Princess Sumaya University for Technology
King Abdullah II School of Engineering

EE27355
Communication Principles
Quiz #7
Monday 11/5/2026

Name:………………………………………………………………….. ☐ **Section 2**

Q.1) Sketch the FM modulated signal for the message signal m(t) shown in Figure Q.1, given $\omega_c=2\pi x10^8$ and $K_f=2\pi x10^6$.

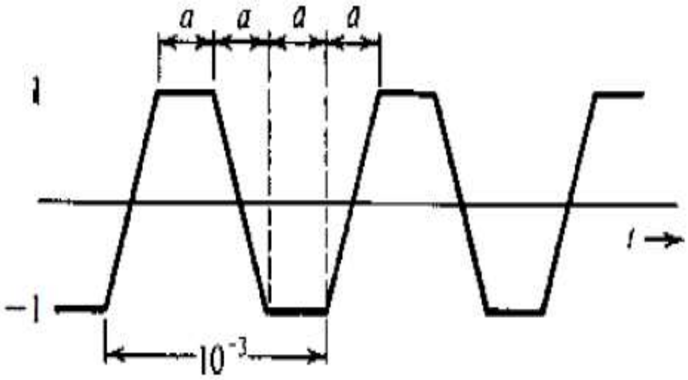


Figure Q.1 m(t)

Hint:

$B=n\omega_o/2\pi$

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

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

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

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

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

$(x_2, y_2) = (1x10^{-4}, 1)$

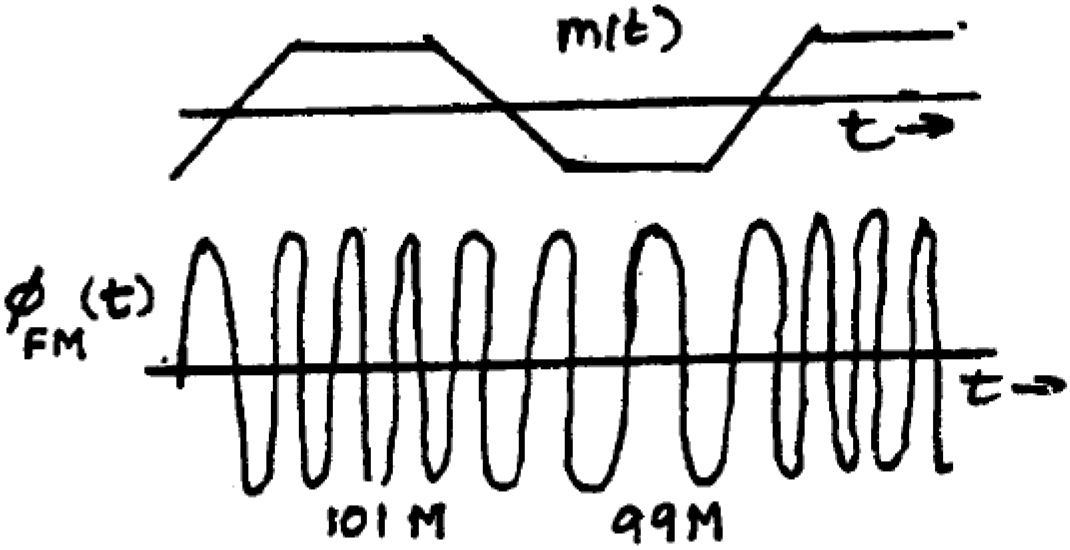
$$\frac{y - y_1}{x - x_1} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$y = 20000x - 1$$

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

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

Solution: [8-Points]



In this case $f_c = 100$ MHz. $m_p = 1$

For FM :

$\Delta f = k_f m_p / 2\pi = 2\pi \times 10^6 / 2\pi = 10^6$ Hz. Also $f_c = 10^8$. Hence, $(f_i)_{max} = 10^8 + 10^6 = 101$ MHz and $(f_i)_{min} = 10^8 - 10^6 = 99$ 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 9.9 MHz. This cycles 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:

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

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

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

<u>Solution:</u> [4-Points]

(a) Find the frequency deviation Δf.

(b) Find the phase deviation Δϕ.

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 Δf=75kHz. A narrow-band FM generator is available at a carrier frequency of 100 kHz and a frequency deviation Δf=10 Hz. The stock room also has the following oscillators with frequencies I0.5, 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)

<u>Solution:</u> [8-Points]

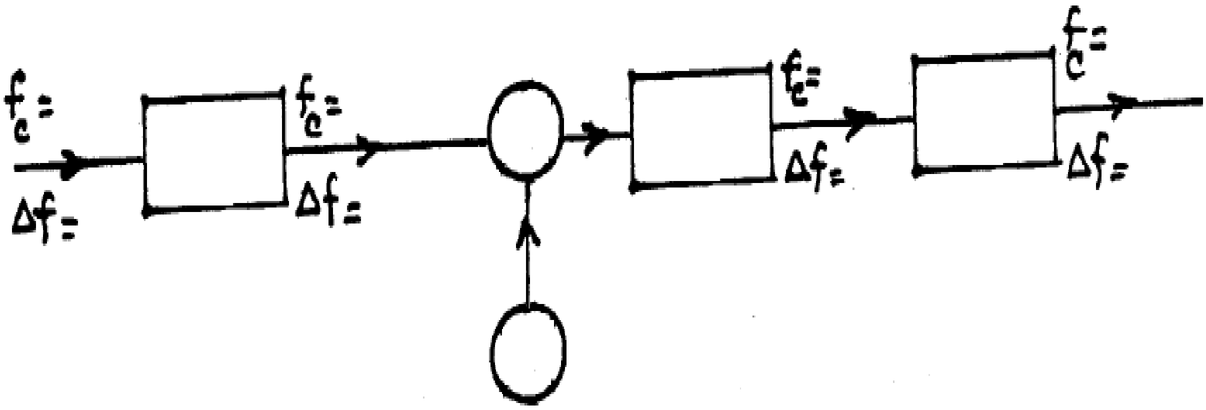


Figure Q.3