ME 481 - H05 **Name ________________________**

1) Use Working Model (WM) to model the two inversions of the Wanzer needle bar mechanism shown below. Provide position, velocity and acceleration MATLAB graphs for point G as a function of rotation angle with disk 2 rotating at constant 240 rpm CW. Attach a screen shot of your WM mechanism and provide hard copy of your code.

Which of these inversions would be used for a sewing machine? Why?

Inversion 2 – dwell at bottom to tension thread, lift to allow slack and throw knot, tighten and return

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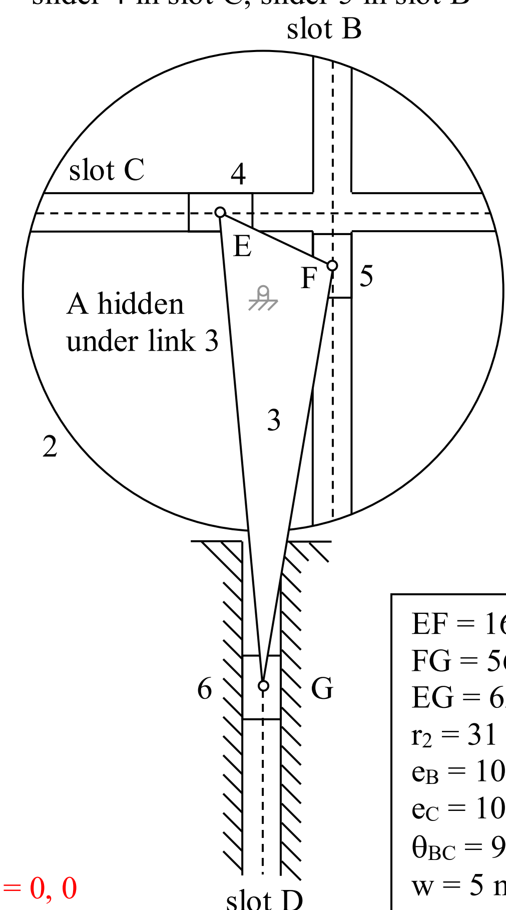
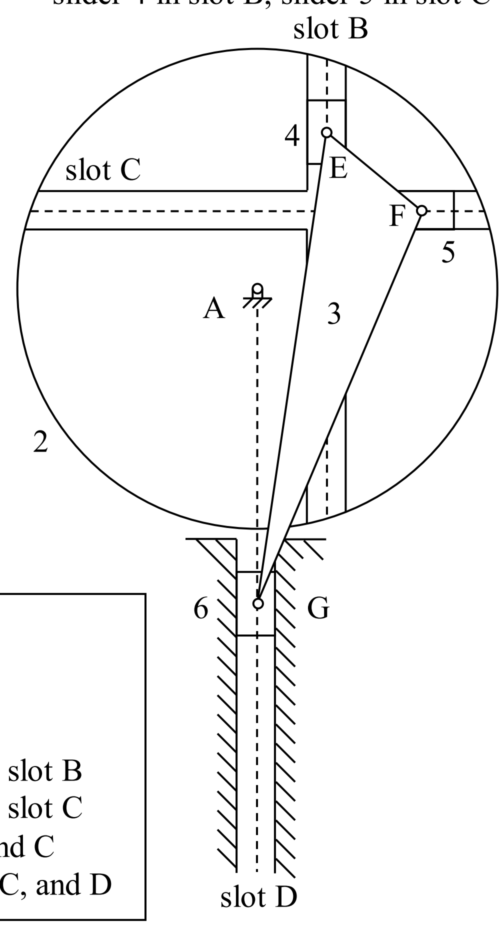
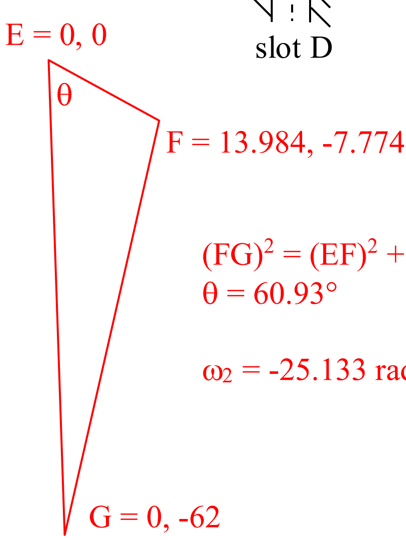
Inversion 1
slider 4 in slot C, slider 5 in slot B



