



Princess Sumaya
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EE27355

Communication Principles

Quiz #7

Sunday 10/5/2026

Name:.....



Section 1

Q.1) Sketch the FM modulated signal for the message signal $m(t)$ shown in Figure Q.1, given $\omega_c = 2\pi \times 10^8$ and $K_f = 2\pi \times 10^6$.

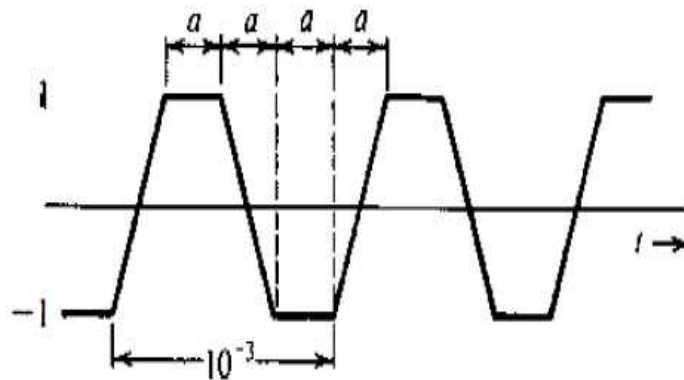


Figure Q.1 $m(t)$

Hint:

$$B = n\omega_0 / 2\pi$$

$$m(t) = \sum_n C_n \cos n\omega_0 t \quad \omega_0 = \frac{2\pi}{2 \times 10^{-4}} = 10^4 \pi$$

$$C_n = \begin{cases} \frac{8}{\pi^2 n^2} & n \text{ odd} \\ 0 & n \text{ even} \end{cases}$$

$$\Delta f = \frac{1}{2\pi} k_f m_p$$

$$\Delta f = \frac{1}{2\pi} k_p m'_p$$

$$B_{FM} = 2(\Delta f + B)$$

$$B_{PM} = 2(\Delta f + B)$$

$$(x_1, y_1) = (0, -1)$$

$$(x_2, y_2) = (1 \times 10^{-4}, 1)$$

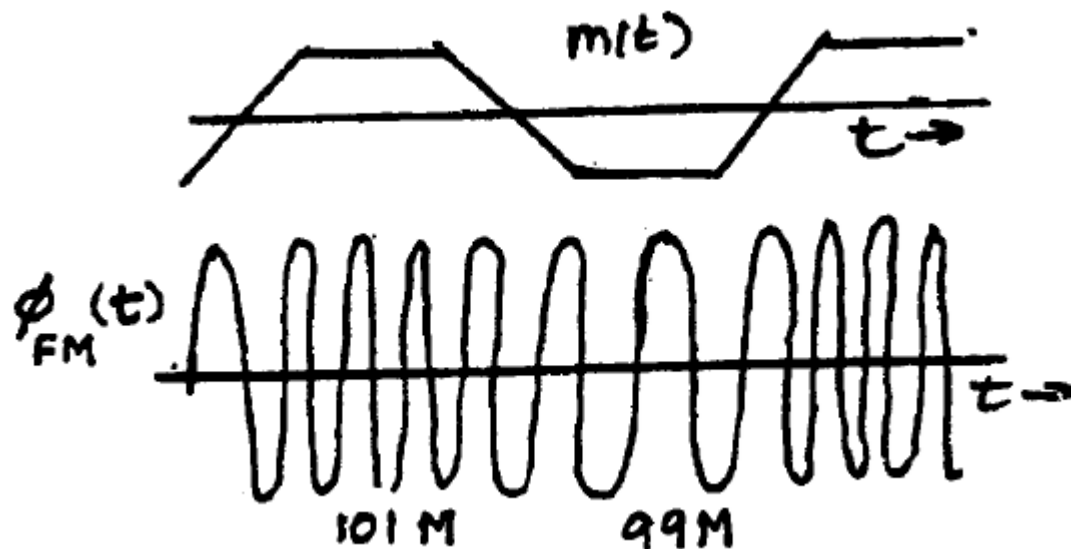
$$\frac{y - y_1}{x - x_1} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$y = 20000x - 1$$

$$\frac{d}{dx} y = 20000$$

$$\varphi_{PM}(t) = A \cos [\omega_c t + k_p m(t)] \quad \varphi_{FM}(t) = A \cos \left[\omega_c t + k_f \int_{-\infty}^t m(\alpha) d\alpha \right]$$

Solution: [8-Points]



