```
% Assignment - 5
% --------------
clc;
clear all;
close all;

% Details given in the question
f = 100;
vFs = 4000;

% Assumed values
Fs = 80000;
Tstart = 0;
Tstop = 0.02;
sAmp = 2.4;
sAdd = -1.1;
ppmWidth = 1;

% Generating time
vTs = 1 / vFs;
Ts = 1 / Fs;
t = Tstart : Ts : Tstop;
N = length(t);

% Generating the message signal
m_t = sin(2*pi*100*t);
subplot(2,1,1);
plot(t, m_t, '--r');
title('Message Signal');
xlabel('Time (s)');
ylabel('Amplitude');
hold on;

% Generating sample-hold signal (PAM)
oldTime = vTs;
oldMsg = 0;
M_t = m_t;
for i = 1 : N
    t0 = mod(t(1, i), vTs);
    if(t0 < oldTime)
        oldMsg = m_t(1, i);
    else
        M_t(1, i) = oldMsg;
    end
    oldTime = t0;
end
subplot(2,1,1);
plot(t, M_t, 'm');
title('Sample-hold message signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Generating the sawtooth signal (for PWM)
s_t = sAdd + sAmp * (mod(t, vTs) / vTs);
subplot(2,1,1);
plot(t, s_t, '--b');
ylim([-2 2]);
title('Sawtooth Signal for Comparision');
xlabel('Time (s)');
ylabel('Amplitude');

% Generating the PWM signal
p_t = 2 * (M_t > s_t) - 1;
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subplot(2,1,2);
plot(t, p_t, 'b', 'LineWidth', 1);
ylim([-2 2]);
title('PWM Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot Spectra
figure;
subplot(2,1,1);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(M_t))));
title('Spectrum of SH Message Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(p_t))));
title('Spectrum of PWM Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

% Low pass Filter the PWM Signal (PWM demodulation)
Fc = 150;
p_f = fft(p_t);
ClrStart = floor((2 * Fc / Fs) * N);
ClrStop = N - ClrStart;
p_f(1, ClrStart:ClrStop) = zeros(1, 1+ClrStop-ClrStart);
m0_t = ifft(p_f);
figure;
subplot(2, 1, 1)
plot(t, m0_t, 'b', 'LineWidth', 1);
ylim([-2 2]);
title('Demodulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(m0_t))));
title('Spectrum of Demodulated Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

% Generating the PPM signal
ppmAdd = 2*ones(1, ppmWidth);
pp_t = zeros(1, N)-1;
oldMsg = 0;
for i = 1 : N
    if(oldMsg > p_t(1, i))
        pp_t(1, i:(i+ppmWidth-1)) = pp_t(1, i:(i+ppmWidth-1)) + ppmAdd;
    end
    oldMsg = p_t(1, i);
end
figure;
subplot(2,1,1);
plot(t, p_t);
ylim([-2 2]);
title('PWM Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(2,1,2);
plot(t, pp_t, 'r');
ylim([-2 2]);
title('PPM Signal');
xlabel('Time (s)');
ylabel('Amplitude');

% Plot Spectra
```
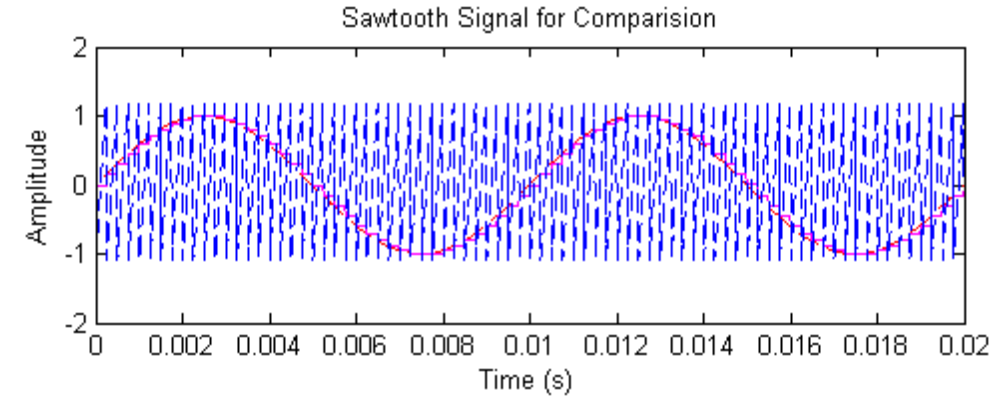
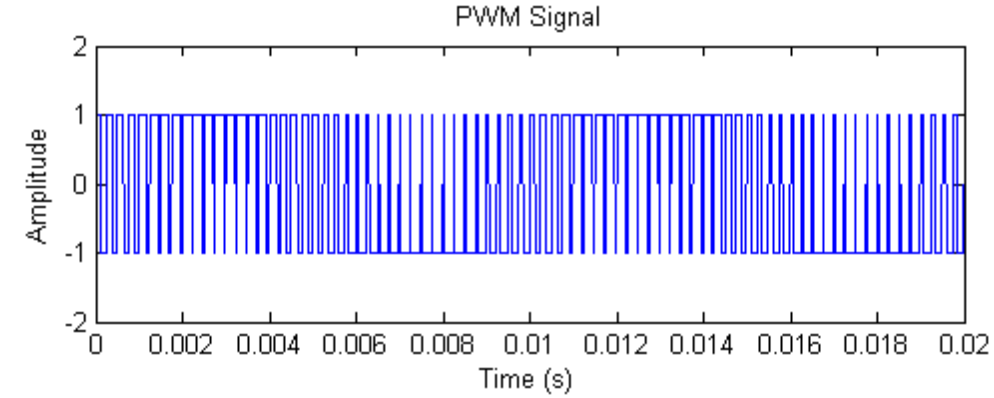
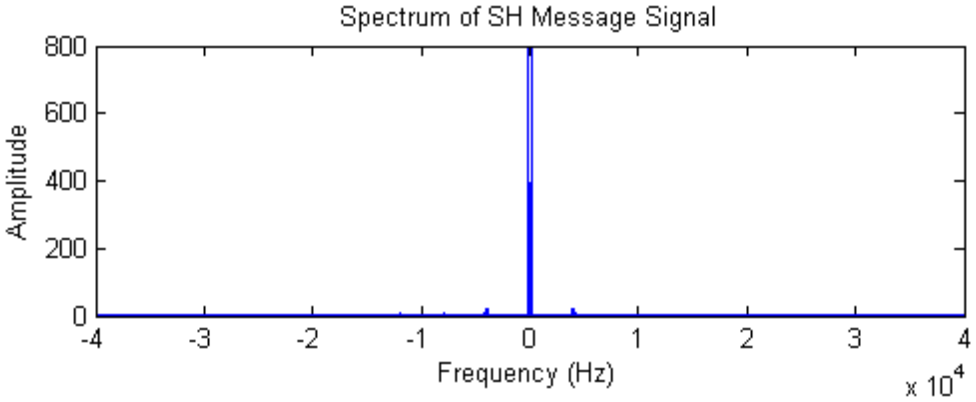
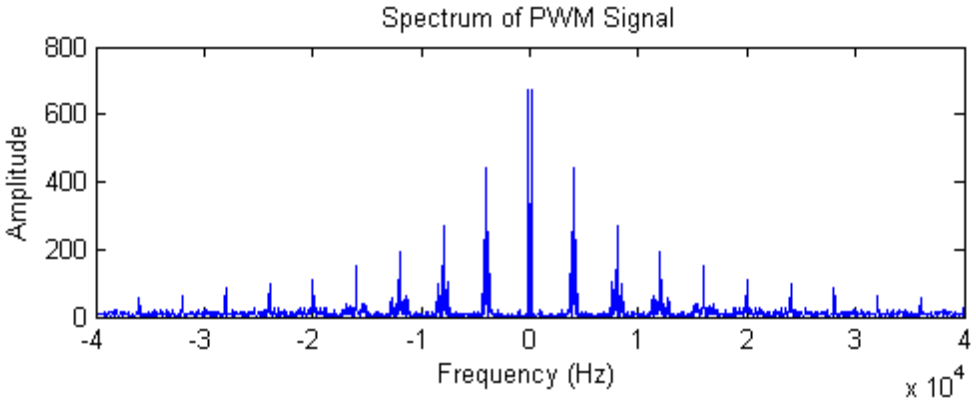

```
figure;
subplot(2,1,1);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(M_t))));
title('Spectrum of SH Message Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(pp_t))));
title('Spectrum of PPM Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

% % PPM demodulation
% Fc = 150;
% p_f = fft(p_t);
% ClrStart = floor((2 * Fc / Fs) * N);
% ClrStop = N - ClrStart;
% p_f(1, ClrStart:ClrStop) = zeros(1, 1+ClrStop-ClrStart);
% m0_t = ifft(p_f);
% figure;
% subplot(2, 1, 1)
% plot(t, m0_t, 'b', 'LineWidth', 1);
% ylim([-2 2]);
% title('Demodulated Signal');
% xlabel('Time (s)');
% ylabel('Amplitude');
% subplot(2,1,2);
% plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(m0_t))));
% title('Spectrum of Demodulated Signal');
% xlabel('Frequency (Hz)');
% ylabel('Amplitude');
%
```

