```
%CAD Hw2 Problem 3
clc
clear all

klocal=[ 1 0 -1 0;0 0 0 0;-1 0 1 0;0 0 0 0];
%Constants (E, A and L values)
theta_A= atand(144/90); %degrees
L_A= sqrt((144^2)+(90^2)); %inches
A = (pi()/4)*(10)^2; %in^2
E=30e6; %psi for steel

theta_B=0;
L_B=90; %inches

theta_C=90;
L_C=144;%inches

theta_D=0;
L_D=90; %inches

theta_E=atand(-12/7.5);
L_E=sqrt((144^2)+(90^2));

theta_F=0;
L_F=90;

theta_G=90;
L_G=144; %inches

%transform to global coordinates
[T_A, K_A] = kglobal(theta_A,L_A,A,E);
[T_B, K_B] = kglobal(theta_B,L_B,A,E);
[T_C, K_C] = kglobal(theta_C,L_C,A,E);
[T_D, K_D]= kglobal(theta_D,L_D,A,E);
[T_E, K_E] = kglobal(theta_E,L_E,A,E);
[T_F, K_F]= kglobal(theta_F,L_F,A,E);
[T_G, K_G] = kglobal(theta_G,L_G,A,E);

%Create the global matrix

K = [K_A(1,1)+K_B(1,1) K_A(1,2)+K_B(1,2) K_A(1,3) K_A(1,4) K_B(1,3) K_B(1,4) 0
 0 0 0;
    K_A(2,1)+K_B(2,1) K_A(2,2)+K_B(2,2) K_A(2,3) K_A(2,4) K_B(2,3) K_B(2,4) 0
 0 0 0;
    K_A(3,1) K_A(3,2) K_A(3,3)+K_C(1,1)+K_E(1,1)+K_F(1,1)
 K_A(3,4)+K_C(1,2)+K_E(1,2)+K_F(1,2) K_C(1,3) K_C(1,4) K_F(1,3) K_F(1,4)
 K_E(1,3) K_E(1,4);
    K_A(4,1) K_A(4,2) K_A(4,3)+K_C(2,1)+K_E(2,1)+K_F(2,1)
 K_A(4,4)+K_C(2,2)+K_E(2,2)+K_F(2,2) K_C(2,3) K_C(2,4) K_F(2,3) K_F(2,4)
 K_E(2,3) K_E(2,4);
    K_B(3,1) K_B(3,2) K_C(3,1) K_C(3,2) K_B(3,3)+K_C(3,3)+K_D(1,1)
 K_B(3,4)+K_C(3,4)+K_D(1,2) 0 0 K_D(1,3) K_D(1,4);
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```
    K_B(4,1) K_B(4,2) K_C(4,1) K_C(4,2) K_B(4,3)+K_C(4,3)+K_D(2,1)
 K_B(4,4)+K_C(4,4)+K_D(2,2) 0 0 K_D(2,3) K_D(2,4);
    0 0 K_F(3,1) K_F(3,2) 0 0 K_F(3,3)+K_G(1,1) K_F(3,4)+K_G(1,2) K_G(1,3)
 K_G(1,4);
    0 0 K_F(4,1) K_F(4,2) 0 0 K_F(4,3)+K_G(2,1) K_F(4,4)+K_G(2,2) K_G(2,3)
 K_G(2,4);
    0 0 K_E(3,1) K_E(3,2) K_D(3,1) K_D(3,2) K_G(3,1) K_G(3,2)
 K_E(3,3)+K_G(3,3)+K_D(3,3) K_E(3,4)+K_G(3,4)+K_D(3,4);
    0 0 K_E(4,1) K_E(4,2) K_D(4,1) K_D(4,2) K_G(4,1) K_G(4,2)
 K_E(4,3)+K_G(4,3)+K_D(4,3) K_E(4,4)+K_G(4,4)+K_D(4,4);];
    %matrix should sum up to zero if it was done correctly
k_sum = sum(K)
    %Recuded system of equations based on boundary conditions
    %we're ignoring any unknown variables, just keeping rows for x2 and y2 and
 y3
k_con=K([3:9],[3:9]);
%column vector of our known forces
F = [130000; -160000; -0; 0; -200000; 0; 0];

%SOlve for unknown displacements
X= k_con\F

%Construct full displacment vector in global cords
XX = [0;0;X(1);X(2);X(3);X(4);X(5);X(6);X(7);0]; % this is all of the global
 displacement
%Calculate reaction forces
F_react=K*XX %solving for reaction forces