Inversion 2
slider 4 in slot B, slider 5 in slot C



EF = 16 mm
FG = 56 mm
EG = 62 mm
r_2 = 31 mm radius of disk 2
e_B = 10 mm radial offset for slot B
e_C = 10 mm radial offset for slot C
θ_{BC} = 90º between slots B and C
w = 5 mm width of slots B, C, and D



$(FG)^2 = (EF)^2 + (EG)^2 – 2\,(EF)\,(EG)\cos\theta$
$\theta = 60.93°$

ω_2 = -25.133 rad/sec

from WM for Inversion 2
V_G = -365 mmps
at initial position

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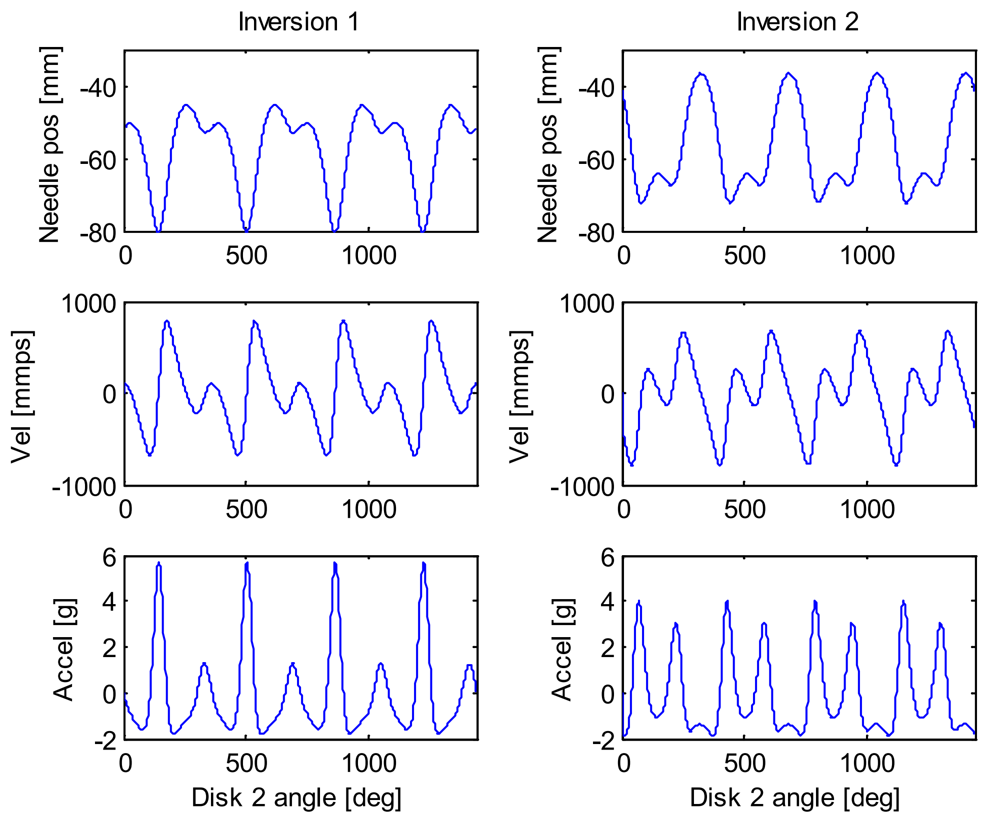
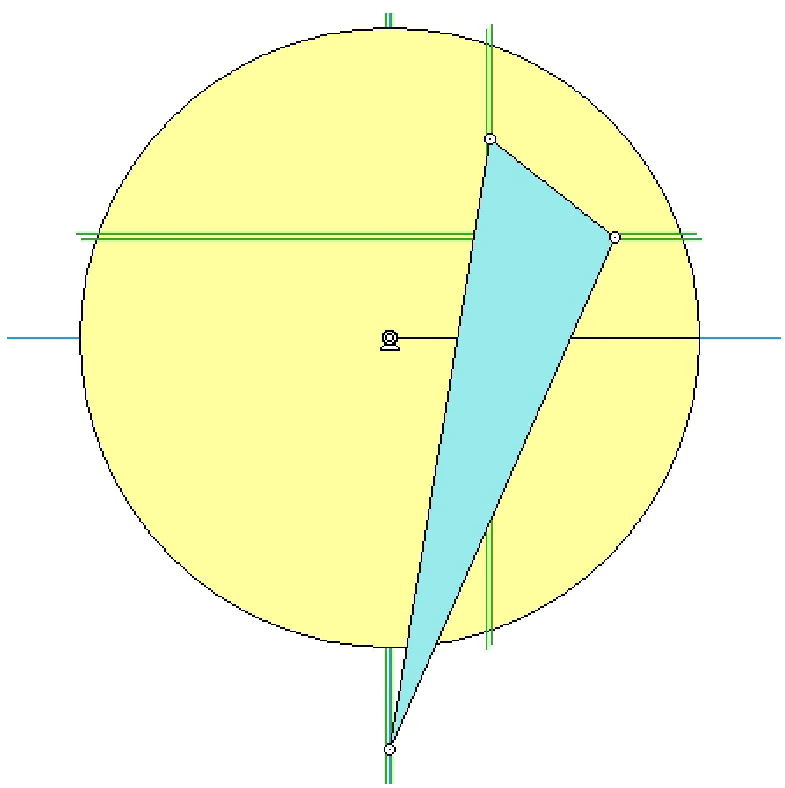

