Appendix (A)

The components of the internal forces for calculation of residuals are:

$$\{R^{\varphi}\} = \int_{\frac{-l}{2}}^{\frac{l}{2}} [B]^T \{S\} dl = \{{R_1}^{\varphi} \dots . {R_6}^{\varphi}\}^T$$

And

$${R_1}^{\varphi} = \frac{-F_1}{2}\left(1 + \frac{\partial u}{\partial x}\right)_1 + \frac{M_1}{2}\left(-\frac{\partial^2 v}{\partial x^2}\right)_1 - \frac{F_2}{2}\left(1 + \frac{\partial u}{\partial x}\right)_2 + \frac{M_2}{2}\left(-\frac{\partial^2 v}{\partial x^2}\right)_2$$

$${R_2}^{\varphi} = \frac{-F_1}{2}\left(\frac{\partial v}{\partial x}\right)_1 - \frac{3M_1}{2l}\left(1 + \frac{\partial u}{\partial x}\right)_1 - \frac{F_2}{2}\left(\frac{\partial v}{\partial x}\right)_2 + \frac{3M_2}{2l}\left(1 + \frac{\partial u}{\partial x}\right)_2$$

$${R_3}^{\varphi} = -\frac{5M_1}{4}\left(1 + \frac{\partial u}{\partial x}\right)_1 + \frac{M_2}{4}\left(1 + \frac{\partial u}{\partial x}\right)_2$$

$${R_4}^{\varphi} = \frac{F_1}{2}\left(1 + \frac{\partial u}{\partial x}\right)_1 - \frac{M_1}{2}\left(-\frac{\partial^2 v}{\partial x^2}\right)_1 + \frac{F_2}{2}\left(1 + \frac{\partial u}{\partial x}\right)_2 - \frac{M_2}{2}\left(-\frac{\partial^2 v}{\partial x^2}\right)_2$$

$${R_5}^{\varphi} = \frac{F_1}{2}\left(\frac{\partial v}{\partial x}\right)_1 + \frac{3M_1}{2l}\left(1 + \frac{\partial u}{\partial x}\right)_1 + \frac{F_2}{2}\left(\frac{\partial v}{\partial x}\right)_2 - \frac{3M_2}{2l}\left(1 + \frac{\partial u}{\partial x}\right)_2$$

$${R_6}^{\varphi} = -\frac{M_1}{4}\left(1 + \frac{\partial u}{\partial x}\right)_1 + \frac{5M_2}{4}\left(1 + \frac{\partial u}{\partial x}\right)_2$$

Appendix (B)

Linear displacement stiffness matrix (K_{0L}):

$$K_0 + K_L =$$

$$\int_{\frac{-l}{2}}^{\frac{l}{2}} [B_0]^T [D][B_0]dx + \int_{\frac{-l}{2}}^{\frac{l}{2}} [B_0]^T [D][B_L]dx + \int_{\frac{-l}{2}}^{\frac{l}{2}} [B_L]^T [D][B_0]dx +$$

$$\int_{\frac{-l}{2}}^{\frac{l}{2}} [B_L]^T [D][B_L]dx$$

$$K_0 + K_L = \int_{\frac{-l}{2}}^{\frac{l}{2}} [B_0]^T [D][B_0]dx + \int_{\frac{-l}{2}}^{\frac{l}{2}} [B_0]^T [D][A\theta][G]dx +$$

$$\int_{\frac{-l}{2}}^{\frac{l}{2}} [G]^T [A\theta]^T [D][B_0]dx + \int_{\frac{-l}{2}}^{\frac{l}{2}} [G]^T [A\theta]^T [D][A\theta][G]dx$$

Where:

$$K_{0L_{11}} = \frac{EA}{2l}\left(\left(1 + \frac{\partial u}{\partial x}\right)_2^2 + \left(1 + \frac{\partial u}{\partial x}\right)_1^2\right) + \frac{EI}{2l}\left(\left(\frac{\partial^2 v}{\partial x^2}\right)_2^2 + \left(\frac{\partial^2 v}{\partial x^2}\right)_1^2\right)$$

$$K_{0L_{12}} = K_{0L_{21}} = \frac{EA}{2l}\left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2 + \left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1 +$$

$$\frac{3EI}{2l^2}\left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1 - \left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2$$

$$K_{0L_{13}} = K_{0L_{31}} = \frac{EA}{8}\left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2 - \left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1 +$$

$$\frac{EI}{4l}\left(5\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1 - \left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2$$

$$K_{0L_{14}} = K_{0L_{41}} = -\frac{EA}{2l}\left(\left(1 + \frac{\partial u}{\partial x}\right)_2^2 + \left(1 + \frac{\partial u}{\partial x}\right)_1^2\right) - \frac{EI}{2l}\left(\left(\frac{\partial^2 v}{\partial x^2}\right)_2^2 + \left(\frac{\partial^2 v}{\partial x^2}\right)_1^2\right)$$

$$K_{0L_{15}} = K_{0L_{51}} = -\frac{EA}{2l}\left(\left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2 + \left(\left(1 + \frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1\right) +$$

$$\frac{3EI}{2l^2}\left(\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2-\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1\right)$$

$$K_{0L_{16}}=K_{0L_{61}}=\frac{EA}{8}\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1-\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2+$$

$$\frac{EI}{4l}\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1-\left(5\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2$$

$$K_{0L_{22}}=-\frac{3EA}{5l}\left(\left(\frac{\partial v}{\partial x}\right)_2^2+\left(\frac{\partial v}{\partial x}\right)_1^2\right)+\frac{6EI}{l^3}\left(\left(1+\frac{\partial u}{\partial x}\right)_2^2-\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)$$

$$K_{0L_{23}}=K_{0L_{32}}=\frac{EA}{160}\left(23\left(\frac{\partial v}{\partial x}\right)_2^2-7\left(\frac{\partial v}{\partial x}\right)_1^2\right)+$$

$$\frac{3EI}{2l^2}\left(\left(1+\frac{\partial u}{\partial x}\right)_2^2+3\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)$$

$$K_{0L_{24}}=K_{0L_{42}}=-\frac{EA}{2l}\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2+\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1+$$

$$\frac{3EI}{2l^2}\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2-\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1$$

$$K_{0L_{25}}=K_{0L_{52}}=-\frac{3EA}{5l}\left(\left(\frac{\partial v}{\partial x}\right)_2^2+\left(\frac{\partial v}{\partial x}\right)_1^2\right)-\frac{6EI}{l^3}\left(\left(1+\frac{\partial u}{\partial x}\right)_2^2+\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)$$

$$K_{0L_{26}}=K_{0L_{62}}=\frac{EA}{160}\left(23\left(\frac{\partial v}{\partial x}\right)_1^2-7\left(\frac{\partial v}{\partial x}\right)_2^2\right)+$$

$$\frac{3EI}{2l^2}\left(3\left(1+\frac{\partial u}{\partial x}\right)_2^2+\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)$$

$$K_{0L_{33}}=\frac{EAl}{480}\left(17\left(\frac{\partial v}{\partial x}\right)_2^2+47\left(\frac{\partial v}{\partial x}\right)_1^2\right)+\frac{EI}{2l}\left(\left(1+\frac{\partial u}{\partial x}\right)_2^2+7\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)$$

$$K_{0L_{34}}=K_{0L_{43}}=\frac{EA}{8}\left(\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1-\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2\right)+$$

$$\frac{EI}{4l}\left(\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2-5\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1\right)$$

