

MAPLE TUTORIAL FOR 2007, HW#3, PROBLEM 1 (checked for MAPLE v. 11 Classic)
(to run on EOS, add MAPLE, then XMAPLE &)

> with(linalg):

input data:

> E:=30000000.;IZZ:=85.;EI:=E*IZZ;

$$E := 0.300000000 \cdot 10^8$$
$$IZZ := 85.$$

$$EI := 0.2550000000 \cdot 10^{10}$$

formulate stiffness matrix and force vector for element 1

> L1:=40.;q:=0.0;

$$L1 := 40.$$

$$q := 0.$$

> k1:=(1.5*EI/L1**3.)*matrix([[12,6*L1,-12,6*L1],
[6*L1,4*L1*L1,-6*L1,2*L1*L1],[-12,-6*L1,12,-6*L1],
[6*L1,2*L1*L1,-6*L1,4*L1*L1]]);

$$k1 := 59765.62500 \begin{bmatrix} 12 & 240. & -12 & 240. \\ 240. & 6400. & -240. & 3200. \\ -12 & -240. & 12 & -240. \\ 240. & 3200. & -240. & 6400. \end{bmatrix}$$

> evalm(k1); 1

$$\begin{bmatrix} 717187.5000 & 0.1434375000 \cdot 10^8 & -717187.5000 & 0.1434375000 \cdot 10^8 \\ 0.1434375000 \cdot 10^8 & 0.3825000000 \cdot 10^9 & -0.1434375000 \cdot 10^8 & 0.1912500000 \cdot 10^9 \\ -717187.5000 & -0.1434375000 \cdot 10^8 & 717187.5000 & -0.1434375000 \cdot 10^8 \\ 0.1434375000 \cdot 10^8 & 0.1912500000 \cdot 10^9 & -0.1434375000 \cdot 10^8 & 0.3825000000 \cdot 10^9 \end{bmatrix}$$

> f1:=q*L1/12*matrix([[6],[L1],[6],[-L1]]);

$$f1 := 0.$$

formulate stiffness matrix and force vector for element 2

> L2:=80.;q:=0;

$$L2 := 80.$$

$$q := 0$$

> k2:=(EI/L2**3.)*matrix([[12,6*L2,-12,6*L2],
[6*L2,4*L2*L2,-6*L2,2*L2*L2], [-12,-6*L2,12,-6*L2],
[6*L2,2*L2*L2,-6*L2,4*L2*L2]]);

$$k2 := 4980.468750 \begin{bmatrix} 12 & 480. & -12 & 480. \\ 480. & 25600. & -480. & 12800. \\ -12 & -480. & 12 & -480. \\ 480. & 12800. & -480. & 25600. \end{bmatrix}$$

> evalm(k2); 1

$$\begin{bmatrix} 59765.62500 & 0.2390625000 \cdot 10^7 & -59765.62500 & 0.2390625000 \cdot 10^7 \\ 0.2390625000 \cdot 10^7 & 0.1275000000 \cdot 10^9 & -0.2390625000 \cdot 10^7 & 0.6375000000 \cdot 10^8 \\ -59765.62500 & -0.2390625000 \cdot 10^7 & 59765.62500 & -0.2390625000 \cdot 10^7 \\ 0.2390625000 \cdot 10^7 & 0.6375000000 \cdot 10^8 & -0.2390625000 \cdot 10^7 & 0.1275000000 \cdot 10^9 \end{bmatrix}$$

```
> f2:=q*L2/12*matrix([[6],[L2],[6],[-L2]]);
f2 := 0.
```

```
>
add element matrices into unconstrained system matrix (ignore error message below- due to the fact that q=0)
```

```
> stiff1:=matrix(6,6,0):
```

```
> stiff2:=matrix(6,6,0):
```

```
> forcel:=matrix(6,1,0):
```

```
> force2:=matrix(6,1,0):
```

```
> copyinto(k1,stiff1,1,1):
```

```
> copyinto(f1,forcel,1,1):
```

```
Error, (in linalg:-copyinto) first argument is zero, need zero matrix
```

```
> copyinto(k2,stiff2,3,3):
```

```
> copyinto(f2,force2,3,1):
```

```
Error, (in linalg:-copyinto) first argument is zero, need zero matrix
```

```
> stiff:=matadd(stiff1,stiff2);
```

```
stiff :=
```

$$\begin{bmatrix} 717187.5000 & 0.1434375000 \cdot 10^8 & -717187.5000 & 0.1434375000 \cdot 10^8 & 0 & 0 \\ 0.1434375000 \cdot 10^8 & 0.3825000000 \cdot 10^9 & -0.1434375000 \cdot 10^8 & 0.1912500000 \cdot 10^9 & 0 & 0 \\ -717187.5000 & -0.1434375000 \cdot 10^8 & 776953.1250 & -0.1195312500 \cdot 10^8 & -59765.62500 & 0.2390625000 \cdot 10^7 \\ 0.1434375000 \cdot 10^8 & 0.1912500000 \cdot 10^9 & -0.1195312500 \cdot 10^8 & 0.5100000000 \cdot 10^9 & -0.2390625000 \cdot 10^7 & 0.6375000000 \cdot 10^8 \\ 0 & 0 & -59765.62500 & -0.2390625000 \cdot 10^7 & 59765.62500 & -0.2390625000 \cdot 10^7 \\ 0 & 0 & 0.2390625000 \cdot 10^7 & 0.6375000000 \cdot 10^8 & -0.2390625000 \cdot 10^7 & 0.1275000000 \cdot 10^9 \end{bmatrix}$$

```
> force:=matadd(forcel,force2);
```

$$\text{force} := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

[>

[formulate constrained stiffness matrix

[>

[> **stiffcon:=delrows(stiff,1..1):**

[> **stiffcon:=delcols(stiffcon,1..1):**

[> **stiffcon:=delrows(stiffcon,4..4):**

[> **stiffcon:=delcols(stiffcon,4..4):**

[> **forcecon:=delrows(force,1..1):**

[> **forcecon:=delrows(forcecon,4..4):**

[> **forcecon[2,1]:=100000;**

$$\text{forcecon}_{2,1} := 100000$$

[> **evalm(forcecon);**

[>

$$\begin{bmatrix} 0 \\ 100000 \\ 0 \\ 0 \end{bmatrix}$$

[>

[Solve linear system of equations

[>

[> **x:=linsolve(stiffcon,forcecon);**

$$x := \begin{bmatrix} 0.02943597192 \\ 0.9915274752 \\ 0.01549261680 \\ -0.02633744856 \end{bmatrix}$$

[>

[View displacements and rotations, including BC's

[>

[> **d:=matrix([[0],[x[1,1]],[x[2,1]],[x[3,1]],[0],[x[4,1]]]);**

$$d := \begin{bmatrix} 0 \\ 0.02943597192 \\ 0.9915274752 \\ 0.01549261680 \\ 0 \\ -0.02633744856 \end{bmatrix}$$

[>

[Calculate external reactions

[

