```matlab
% Illustrative Problem 3.9
% ------------------------
clc;
clear all;
close all;

% Details given in the question
Fc = 250;
t0 = 0.15;
a = 0.85;

% Assumed values
Tstart = 0;
Tstop = 1;
Fs = 2.5 * 10^3;

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

% Generating the message signal
tk = mod(t, t0);
m_t = (tk <= (1/3)*t0) - 2*((tk > (1/3)*t0) .* (tk <= (2/3)*t0));
figure;
subplot(2,1,1);
plot(t, m_t);
ylim([-2.5 1.5]);
title('Message Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(m_t))));
title('Spectrum of Message Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

% Generating the carrier signal
c_t = cos(2*pi*Fc*t);
figure;
subplot(2,1,1);
plot(t, c_t);
title('Carrier Signal');
xlabel('Time (s)');
ylabel('Amplitude');
ylim([-1.5 1.5]);
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(c_t))));
title('Spectrum of Carrier Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');
```

```matlab
% Generating the modulated signal
u_t = (2/a)*c_t + m_t.*c_t;
figure;
subplot(2,1,1);
plot(t, u_t);
title('Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(u_t))));
title('Spectrum of Modulated Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

% Demodulate the modulated signal
md_t = am_envelope_detect(u_t, 1/Fs, 1/50);

% Plot the demodulated signal
figure;
subplot(2,1,1);
plot(t, md_t);
title('Demodulated Signal (using Envelope Detector)');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(md_t))));
title('Spectrum of Demodulated Signal (using Envelope Detector)');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

% Demodulate the modulated signal with noise
un_t = awgn(u_t, 20);
mdn_t = am_envelope_detect(un_t, 1/Fs, 1/50);

% Plot the demodulated signal with noise
figure;
subplot(2,1,1);
plot(t, mdn_t);
title('Demodulated Signal (with noise, SNR = 20dB)');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(mdn_t))));
