

Modal Analysis

When the beam is deflected from its equilibrium position it undergoes oscillation at the natural frequency.

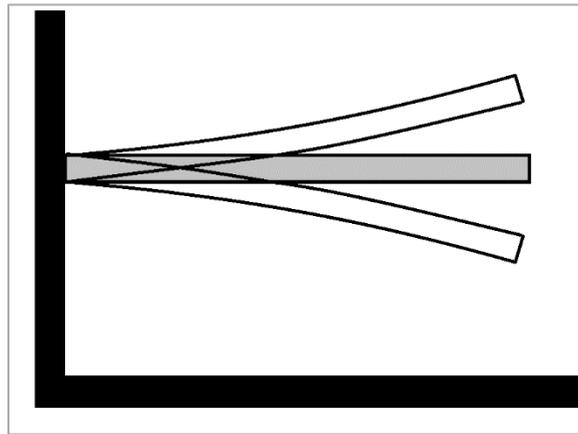


Figure: First mode of oscillation of the beam

There are multiple modes of vibration that are activated when the cantilever beam is deflected from its equilibrium, but we shall consider only the first mode for the sake of simplicity and also because the contribution of the subsequent modes of vibration is negligible in comparison to the first mode.

The natural frequency of the first mode of a cantilever beam is given by:

$$f = \frac{1}{2\pi} \times 1.875^2 \times \sqrt{\frac{EI}{\rho AL^4}}$$

Equation 1: The natural frequency of the first mode

Where,

E = Young's modulus

I = Moment of Inertia

ρ = Density (steel)

A = cross-sectional area

L = length of the cantilever beam

Note:

The “effective” length of the cantilever beam is to be considered i.e. removing the part which rests on the circular support

Compose Implementation

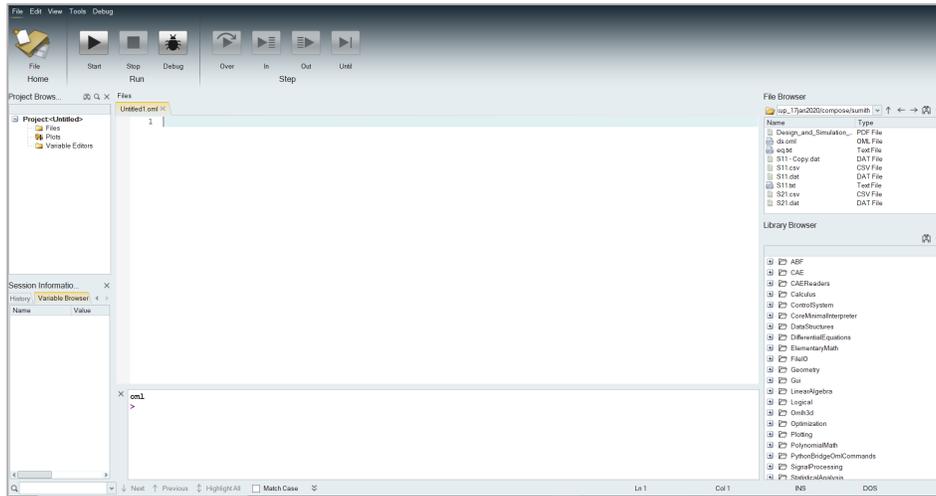
We are using equation 1 (f), to calculate the natural frequency and the same is written in oml language for this we have to just initialize some variable and constants as follows:

```
% To calculate the frequency
clc;clear all;close all;
E = 193*10^9; % young's modulus
I1 = 3*10^-12; % Area moment of inertia
L = 0.280; % Length of beam(m)
m = 0.0786; % mass of beam (any addition mass has to be added to the m
value in terms kg)
F = ((1/(2*pi))*1.875^2*(sqrt((E*I1)/(m*L^3)))) % frequency
```

Step 1: Launch Compose



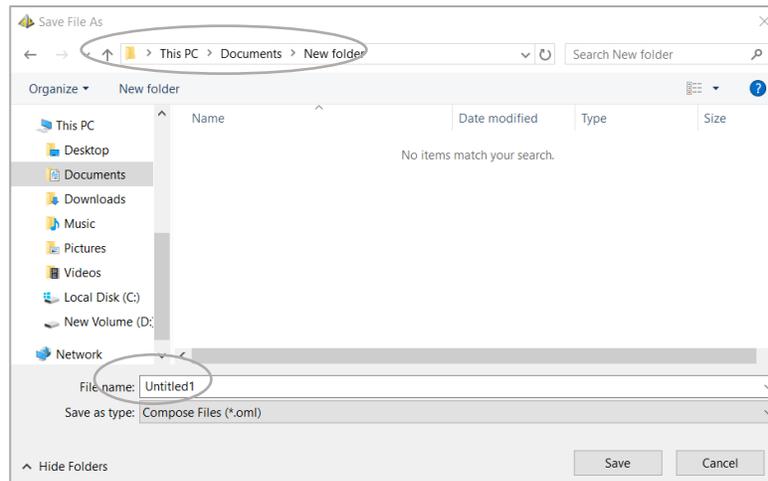
Double click on the icon. This launches the Altair Compose MATH GUI in the Authoring Mode and by default a file named Untitled1.oml exists in the Editor Window.



Step 2: Save File and Enter the Basic Commands



1. "Save file" by selecting single folder icon as shown. . Select the location where the file as to be saved.



2. Type “`clc`”, “`close all`” and “`clear all`” in the editor window to close all plots opened, clear all variables, and remove previous command.

```
clc;close all;clear all;
```

Step 3: Initialize Variable

Young’s modulus, moment of inertia, length and mass of the beam values are constant.

F is the natural frequency of the first mode (equation).

```
E = 193*10^9; % young's modulus
I1 = 3*10^-12; % Area moment of inertia
L = 0.280; % Length of beam(m)
m = .061; % mass of beam (any addition mass has to be added to the m value(kg))
F = ((1/(2*pi))*1.875^2*(sqrt((E*I1)/(m*L^3)))) % frequency
```

Step 4: Run File



Run the file by clicking on the start button in the Editor toolbar

Result

Observe the frequency value.

$$F = 10.2497586$$