

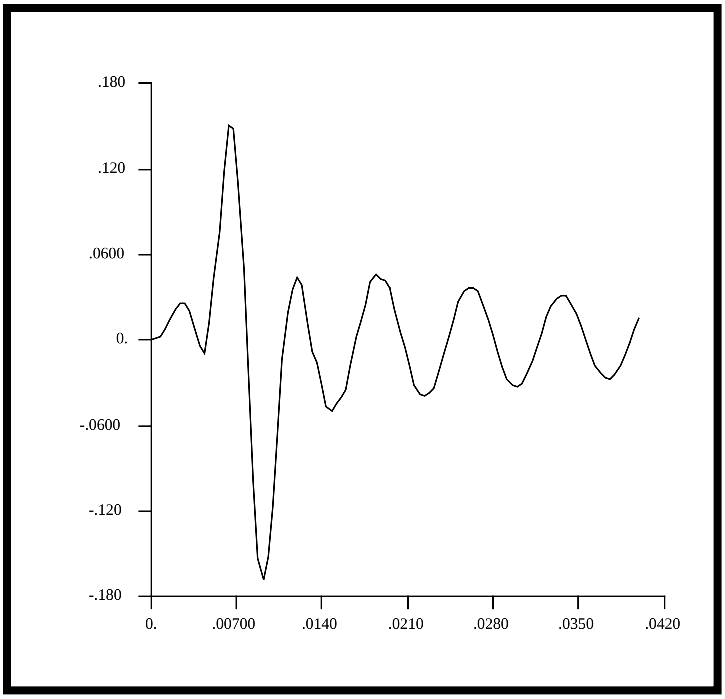
New Title or Title Filter: **Displacement Response At Loaded Corner**

Rename

Apply

The output should look similar to Figure 4.3.

Figure 4.3-Displacement Response at Loaded Corner



19. Repeat the procedure to find the nodal displacement for Node 33.

◆ **Results**

Form Type: **Advanced**

Select Results Case
(Select all.)

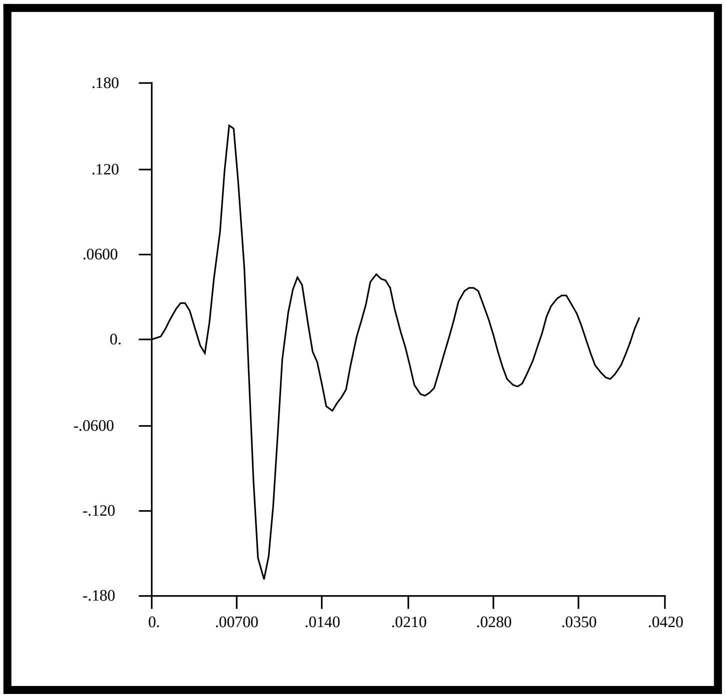
Get Results

Select Result **1.1 Displacements, Translational**

Plot Type	**XY Plot**
Plot Type Options...	
Global Variable	
Global Variables:	**1. Time**
Apply	
Result(Y)...	
Results:	**1.1 Displacements, Translational**
Result(Y)...	❐**X** ❐**Y** ■**Z**
OK	
Node IDs	**Node 33**
Apply	
New Title or Title Filter:	**Displacement Response at Tip Center**
Rename	
Apply	

The output should look similar to Figure 4.4.

Figure 4.4-Displacement Response at Tip Center



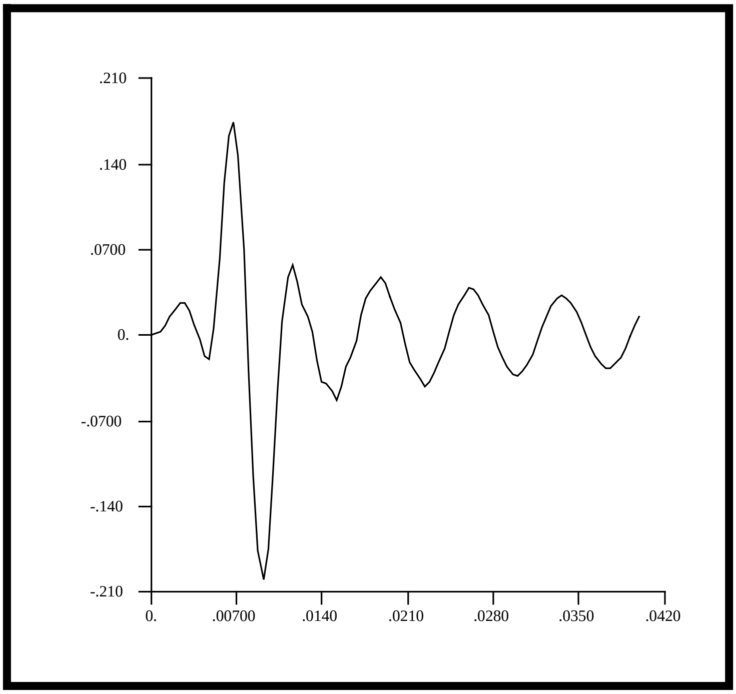
20. Repeat the procedure to find the nodal displacement for Node 55.

◆ **Results**

Form Type:	**Advanced**
Select Results Case *(Highlight all.)*	
Get Results	
Select Result	**1.1 Displacements, Translational**
Plot Type	**XY Plot**
Plot Type Options...	
Global Variable	
Global Variables:	**1. Time**
Apply	
Result(Y)...	
Results:	**1.1 Displacement, Translational**
Result(Y)	❒**X** ❒**Y** ■**Z**
OK	
Node IDs	**Node 55**
Apply	
New Title or Title Filter:	**Displacement Response at Opposite Corner**
Rename	
Apply	

The output should look similar to Figure 4.5.

Figure 4.5-Displacement Response at Opposite Corner



Quit MSC/PATRAN when you are finished with this exercise.