%Find local displacments for each element
%local x_local=transfor*X_gloabal

XAlocal = T_A*[XX(1:4)];
XBlocal = T_B*[XX(1:2); XX(4:5)];
XClocal = T_C*[XX(3:6)];
XDlocal = T_D*[XX(4:5); XX(9:10)];
XElocal = T_E*[XX(3:4); XX(9:10)];
XFlocal = T_F*[XX(3:4); XX(7:8)];
XGlocal = T_G*[XX(7:10)];

%Calculate axial force
F_axial_A=((E*A)/L_A)*klocal*XAlocal
F_axial_B=(E*A/L_B)*klocal*XBlocal
F_axial_C=(E*A*L_C)*klocal*XClocal
F_axial_D=(E*A*L_D)*klocal*XDlocal
F_axial_E=(E*A*L_E)*klocal*XElocal
F_axial_F=(E*A*L_F)*klocal*XFlocal
F_axial_G=(E*A*L_G)*klocal*XGlocal

%Calculate stress
StressA = F_axial_A/A
StressB = F_axial_B/A
StressC = F_axial_C/A
StressD = F_axial_D/A
StressE = F_axial_E/A
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```
StressF = F_axial_F/A
StressG = F_axial_G/A

function [l kglb1] = kglobal(theta, h, A, E)

l=[cosd(theta) sind(theta) 0 0;
    -sind(theta) cosd(theta) 0 0;
    0 0 cosd(theta) sind(theta);
    0 0 -sind(theta) cosd(theta)];

klocal1 = [ 1 0 -1 0;
            0 0 0 0;
            -1 0 1 0;
            0 0 0 0];
linv=inv(l);
kglb1=(E*A/h)*(linv*klocal1*l);

end
```

```
k_sum =

   1.0e-08 *

  Columns 1 through 7

         0         0    0.0931    0.3725         0         0         0

  Columns 8 through 10

         0    0.0931         0


X =

   -0.0084
   -0.0084
    0.0006
   -0.0084
   -0.0160
         0
    0.0011


F_react =

   1.0e+05 *

    0.7000
    1.3600
    1.3000
   -1.6000
         0
         0
```

```
   -2.0000
         0
   -0.0000
    0.2400


F_axial_A =

   1.0e+05 *

    1.6038
         0
   -1.6038
         0


F_axial_B =

   1.0e+05 *

    2.1928
         0
   -2.1928
         0


F_axial_C =

     0
     0
     0
     0


F_axial_D =

   1.0e+09 *

   -2.0192
         0
    2.0192
         0


F_axial_E =

   1.0e+08 *

    8.1611
         0
   -8.1611
         0
```

```
F_axial_F =

   1.0e+09 *

    1.6200
         0
   -1.6200
         0


F_axial_G =

     0
     0
     0
     0


StressA =

   1.0e+03 *

    2.0420
         0
   -2.0420
         0


StressB =

   1.0e+03 *

    2.7920
         0
   -2.7920
         0


StressC =

     0
     0
     0
     0


StressD =

   1.0e+07 *

   -2.5709
         0
    2.5709
         0
```

```
StressE =

   1.0e+07 *

    1.0391
         0
   -1.0391
         0


StressF =

   1.0e+07 *

    2.0626
         0
   -2.0626
         0


StressG =

     0
     0
     0
     0
```

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