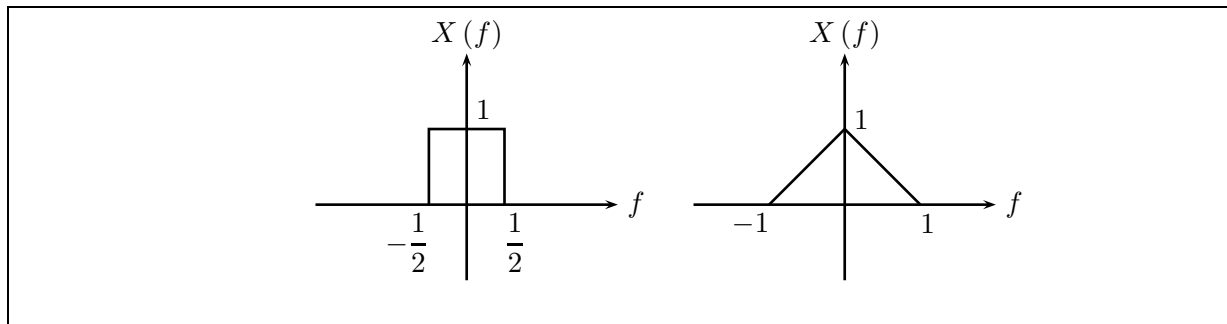


QUESTIONS

Q1) Consider that Hilbert transform of $m(t)$ is $\hat{m}(t)$. Show that Hilbert transform of $m_1(t) = \text{sgn}(a) m(at)$ is $\hat{m}_1(t) = \hat{m}(at)$.

Find the inverse Fourier transformation of the following Fourier transforms.



Q2) Consider a double side band suppressed carrier signal $s(t) = m(t) \cos(2\pi f_c t)$. Show that squaring it; $s^2(t)$, and narrow band filtering of frequency; $2f_c$, produces $\frac{1}{2}E\Delta f \cos(2\pi f_c t)$, where $E = \int_{-\infty}^{\infty} m^2(t) dt$ which is the energy of $m(t)$ and Δf is the bandwidth of the narrow-band filter.

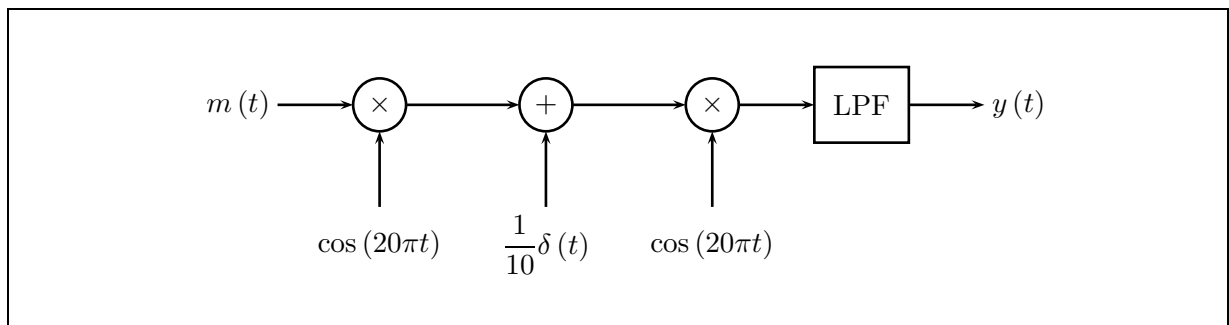
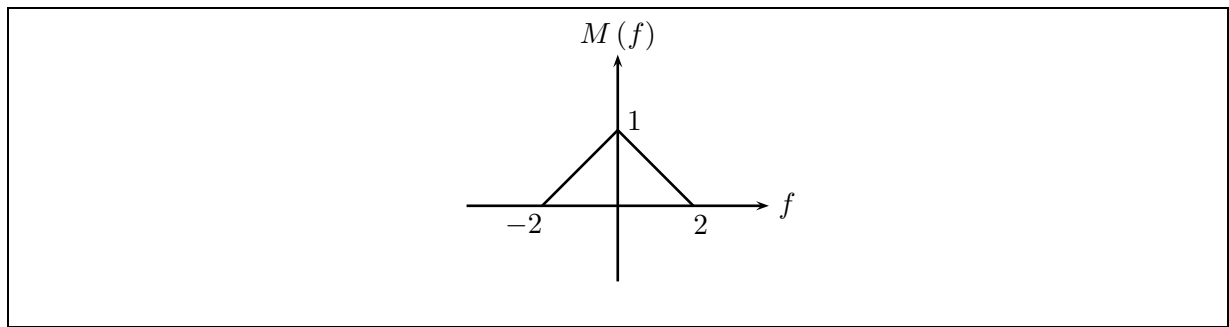
Q3) The Fourier transform of a signal $m(t)$ is given as

