Problem 3.17

(a) We are given

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

and

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

Invoking the definition of AM wave

$s(t) = [1 + k_a m(t)]c(t)$

we now write

$$s(t) = A_c[1 + k_a A_m \sin(2\pi f_m t)]\sin(2\pi f_c t)$$
$$= A_c \sin(2\pi f_c t) + \mu A_c \sin(2\pi f_m t)\sin(2\pi f_c t) \quad (1)$$

where

$\mu = k_a A_m$

is the modulation factor. Next, we use the trigonometric identity

$$\sin A \sin B = \frac{1}{2}[\cos(A - B) - \cos(A + B)]$$

Hence, we may rewrite Eq. (1) as

$$s(t) = A_c \sin(2\pi f_c t) + \frac{1}{2}\mu A_c[\cos(2\pi(f_c - f_m)t) - \cos(2\pi(f_c + f_m)t)] \quad (2)$$

The spectrum of the AM wave s(t) consists of three components:

(i) Carrier: $A_c \sin(2\pi f_c t)$

(ii) Lower side-frequency: $\frac{1}{2}\mu A_c \cos(2\pi(f_c - f_m)t)$

(iii) Upper side-frequency: $-\frac{1}{2}\mu A_c \cos(2\pi(f_c + f_m)t)$

This spectrum is depicted in Fig. 1.

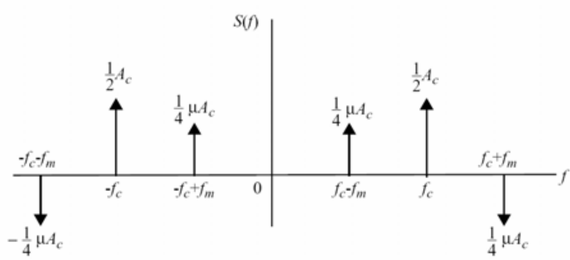

Figure 1

(b) Comparing the AM spectrum of Fig. 1 with the corresponding AM spectrum of Fig. 3.3(c) on page 105 of the text, we may make two observations:

- The frequency locations of the spectral components of these two AM waves are identical.
- The only difference between them is that the upper side-frequency $f_c + f_m$ in Fig. 1 is the negative of the upper side-frequency $f_c + f_m$ in Fig. 3.3(c).

Note: The following correction in the first printing of the book should be made. The modulating wave should read as follows:

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