$$K_{0L_{35}}=K_{0L_{53}}=-\frac{EA}{160}\left(23\left(\frac{\partial v}{\partial x}\right)_2^2+7\left(\frac{\partial v}{\partial x}\right)_1^2\right)-\frac{3EI}{2l^2}\begin{pmatrix}\left(1+\frac{\partial u}{\partial x}\right)_2^2\\+3\left(1+\frac{\partial u}{\partial x}\right)_1^2\end{pmatrix}$$

$$K_{0L_{36}}=K_{0L_{63}}=-\frac{EAl}{60}\left(\left(\frac{\partial v}{\partial x}\right)_2^2+\left(\frac{\partial v}{\partial x}\right)_1^2\right)+\frac{EI}{l}\begin{pmatrix}\left(1+\frac{\partial u}{\partial x}\right)_2^2\\-\left(1+\frac{\partial u}{\partial x}\right)_1^2\end{pmatrix}$$

$$K_{0L_{44}}=\frac{EA}{2l}\left(\left(1+\frac{\partial u}{\partial x}\right)_2^2+\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)+\frac{EI}{2l}\left(\left(\frac{\partial v}{\partial x}\right)_2^2+\left(\frac{\partial v}{\partial x}\right)_1^2\right)$$

$$K_{0L_{45}}=K_{0L_{54}}=\frac{EA}{2l}\left(\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2+\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1\right)+$$

$$\frac{3EI}{2l^2}\left(\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1-\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2\right)$$

$$K_{0L_{46}}=K_{0L_{64}}=\frac{EA}{8}\left(\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_2-\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial v}{\partial x}\right)_1\right)+$$

$$\frac{EI}{4l}\left(5\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_2-\left(\left(1+\frac{\partial u}{\partial x}\right)\frac{\partial^2 v}{\partial x^2}\right)_1\right)$$

$$K_{0L_{55}}=\frac{3EA}{5l}\left(\left(\frac{\partial v}{\partial x}\right)_2^2-\left(\frac{\partial v}{\partial x}\right)_1^2\right)+\frac{6EI}{l^3}\left(\left(1+\frac{\partial u}{\partial x}\right)_2^2+\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)$$

$$K_{0L_{56}}=K_{0L_{65}}=\frac{EA}{160}\left(7\left(\frac{\partial v}{\partial x}\right)_2^2-23\left(\frac{\partial v}{\partial x}\right)_1^2\right)-\frac{3EI}{2l^2}\begin{pmatrix}3\left(1+\frac{\partial u}{\partial x}\right)_2^2\\+\left(1+\frac{\partial u}{\partial x}\right)_1^2\end{pmatrix}$$

$$K_{0L_{66}}=\frac{EAl}{480}\left(47\left(\frac{\partial v}{\partial x}\right)_2^2+17\left(\frac{\partial v}{\partial x}\right)_1^2\right)+\frac{EI}{2l}\left(7\left(1+\frac{\partial u}{\partial x}\right)_2^2+\left(1+\frac{\partial u}{\partial x}\right)_1^2\right)$$

