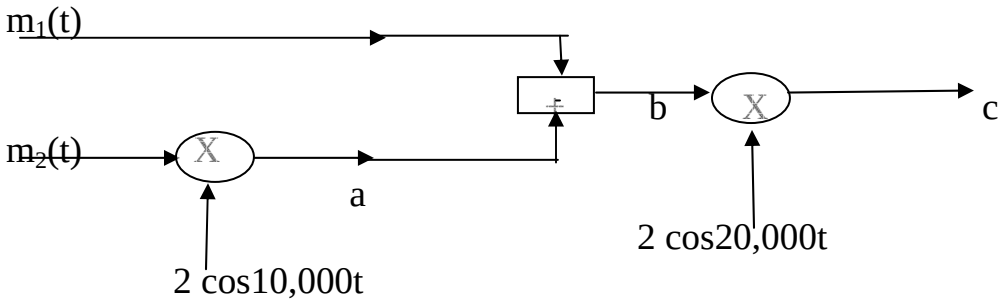
American University of Beirut
Department of Electrical and Computer Engineering

EECE 440 Signals and Systems

Homework 3: Due July 18, 2006

Problem 1

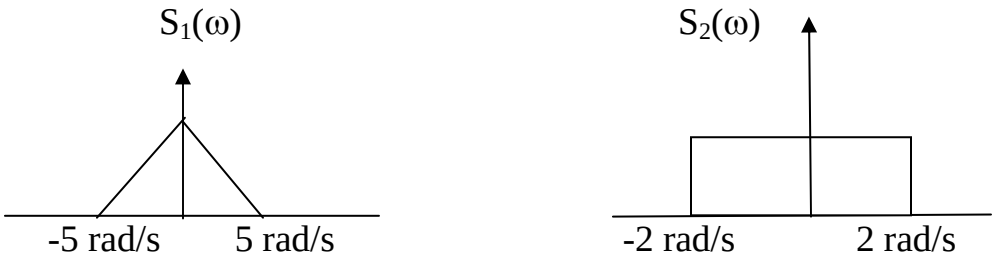
Two signals $m_1(t)$ and $m_2(t)$, both band-limited to 500 rad/s, are to be transmitted simultaneously over a channel as shown below



The modulated signal at point c is transmitted over a channel. Determine the bandwidth of the output signal at point c.

Problem 2

The spectrum of the two band-limited signals $s_1(t)$ and $s_2(t)$ are shown below.



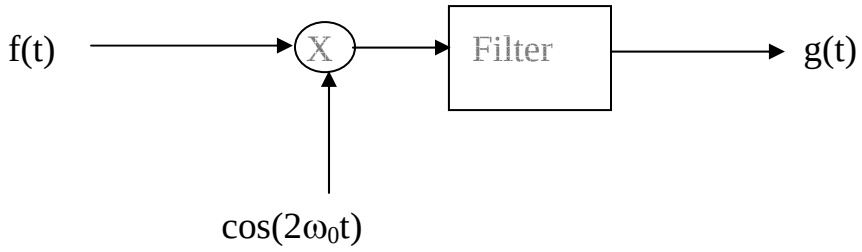
Determine the bandwidth of the signal y(t) given by: $y(t)=s_1(t)+10s_2(t)\cos 10t$.

Problem 3

The signal

$$f(t) = \text{rect}\left(\frac{t}{T}\right)\cos\omega_0 t$$

is applied to the following system



The filter in the above figure is considered to be a unity gain ideal band-pass filter of mid-frequency (ω_0) and bandwidth (2W) rad/s. Determine the output of this filter. Assume that rect(t/T) has a bandwidth of W rad/s.

Problem 4

An electric filter system has the frequency response

$$H(\omega) = \frac{j\omega}{1 + j\omega}$$

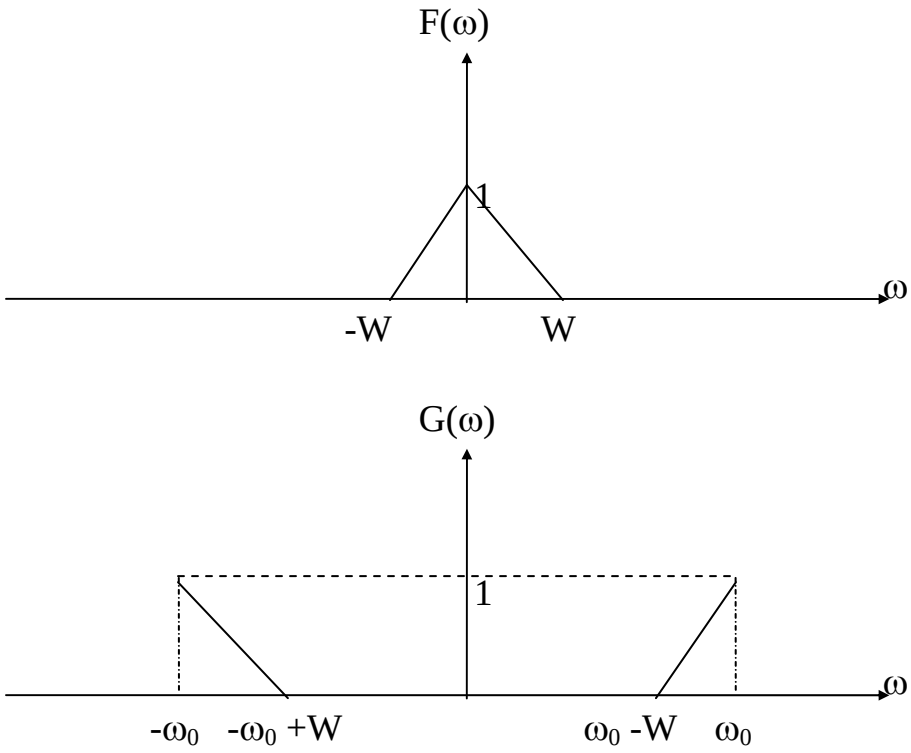
What type of filter is this?