Inversion 1
Inversion 2
Needle pos [mm]
-40
-60
-80
Vel [mmps]
1000
0
-1000
Accel [g]
6
4
2
0
-2
0
500
1000
Disk 2 angle [deg]



```
% h05.m - ME 481 HW05 - read and plot WM data for Wanzer inversions
% HJSIII, 09.03.07

% general constants
d2r = pi / 180;

% mechanism constants
w2 = 240 *2*pi /60;  % crank speed [rad/sec]

% load WM data
%t  th2  t  x  y  rot  t  Vx  Vy  |V|  Vø  t  Ax  Ay  |A|  Aø

Inv1 = load( 'WanzerInv1_cut.txt' );
t = Inv1(:,1);
th = -Inv1(:,2);
th_deg = th / d2r;
s1 = Inv1(:,5);
v1 = Inv1(:,9);
a1 = Inv1(:,14) / 9810;  % convert to G

Inv2 = load( 'WanzerInv2_cut.txt' );
s2 = Inv2(:,5);
v2 = Inv2(:,9);
a2 = Inv2(:,14) / 9810;  % convert to G

% plot results
figure( 1 )
  clf

% Inversion 1
  subplot( 3, 2, 1 )
  plot( th_deg,s1 )
  axis( [ 0 4*360  -80 -30 ] )
  ylabel( 'Needle pos [mm]' )
  title( 'Inversion 1' )

  subplot( 3, 2, 3 )
  plot( th_deg,v1 )
  axis( [ 0 4*360  -1000 1000 ] )
  ylabel( 'Vel [mmps]' )

  subplot( 3, 2, 5 )
  plot( th_deg,a1 )
  axis( [ 0 4*360  -2 6 ] )
  xlabel( 'Disk 2 angle [deg]' )
  ylabel( 'Accel [g]' )

% Inversion 2
  subplot( 3, 2, 2 )
  plot( th_deg,s2 )
  axis( [ 0 4*360  -80 -30 ] )
  ylabel( 'Needle pos [mm]' )
  title( 'Inversion 2' )

  subplot( 3, 2, 4 )
  plot( th_deg,v2 )
  axis( [ 0 4*360  -1000 1000 ] )
  ylabel( 'Vel [mmps]' )

  subplot( 3, 2, 6 )
