Homework 2

1) In AM, *spectral overlap* is said to occur if the lower sideband for positive frequencies overlaps with its *image* for negative frequencies. What condition must the modulated wave satisfy if we are to avoid spectral overlap? Assume that the message signal $m(t)$ is of a low-pass kind with bandwidth W.

2)

Throughout the chapter we focused on

$$c(t) = A_c \cos(2\pi f_c t)$$

as the sinusoidal carrier wave. Suppose we choose

$$c(t) = A_c \sin(2\pi f_c t)$$

as the sinusoidal carrier wave. To be consistent, suppose we also define

$$m(t) = A_m \sin(2\pi f_m t)$$

(a) Evaluate the spectrum of the new definition of AM:

$$s(t) = A_c[1 + k_a m(t)] \sin(2\pi f_c t)$$

where k_a is the amplitude sensitivity.

(b) Compare the result derived in part (a) with that studied in Example 3.1.

(c) What difference does the formulation in this problem make to the formulation of modulation theory illustrated in Example 3.1?

3) Suppose a non-linear device is which the output current i_0 and input voltage v_i are related by

$$i_0 = a_1 v_i + a_3 v_i^3$$

where a_1 and a_3 are constants. Explain how this device could be used as a product modulator.

4)

Consider a message signal $m(t)$ with the spectrum shown in Fig. 3.31. The message bandwidth $W = 1$ kHz. This signal is applied to a product modulator, together with a carrier wave $A_c \cos(2\pi f_c t)$, producing the DSB-SC modulated wave $s(t)$. This modulated wave is next applied to a coherent detector. Assuming perfect synchronism between the carrier waves in the modulator and detector, determine the spectrum of the detector output when: (a) the carrier frequency $f_c = 1.25$ kHz and (b) the carrier frequency $f_c = 0.75$ kHz. What is the lowest carrier frequency for which each component of the modulated wave $s(t)$ is uniquely determined by $m(t)$?

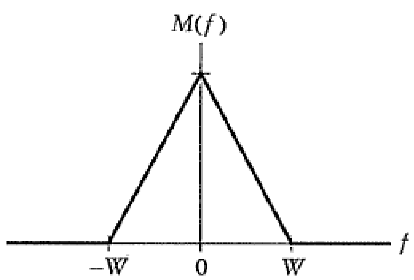

FIGURE 3.31