

```

1  clc; clear; close all;
2  % *****
3  % MECE:340 - Systems & Dynamics Response
4  % *****
5
6  % *****
7  %% Problems 8, 9, and 10 HW 1
8  % *****
9
10 % *****
11 %% Problem 8
12 %  $y(t) = -4.9 t^2 + 20 t + 0.50$ 
13 % *****
14
15 t = linspace(0,5,1000);
16
17 y = -4.9*t.^2 + 20*t + 0.5;      % position
18 v = gradient(y,t);              % velocity
19 a = gradient(v,t);              % acceleration
20
21 figure;
22 subplot(3,1,1)
23 plot(t,y,'LineWidth',1.5)
24 grid on
25 ylabel('y (m)')
26 title('Problem 8: Ball Motion')
27
28 subplot(3,1,2)
29 plot(t,v,'LineWidth',1.5)
30 grid on
31 ylabel('v (m/s)')
32
33 subplot(3,1,3)
34 plot(t,a,'LineWidth',1.5)
35 grid on
36 ylabel('a (m/s^2)')
37 xlabel('Time (s)')
38
39 % Time when ball hits the ground
40 y_fun = @(t) -4.9*t.^2 + 20*t + 0.5;
41 t_ground = fzero(y_fun,4);
42
43 fprintf('Problem 8: Ball hits the ground at t = %.3f s\n', t_ground);
44
45
46 % *****
47 %% Problem 9
48 %  $x(t) = 2e^{-t} + 2t - 0.5t^2$ 
49 % *****
50
51 t = linspace(0,6,1000);
52 x = 2*exp(-t) + 2*t - 0.5*t.^2;
53
54 figure;
55 subplot(2,1,1)
56 plot(t,x,'LineWidth',1.5)
57 grid on
58 ylabel('x(t)')
59 title('Problem 9: Position Function')
60
61 % Find zero crossing

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62 x_fun = @(t) 2*exp(-t) + 2*t - 0.5*t.^2;
63 t_star = fzero(x_fun,4);
64
65 subplot(2,1,2)
66 plot(t,x,'LineWidth',1.5)
67 hold on
68 plot(t_star,0,'ro','MarkerSize',8,'LineWidth',1.5)
69 grid on
70 xlabel('Time (s)')
71 ylabel('x(t)')
72 title('Root of x(t)')
73
74 fprintf('Problem 9: x(t) = 0 at t* = %.3f s\n', t_star);
75
76
77 % *****
78 %% Problem 10
79 % m xddot2 + b xdot + k x = F0 sin(wt)
80 % *****
81
82 m = 12;          % kg
83 b = 90;          % N*s/m
84 k = 450;         % N/m
85 F0 = 20;         % N
86 omega = 2*pi; % rad/s
87
88 % Acceleration function
89 xddot = @(x,xdot,t) (F0*sin(omega*t) - b*xdot - k*x)/m;
90
91 % Sample values for visualization
92 t = linspace(0,2,1000);
93 x_sample = 0.05*sin(2*t);
94 xdot_sample = gradient(x_sample,t);
95 xddot_sample = xddot(x_sample, xdot_sample, t);
96
97 figure;
98 subplot(3,1,1)
99 plot(t,x_sample,'LineWidth',1.5)
100 grid on
101 ylabel('x (m)')
102 title('Problem 10: Mass-Spring-Damper')
103
104 subplot(3,1,2)
105 plot(t,xdot_sample,'LineWidth',1.5)
106 grid on
107 ylabel('ẋ (m/s)')
108
109 subplot(3,1,3)
110 plot(t,xddot_sample,'LineWidth',1.5)
111 grid on
112 ylabel('ẍ (m/s^2)')
113 xlabel('Time (s)')
114 % *****

```