  plot( th_deg,a2 )
  axis( [ 0 4*360  -2 6 ] )
  xlabel( 'Disk 2 angle [deg]' )
  ylabel( 'Accel [g]' )
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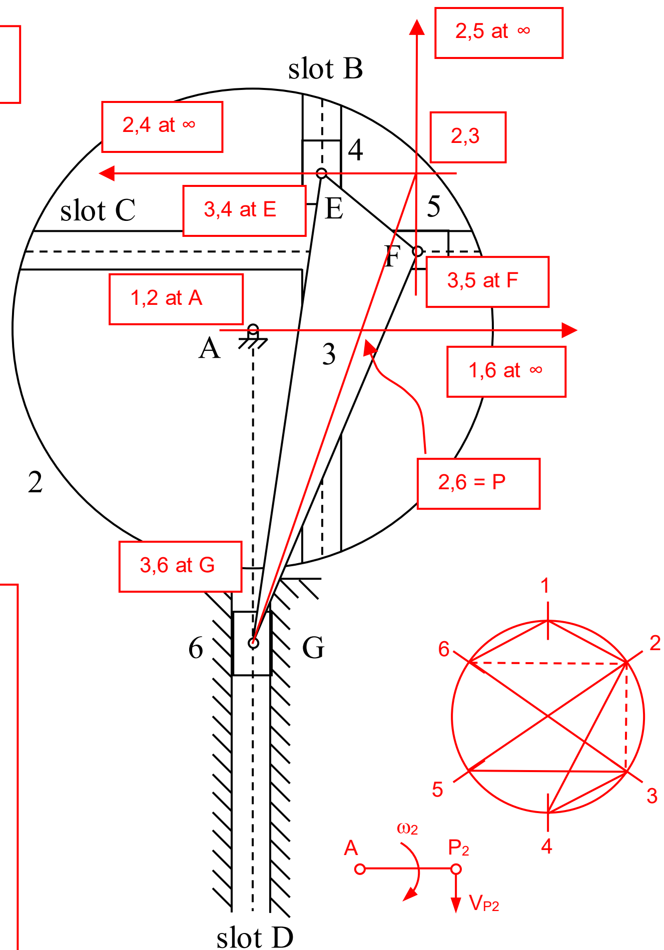
2) Check your WM velocity solution for Inversion 2 using instantaneous centers at the position shown below with disk 2 rotating at constant 240 rpm CW. The mechanism is drawn to scale full size. Show your work.

V_G ____ V_{G6} = 370 mmps ____

ω_2 = 240 rpm = 8π rad/sec

Kennedy-Aronhold
2,5 and 3,5 intersect 2,3
2,4 and 3,4 intersect 2,3

1,2 and 1,6 intersect 2,6
2,3 and 3,6 intersect 2,6



define P at $IC_{2,6}$
AP = 14.7 mm by ruler
$V_{P2} = \omega_2$ (AP)
= 370 mmps down
$V_{P2} = V_{P6}$ because P = $IC_{2,6}$
$V_{P6} = V_{G6}$

V_{G6} = 370 mmps down

from WM
V_G = 365 mmps down
1.4% difference

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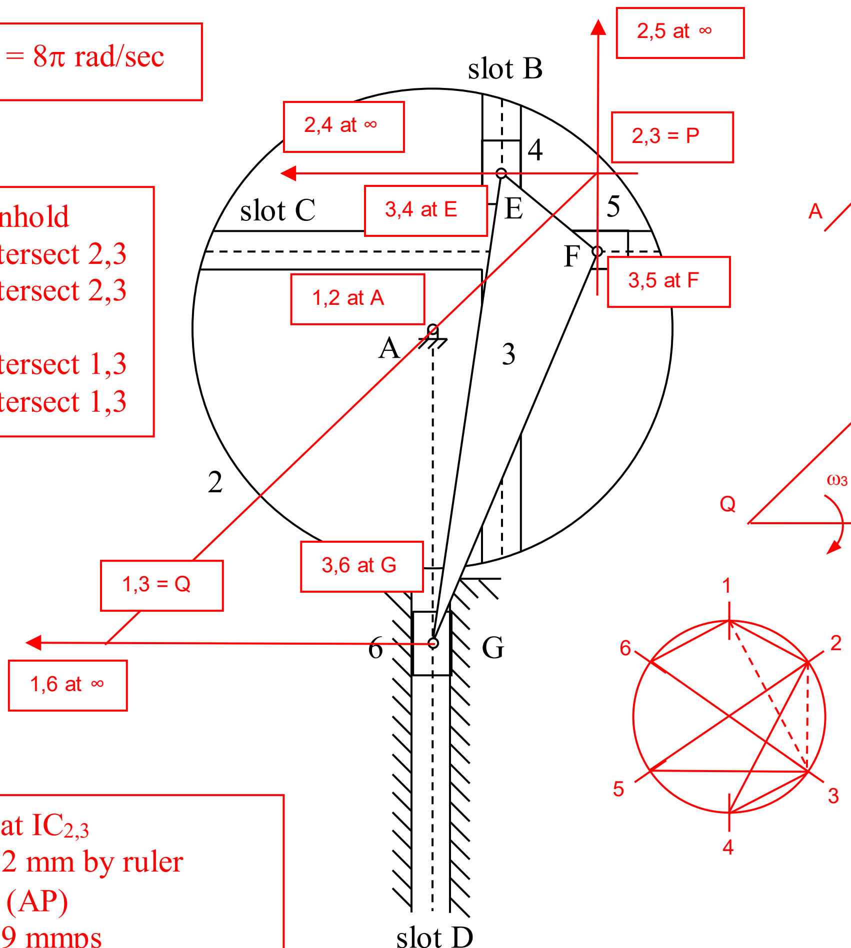
2) Check your WM velocity solution for Inversion 2 using instantaneous centers at the position shown below with disk 2 rotating at constant 240 rpm CW. The mechanism is drawn to scale full size. Show your work.

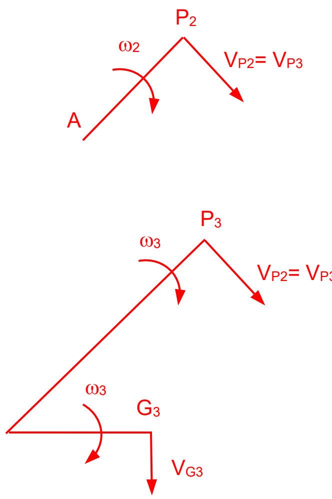
V_G _____ V_{G3} = 365 mmps _____

ω_2 = 240 rpm = 8π rad/sec

Kennedy-Aronhold
2,5 and 3,5 intersect 2,3
2,4 and 3,4 intersect 2,3

1,2 and 2,3 intersect 1,3
