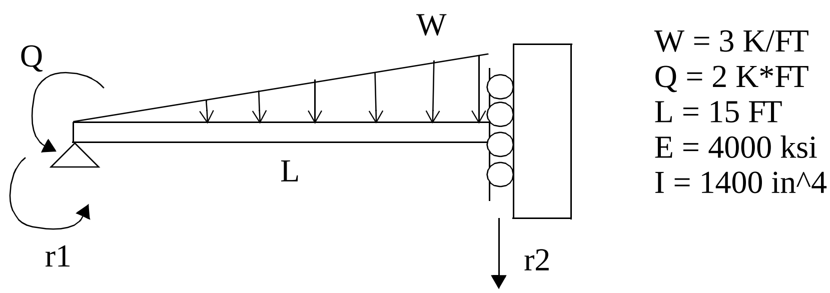
The following is an example of how to use Mathcad to solve the matrix problems we are looking at in CES4141. The specific matrix under analysis here is from the figure below. We derived this in class



Mathcad is available in 200 Weil, and in the Circa labs. You can buy it at the TechHub (version 2001) for about $120.00. These notes were created entirely in mathcad, then converted to a PDF file for web-posting. You should be able to reproduce the work below

Define Stiffness K as a function of E, I, L

Define Load Vector R as a function of Q, W, L

Note that the := is the standard way of assigning stuff to a name. You get this by just typing a colon ' : '

$$K(E,I,L) := \begin{pmatrix} \frac{4\cdot E\cdot I}{L} & \frac{6\cdot E\cdot I}{L^2} \\ \frac{6\cdot E\cdot I}{L^2} & \frac{12\cdot E\cdot I}{L^3} \end{pmatrix}$$

$$R(Q,W,L) := \begin{pmatrix} Q - \frac{W\cdot L^2}{30} \\ \frac{7}{20}\cdot W\cdot L \end{pmatrix}$$

We form the matrices above by typing Ctrl m and asking for a 2 row, 2 column blank matrix

The variables in the parenthesis (E,I,L) and (Q,W,L) is telling mathcad that the variables K and R, respectively, will be a function of those variables.

Show me the inverse of the stiffness matrix
Not a necessary step, but pretty cool see the matrix version of 1/K

$$K(E,I,L)^{-1} \rightarrow \begin{bmatrix} \frac{1}{(E\cdot I)}\cdot L & \frac{-1}{(2\cdot E\cdot I)}\cdot L^2 \\ \frac{-1}{(2\cdot E\cdot I)}\cdot L^2 & \frac{1}{(3\cdot E\cdot I)}\cdot L^3 \end{bmatrix}$$

Note the arrow --> is the way to initiate a symbolic operation. Here we are asking what is the inverse of K ? The arrow comes from the view => toolbars => symbolic pad

Calculate the displacement vector as K^{-1} * R

Note that we DO need to keep writing the names of the independent variables next to K, r, and R to tell Mathcad what symbols to look for

Note that the := is the standard way of assigning stuff to a name. You get this by just typing :

$$r(E,I,L,Q,W) := K(E,I,L)^{-1}\cdot R(Q,W,L)$$

This is a function that we can plug numbers into later

Display the resulting displacement vector calculated in terms of W, Q, L, E, I

$$r(E,I,L,Q,W) \rightarrow \begin{bmatrix} \frac{1}{(E \cdot I)} \cdot L \cdot \left(Q - \frac{1}{30} \cdot W \cdot L^2 \right) - \frac{7}{(40 \cdot E \cdot I)} \cdot L^3 \cdot W \\ \frac{-1}{(2 \cdot E \cdot I)} \cdot L^2 \cdot \left(Q - \frac{1}{30} \cdot W \cdot L^2 \right) + \frac{7}{(60 \cdot E \cdot I)} \cdot L^4 \cdot W \end{bmatrix}$$

Note the arrow displays a symbolic result

The above is a 2x1 vector describing the rotation r1 and the translation r2 as a function of E, I, L, P, Q

We can now send specific values into the function for r by first assigning numbers to the parameters. Note that units are not being declared, so its up to the user to be consistent.

$E := 4000 \qquad I := 1400 \qquad L := 15 \cdot 12$

Here are the material/geometric properties

$W := \frac{3}{12} \qquad Q := 2 \cdot 12$

Here are the external load values

Finally, we can now ask Mathcad to evaluate the results of sending the parameters into the function we created above. Now that E, I, L, Q, W have numbers, they will be subsituted into the equations to get answers
Be sure to use the same order for the parameters as defined above

$$r(E,I,L,Q,W) = \begin{pmatrix} -0.053 \\ 6.179 \end{pmatrix}$$

Now let's change the external load values and get new answers

$W := \frac{-5}{12} \qquad Q := 4 \cdot 12$

$$r(E,I,L,Q,W) = \begin{pmatrix} 0.092 \\ -10.553 \end{pmatrix}$$

Likewise we could change the material properties in any combination
But If the structural geometry or boundary conditions change, we have to derive a new stiffness matrix K.