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% Exercise Problem 3.3
% -----
clc;
clear all;
close all;

% Details given in the question
Fc = 100;
t0 = 4;

% Assumed values
Tstart = -6;
Tstop = 6;
Fs = 1000;

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

% Generating the message signal
tk = mod(t - (t0/2), t0) - (t0/2);
m_t = (sin(pi*10*tk) ./ (pi*tk)) .^ 2;
for i = 1 : N
    if(isnan(m_t(1, i)))
        m_t(1, i) = 100;
    end
end
figure;
subplot(2,1,1);
plot(t, m_t);
ylim([-1.5 102.5]);
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))));
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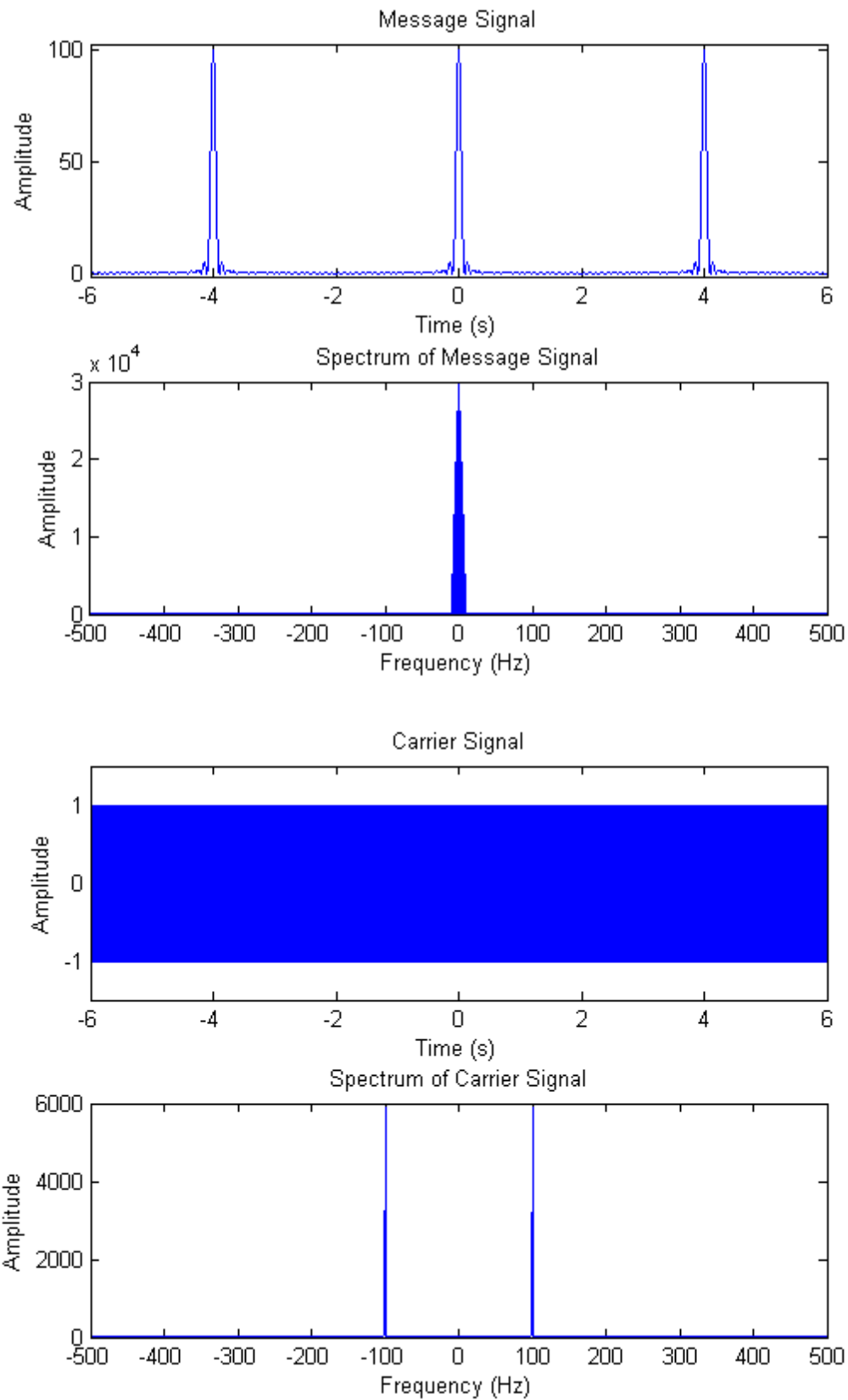
title('Spectrum of Carrier Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

