ME 481 – H12 **Name** _____

Develop a Working Model (WM) simulation of a stick-slip drag-sled friction testing device. Attach a screen shot of your WM device.

Your device should contain the following –
a) a driver block that translates horizontally at 3.4 cm/sec,
b) a drag-sled with mass 12.5 kg and length 14.9 cm that slides horizontally on a large plate, and
c) a horizontal tension spring with 742.5 N/m stiffness that connects the driver and drag-sled.

1) To simulate dry metal-on-metal contact, use coefficient of static friction $\mu_S = 0.4$ and coefficient of dynamic friction $\mu_D = 0.3$ for both the drag-sled and the plate. Provide MATLAB graphs of drag-sled position, velocity, acceleration and friction force as functions for time.

What is the maximum absolute acceleration ignoring blips? a_{MAX} 1.01 mps^2

2) Repeat to simulate Neolite (standard footwear slip testing material) on a tile floor using coefficients of static friction $\mu_S = 0.9$ and dynamic friction $\mu_D = 0.6$. Discuss differences in between parts 1) and 2).

What is the maximum absolute acceleration ignoring blips? a_{MAX} 2.95 mps^2

3) Experiment with height above the plate at which you attach the spring to the drag-sled to investigate how it might influence your results. **Be certain to keep the spring horizontal.** Provide a brief discussion and plots.

What is the ratio of attachment height (h) divided by drag-sled length (L) that causes tipping expressed as function of static coefficient of friction μ_S ?

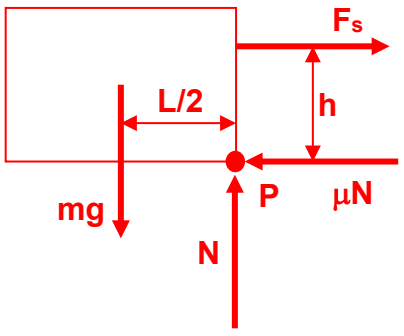
h/L = $1 / 2\mu_S$

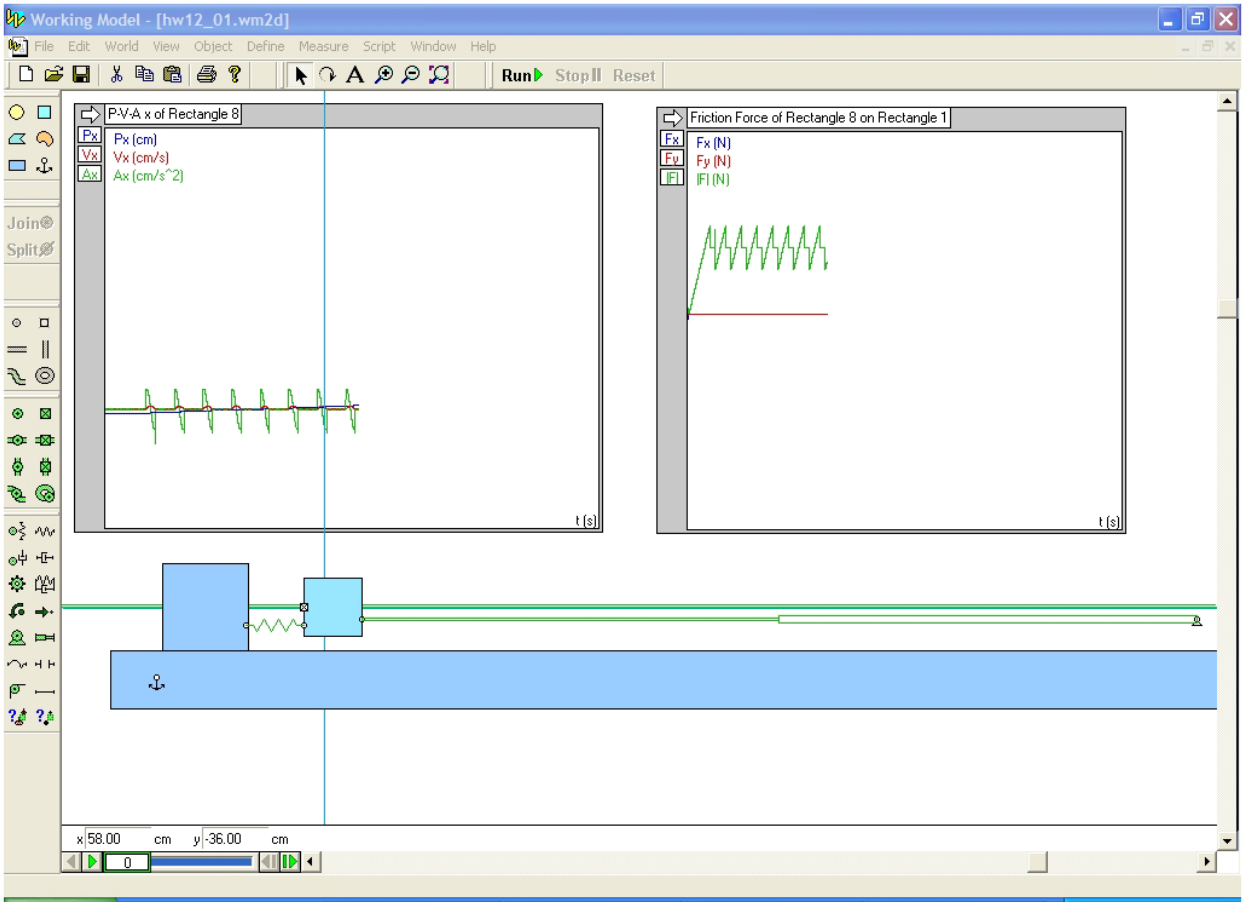
Are results different if you attach the spring too low? no