Appendix (C)

```
clc
clear all
close all
g = ' cantilever beam '
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%% CANTILEVER
BEAM%%%%%%%%%%%%%%%%%%%%%%%%%%%
E = input('Enter Youngs Modulus of beam:');
j = input('Enter 1 for circular c/s, 2 for
rectangular c/s or 3 to enter value of I
manually:');
if(j==1)
d = input('Enter Diameter:');
I = pi*(d/2)^4/4
elseif(j==2)
b = input('Enter width of beam:');
h= input('Enter height of beam:');
I = b*h^3/12
elseif(j==3)
I = input('Enter value of I manually:');
end
n = input('Enter number of elements:');
%L = length of beam
L = input('Enter Length of the beam: \n');
%input length if each element, l1, l2, ..., ln
%l = [3; 3];
for i=1:n
%fprintf('element %g', i);
%l(i)=input('Enter length of element :');
l(i)=L/n;
end
%k = [E*A/le 0 0 -E*A/le 0 0;0 12*E*I/le^3
6*E*I/le^2 0 -12*E*I/le^3
%6*E*I/le^2;0 6*E*I/le^2 4*E*I/le 0 -6*E*I/le^2
2*E*I/le;-E*A/le 0 0 E*A/le
%0 0;0 -12*E*I/le^3 -6*E*I/le^2 0 12*E*I/le^3 -
6*E*I/le^2;0 6*E*I/le^2
%2*E*I/le 0 -6*E*I/le^2 4*E*I/le];
%enter boundary condition at each node
%K2 = zeros(3*(n+1),3*(n+1));
%K = zeros(3*(n+1),3*(n+1));
%K11 = zeros(3*(n+1),3*(n+1));
```

```
%DB = zeros(4,6);
%B = zeros(4,6);
%G = zeros(8,6);
K = zeros(3*(n+1),3*(n+1));
K11 = zeros(3*(n+1),3*(n+1));
K2 = zeros(3*(n+1),3*(n+1));
ELOAD=zeros(6,n);
DB0 = zeros(4,6);
DB1 = zeros(4,6);
DB = zeros(4,6);
B = zeros(4,6);
G = zeros(4,6);
ds = zeros((3*(n+1)),1);
dds = zeros((3*(n+1)),1);
drs = zeros((3*(n+1)),1);
for i = n+1:-1:3
fprintf('Node %g \n', i);
lc =0;
if (lc == 1)
K2((i-1)*3+1,:) = [];
K2(:,(i-1)*3+1) = [];
ds((i-1)*3+1) = 1;
end
end
drs(1)=1;
drs(2)=1;
drs(3)=1;
%BC

r = size(K2,1);

ASLOD=zeros(3*(n+1),1);
RLOD=zeros(1,3*(n+1));
Fr=zeros(3*(n+1),1);
SR1=zeros(4,n);
deltaSR1=zeros(4,n);
Theta=zeros(8,n);
RINT=zeros(6,n);
ddEs=zeros(6,n);
dEs=zeros(6,n);
dEsi=zeros(6,n);
Ks = zeros(3*(n+1),3*(n+1));
K01=zeros(3*(n+1),3*(n+1));
Ksigma=zeros(3*(n+1),3*(n+1));
```

```
fprintf('Enter  forces position');
IP = input('');
fprintf('Enter  forces value');
RLOD(IP) = input('');
INC=input('INC=');
FACTO=1/INC ;
niter=input('niter=');
Res1=zeros(3*(n+1),1);
DEPSI1=zeros(1,n);
DEPSI2=zeros(1,n);
DEx1=zeros(1,n);
DEx2=zeros(1,n);
TRINT=zeros(3*(n+1),1);

for jnc=1:INC
    LINC = RLOD'*FACTO;
    ASLOD=ASLOD+LINC;
  for iter =1:niter
      if NTYPE==1
       ASLOD1=LINC;
      else
       ASLOD1=ASLOD-TRINT;
      end
K = zeros(3*(n+1),3*(n+1));
K01=zeros(3*(n+1),3*(n+1));
Ksigma=zeros(3*(n+1),3*(n+1));

if n == 1
le = l(n);
k = [(E*A)/le 0 0 (-E*A)/le 0 0;0 (12*E*I)/le^3
(6*E*I/le^2) 0 (-12*E*I)/le^3 (6*E*I)/le^2;
    0 (6*E*I)/le^2 (4*E*I)/le 0 (-6*E*I)/le^2
(2*E*I)/le;(-E*A)/le 0 0 (E*A)/le 0 0;
    0 (-12*E*I)/le^3 (-6*E*I/le^2) 0
(12*E*I)/le^3 (-6*I*E)/le^2;
    0 (6*E*I)/le^2 (2*E*I)/le 0 (-6*E*I)/le^2
(4*E*I)/le];

K = k;
else
for i = 1:n-1
if (i == 1)
le = l(i);
```

```
k = [(E*A)/le 0 0 (-E*A)/le 0 0;0 (12*E*I)/le^3
(6*E*I/le^2) 0 (-12*E*I)/le^3 (6*E*I)/le^2;
    0 (6*E*I)/le^2 (4*E*I)/le 0 (-6*E*I)/le^2
(2*E*I)/le;(-E*A)/le 0 0 (E*A)/le 0 0;
    0 (-12*E*I)/le^3 (-6*E*I/le^2) 0
(12*E*I)/le^3 (-6*I*E)/le^2;
    0 (6*E*I)/le^2 (2*E*I)/le 0 (-6*E*I)/le^2
(4*E*I)/le];

K = wextend(2,'zpd',k,3, 'r');
else
K = wextend(2,'zpd',K,3, 'r');
end
le = l(i+1);
k = [(E*A)/le 0 0 (-E*A)/le 0 0;0 (12*E*I)/le^3
(6*E*I/le^2) 0 (-12*E*I)/le^3 (6*E*I)/le^2;
    0 (6*E*I)/le^2 (4*E*I)/le 0 (-6*E*I)/le^2
(2*E*I)/le;(-E*A)/le 0 0 (E*A)/le 0 0;
    0 (-12*E*I)/le^3 (-6*E*I/le^2) 0
(12*E*I)/le^3 (-6*I*E)/le^2;
    0 (6*E*I)/le^2 (2*E*I)/le 0 (-6*E*I)/le^2
(4*E*I)/le];
K1 = wextend(2,'zpd',k,3*i, 'l');
K= K+K1;
end
end
% BC
%K2 = K;
   if n == 1
le = l(n);
 ksigma=
[(SR1(1,n)/(2*le))+(SR1(3,n)/(2*le)),(3/(2*le^2))
*((SR1(2,n))-(SR1(4,n))),(1/(4*le))*(-
5*SR1(2,n)+SR1(4,n)),(-
1/(2*le))*(SR1(1,n)+SR1(3,n)),(3/(2*le^2))*(SR1(4
,n)-SR1(2,n)),(1/(4*le))*((SR1(2,n))-5*SR1(4,n));
(3/(2*le^2))*((SR1(2,n))-
(SR1(4,n))),(3/(5*le))*(SR1(1,n) +
SR1(3,n)),(1/160)*(23*(SR1(3,n))-
7*SR1(1,n)),(3/(2*le^2))*((SR1(4,n))-
(SR1(2,n))),(-
3/(5*le))*(SR1(1,n)+SR1(3,n)),(1/160)*(23*(SR1(1,
n))-7*(SR1(3,n)));
```

```
(1/(4*le))*(-
5*SR1(2,n)+SR1(4,n)),(1/160)*(23*(SR1(3,n))-
7*SR1(1,n)),(le/480)*(47*SR1(1,n)+17*SR1(3,n)),(1
/(4*le))*((-SR1(4,n))+(5*SR1(2,n))),(-
1/160)*(23*(SR1(3,n))-7*(SR1(1,n))),(-
le/60)*((SR1(1,n))+(SR1(3,n)));
(-
1/(2*le))*(SR1(1,n)+SR1(3,n)),(3/(2*le^2))*((SR1(
4,n))-(SR1(2,n))),(1/(4*le))*(-
(SR1(4,n))+(5*SR1(2,n))),(1/(2*le))*(SR1(1,n)+SR1
(3,n)),(3/(2*le^2))*((SR1(2,n))-
(SR1(4,n))),(1/(4*le))*(5*(SR1(4,n))-(SR1(2,n)));
(3/(2*le^2))*(SR1(4,n)-SR1(2,n)),(-
3/(5*le))*(SR1(1,n)+SR1(3,n)),(-
1/160)*(23*(SR1(3,n))-
7*(SR1(1,n))),(3/(2*le^2))*((SR1(2,n))-
(SR1(4,n))),(3/(5*le))*(SR1(3,n)+SR1(1,n)),(-
1/160)*(23*(SR1(1,n))-7*(SR1(3,n)));
(1/(4*le))*((SR1(2,n))-
5*SR1(4,n)),(1/160)*(23*(SR1(1,n))-
7*(SR1(3,n))),(-
le/60)*((SR1(1,n))+(SR1(3,n))),(1/(4*le))*(5*(SR1
(4,n))-(SR1(2,n))),(-1/160)*(23*(SR1(1,n))-