Problem 5

Consider the signal s(t) given by: $s(t) = 12\cos(160t) + 20\cos(220t)$. This signal is present at the input of a unity gain ideal band-pass filter of mid-frequency 210 rad/s and bandwidth 25 rad/s. Determine the average power at the output of the filter.

Problem 6

The spectrum of the signals f(t) and g(t) are shown below. Express g(t) as a function of f(t).

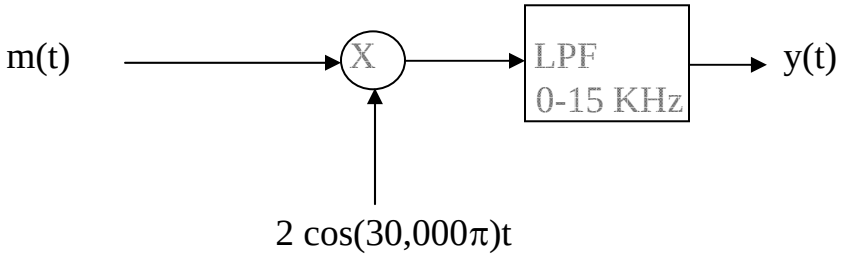


Problem 7

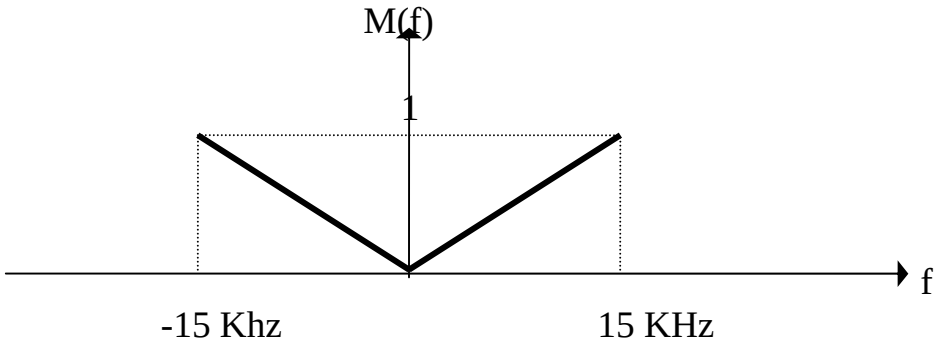
A sinusoidal signal of frequency 1 Hz is to be sampled periodically. Find the maximum allowable time interval between samples.

Problem 8

The system shown below is used for scrambling audio signals.



The output y(t) is the scrambled version of the input signal m(t). Let the spectrum of the signal m(t) be as shown below, write m(t) as a function of y(t)



Problem 9

An amplitude modulated wave-form has the form

$$s(t) = 10\left[1 + 0.5\cos(200\pi t) + 0.5\cos(400\pi t)\right]\cos(2000\pi t)$$

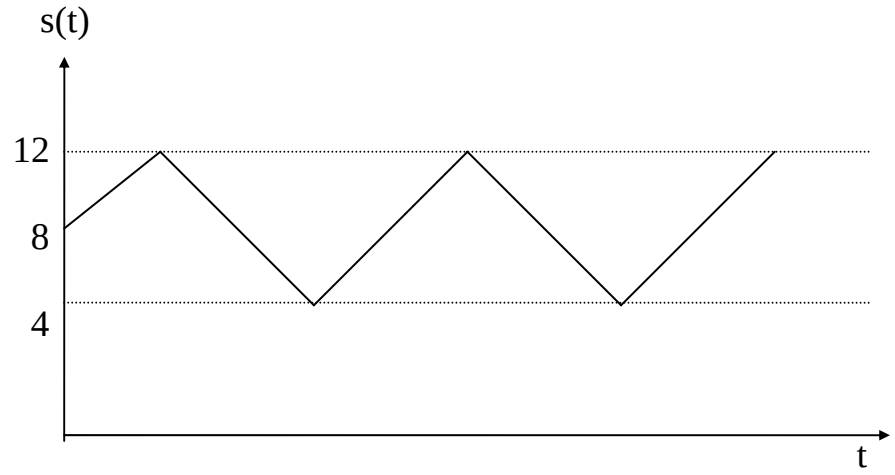
a. Sketch the spectrum of s(t)
b. Find the total power.
c. Find the total side-band power
d. What is the modulation index?

Problem 10

An AM transmitter develops a carrier power output of 50 Watts across 1 Ohm resistive load. The carrier is modulated by a single tome with a modulation index of 0.8. Write the expression of the AM signal s(t) assume f_m=5Khz and f_c=1 Mhz.

Problem 11

The envelope of the output of an AM modulator is shown below



Determine the following:

a. The modulation index.
b. The carrier amplitude.

Problem 12

An AM modulator operates with the message signal: $m(t)=-6\cos(20\pi t)-2\cos(60\pi t)$. The unmodulated carrier is given by: $c(t)=100\cos(200\pi t)$ and the modulation index is 0.5.

a. Write the time-domain expression of the AM wave s(t).
b. Write the time-domain expression of the USB of s(t) including carrier.