In this case $f_c = 100 \text{ MHz}$, $m_p = 1$

For FM :

$\Delta f = k_f m_p / 2\pi = 2\pi \times 10^6 / 2\pi = 10^6 \text{ Hz}$. Also $f_c = 10^8$. Hence, $(f_i)_{\max} = 10^8 + 10^6 = 101 \text{ MHz}$ and $(f_i)_{\min} = 10^8 - 10^6 = 99 \text{ MHz}$. The carrier frequency increases linearly from 99 MHz to 101 MHz over a quarter (rising) cycle of duration a seconds. For the next a seconds, when $m(t) = 1$, the carrier frequency remains at 101 MHz. Over the next quarter (the falling) cycle of duration a , the carrier frequency decreases linearly from 101 MHz to 99 MHz, and over the last quarter cycle, when $m(t) = -1$, the carrier frequency remains at 99 MHz. This cycle repeats periodically with the period $4a$ seconds as shown in Fig. S5.1-1a.

Q.2) An angle-modulated signal with carrier frequency $\omega_c = 2\pi \times 10^5$ is described by the equation

$$\phi_{EM}(t) = 10 \cos(\omega_c t + 5 \sin 3000t + 10 \sin 4000\pi t)$$

Hint:

$$\omega_i = \frac{d}{dt}\theta(t) \quad \Delta f = \frac{\Delta\omega}{2\pi} \quad \beta = \frac{\Delta f}{B} \quad B_{EM} = 2(\Delta f + B)$$

$$\int \sin(ax) dx = -\frac{1}{a} \cos(ax) + c \quad \int \cos(ax) dx = \frac{1}{a} \sin(ax) + c$$

$$\frac{d}{dx}(\sin x) = \cos x. \quad \frac{d}{dx}(\cos x) = -\sin x.$$

Solution: [4-Points]

(a) Find the frequency deviation Δf .

(b) Find the phase deviation $\Delta\phi$.

a) $\Delta f = (15000 + 40000\pi)/(2\pi) = 22,388.54$

b) $\Delta\phi = 15$

Q.3) Design an Armstrong indirect FM modulator to generate an FM carrier with a carrier frequency of 96 MHz and $\Delta f = 75 \text{ kHz}$. A narrow-band FM generator is available at a carrier frequency of 100 kHz and a frequency deviation $\Delta f = 10 \text{ Hz}$. The stock room also has the following oscillators with frequencies 10.5, 10.6, 10.7, 10.8, 10.9, and 11 MHz. There are also plenty of frequency doublers, triplers, and quintuplers.

Hint: You may use one of these total frequency multipliers:

(32x64=2048) or (64x32=2048) or (48x64=3072) or (64x48=3072) or (125x60=7500) or (60x125=7500)

Solution: [8-Points]

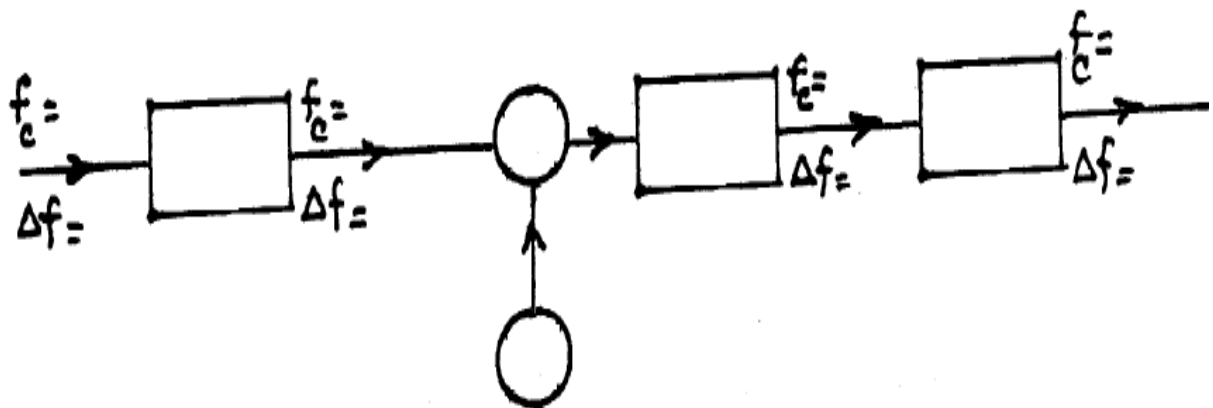


Figure Q.3