7*(SR1(3,n))),(le/480)*(47*(SR1(3,n))+17*(SR1(1,n
)))];
Ksigma = ksigma;
k01=[((E*A)/(2*le))*(((1+(Theta(5,n)))^2)+(1+(The
ta(1,n)))^2)+((E*I)/(2*le))*((Theta(7,n))^2+(Thet
a(3,n))^2),((E*A)/(2*le))*((1+(Theta(5,n)))*(Thet
a(6,n))+(1+(Theta(1,n)))*(Theta(2,n)))+((3*E*I)/(
2*le^2))*(((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((E*A)/8)*(((1+(
Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n))))+((E*I)/(4*le))*(
5*((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n))))*(Theta(7,n))),((-
E*A)/(2*le))*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))
^2)-
((E*I)/(2*le))*((Theta(7,n))^2+(Theta(3,n))^2),((
-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n))+((1+
(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le)^2)*(
(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((E*A)/8)*(((1+(
```

```
Theta(1,n)))*Theta(2,n))-
((1+(Theta(5,n)))*Theta(6,n)))+((E*I)/(4*le))*(((
(1+(Theta(1,n)))*(Theta(3,n))))-
(5*(1+(Theta(5,n)))*(Theta(7,n))));
((E*A)/(2*le))*((1+(Theta(5,n)))*(Theta(6,n))+(1+
(Theta(1,n)))*(Theta(2,n)))+((3*E*I)/(2*le^2))*((
(1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((-
3*E*A)/(5*le))*((Theta(6,n))^2+(Theta(2,n))^2)+((
6*E*I)/le^3)*((1+(Theta(5,n)))^2-
(1+(Theta(1,n)))^2),((E*A)/160)*((23*(Theta(6,n))
^2)-
7*(Theta(2,n))^2)+((3*E*I)/(2*le^2))*((1+(Theta(5
,n)))^2+3*(1+(Theta(1,n)))^2),((-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n)))+((1
+(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le^2))*
(((1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((-
3*E*A)/(5*le))*((Theta(6,n))^2+(Theta(2,n))^2)-
((6*E*I)/le^3)*((1+(Theta(1,n)))^2+(1+(Theta(5,n)
))^2),((E*A)/160)*((23*(Theta(2,n))^2)-
7*(Theta(6,n))^2)+((3*E*I)/(2*le^2))*(3*(1+(Theta
(5,n)))^2+(1+(Theta(1,n)))^2);
((E*A)/8)*(((1+(Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n))))+((E*I)/(4*le))*(
5*((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n))))*(Theta(7,n))),((E*A)/160)*((23
*(Theta(6,n))^2)-
7*(Theta(2,n))^2)+((3*E*I)/(2*le^2))*((1+(Theta(5
,n)))^2+3*(1+(Theta(1,n)))^2),((E*A*le)/480)*(17*
((Theta(6,n))^2)+47*(Theta(2,n))^2)+((E*I)/(2*le)
)*((1+(Theta(5,n)))^2+7*(1+(Theta(1,n)))^2),((E*A
)/8)*(((1+(Theta(1,n)))*(Theta(2,n)))-
((1+(Theta(5,n)))*(Theta(6,n)))+((E*I)/(4*le))*((
(1+(Theta(5,n)))*(Theta(7,n)))-
5*((1+(Theta(1,n))))*(Theta(3,n)))),((-
E*A)/160)*((23*(Theta(6,n))^2)+7*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*((1+(Theta(5,n)))^2+3*(1+(Thet
a(1,n)))^2),((-
E*A*le)/60)*(((Theta(2,n))^2)+(Theta(6,n))^2)+((E
*I)/le)*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))^2);
((-
E*A)/(2*le))*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))
^2)-
```

```
((E*I)/(2*le))*((Theta(7,n))^2+(Theta(3,n))^2),((
-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n)))+((1
+(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le^2))*
(((1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((E*A)/8)*(((1+(
Theta(1,n)))*(Theta(2,n)))-
((1+(Theta(5,n)))*(Theta(6,n)))+((E*I)/(4*le))*((
(1+(Theta(5,n)))*(Theta(7,n)))-
5*((1+(Theta(1,n))))*(Theta(3,n)))),((E*A)/(2*le)
)*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))^2)+((E*I)/
(2*le))*((Theta(7,n))^2+(Theta(3,n))^2),((E*A)/(2
*le))*(((1+(Theta(5,n)))*(Theta(6,n)))+((1+(Theta
(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le^2))*(((1+(T
heta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((E*A)/8)*(((1+(
Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n)))+((E*I)/(4*le))*((
5*(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n))))*(Theta(3,n))));
((-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n))+((1+
(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le)^2)*(
(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((-
3*E*A)/(5*le))*((Theta(6,n))^2+(Theta(2,n))^2)-
((6*E*I)/le^3)*((1+(Theta(1,n)))^2+(1+(Theta(5,n)
))^2),((-
E*A)/160)*((23*(Theta(6,n))^2)+7*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*((1+(Theta(5,n)))^2+3*(1+(Thet
a(1,n)))^2),((E*A)/(2*le))*(((1+(Theta(5,n)))*(Th
eta(6,n)))+((1+(Theta(1,n)))*(Theta(2,n))))+((3*E
*I)/(2*le^2))*(((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((3*E*A)/(5*le))
*((Theta(6,n))^2-
(Theta(2,n))^2)+((6*E*I)/le^3)*((1+(Theta(1,n)))^
2+(1+(Theta(5,n)))^2),((E*A)/160)*((7*(Theta(6,n)
)^2)-23*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*(3*(1+(Theta(5,n)))^2+(1+(Thet
a(1,n)))^2);
((E*A)/8)*(((1+(Theta(1,n)))*Theta(2,n))-
((1+(Theta(5,n)))*Theta(6,n)))+((E*I)/(4*le))*(((
(1+(Theta(1,n)))*(Theta(3,n))))-
(5*(1+(Theta(5,n)))*(Theta(7,n)))),((E*A)/160)*((
```

```
23*(Theta(2,n))^2)-
7*(Theta(6,n))^2)+((3*E*I)/(2*le^2))*(3*(1+(Theta
(5,n)))^2+(1+(Theta(1,n)))^2),((-
E*A*le)/60)*(((Theta(2,n))^2)+(Theta(6,n))^2)+((E
*I)/le)*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))^2),(
(E*A)/8)*(((1+(Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n)))+((E*I)/(4*le))*((