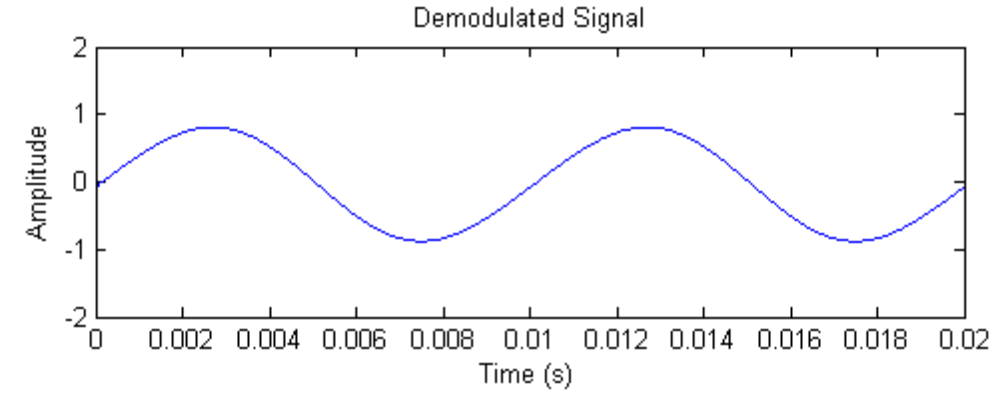
Warning: Imaginary parts of complex X and/or Y arguments ignored