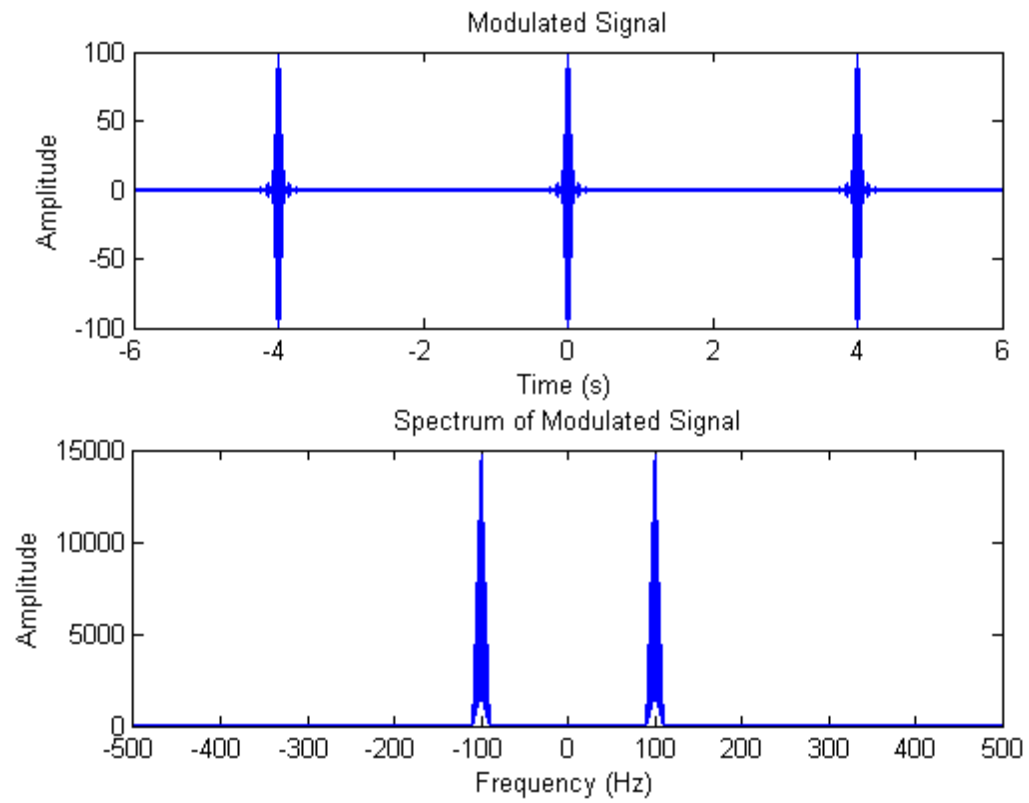
% Generating the modulated signal
u_t = m_t .* c_t;
figure;
subplot(2,1,1);
plot(t, u_t);
title('Modulated Signal');
xlabel('Time (s)');
ylabel('Amplitude');
subplot(2,1,2);
plot(linspace(-Fs/2, Fs/2, N), abs(fftshift(fft(u_t))));
title('Spectrum of Modulated Signal');
xlabel('Frequency (Hz)');
ylabel('Amplitude');

% Calculate power
u_pow = sum(u_t.^2) / N;
fprintf(1, 'Power of modulated signal u(t) = %f\n', u_pow);
u_f_pow = sum(abs(fft(u_t)).^2) / N;
m_f_pow = sum(abs(fft(m_t)).^2) / N;
fprintf(1, 'Power spectral density of modulated signal u(f) = %f\n', u_f_pow);
fprintf(1, 'Power spectral density of message signal m(f) = %f\n\n', m_f_pow);

    Power of modulated signal u(t) = 83.326349
    Power spectral density of modulated signal u(f) = 999999.519238
    Power spectral density of message signal m(f) = 1999999.038477

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