5*(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n))))*(Theta(3,n)))),((E*A)/160)*((7
*(Theta(6,n))^2)-23*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*(3*(1+(Theta(5,n)))^2+(1+(Thet
a(1,n)))^2),((E*A*le)/480)*(47*((Theta(6,n))^2)+1
7*(Theta(2,n))^2)+((E*I)/(2*le))*(7*(1+(Theta(5,n
)))^2+(1+(Theta(1,n)))^2)];
K01 = k01;
       else
for i = 1:n-1
if (i == 1)
le = l(i);

ksigma=
[(SR1(1,i)/(2*le))+(SR1(3,i)/(2*le)),(3/(2*le^2))
*((SR1(2,i))-(SR1(4,i))),(1/(4*le))*(-
5*SR1(2,i)+SR1(4,i)),(-
1/(2*le))*(SR1(1,i)+SR1(3,i)),(3/(2*le^2))*(SR1(4
,i)-SR1(2,i)),(1/(4*le))*((SR1(2,i))-5*SR1(4,i));
(3/(2*le^2))*((SR1(2,i))-
(SR1(4,i))),(3/(5*le))*(SR1(1,i) +
SR1(3,i)),(1/160)*(23*(SR1(3,i))-
7*SR1(1,i)),(3/(2*le^2))*((SR1(4,i))-
(SR1(2,i))),(-
3/(5*le))*(SR1(1,i)+SR1(3,i)),(1/160)*(23*(SR1(1,
i))-7*(SR1(3,i)));
(1/(4*le))*(-
5*(SR1(2,i))+SR1(4,i)),(1/160)*(23*(SR1(3,i))-
7*SR1(1,i)),(le/480)*(47*SR1(1,i)+17*SR1(3,i)),(1
/(4*le))*(-(SR1(4,i))+(5*SR1(2,i))),(-
1/160)*(23*(SR1(3,i))-7*(SR1(1,i))),(-
le/60)*((SR1(1,i))+(SR1(3,i)));
(-
1/(2*le))*(SR1(1,i)+SR1(3,i)),(3/(2*le^2))*((SR1(
4,i))-(SR1(2,i))),(1/(4*le))*(-
(SR1(4,i))+(5*SR1(2,i))),(1/(2*le))*(SR1(1,i)+SR1
```

```
(3,i)),(3/(2*le^2))*((SR1(2,i))-
(SR1(4,i))),(1/(4*le))*(5*(SR1(4,i))-(SR1(2,i)));
(3/(2*le^2))*(SR1(4,i)-SR1(2,i)),(-
3/(5*le))*(SR1(1,i)+SR1(3,i)),(-
1/160)*(23*(SR1(3,i))-
7*(SR1(1,i))),(3/(2*le^2))*((SR1(2,i))-
(SR1(4,i))),(3/(5*le))*(SR1(3,i)+SR1(1,i)),(-
1/160)*(23*(SR1(1,i))-7*(SR1(3,i)));
(1/(4*le))*((SR1(2,i))-
5*SR1(4,i)),(1/160)*(23*(SR1(1,i))-
7*(SR1(3,i))),(-
le/60)*((SR1(1,i))+(SR1(3,i))),(1/(4*le))*(5*(SR1
(4,i))-(SR1(2,i))),(-1/160)*(23*(SR1(1,i))-
7*(SR1(3,i))),(le/480)*(47*(SR1(3,i))+17*(SR1(1,i
)))];
Ksigma = wextend(2,'zpd',ksigma,3, 'r');
%for ir = 1:6
    %for ic = 1:6
        %ick = 3*(n-1)+ ic;
        %icr = 3*(n-1)+ ir;
        %Ksigma(ick,icr)=Ksigma(ick,icr)+
ksigma(ic,ir);
    %end
%end
k01  =
[((E*A)/(2*le))*(((1+(Theta(5,i)))^2)+(1+(Theta(1
,i)))^2)+((E*I)/(2*le))*((Theta(7,i))^2+(Theta(3,
i))^2),((E*A)/(2*le))*((1+(Theta(5,i)))*(Theta(6,
i))+(1+(Theta(1,i)))*(Theta(2,i)))+((3*E*I)/(2*le
^2))*(((1+(Theta(1,i)))*(Theta(3,i)))-
((1+(Theta(5,i)))*(Theta(7,i)))),((E*A)/8)*(((1+(
Theta(5,i)))*(Theta(6,i)))-
((1+(Theta(1,i)))*(Theta(2,i))))+((E*I)/(4*le))*(
5*((1+(Theta(1,i)))*(Theta(3,i)))-
((1+(Theta(5,i))))*(Theta(7,i))),((-
E*A)/(2*le))*((1+(Theta(5,i)))^2+(1+(Theta(1,i)))
^2)-
((E*I)/(2*le))*((Theta(7,i))^2+(Theta(3,i))^2),((
-
E*A)/(2*le))*(((1+(Theta(5,i)))*(Theta(6,i))+((1+
(Theta(1,i)))*(Theta(2,i))))+((3*E*I)/(2*le)^2)*(
(1+(Theta(5,i)))*(Theta(7,i)))-
((1+(Theta(1,i)))*(Theta(3,i)))),((E*A)/8)*(((1+(
Theta(1,i)))*Theta(2,i))-
```

```
((1+(Theta(5,i)))*Theta(6,i)))+((E*I)/(4*le))*(((
(1+(Theta(1,i)))*(Theta(3,i))))-
(5*(1+(Theta(5,i)))*(Theta(7,i))));
((E*A)/(2*le))*((1+(Theta(5,i)))*(Theta(6,i))+(1+
(Theta(1,i)))*(Theta(2,i)))+((3*E*I)/(2*le^2))*((
(1+(Theta(1,i)))*(Theta(3,i)))-
((1+(Theta(5,i)))*(Theta(7,i)))),((-
3*E*A)/5)*((Theta(6,i))^2+(Theta(2,i))^2)+((6*E*I
)/le^3)*((1+(Theta(5,i)))^2-
(1+(Theta(1,i)))^2),((E*A)/160)*((23*(Theta(6,i))
^2)-
7*(Theta(2,i))^2)+((3*E*I)/(2*le^2))*((1+(Theta(5
,i)))^2+3*(1+(Theta(1,i)))^2),((-
E*A)/(2*le))*(((1+(Theta(5,i)))*(Theta(6,i)))+((1
+(Theta(1,i)))*(Theta(2,i))))+((3*E*I)/(2*le^2))*
(((1+(Theta(5,i)))*(Theta(7,i)))-
((1+(Theta(1,i)))*(Theta(3,i)))),((-
3*E*A)/(5*le))*((Theta(6,i))^2+(Theta(2,i))^2)-
((6*E*I)/le^3)*((1+(Theta(1,i)))^2+(1+(Theta(5,i)
))^2),((E*A)/160)*((23*(Theta(2,i))^2)-
7*(Theta(6,i))^2)+((3*E*I)/(2*le^2))*(3*(1+(Theta
(5,i)))^2+(1+(Theta(1,i)))^2);
((E*A)/8)*(((1+(Theta(5,i)))*(Theta(6,i)))-
((1+(Theta(1,i)))*(Theta(2,i))))+((E*I)/(4*le))*(
5*((1+(Theta(1,i)))*(Theta(3,i)))-
((1+(Theta(5,i))))*(Theta(7,i))),((E*A)/160)*((23
*(Theta(6,i))^2)-
7*(Theta(2,n))^2)+((3*E*I)/(2*le^2))*((1+(Theta(5
,i)))^2+3*(1+(Theta(1,i)))^2),((E*A*le)/480)*(17*
((Theta(6,i))^2)+47*(Theta(2,i))^2)+((E*I)/(2*le)
)*((1+(Theta(5,i)))^2+7*(1+(Theta(1,i)))^2),((E*A
)/8)*(((1+(Theta(1,i)))*(Theta(2,n)))-
((1+(Theta(5,i)))*(Theta(6,i)))+((E*I)/(4*le))*((
(1+(Theta(5,i)))*(Theta(7,i)))-
5*((1+(Theta(1,n))))*(Theta(3,i)))),((-
E*A)/160)*((23*(Theta(6,i))^2)+7*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*((1+(Theta(5,i)))^2+3*(1+(Thet
a(1,i)))^2),((-
E*A*le)/60)*(((Theta(2,i))^2)+(Theta(6,i))^2)+((E
*I)/le)*((1+(Theta(5,i)))^2+(1+(Theta(1,i)))^2);
((-
E*A)/(2*le))*((1+(Theta(5,i)))^2+(1+(Theta(1,i)))
^2)-
((E*I)/(2*le))*((Theta(7,i))^2+(Theta(3,i))^2),((
```

```
-
E*A)/(2*le))*(((1+(Theta(5,i)))*(Theta(6,i)))+((1
+(Theta(1,i)))*(Theta(2,i))))+((3*E*I)/(2*le^2))*
(((1+(Theta(5,i)))*(Theta(7,i)))-
((1+(Theta(1,i)))*(Theta(3,i)))),((E*A)/8)*(((1+(
Theta(1,i)))*(Theta(2,i)))-
((1+(Theta(5,i)))*(Theta(6,i)))+((E*I)/(4*le))*((
(1+(Theta(5,i)))*(Theta(7,i)))-
5*((1+(Theta(1,i))))*(Theta(3,i)))),((E*A)/(2*le)
)*((1+(Theta(5,i)))^2+(1+(Theta(1,i)))^2)+((E*I)/
