Contents

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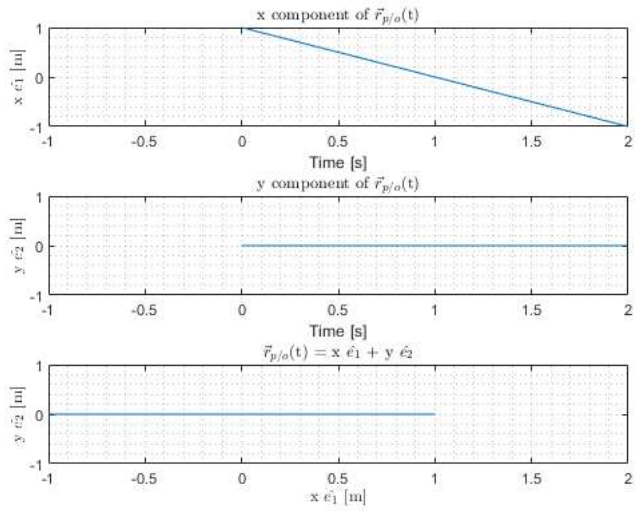
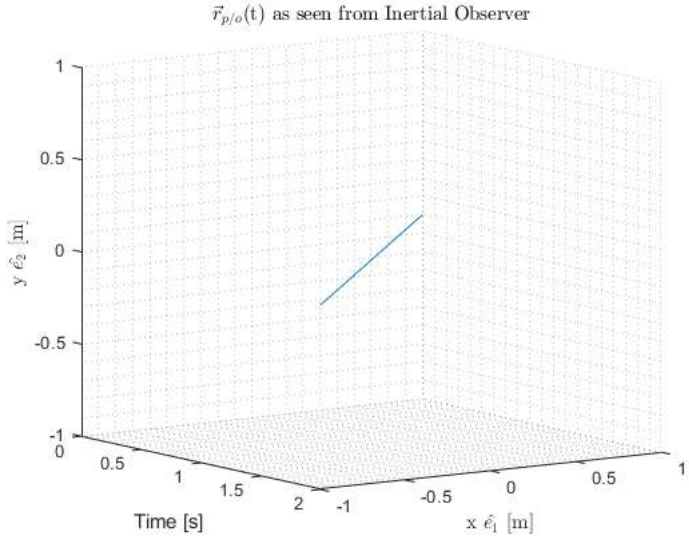
```
clear
close all
clc
```

Problem 8.10.B

```
t           = (0:0.01:2)';          % Time [s]
x           = -t + 1;               % component of r_p/o in e1 [m], derived from xdotdot = 0
y           = zeros(length(t),1);   % component of r_p/o in e2 [m], derived from ydotdot = 0

figure()
ax1         = subplot(3,1,1);
plot(t,x)
ylabel('x $\hat{e_1}$ [m]','Interpreter','latex')
xlabel('Time [s]')
title('x component of $\vec{r}_{p/o}$(t)','Interpreter','latex')
grid minor

ax2         = subplot(3,1,2);
plot(t,y)
ylabel('y $\hat{e_2}$ [m]','Interpreter','latex')
xlabel('Time [s]')
title('y component of $\vec{r}_{p/o}$(t)','Interpreter','latex')
grid minor

ax3         = subplot(3,1,3);
plot(x,y)
ylabel('y $\hat{e_2}$ [m]','Interpreter','latex')
xlabel('x $\hat{e_1}$ [m]','Interpreter','latex')
title('$\vec{r}_{p/o}$(t) = x $\hat{e_1}$ + y $\hat{e_2}$','Interpreter','latex')
grid minor

linkaxes([ax1 ax2 ax3],'x')

figure()
plot3(t,x,y)
grid minor
xlabel('Time [s]')
ylabel('x $\hat{e_1}$ [m]','Interpreter','latex')
zlabel('y $\hat{e_2}$ [m]','Interpreter','latex')
title('$\vec{r}_{p/o}$(t) as seen from Inertial Observer','Interpreter','latex')
view(55,10);
```

