

# XMUT310 Communications Engineering

## Homework 2 (7.5%) Total= 70 marks

Show your working clearly. Write your name in English and your student ID clearly.

### Question 1 [15 marks]

Weaver's SSB modulator is illustrated in Figure P-3.17. By taking the input signal as  $m(t) = \cos 2\pi f_m t$  where  $f_m < W$ , demonstrate that by proper choice of  $f_1$  and  $f_2$ , the output is an SSB signal.

(Hint: have a look at Example 3.2.6 in Proakis textbook; consider both the upper and lower branches)

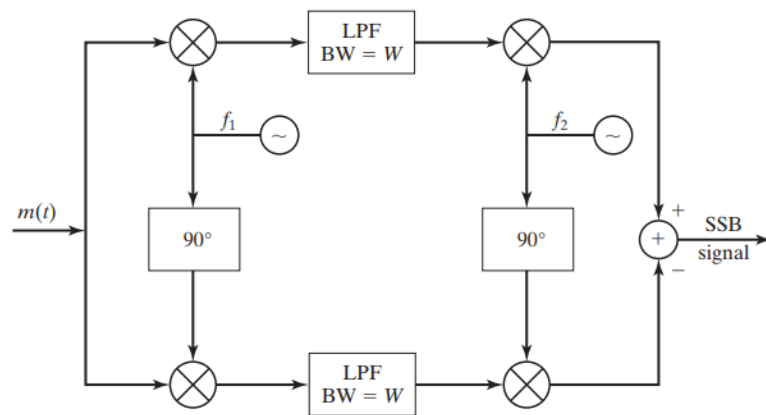
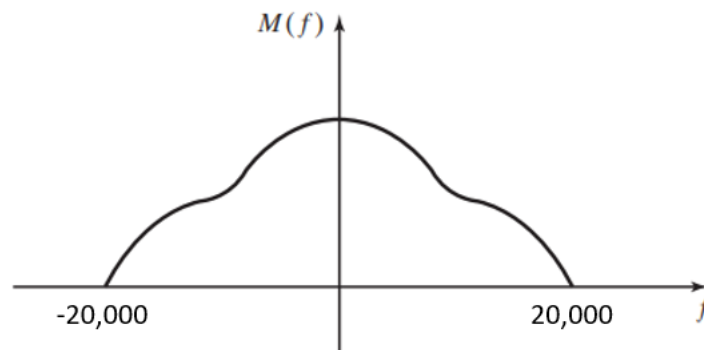


Figure P-3.17

### Question 2 [15 marks; 5 marks each for 1,2,3]

A message  $m(t)$ , whose Fourier transform  $M(f)$  is shown in the figure below, is to be transmitted from point A to point B. We know that the signal is normalised, meaning that  $-1 \leq m(t) \leq 1$ .



1. If USSB is employed, what is the bandwidth of the modulated signal?
2. If DSB is employed, what is the bandwidth of the modulated signal?
3. If an AM scheme with  $a = 0.6$  is used, what is the bandwidth of the modulated signal?

**Question 3 [10 marks; 5 marks each for FM and PM]**

A message signal,  $m(t) = a\cos(2\pi f_m t)$ , is used to either frequency modulate (FM) or phase modulate (PM) a carrier  $A_c\cos(2\pi f_c t)$ .

Find the modulated signal in each case (i.e. to show and derive the equations leading to both the FM and PM waves).

**Question 4 [15 marks; 5 marks each for 1,2,3]**

Assume  $x(t)$  has a bandwidth of 80 kHz.

1. What is the minimum sampling rate for this signal?
2. What is the minimum rate if a guard band of 10kHz is required?
3. What is the maximum sampling interval for the signal  $x_1(t) = x(t)\cos(160,000\pi t)$ ?

**Question 5 [5 marks]**

Let  $x(t)$  be a signal for which  $X(j\omega) = 0$  when  $|\omega| > \omega_M$ .

Another signal  $y(t)$  is specified as having the Fourier transform  $Y(j\omega) = 2X[j(\omega - \omega_c)]$ .

Determine a signal  $m(t)$  such that  $x(t) = y(t)m(t)$ .

**Question 6 [10 marks; 5 marks each]**

Let  $x(t)$  be a real-valued signal for which  $X(j\omega) = 0$  when  $|\omega| > 2000\pi$ . Supposing that  $y(t) = e^{j\omega_c t}x(t)$ , answer the following questions:

- (a) What constraint should be placed on  $\omega_c$  to ensure that  $x(t)$  is recoverable from  $y(t)$ ?
- (b) What constraint should be placed on  $\omega_c$  to ensure that  $x(t)$  is recoverable from  $\text{Re}\{y(t)\}$ ?