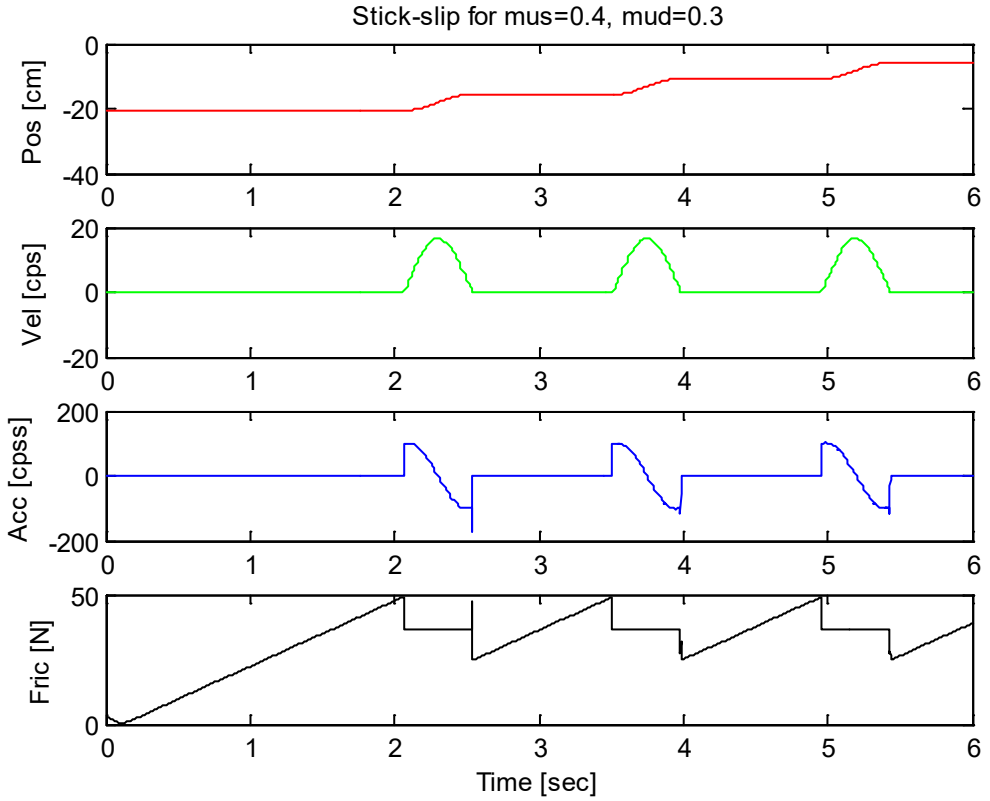
FBD of drag-sled at tipping

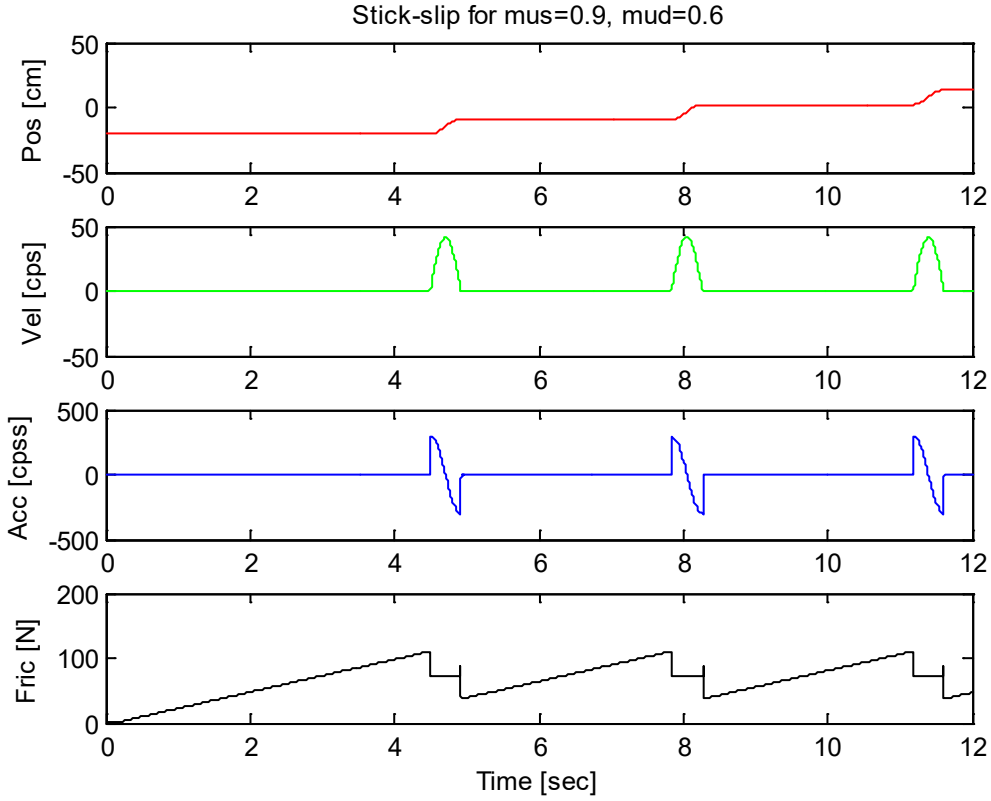
ΣM CCW positive about P $+mg\,(L/2) - F_s\,h = 0$
ΣF right positive $+F_s - \mu N = 0$
ΣF up positive $+N - mg = 0$

$$F_s h = \frac{mgL}{2} \qquad \frac{h}{L} = \frac{mg}{2F_s} = \frac{1}{2\mu}$$




Working Model - [hw12_01.wm2d]
File Edit World View Object Define Measure Script Window Help
Run Stop Reset
P-V-A x of Rectangle 8
Px (cm)
Vx (cm/s)
Ax (cm/s^2)
t (s)
Friction Force of Rectangle 8 on Rectangle 1
Fx (N)
Fy (N)
|F| (N)
t (s)
Join
Split
x 58.00 cm y -36.00 cm
0


Stick-slip for mus=0.4, mud=0.3
Pos [cm]
Vel [cps]
Acc [cpss]
Fric [N]
Time [sec]


Stick-slip for mus=0.9, mud=0.6
Pos [cm]
Vel [cps]
Acc [cpss]
Fric [N]
Time [sec]

ME 481 – H12 **Name _____**

```
% hw12.m - plot stick-slip for ME 481 H12
% HJSIII, 11.04.01

clear

% part 1
% load file and rip data
raw = load( 'hw12_01_cut.txt' );
t = raw( :,1 );