1,6 and 3,6 intersect 1,3





define P at $IC_{2,3}$
AP = 30.2 mm by ruler
$V_{P2} = \omega_2$ (AP)
= 759 mmps
$V_{P3} = V_{P2}$ because P = $IC_{2,3}$

define Q at $IC_{1,3}$
PQ = 90.1 mm by ruler
$V_{P3} = \omega_3$ (PQ)
$\omega_3 = V_{P3}$ / (PQ)
= 8.4241 rad/sec CW

GQ = 43.3 mm by ruler
$V_{G3} = \omega_3$ (GQ)
= 365 mmps down

from WM
V_G = 365 mmps down

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geometry solution

$$\{r\}^E = \begin{Bmatrix} 10 \\ 19.9279 \end{Bmatrix} \qquad \{r\}^F = \begin{Bmatrix} 22.5473 \\ 10 \end{Bmatrix} \qquad \{r\}^G = \begin{Bmatrix} 0 \\ -41.2603 \end{Bmatrix}$$

```
% wanzer_geom.m - geometry for Wanzer needle bar ME 481 H05 inversion 2
% HJSIII, 16.02.29

% constants - units = [mm]
EF = 16;  % triangular link 3
FG = 56;
EG = 62;

xE = 10;  % offset slot B
yF = 10;  % offset slot C
xG = 0;   % offset slot D

% initial estimates - yE xF yG
q = [ 20  20  -40 ]';

% Newton-Raphson loop
for k = 1 : 10,

% update constraints
  yE = q(1);
  xF = q(2);
  yG = q(3);
  PHI = [  (xE-xF)^2+(yE-yF)^2-EF^2 ;
           (xF-xG)^2+(yF-yG)^2-FG^2 ;
           (xE-xG)^2+(yE-yG)^2-EG^2 ];

% Jacobian
  JAC = [   2*(yE-yF)   -2*(xE-xF)    0          ;
            0            2*(xF-xG)   -2*(yF-yG)  ;
            2*(yE-yG)    0           -2*(yE-yG)  ];

% update
  q = q - inv(JAC)*PHI

  pause

end
```