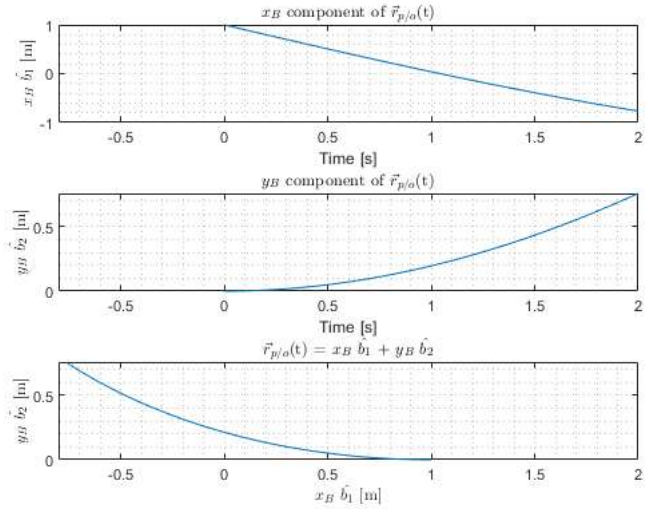


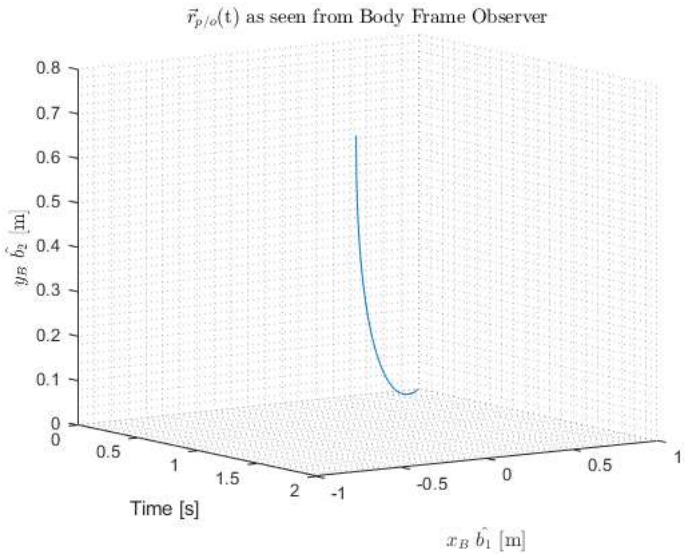


Problem 8.10.D

```
Omega   = 0.2                                                          ; % Angular velocity IwB [rad/s] about b3 = e3

IC1      = [1 0 -1 0]'                                                 ; % Initial conditions of xb = R = 1 [m] and v0 = -1 [m/s] b1
options = odeset('AbsTol',1e-8,'RelTol',1e-8)                          ; % ODE45 solver options

[T,Z1] = ode45(@(t,z) BodyParticle(t,z,Omega),t,IC1,options)           ; % Simulation

figure()
ax1         = subplot(3,1,1);
plot(t,Z1(:,1))
ylabel('$x_B$ $\hat{b_1}$ [m]','Interpreter','latex')
xlabel('Time [s]')
title('$x_B$ component of $\vec{r}_{p/o}$(t)','Interpreter','latex')
grid minor

ax2         = subplot(3,1,2);
plot(t,Z1(:,2))
ylabel('$y_B$ $\hat{b_2}$ [m]','Interpreter','latex')
xlabel('Time [s]')
title('$y_B$ component of $\vec{r}_{p/o}$(t)','Interpreter','latex')
grid minor

ax3         = subplot(3,1,3);
plot(Z1(:,1),Z1(:,2))
ylabel('$y_B$ $\hat{b_2}$ [m]','Interpreter','latex')
xlabel('$x_B$ $\hat{b_1}$ [m]','Interpreter','latex')
title('$\vec{r}_{p/o}$(t) = $x_B$ $\hat{b_1}$ + $y_B$ $\hat{b_2}$','Interpreter','latex')
grid minor

linkaxes([ax1 ax2 ax3],'x')

figure()
plot3(t,Z1(:,1),Z1(:,2))
grid minor
```

```
xlabel('Time [s]')
ylabel('$x_B$ $\hat{b_1}$ [m]','Interpreter','latex')
zlabel('$y_B$ $\hat{b_2}$ [m]','Interpreter','latex')
title('$\vec{r}_{p/o}$(t) as seen from Body Frame Observer','Interpreter','latex')
view(55,10);
```

