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Section: 'A'

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Communication Systems
Assignment no. 3rd.

1:

Question # 1:

Analyze the wideband frequency modulated and describe the fallacy exposed while estimating the bandwidth.

Solution:

If $|K_f a(t)| << 1$ is not satisfied then we will take another way

$$|K_f a(t)| >> 1$$

$$\omega_i = \omega_c + K_f m(t)$$

$$f_i = f_c + \frac{K_f}{2\pi} m(t) \quad , \div \text{ by } 2\pi$$

$$f_i = f_c + \Delta f .$$

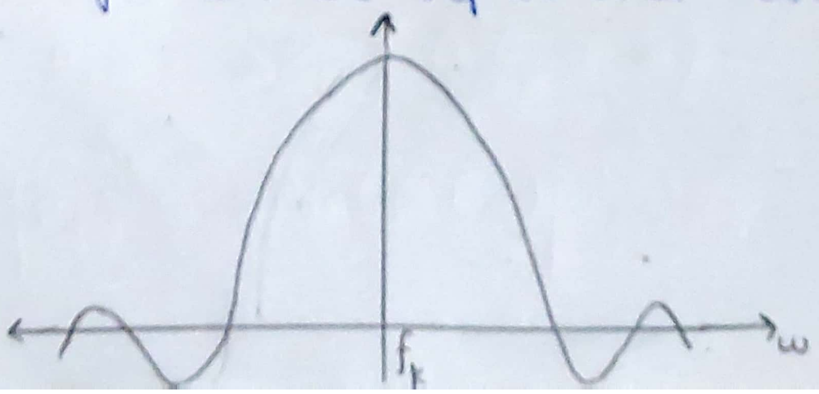
We will take the signal samples that should be taken atleast twice of the heighest frequency component present in the signal.

$$R_s \geq 2B_m$$

We also know that

$$rect\left(\frac{t}{\tau}\right) \Leftrightarrow \tau \, sinc\left(\frac{\omega\tau}{2}\right)$$

One sample can be represented as:



$$\frac{\omega\pi}{2} = \pm n\pi$$

$$\omega = \pm \frac{2n\pi}{T_s}$$

$$f_s = \frac{\cancel{2}n\cancel{\pi}}{T_s \cdot \cancel{2}\cancel{\pi}} = \frac{n}{T_s}$$

Hence the sampling frequency of n^{th} element is

$$f_s = \frac{n}{T_s}$$

$$f_{i_{max}} = f_c + \frac{K_f}{2\pi} m_p$$

$$f_{i_{min}} = f_c - \frac{K_f}{2\pi} m_p$$

$$f_{i_{max}} - f_{i_{min}} = \cancel{f_c} + \frac{K_f}{2\pi} m_p - \cancel{f_c} + \frac{K_f}{2\pi} m_p$$

$$B_{FM} = \cancel{2}\, K_f/\cancel{2\pi}\; m_p + 4B_m$$

$$= 2\ \Delta f + 4B_m$$

$$B_{FM} = 2B_M\left(\Delta f/B_m + 2\right)$$

$$\boxed{B_{FM} = 2B_M(\beta + 2)}$$

It is good metric to consider

$$B_{FM} = 2\Delta f + 2B_m$$

$$= 2B_m\left(\frac{\Delta f}{B_m} + 1\right)$$

$$= 2B_m(\beta + 1)$$

Question # 2:

An angle modulated signal with carrier frequency $\omega_c = 2\pi \times 10^6$ is described by equation:

$$\phi_{EM}(t) = 10\cos(\omega_c t + 0.1 \sin 2000\pi t).$$

a) find power of the modulated signal.

Sol: Power of modulated signal is

$$P = \frac{A^2}{2}$$

$$= \frac{10^2}{2} = \frac{100}{2} = \boxed{50\ W}$$

b) find the frequency deviation Δf ?

Sol: As $\omega_i = \frac{d}{dt}\theta(t)$

As $\theta(t) = \omega_c t + 0.1 \sin 2000\pi t$

and Bandwith is given by

$$B = \frac{\cancel{2}000\cancel{\pi}}{\cancel{2}\cancel{\pi}} = 1000\ Hz$$

$$\omega_i = \omega_c + 200\pi \cos 2000\pi t$$

which shows that

$$\Delta\omega = 200\pi$$

$$\Delta f = \frac{\cancel{2}00\cancel{\pi}}{\cancel{2}\cancel{\pi}} = 100\ Hz$$

$$\boxed{\Delta f = 100\ Hz}$$

(c) find the phase deviation $\Delta\varphi$?

Solution:

d) Estimate the bandwidth of $\phi_{EM}(t)$?

Solution: $B_{EM} = 2(\Delta f + B)$

$= 2(100 + 1000)$

$= 2(1100)$

$= 2200$

$$\boxed{B_{EM} = 2.2\ kHz}$$

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