title('Spectrum of Demodulated Signal (with noise, SNR = 20dB)');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

%
% function y = am_envelope_detect(x, Ts, time_const)
% % Function to simulate envelope detection
% N = length(x);
% y = zeros(1, N);
% amp = 0;
% tp = 0;
```
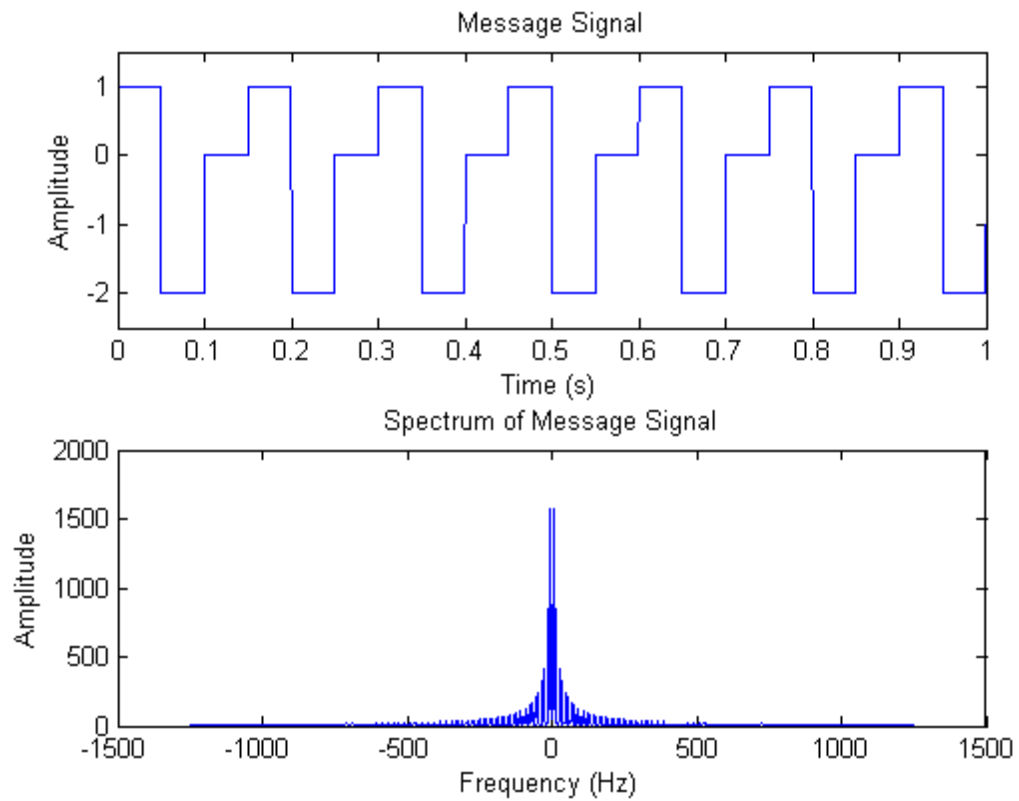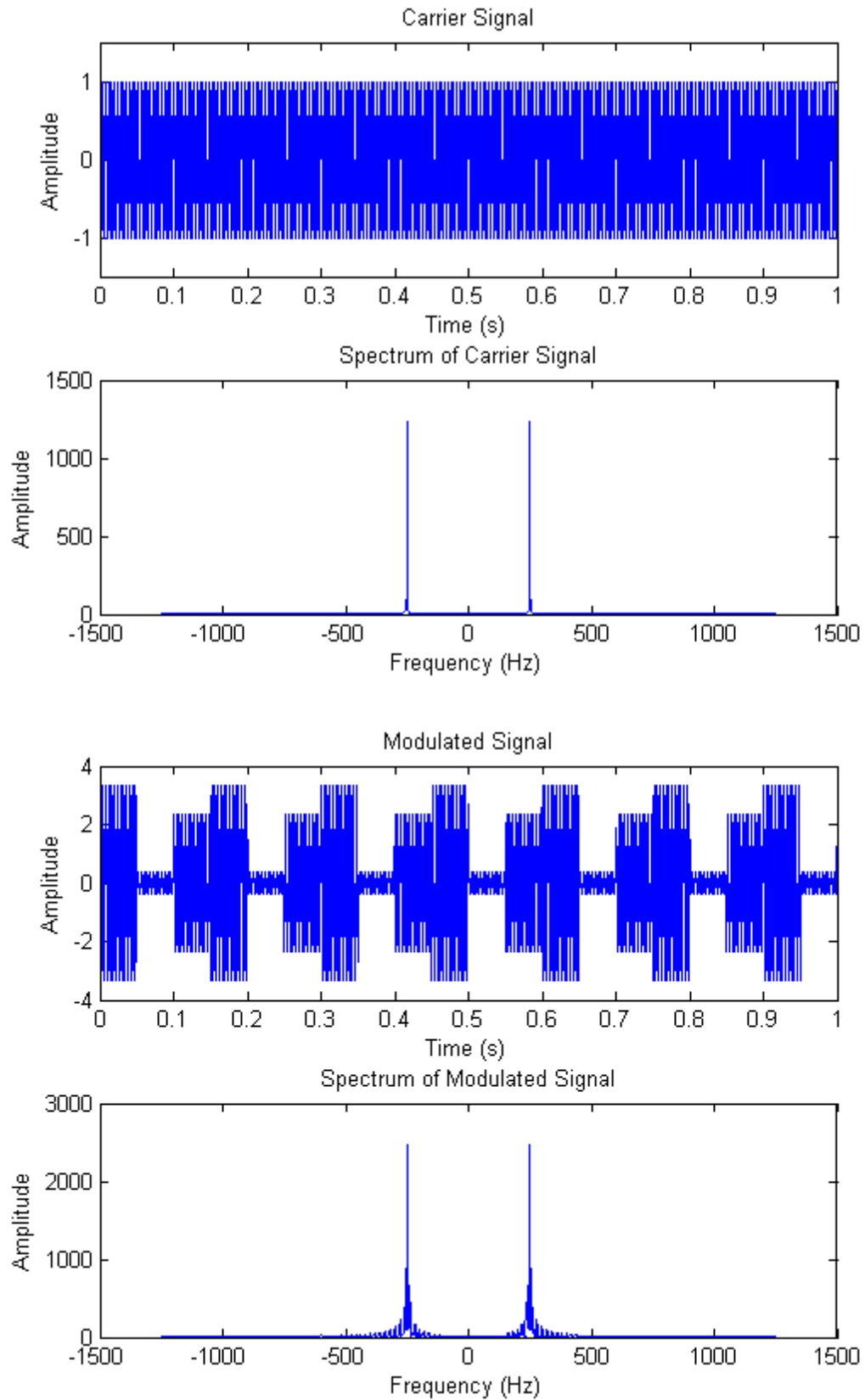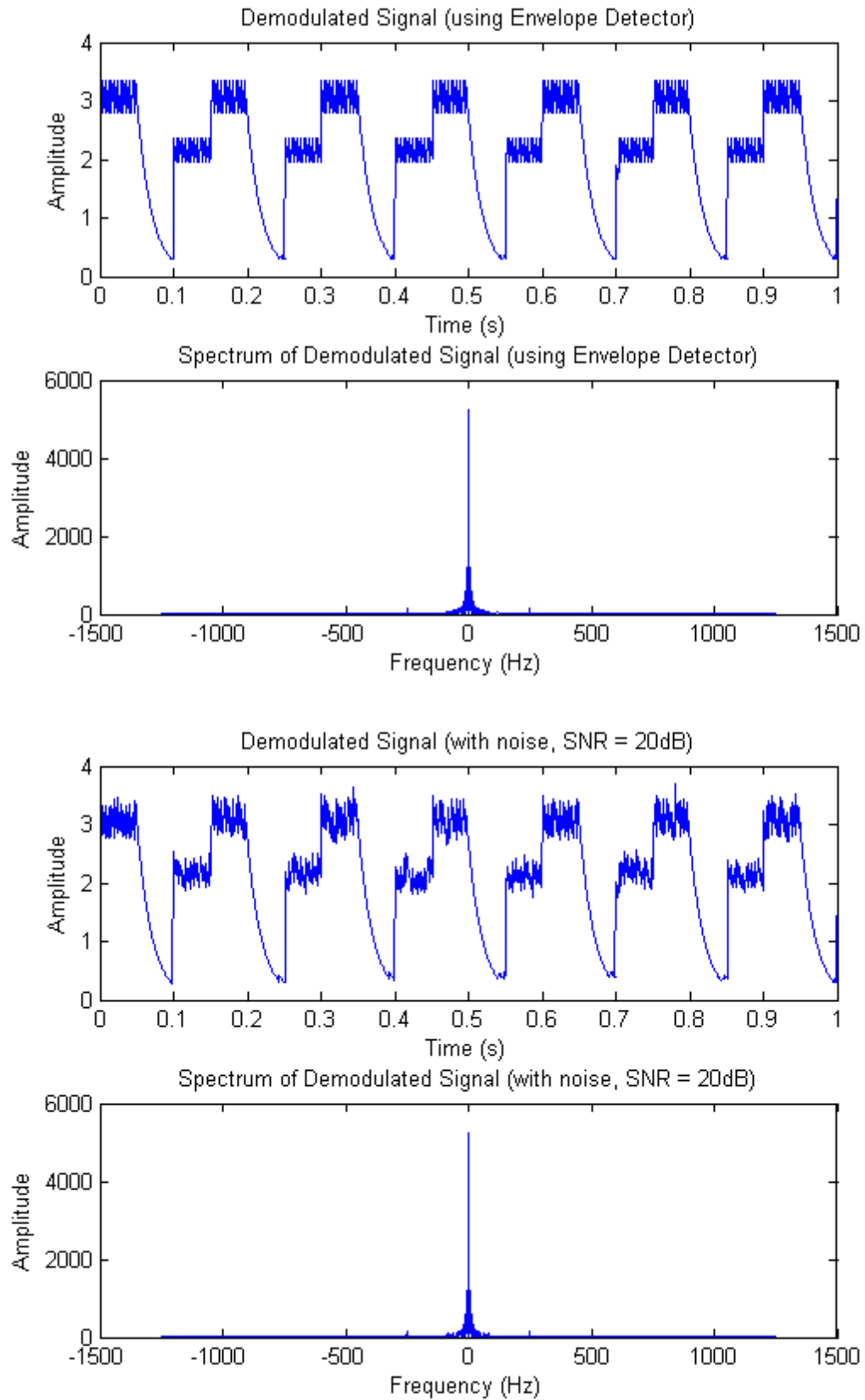
```
% for i = 1 : N
%     if(x(1, i) > (amp * exp(-tp / time_const)))
%         amp = x(1, i);
%         tp = 0;
%     else
%         tp = tp + Ts;
%     end
%     y(1, i) = amp * exp(-tp / time_const);
% end
% end
%
```

Message Signal

Spectrum of Message Signal

Carrier Signal

Spectrum of Carrier Signal

Modulated Signal

Spectrum of Modulated Signal

Demodulated Signal (using Envelope Detector)

Spectrum of Demodulated Signal (using Envelope Detector)

Demodulated Signal (with noise, SNR = 20dB)

Spectrum of Demodulated Signal (with noise, SNR = 20dB)

Published with MATLAB® 7.14