Building State-Space Models for Eigenvalue Analysis in LabVIEW

Prof. R.G. Longoria

*Summer 2015*

– *for pre-lab*
You should be familiar with the systems studied in this lab.

Two-story building system

Lower story fixed

\[ k = \frac{12NEI}{L^3} \]
The two-story model is described in a related lecture / video.

The result is a 4\textsuperscript{th} order system (4 states). Here we want to show one way to calculate the 4 eigenvalues of this system from the model equations. Eigenvalues provide information about the natural frequencies of the system.
This is the form of the state equations as derived in the class lecture/video.
Put into **state-space** form.

You should be familiar with this method from ME 344 lecture.
Once you have a numerical A matrix in LabVIEW, you can use a built-in VI to calculate the eigenvalues and, if needed, the eigenvectors.

This VI can be found under Mathematics->Linear Algebra

You can simply create a numerical matrix an input the values directly into the matrix array (see next slide).

An alternative approach is also described in the following slides.
Using the eigenvalues/eigenvectors VI directly with a numerical input is straightforward. You will need to calculate the elements each time you change a system parameter (m1, m2, b1, k1, etc.)
If you want to experiment with different system parameter values, you can build a front-panel that allows you to input the $A$, $B$, $C$ and $D$ matrices. You can also define the elements of each matrix in symbolic form and then define each of the parameter values separately. Below is what this will look like. Continue to see how this can be done. It requires learning about another VI from the Control Design package in LabVIEW.
Call up the CD Construct State-Space Model VI shown below. It can be found in the menu path given here.
Once you have the numerical A matrix, you can use built-in VI for eigenvalues.
A while loop is used here so you can run and make changes to the numerical values of the system parameters, see effect on results.

Here you get a numerical A using ‘Unbundle by Name’

Then use this VI that calculates eigenvalues (use LV help for this VI).

This code is for natural frequencies and damping ratios

Note that ‘n’ eigenvalues will be generated but they are repeated, complex-conjugate eigenvalues for the two-story system – we know this is an underdamped system. So we ask for only the 0\(^{th}\) and 2\(^{nd}\) indexed values and then calculate the frequency and damping ratio. These relations are described in a related lecture video.
Here is the front panel for this example