pos = raw( :,2 );
vel = raw( :,3 );
acc = raw( :,4 );
fric = raw( :, 8 );

% plot
figure( 1 )
  clf
  subplot( 4,1,1 )
  plot( t,pos,'r' )
  ylabel( 'Pos [cm]' )
  title( 'Stick-slip for mus=0.4, mud=0.3' )

  subplot( 4,1,2 )
  plot( t,vel,'g' )
  ylabel( 'Vel [cps]' )

  subplot( 4,1,3 )
  plot( t,acc,'b' )
  ylabel( 'Acc [cpss]' )

  subplot( 4,1,4 )
  plot( t,fric,'k' )
  ylabel( 'Fric [N]' )
  xlabel( 'Time [sec]' )

% part 2
% load file and rip data
raw = load( 'hw12_02_cut.txt' );
t = raw( :,1 );
pos = raw( :,2 );
vel = raw( :,3 );
acc = raw( :,4 );
fric = raw( :, 8 );

% plot
figure( 2 )
  clf
  subplot( 4,1,1 )
  plot( t,pos,'r' )
  ylabel( 'Pos [cm]' )
  title( 'Stick-slip for mus=0.9, mud=0.6' )

  subplot( 4,1,2 )
  plot( t,vel,'g' )
  ylabel( 'Vel [cps]' )

  subplot( 4,1,3 )
  plot( t,acc,'b' )
  ylabel( 'Acc [cpss]' )

  subplot( 4,1,4 )
  plot( t,fric,'k' )
  ylabel( 'Fric [N]' )
  xlabel( 'Time [sec]' )
```