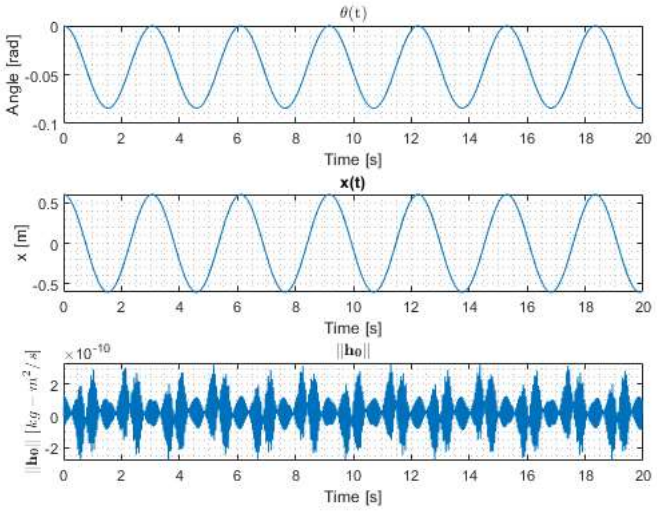




Problem 9.6

```
r           = 1             ; % radius of disk [m]
I           = 2.5           ; % Moment of Inertia [kg-m^2]
l           = .75           ; % offset [m]
m           = 0.25          ; % mass of particle m [kg]
k           = 1             ; % spring constant [N/m]
time        = (0:.01:20)'   ; % time [s]
IC1         = [0 0 .6 0]    ; % IC of x = 60 cm

[T,Z2]      = ode45(@(t,z) SlottedDisk(t,z,m,l,k,I),time,IC1,options);

x           = Z2(:,3);
theta       = Z2(:,1);
xdot        = Z2(:,4);
thetadot    = Z2(:,2);

h0          = m.*thetadot.*x.^2 - m*l.*xdot + m*l^2.*thetadot + I.*thetadot;

figure()
ax1         = subplot(3,1,1);
plot(time,Z2(:,1))
xlabel('Time [s]')
ylabel('Angle [rad]')
grid minor
title('$\theta$(t)','Interpreter','latex')

ax2         = subplot(3,1,2);
plot(time,Z2(:,3))
```

```
xlabel('Time [s]')
ylabel('x [m]')
grid minor
title('x(t)')

ax3         = subplot(3,1,3);
plot(time,h0)
xlabel('Time [s]')
ylabel('$\| \mathbf{h_0} \|$ $[kg-m^2/s]$','Interpreter','latex')
grid minor
title('$\| \mathbf{h_0} \|$','Interpreter','latex')
```



Functions

```
function zdot  = BodyParticle(t,z,Omega)
z1          = z(1,1); % z1 = xB
z2          = z(2,1); % z2 = yB
z3          = z(3,1); % z3 = xBdot
z4          = z(4,1); % z4 = yBdot

% Equations of motion is first order form
zdot(1,1)   = z3;
zdot(2,1)   = z4;
zdot(3,1)   = 2*z4*Omega + z1*Omega^2;
zdot(4,1)   = -2*z3*Omega + z2*Omega^2;
end

function zdot  = SlottedDisk(t,z,m,l,k,I)
z1          = z(1,1); % z1 = theta
z2          = z(2,1); % z2 = thetadot
z3          = z(3,1); % z3 = x
z4          = z(4,1); % z4 = xdot

% Equations of motion is first order form
zdot(1,1)   = z2;
zdot(2,1)   = (-2*m*z3*z4*z2 + m*l*z3*z2^2 - k*l*z3)/(I + m*z3^2);
zdot(3,1)   = z4;
zdot(4,1)   = l*zdot(2,1) + z3*z2^2 - (k/m)*z3;
end
```

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