$$M(f) = \begin{cases} A, & -W < f < W \\ 0, & \text{otherwise} \end{cases}$$

Find the Fourier transform of $m^2(t)$. What are the bandwidths of $m(t)$ and $m^2(t)$. Also compute the energy of $m(t)$ and $m^2(t)$.

Q4) A message signal $m(t)$ is modulated via a double side band suppressed carrier modulator. A noise (an impulse) is added to the modulated signal in the channel. This signal is demodulated by a coherent detector in the receiver (see the block diagram given below). The bandwidth of the low pass filter in the detector is 2 Hz. The spectrum of the message signal is given in the following.

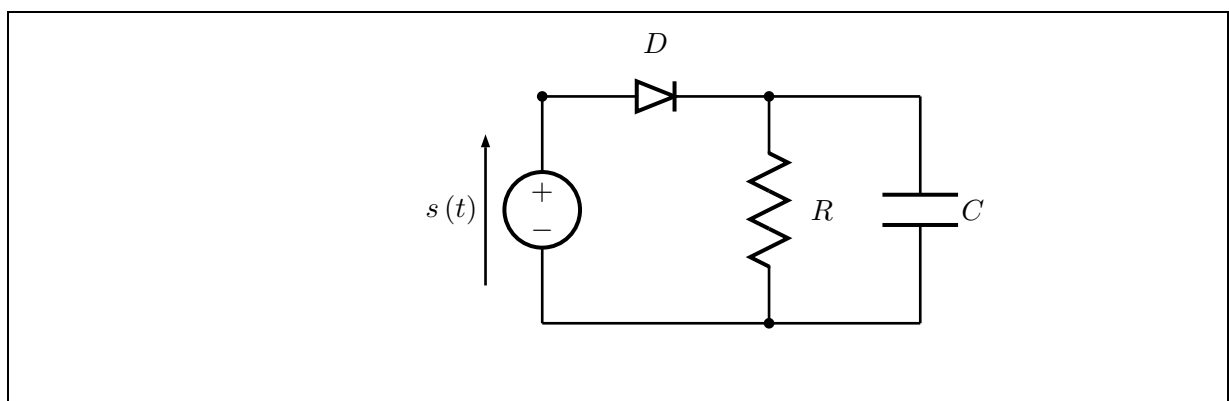
Find $Y(f)$. Compute signal to noise ratio at the output; ratio of the energy of the recovered message signal and the energy of the noise at the output.



Q5) An envelope detector is shown in the following figure. For AM signal

$$s(t) = (1 + 0.5 \cos(200\pi t)) \cos(2000\pi t)$$

Determine R and C .



Q6) A message signal, $m(t) = 8 \cos^3(2\pi f_o t)$ and a carrier, $c(t) = \cos(2\pi f_c t)$ are given. Suppose that $f_c = 10f_o$.

- Write AM signal. What should amplitude sensitivity; k_a be chosen for 50% modulation index? Obtain lower and upper side band signals. Plot the spectrum of this AM signal. What is the transmission bandwidth of the AM signal.
- Write DSB-SC signal. Obtain lower and upper side band signals. Plot the spectrum of this DSB-SC signal. Plot the spectrum of this DSB-SC signal. What is the transmission bandwidth of the DSB-SC signal.
- Write SSB-SC signal for both cases; upper-side band is transmitted and lower side band is transmitted. Obtain the side band signal. Plot the spectrum of this SSB-SC signal. Plot the spectrum of this SSB-SC signal. What is the transmission bandwidth of the SSB-SC signal.

Q7) Consider an SSB signal with carrier;

$$s(t) = A_c \cos(2\pi f_c t) + k_a A_c m(t) \cos(2\pi f_c t) \pm k_a A_c \hat{m}(t) \sin(2\pi f_c t)$$

Obtain the envelope of $s(t)$. Can the message signal be obtained from the envelope?

Q8) The following trigonometric function is given. Find the instantaneous frequency. Plot the angle and the instantaneous frequency.

$$s(t) = A \cos(2\pi f_o t + \pi f_o \ln(1 + t^2))$$