(2*le))*((Theta(7,i))^2+(Theta(3,i))^2),((E*A)/(2
*le))*(((1+(Theta(5,i)))*(Theta(6,i)))+((1+(Theta
(1,i)))*(Theta(2,i))))+((3*E*I)/(2*le^2))*(((1+(T
heta(1,i)))*(Theta(3,i)))-
((1+(Theta(5,i)))*(Theta(7,i)))),((E*A)/8)*(((1+(
Theta(5,i)))*(Theta(6,i)))-
((1+(Theta(1,i)))*(Theta(2,i)))+((E*I)/(4*le))*((
5*(1+(Theta(5,i)))*(Theta(7,i)))-
((1+(Theta(1,i))))*(Theta(3,i))));
((-
E*A)/(2*le))*(((1+(Theta(5,i)))*(Theta(6,i))+((1+
(Theta(1,i)))*(Theta(2,i))))+((3*E*I)/(2*le)^2)*(
(1+(Theta(5,i)))*(Theta(7,i)))-
((1+(Theta(1,i)))*(Theta(3,i)))),((-
3*E*A)/(5*le))*((Theta(6,i))^2+(Theta(2,i))^2)-
((6*E*I)/le^3)*((1+(Theta(1,i)))^2+(1+(Theta(5,i)
))^2),((-
E*A)/160)*((23*(Theta(6,i))^2)+7*(Theta(2,i))^2)-
((3*E*I)/(2*le^2))*((1+(Theta(5,i)))^2+3*(1+(Thet
a(1,i)))^2),((E*A)/(2*le))*(((1+(Theta(5,i)))*(Th
eta(6,i)))+((1+(Theta(1,i)))*(Theta(2,i))))+((3*E
*I)/(2*le^2))*(((1+(Theta(1,i)))*(Theta(3,i)))-
((1+(Theta(5,i)))*(Theta(7,i)))),((3*E*A)/(5*le))
*((Theta(6,i))^2-
(Theta(2,i))^2)+((6*E*I)/le^3)*((1+(Theta(1,i)))^
2+(1+(Theta(5,i)))^2),((E*A)/160)*((7*(Theta(6,i)
)^2)-23*(Theta(2,i))^2)-
((3*E*I)/(2*le^2))*(3*(1+(Theta(5,i)))^2+(1+(Thet
a(1,i)))^2);
((E*A)/8)*(((1+(Theta(1,i)))*Theta(2,i))-
((1+(Theta(5,i)))*Theta(6,i)))+((E*I)/(4*le))*(((
(1+(Theta(1,i)))*(Theta(3,i))))-
(5*(1+(Theta(5,i)))*(Theta(7,i)))),((E*A)/160)*((
23*(Theta(2,i))^2)-
```

```
7*(Theta(6,i))^2)+((3*E*I)/(2*le^2))*(3*(1+(Theta
(5,i)))^2+(1+(Theta(1,i)))^2),((-
E*A*le)/60)*(((Theta(2,i))^2)+(Theta(6,i))^2)+((E
*I)/le)*((1+(Theta(5,i)))^2+(1+(Theta(1,i)))^2),(
(E*A)/8)*(((1+(Theta(5,i)))*(Theta(6,i)))-
((1+(Theta(1,i)))*(Theta(2,i)))+((E*I)/(4*le))*((
5*(1+(Theta(5,i)))*(Theta(7,i)))-
((1+(Theta(1,i))))*(Theta(3,i)))),((E*A)/160)*((7
*(Theta(6,i))^2)-23*(Theta(2,i))^2)-
((3*E*I)/(2*le^2))*(3*(1+(Theta(5,i)))^2+(1+(Thet
a(1,i)))^2),((E*A*le)/480)*(47*((Theta(6,i))^2)+1
7*(Theta(2,i))^2)+((E*I)/(2*le))*(7*(1+(Theta(5,i
)))^2+(1+(Theta(1,i)))^2)];
K01 = wextend(2,'zpd',k01,3, 'r');
else
    Ksigma = wextend(2,'zpd',Ksigma,3, 'r');
K01 = wextend(2,'zpd',K01,3, 'r');
end
le = l(i+1);
ksigma=
[(SR1(1,n)/(2*le))+(SR1(3,n)/(2*le)),(3/(2*le^2))
*((SR1(2,n))-(SR1(4,n))),(1/(4*le))*(-
5*SR1(2,n)+SR1(4,n)),(-
1/(2*le))*(SR1(1,n)+SR1(3,n)),(3/(2*le^2))*(SR1(4
,n)-SR1(2,n)),(1/(4*le))*((SR1(2,n))-5*SR1(4,n));
(3/(2*le^2))*((SR1(2,n))-
(SR1(4,n))),(3/(5*le))*(SR1(1,n) +
SR1(3,n)),(1/160)*(23*(SR1(3,n))-
7*SR1(1,n)),(3/(2*le^2))*((SR1(4,n))-
(SR1(2,n))),(-
3/(5*le))*(SR1(1,n)+SR1(3,n)),(1/160)*(23*(SR1(1,
n))-7*(SR1(3,n)));
(1/(4*le))*(-
5*SR1(2,n)+SR1(4,n)),(1/160)*(23*(SR1(3,n))-
7*SR1(1,n)),(le/480)*(47*SR1(1,n)+17*SR1(3,n)),(1
/(4*le))*(-(SR1(4,n))+(5*SR1(2,n))),(-
1/160)*(23*(SR1(3,n))-7*(SR1(1,n))),(-
le/60)*((SR1(1,n))+(SR1(3,n)));
(-
1/(2*le))*(SR1(1,n)+SR1(3,n)),(3/(2*le^2))*((SR1(
4,n))-(SR1(2,n))),(1/(4*le))*(-
(SR1(4,n))+(5*SR1(2,n))),(1/(2*le))*(SR1(1,n)+SR1
(3,n)),(3/(2*le^2))*((SR1(2,n))-
(SR1(4,n))),(1/(4*le))*(5*(SR1(4,n))-(SR1(2,n)));
```

```
(3/(2*le^2))*(SR1(4,n)-SR1(2,n)),(-
3/(5*le))*(SR1(1,n)+SR1(3,n)),(-
1/160)*(23*(SR1(3,n))-
7*(SR1(1,n))),(3/(2*le^2))*((SR1(2,n))-
(SR1(4,n))),(3/(5*le))*(SR1(3,n)+SR1(1,n)),(-
1/160)*(23*(SR1(1,n))-7*(SR1(3,n)));
(1/(4*le))*((SR1(2,n))-
5*SR1(4,n)),(1/160)*(23*(SR1(1,n))-
7*(SR1(3,n))),(-
le/60)*((SR1(1,n))+(SR1(3,n))),(1/(4*le))*(5*(SR1
(4,n))-(SR1(2,n))),(-1/160)*(23*(SR1(1,n))-
7*(SR1(3,n))),(le/480)*(47*(SR1(3,n))+17*(SR1(1,n
)))];

k01
=[((E*A)/(2*le))*(((1+(Theta(5,n)))^2)+(1+(Theta(
1,n)))^2)+((E*I)/(2*le))*((Theta(7,n))^2+(Theta(3
,n))^2),((E*A)/(2*le))*((1+(Theta(5,n)))*(Theta(6
,n))+(1+(Theta(1,n)))*(Theta(2,n)))+((3*E*I)/(2*l
e^2))*(((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((E*A)/8)*(((1+(
Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n))))+((E*I)/(4*le))*(
5*((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n))))*(Theta(7,n))),((-
E*A)/(2*le))*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))
^2)-
((E*I)/(2*le))*((Theta(7,n))^2+(Theta(3,n))^2),((
-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n))+((1+
(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le)^2)*(
(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((E*A)/8)*(((1+(
Theta(1,n)))*Theta(2,n))-
((1+(Theta(5,n)))*Theta(6,n)))+((E*I)/(4*le))*(((
(1+(Theta(1,n)))*(Theta(3,n))))-
(5*(1+(Theta(5,n)))*(Theta(7,n))));
((E*A)/(2*le))*((1+(Theta(5,n)))*(Theta(6,n))+(1+
(Theta(1,n)))*(Theta(2,n)))+((3*E*I)/(2*le^2))*((
(1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((-
3*E*A)/(5*le))*((Theta(6,n))^2+(Theta(2,n))^2)+((
6*E*I)/le^3)*((1+(Theta(5,n)))^2-
(1+(Theta(1,n)))^2),((E*A)/160)*((23*(Theta(6,n))
```

```
^2)-
7*(Theta(2,n))^2)+((3*E*I)/(2*le^2))*((1+(Theta(5
,n)))^2+3*(1+(Theta(1,n)))^2),((-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n)))+((1
+(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le^2))*
(((1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((-
3*E*A)/(5*le))*((Theta(6,n))^2+(Theta(2,n))^2)-
