ME 581 – C02 **Name ______________________________**

1) Program your constraints and Jacobian for the web cutter into a Newton-Raphson iterative algorithm to solve position kinematics for any desired crank angle. To check your work, when ϕ_2 = 90 degrees, ϕ_3 = 65.3 degrees and ϕ_4 = -69.0 degrees.

2) Develop the velocity right-hand-side vector $\{v\}$ for your constraints, and program them to solve for the generalized coordinate velocities $\{\dot{q}\}$. To check your work, when ϕ_2 = 90 degrees, $\dot{\phi}_3$ = 0.88 rad/s CW and $\dot{\phi}_4$ = 0.72 rad/s CCW.

3) Develop the acceleration right-hand-side vector $\{\gamma\}$ for your constraints, and program them to solve for the generalized coordinate accelerations $\{\ddot{q}\}$. To check your work, when ϕ_2 = 90 degrees, $\ddot{\phi}_3$ = 14.2 rad/s/s CCW and $\ddot{\phi}_4$ = 10.1 rad/s/s CCW.

4) Place your position, velocity and acceleration algorithms within an outer loop to drive the crank through one complete revolution, and plot $\ddot{\phi}_4$ as a function of crank angle. Also plot the determinant of your Jacobian as a function of crank angle. Start the crank at ϕ_2 = 0 degrees in your plots.

5) Determine the speed of the web.

V_{WEB} ______________________________

EXTRA CREDIT

Modify your code to simulate an in-line slider crank with R = 4.00 cm and L = 14.23 cm operating at constant 60 rpm CCW crank speed. Validate your results by plotting piston acceleration as a function of crank angle compared to simple geometric equations.

```
% sc_geometric.m - in-line slider crank geometric equations
% HJSIII, 14.02.22

clear

% constants
d2r = pi / 180;

% geometry and driver
R = 4;                  % crank length [inch]
L = 14.23;              % connecting rod length [inch[
w = 60 * 2*pi / 60;     % constant crank speed - 60 rpm CCW converted to rad/sec

% constant speed rotation driver motion
theta_deg = ( 0 : 6 : 360 )';
theta = theta_deg * d2r;
st = sin(theta);
ct = cos(theta);

thetad = w * ones( size( theta ) );
thetadd = zeros( size( theta ) );

% position
phi = asin( R * sin(theta) / L );
sp = sin(phi);
cp = cos(phi);

phid = R*thetad.*ct ./ (L*cp);
sd = -R*thetad.*st -L*phid.*sp;

phidd = ( R*thetadd.*ct -R*thetad.*thetad.*st +L*phid.*phid.*sp ) ./ (L*cp);
sdd = -R*thetadd.*st -R*thetad.*thetad.*ct -L*phidd.*sp -L*phid.*phid.*cp;

figure( 1 )
  plot( theta_deg, sdd, 'r' )
  axis( [ 0 360 -250 150 ] )
  title( 'Slider crank geometric solution - 60 rpm CCW' )
  xlabel( 'Crank angle [deg]' )
  ylabel( 'Piston acceleration [ipss]' )

% bottom of sc_geometric
```