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```
% SD_Hw4_prob2
close all;clear;clc;
opengl hardware;
% parameters
m = 100;
wn = 2*pi*0.5;
dmp = 0.03;
k = wn^2*m;
c = 2*dmp*wn*m;
```

(C) Form transfer function

```
%--------------------------------------------------------------------------
% Form transfer function
% Hwz = -m/(ms^2+cs+k)
%--------------------------------------------------------------------------
den = [m c k];
Hwz = tf(-m,den,'InputName','t','OutputName','s')      % ## 0s-m
Hvz = tf([-m 0],den,'InputName','t','OutputName','s')  % ## -ms+0
Huz = tf([c k],den,'InputName','t','OutputName','s')   % ## cs+k
```

(E) Impulse response function

```
%--------------------------------------------------------------------------
% Impulse response function
%--------------------------------------------------------------------------
wd = wn*sqrt(1-dmp^2);
% Transfer function
ff = (0:0.01:10)';   % better to use a column vector % 10 Hz
Hwz_c = 1./((2*pi*ff).^2-wn^2-sqrt(-1)*2*dmp*wn*(2*pi*ff));
Hvz_c = sqrt(-1)*(2*pi*ff)./((2*pi*ff).^2-wn^2-sqrt(-1)*2*dmp*wn*(2*pi*ff));
Huz_c = (sqrt(-1)*2*dmp*wn*(2*pi*ff)+wn^2)./(wn^2-
(2*pi*ff).^2+sqrt(-1)*2*dmp*wn*(2*pi*ff));

figure('name','2(d)');
subplot(3,2,1);
plot(ff,db(abs(Hwz_c)));
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');

subplot(3,2,2);
plot(ff,mod(angle(Hwz_c)*180/pi+180,360)-180);
```

```
xlabel('frequency (Hz)');
ylabel('phase (deg)');

subplot(3,2,3);
plot(ff,db(abs(Hvz_c)));
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');

subplot(3,2,4);
plot(ff,mod(angle(Hvz_c)*180/pi+180,360)-180);
xlabel('frequency (Hz)');
ylabel('phase (deg)');

subplot(3,2,5);
plot(ff,db(abs(Huz_c)));
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');

subplot(3,2,6);
plot(ff,mod(angle(Huz_c)*180/pi+180,360)-180);
xlabel('frequency (Hz)');
ylabel('phase (deg)');
sgtitle('Using the equations in (d)');

Hwz_m = squeeze(freqresp(Hwz,2*pi*ff));
Hvz_m = squeeze(freqresp(Hvz,2*pi*ff));
Huz_m = squeeze(freqresp(Huz,2*pi*ff));
figure('name','2(e)');

subplot(3,2,1);
plot(ff,db(abs(Hwz_m)),'r');
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');

subplot(3,2,2);
plot(ff,mod(angle(Hwz_m)*180/pi+180,360)-180,'r')
xlabel('frequency (Hz)');
ylabel('phase (deg)');

subplot(3,2,3);
plot(ff,db(abs(Hvz_m)),'r')
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');

subplot(3,2,4);
plot(ff,mod(angle(Hvz_m)*180/pi+180,360)-180,'r')
xlabel('frequency (Hz)');
ylabel('phase (deg)');

subplot(3,2,5);
plot(ff,db(abs(Huz_m)),'r');
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');
```

```
subplot(3,2,6);
plot(ff,mod(angle(Huz_m)*180/pi+180,360)-180,'r')
xlabel('frequency (Hz)');
ylabel('phase (deg)');
sgtitle('Using MATLAB function');
```

(G) state-space model

```
%--------------------------------------------------------------------------
% sate-space model
%--------------------------------------------------------------------------
Ac = [0 1;-k/m -c/m]
Bc = [0;-1]
Cc = [eye(2);[-k/m -c/m]]
Dc = [0;0;0]

sys = ss(Ac,Bc,Cc,Dc);
Hwz_ss = tf(sys(1,:));
Hvz_ss = tf(sys(2,:));
Huz_ss = tf(sys(3,:));
ff = (0:0.01:10)';

Hwz_ss = squeeze(freqresp(tf(sys(1,:)),2*pi*ff));
Hvz_ss = squeeze(freqresp(tf(sys(2,:)),2*pi*ff));
Huz_ss = squeeze(freqresp(tf(sys(3,:)),2*pi*ff));

figure('name','2(g)');
subplot(3,2,1);
plot(ff,db(abs(Hwz_ss)),'r-','linewidth',2)
hold on
plot(ff,db(abs(Hwz_m)),'b--')
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');
legend('(g)','(e)');

subplot(3,2,2);
plot(ff,mod(angle(Hwz_ss)*180/pi+180,360)-180,'r-','linewidth',2)
hold on
plot(ff,mod(angle(Hwz_m)*180/pi+180,360)-180,'b--')
xlabel('frequency (Hz)');
ylabel('phase (deg)');
legend('(g)','(e)');

subplot(3,2,3);
plot(ff,db(abs(Hvz_ss)),'r-','linewidth',2)
hold on
plot(ff,db(abs(Hvz_m)),'b--')
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');
legend('(g)','(e)');

subplot(3,2,4);
plot(ff,mod(angle(Hvz_ss)*180/pi+180,360)-180,'r-','linewidth',2)
```

```
hold on
plot(ff,mod(angle(Hvz_m)*180/pi+180,360)-180,'b--')
xlabel('frequency (Hz)');
ylabel('phase (deg)');
legend('(g)','(e)');

subplot(3,2,5);
plot(ff,db(abs(Huz_ss)),'r-','linewidth',2)
hold on
plot(ff,db(abs(Huz_m)),'b--')
xlabel('frequency (Hz)');
ylabel('magnitude (dB)');
legend('(g)','(e)');

subplot(3,2,6);
plot(ff,mod(angle(Huz_ss)*180/pi+180,360)-180,'r-','linewidth',2)
hold on
plot(ff,mod(angle(Huz_m)*180/pi+180,360)-180,'b--')
xlabel('frequency (Hz)');
ylabel('phase (deg)');
legend('(g)','(e)')

sgtitle('(g)');
```

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