((6*E*I)/le^3)*((1+(Theta(1,n)))^2+(1+(Theta(5,n)
))^2),((E*A)/160)*((23*(Theta(2,n))^2)-
7*(Theta(6,n))^2)+((3*E*I)/(2*le^2))*(3*(1+(Theta
(5,n)))^2+(1+(Theta(1,n)))^2);
((E*A)/8)*(((1+(Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n))))+((E*I)/(4*le))*(
5*((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n))))*(Theta(7,n))),((E*A)/160)*((23
*(Theta(6,n))^2)-
7*(Theta(2,n))^2)+((3*E*I)/(2*le^2))*((1+(Theta(5
,n)))^2+3*(1+(Theta(1,n)))^2),((E*A*le)/480)*(17*
((Theta(6,n))^2)+47*(Theta(2,n))^2)+((E*I)/(2*le)
)*((1+(Theta(5,n)))^2+7*(1+(Theta(1,n)))^2),((E*A
)/8)*(((1+(Theta(1,n)))*(Theta(2,n)))-
((1+(Theta(5,n)))*(Theta(6,n)))+((E*I)/(4*le))*((
(1+(Theta(5,n)))*(Theta(7,n)))-
5*((1+(Theta(1,n))))*(Theta(3,n)))),((-
E*A)/160)*((23*(Theta(6,n))^2)+7*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*((1+(Theta(5,n)))^2+3*(1+(Thet
a(1,n)))^2),((-
E*A*le)/60)*(((Theta(2,n))^2)+(Theta(6,n))^2)+((E
*I)/le)*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))^2);
((-
E*A)/(2*le))*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))
^2)-
((E*I)/(2*le))*((Theta(7,n))^2+(Theta(3,n))^2),((
-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n)))+((1
+(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le^2))*
(((1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((E*A)/8)*(((1+(
Theta(1,n)))*(Theta(2,n)))-
((1+(Theta(5,n)))*(Theta(6,n)))+((E*I)/(4*le))*((
(1+(Theta(5,n)))*(Theta(7,n)))-
5*((1+(Theta(1,n))))*(Theta(3,n)))),((E*A)/(2*le)
)*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))^2)+((E*I)/
```

```
(2*le))*((Theta(7,n))^2+(Theta(3,n))^2),((E*A)/(2
*le))*(((1+(Theta(5,n)))*(Theta(6,n)))+((1+(Theta
(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le^2))*(((1+(T
heta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((E*A)/8)*(((1+(
Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n)))+((E*I)/(4*le))*((
5*(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n))))*(Theta(3,n))));
((-
E*A)/(2*le))*(((1+(Theta(5,n)))*(Theta(6,n))+((1+
(Theta(1,n)))*(Theta(2,n))))+((3*E*I)/(2*le)^2)*(
(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n)))*(Theta(3,n)))),((-
3*E*A)/(5*le))*((Theta(6,n))^2+(Theta(2,n))^2)-
((6*E*I)/le^3)*((1+(Theta(1,n)))^2+(1+(Theta(5,n)
))^2),((-
E*A)/160)*((23*(Theta(6,n))^2)+7*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*((1+(Theta(5,n)))^2+3*(1+(Thet
a(1,n)))^2),((E*A)/(2*le))*(((1+(Theta(5,n)))*(Th
eta(6,n)))+((1+(Theta(1,n)))*(Theta(2,n))))+((3*E
*I)/(2*le^2))*(((1+(Theta(1,n)))*(Theta(3,n)))-
((1+(Theta(5,n)))*(Theta(7,n)))),((3*E*A)/(5*le))
*((Theta(6,n))^2-
(Theta(2,n))^2)+((6*E*I)/le^3)*((1+(Theta(1,n)))^
2+(1+(Theta(5,n)))^2),((E*A)/160)*((7*(Theta(6,n)
)^2)-23*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*(3*(1+(Theta(5,n)))^2+(1+(Thet
a(1,n)))^2);
((E*A)/8)*(((1+(Theta(1,n)))*Theta(2,n))-
((1+(Theta(5,n)))*Theta(6,n)))+((E*I)/(4*le))*(((
(1+(Theta(1,n)))*(Theta(3,n))))-
(5*(1+(Theta(5,n)))*(Theta(7,n)))),((E*A)/160)*((
23*(Theta(2,n))^2)-
7*(Theta(6,n))^2)+((3*E*I)/(2*le^2))*(3*(1+(Theta
(5,n)))^2+(1+(Theta(1,n)))^2),((-
E*A*le)/60)*(((Theta(2,n))^2)+(Theta(6,n))^2)+((E
*I)/le)*((1+(Theta(5,n)))^2+(1+(Theta(1,n)))^2),(
(E*A)/8)*(((1+(Theta(5,n)))*(Theta(6,n)))-
((1+(Theta(1,n)))*(Theta(2,n)))+((E*I)/(4*le))*((
5*(1+(Theta(5,n)))*(Theta(7,n)))-
((1+(Theta(1,n))))*(Theta(3,n)))),((E*A)/160)*((7
*(Theta(6,n))^2)-23*(Theta(2,n))^2)-
((3*E*I)/(2*le^2))*(3*(1+(Theta(5,n)))^2+(1+(Thet
```

```
a(1,n)))^2),((E*A*le)/480)*(47*((Theta(6,n))^2)+1
7*(Theta(2,n))^2)+((E*I)/(2*le))*(7*(1+(Theta(5,n
)))^2+(1+(Theta(1,n)))^2)];
K11 = wextend(2,'zpd',ksigma,3*i, 'l');
%for ir = 1:6
    %for ic = 1:6
        %ick = 3*(n-1)+ ic;
        %icr = 3*(n-1)+ ir;
       % K11(ick,icr)=K11(ick,icr)+
ksigma(ic,ir);
    %end
%end
Ksigma= Ksigma+K11;
K111 = wextend(2,'zpd',k01,3*i, 'l');
K01=K01+K111;
end
   end
   if NTYPE==1
      K2=K;
   else
    K2=Ksigma+K;
   end
   K3=K2;

K2(1:3,:) = [];
K2(:,1:3) = [];
jnc

ASLOD1(1:3)=[];
  K2;

dsi=ds;
    dds = zeros((3*(n+1)),1);
a = 1;
%displacements

dis = inv(K2)* ASLOD1;
for id = 1:3*(n+1)
if(drs(id)==1)
dds(id)=0;
else
dds(id)=dis(a);
a=a+1;
end
```

```
end

Fr = Fr+ K3*dds;
ds = ds+dds;
for j=1:n
     for Ie =1:6;
    ddEs(Ie,j)=dds((3*(j-1))+Ie);
     dEs(Ie,j)=ds(Ie+(3*(j-1)));
     dEsi(Ie,j)=dsi(Ie+(3*(j-1)));
    end
     end
     ddEs;
     dEs;
     deltaSR1=zeros(4,n);
     for j=1:n
         le=l(j);
  G =[-1/le 0 0 1/le 0 0;0 0 1 0 0 0;0 (-6/le^2)
(-4/le) 0 (6/le^2) (-2/le);0 0 0 0 0 0;
    -1/le 0 0 1/le 0 0;0 0 0 0 0 1;0 (6/le^2)
(2/le) 0 (-6/le^2) (4/le);0 0 0 0 0 0];
  Theta=G*dEsi;
Theta1=G*ddEs;

 DB0 = [(-E*A/le),0,0,(E*A/le),0,0;0,((-
6*E*I)/le^2),((-4*E*I)/le),0,((6*E*I)/le^2),((-
2*E*I)/le);
       (-
E*A/le),0,0,(E*A/le),0,0;0,((6*E*I)/le^2),((2*E*I
)/le),0,((-6*E*I)/le^2),((4*E*I)/le)];

DB1=[((-E*A)/le)*(Theta(1,j)) 0 E*A*(Theta(2,j))
((E*A)/le)*(Theta(1,j)) 0 0;