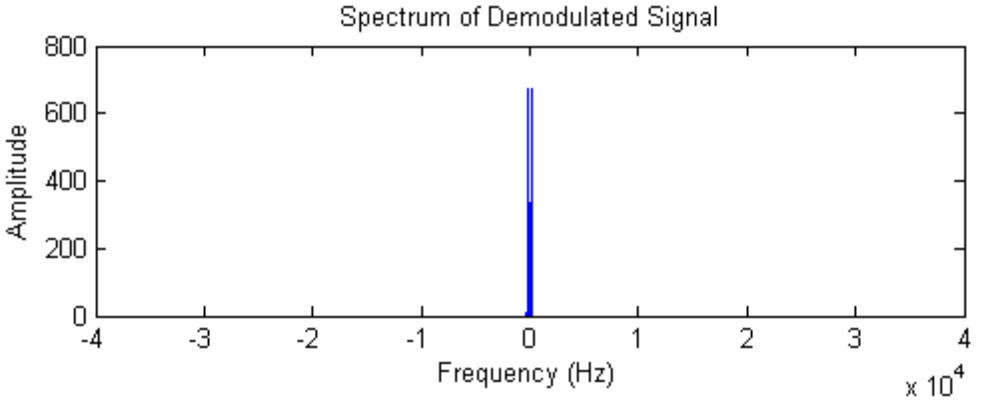

Sawtooth Signal for Comparision
Amplitude
Time (s)
2
1
0
-1
-2
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

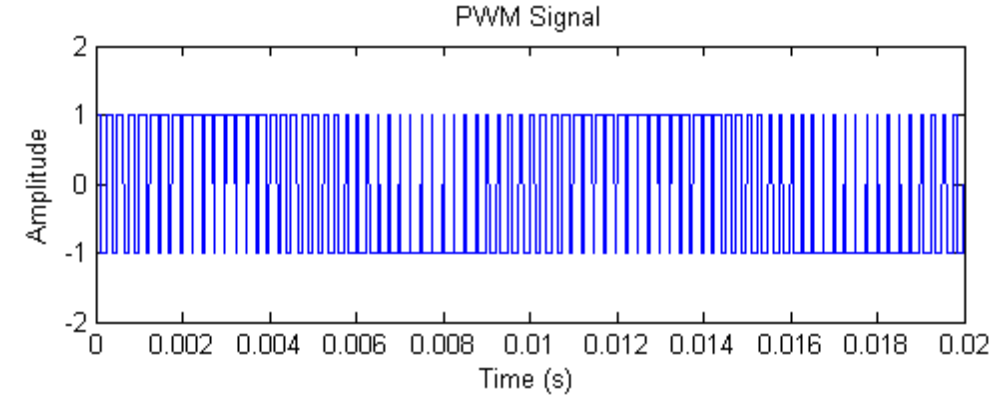

PWM Signal
Amplitude
Time (s)
2
1
0
-1
-2
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02

