Problem 4.8

For the PM case, we have by definition

$s(t) = A_c \cos[2\pi f_c t + k_p m(t)]$.

whose angle is

$\theta_i(t) = 2\pi f_c t + k_p m(t)$.

The instantaneous frequency is therefore

$$f_i(t) = \frac{1}{2\pi}\frac{d\theta_i(t)}{dt},$$

$$= f_c + \frac{k_p}{2\pi}\frac{dm(t)}{dt}$$

$$= f_c + \frac{Ak_p}{2\pi T_0} - \frac{Ak_p}{2\pi}\sum_n \delta(t - nT_0) \qquad (1)$$

which is equal to $f_c + Ak_p/2\pi T_0$ except for the instants that the message signal has discontinuities. At these instants, the phase shifts by $-k_pA/T_0$ radians.Accordingly, the PM wave has the waveform depicted in Fig. 1

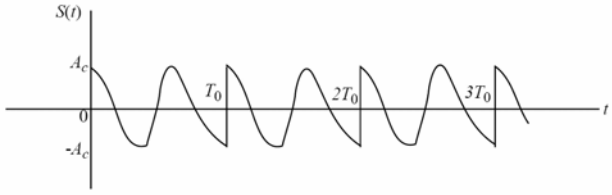

Figure 1

For the FM case, we have

$f_i(t) = f_c + k_f m(t)$

and the modulated wave is defined by

$$s(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int_0^t m(\tau)dt\right]$$

The modulated wave is therefore depicted in Fig. 2.

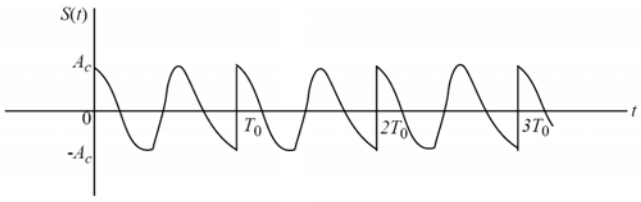

Figure 2