    ((-E*I)/le)*(Theta(3,j)) ((-
6*E*I)/le^2)*(Theta(1,j)) ((-
4*E*I)/le)*(Theta(1,j)) ((E*I)/le)*(Theta(3,j))
((6*E*I)/le^2)*(Theta(1,j)) ((-
2*E*I)/le)*(Theta(1,j));
    ((-E*A)/le)*(Theta(5,j)) 0 0
((E*A)/le)*(Theta(5,j)) 0 (E*A)*(Theta(6,j));
    ((-E*I)/le)*(Theta(7,j))
((6*E*I)/le^2)*(Theta(5,j))
((2*E*I)/le)*(Theta(5,j)) ((E*I)/le)*(Theta(7,j))
((-6*E*I)/le^2)*(Theta(5,j))
((4*E*I)/le)*(Theta(5,j))];
```

```
DB11=.5*[((-E*A)/le)*(Theta1(1,j)) 0
E*A*(Theta1(2,j)) ((E*A)/le)*(Theta1(1,j)) 0 0;
    ((-E*I)/le)*(Theta1(3,j)) ((-
6*E*I)/le^2)*(Theta1(1,j)) ((-
4*E*I)/le)*(Theta1(1,j)) ((E*I)/le)*(Theta1(3,j))
((6*E*I)/le^2)*(Theta1(1,j)) ((-
2*E*I)/le)*(Theta1(1,j));
    ((-E*A)/le)*(Theta1(5,j)) 0 0
((E*A)/le)*(Theta1(5,j)) 0 (E*A)*(Theta1(6,j));
    ((-E*I)/le)*(Theta1(7,j))
((6*E*I)/le^2)*(Theta1(5,j))
((2*E*I)/le)*(Theta1(5,j))
((E*I)/le)*(Theta1(7,j)) ((-
6*E*I)/le^2)*(Theta1(5,j))
((4*E*I)/le)*(Theta1(5,j))];
if NTYPE==1
      DB=DB0;
else
DB=DB0+DB1+DB11;
end
for is=1:4
    for js=1:6
 deltaSR1(is,j)=DB(is,js)*ddEs(js,j);
        SR1(is,j)= SR1(is,j)+deltaSR1(is,j);
    end
end
     end
  SR1;
       for j=1:n
  SR11(1,j)=SR1(1,j);
  SR11(2,j)=SR1(3,j);
  SR12(1,j)=SR1(2,j);
  SR12(2,j)=SR1(4,j);
  end
   M1=SR12(1,:);
   M2=SR12(2,:);
  F1=SR11(1,:);
  F2=SR11(2,:);
for i=1:n
    for j=1:1
    if i==1&&j==1
        Mav(j,i)=M1(j,i);
        Fav(j,i)=F1(j,i);
```

```
    else
   Mav(j,i)=0.5*(M1(j,i)+M2(j,i-1));
   Fav(j,i)=0.5*(F1(j,i)+F2(j,i-1));
    end

    end
   Mav(j,i+1)=M2(j,n);
   Fav(j,i+1)=F2(j,n);
end
  Mav;
  Fav;
        RINT=zeros(6,n);
        for j=1:n
             le=l(j);
  G =[-1/le 0 0 1/le 0 0;0 0 1 0 0 0;0 (-6/le^2)
(-4/le) 0 (6/le^2) (-2/le);0 0 0 0 0 0;
    -1/le 0 0 1/le 0 0;0 0 0 0 0 1;0 (6/le^2)
(2/le) 0 (-6/le^2) (4/le);0 0 0 0 0 0];
  Theta=G*dEs;
          RINT(1:6,j)=[-.5*SR1(1,j)-.5*SR1(3,j);
            -
(3/(2*le))*SR1(2,j)+(3/(2*le))*SR1(4,j);
             -(5/4)*SR1(2,j)+.25*SR1(4,j);
             .5*SR1(1,j)+.5*SR1(3,j);
            (3/(2*le))*SR1(2,j)-
(3/(2*le))*SR1(4,j);
             -.25*SR1(2,j)+(5/4)*SR1(4,j)];
 %RINT(1:6,j)=[-.5*Fav(1,j)-.5*Fav(1,j+1);
            % -
(3/(2*le))*Mav(1,j)+(3/(2*le))*Mav(1,j+1);
            % -(5/4)*Mav(1,j)+.25*Mav(1,j+1);
            % .5*Fav(1,j)+.5*Fav(1,j+1);
            %(3/(2*le))*Mav(1,j)-
(3/(2*le))*Mav(1,j+1);
            % -.25*Mav(1,j)+(5/4)*Mav(1,j+1)];
end
        RINT;
        TRINT=zeros(3*(n+1),1);
        for j=1:n
       for Ie =1:6;
   TRINT((3*(j-1))+Ie)  =TRINT((3*(j-
1))+Ie)+RINT(Ie,j);
       end
        end
```

```
        TRINT;
        ASLOD1=ASLOD-TRINT;

RNORm=((transpose(ASLOD1)*ASLOD1)^0.5)/ASLOD;
    end
    ASLOD;
    fprintf(' the displacements at the the nodes
are: ')
    ds
   fprintf('the reactions at the nodes are:')
    Fr;
    fprintf('the stresses in the elements are:')
    SR1 ;
    TRINT;
    ASLOD1;
    Mav;
  Fav;
end


 for j=1:n
  dEs(1,j)=dEs(1,j);
  dEs(2,j)=dEs(2,j);
  dEs(3,j)=dEs(3,j);
  dEs(4,j)=dEs(4,j);
  dEs(5,j)=dEs(5,j);
  dEs(6,j)=dEs(6,j);
end
   dEs1=dEs(2,:);
   dEs2=dEs(5,:);
   dEs3=dEs(3,:);
   dEs4=dEs(6,:);
   dEs5=dEs(1,:);
   dEs6=dEs(4,:);
for i=1:n
    for j=1:1
    if i==1&&j==1
        dEsv(j,i)=dEs1(j,i);
        dEstheta(j,i)=dEs3(j,i);
        dEsu(j,i)=dEs5(j,i);
    else
   dEsv(j,i)=0.5*(dEs1(j,i)+dEs2(j,i-1));
   dEstheta(j,i)=0.5*(dEs3(j,i)+dEs4(j,i-1));
   dEsu(j,i)=0.5*(dEs5(j,i)+dEs6(j,i-1));
```

```
    end

    end
   dEsv(j,i+1)=dEs2(j,n);
   dEstheta(j,i+1)=dEs4(j,n);
   dEsu(j,i+1)=dEs6(j,n);
end
dEsv;
dEstheta;
dEsu;
ee=0:le:L;
plot(ee,dEsv,'k',ee,dEstheta,'c',ee,dEsu,'m','Lin
eWidth',2.27)
dEsvmax=max(dEsv);
ind=find(dEsv==dEsvmax);
dEsthetamax=dEstheta(ind);
legend('v','theta','u')
xlabel('le(m)')
 ylabel('ds')
 title('displacements')
 grid on
 figure
 for j=1:n
  SR11(1,j)=SR1(1,j);
  SR11(2,j)=SR1(3,j);
  SR12(1,j)=SR1(2,j);
  SR12(2,j)=SR1(4,j);
  end
   M1=SR12(1,:);
   M2=SR12(2,:);

for i=1:n
    for j=1:1
    if i==1&&j==1
        M(j,i)=M1(j,i);
    else
   M(j,i)=0.5*(M1(j,i)+M2(j,i-1));
    end

    end
   M(j,i+1)=M2(j,n);
end
  M ;
   ee=0:le:L;
```

```
 plot(ee,M,'m','LineWidth',2.27)
 xlabel('Length(m)')
 ylabel('M')
 title('bending moment')
 grid on
figure
```

Appendix (D)

cantilever beam

Enter Youngs Modulus of beam:200000000

Enter 1 for circular c/s, 2 for rectangular c/s or 3 to enter value of I manually:2

Enter I of beam:8.33*10^-5

I =

e-058.3300

Enter area of beam:.1

solution type1

Enter number of elements:2

:Enter Length of the beam

2.5

Node 3

Enter forces position8

Enter forces value-13328

INC=1

FACTO =1

niter=1

LINC =

0

0

0

0

0

0

0

-13328

0

ASLOD=

0

0

0

0

0

0

0

-13328

0

ASLOD1=

0

0

0

0

0

0

0

-13328

0

Jnc=

1

Mav=

* e+041.0

0.0000 -1.6660 -3.3320

Fav=

0 0 0

:the displacements at the the nodes are

ds=

0

0

0

0

-1.3021

-1.8750

0

-4.1667

-2.5000