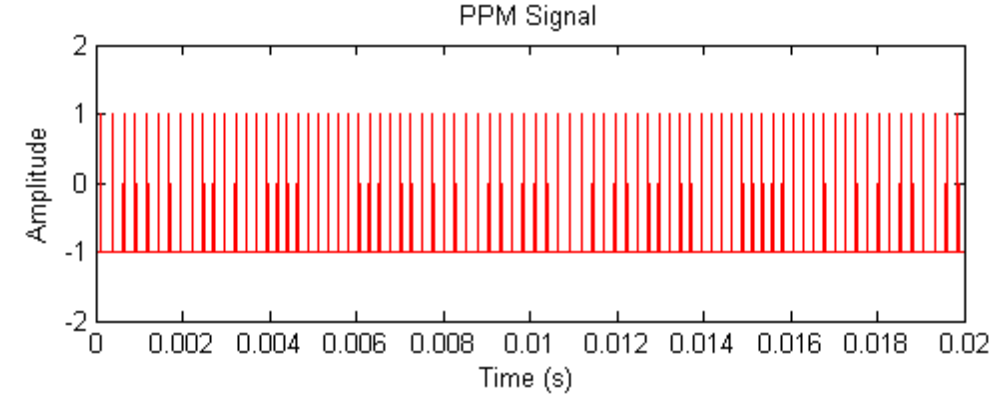

Spectrum of SH Message Signal
Amplitude
Frequency (Hz)
x 10^4
800
600
400
200
0
-4
-3
-2
-1
0
1
2
3
4

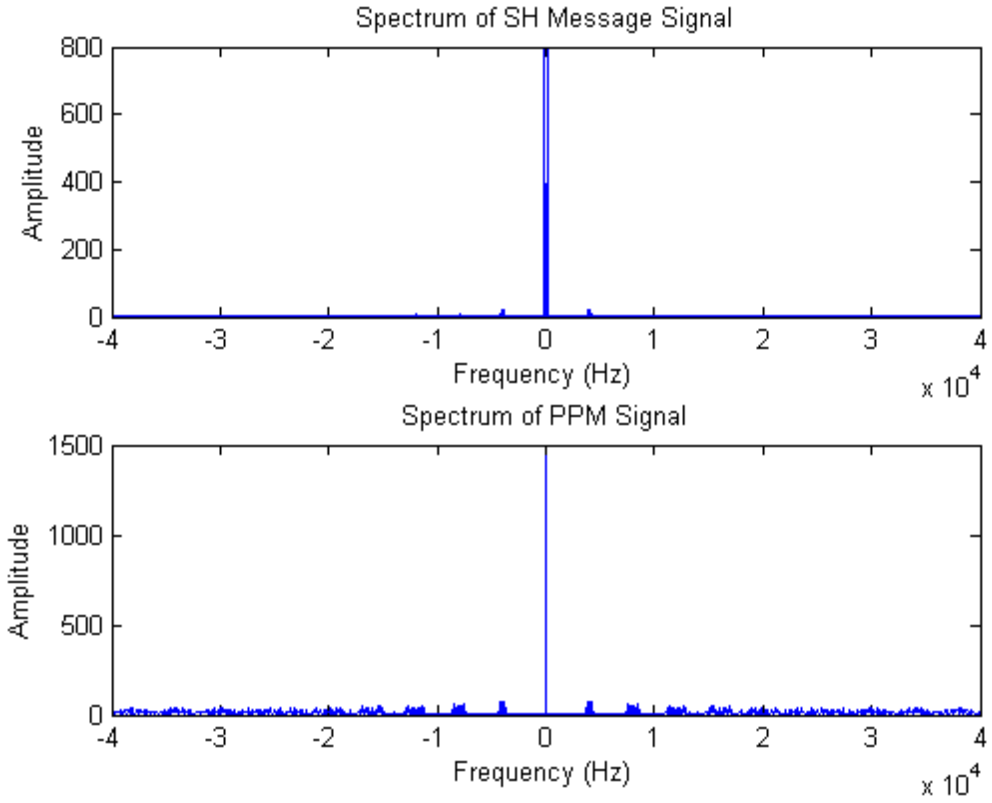

Spectrum of PWM Signal
Amplitude
Frequency (Hz)
x 10^4
800
600
400
200
0
-4
-3
-2
-1
0
1
2
3
4


Demodulated Signal
Amplitude
Time (s)
2
1
0
-1
-2
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02


Spectrum of Demodulated Signal
Amplitude
Frequency (Hz)
x 10^4
800
600
400
200
0
-4
-3
-2
-1
0
1
2
3
4


PWM Signal
Amplitude
Time (s)
2
1
0
-1
-2
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02


PPM Signal
Amplitude
Time (s)
2
1
0
-1
-2
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
0.018
0.02



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