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EEEN 322 Spring 2019
QUIZ #2
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(Section 01)

The mathematical expression for a frequency-modulated signal is given as

$$\varphi_{FM}(t) = 2\cos(2\pi \times 10^8 t + 0.5 \sin 3000\pi t)$$

and we are also given that $k_f = 500\pi$.

a) Find the carrier frequency f_c and the carrier amplitude A.

b) Write the mathematical expression for the message signal $m(t)$.

c) Find the power of $\varphi_{FM}(t)$.

d) Find the frequency deviation Δf.

e) Estimate the bandwidth B_{FM}.

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

$= 2\cos\left[2\pi\times 10^8 t + 0.5\sin 3000\pi t\right]$

$\Rightarrow A = 2$ (10)

$\omega_c = 2\pi\times 10^8 = 2\pi f_c \Rightarrow f_c = \frac{2\pi\times 10^8}{2\pi} = 10^8\ Hz = 100\,MHz$ (10)

b) $k_f \int_{-\infty}^{t} m(\alpha)\,d\alpha = 500\pi \int_{-\infty}^{t} m(\alpha)\,d\alpha = 0.5\sin 3000\pi t$

$\Rightarrow \int_{-\infty}^{t} m(\alpha)\,d\alpha = \frac{0.5}{500\pi}\sin 3000\pi t$

$\Rightarrow m(t) = \frac{d}{dt}\left(\frac{0.5}{500\pi}\sin 3000\pi t\right)$

$= \frac{0.5}{500\pi}\times 3000\pi \times \cos 3000\pi t$

$= 3\cos 3000\pi t$ (20)

c) $P = A^2/2 = 2^2/2 = 2$ (20)

d) $m_p = 3 \Rightarrow \Delta f = \frac{k_f m_p}{2\pi} = \frac{500\pi\times 3}{2\pi} = 750\ Hz$

e) $B = \frac{3000\pi}{2\pi} = 1500\ Hz \Rightarrow B_{FM} = 2(\Delta f + B)$

$= 2(750+1500) = 4500\ Hz = 4.5\ kHz$

(20)