Date: __/__/20__

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COMMUNICATION SYSTEMS

ASSIGNMENT 1

SUBMITTED TO

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SUBMITTED BY

NOOR UL HAQ

REG

21PWCSE2046

SECTION

A

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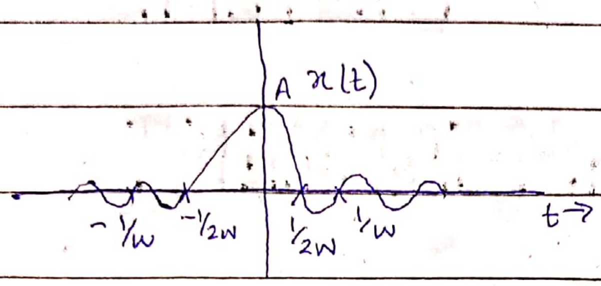
Question No 1



It's basically a sinc function in time domain and we're required to find its Fourier transform and plot the spectrum.

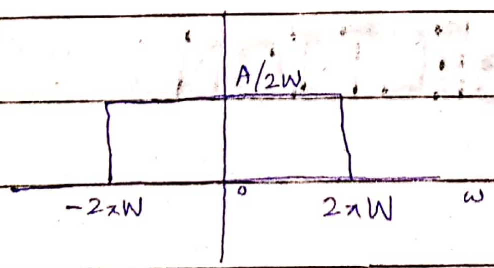
Eq. of this sinc ftn is;

$$x(t) = A \operatorname{sinc}(2W t)$$

and from FT table

$$X(\omega) = \frac{A}{2W} \operatorname{rect}\left(\frac{\omega}{4\pi W}\right)$$

To plot the spectrum



Question NO 2

$$x(t) = A\cos(\omega_0 t)$$

$$= A\cos(2\pi f_0 t)$$

$$= 1 \cos 2\pi f_0 t$$

$$= \cos 2\pi f_0 t.$$

$$FT = \int_{-\infty}^{\infty} \cos(2\pi f_0 t)\, e^{-j2\pi f t}\, dt$$

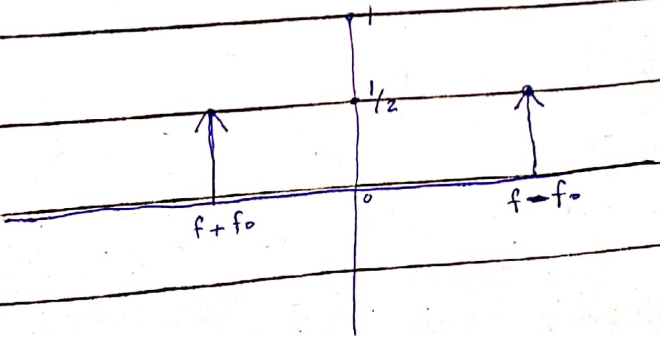
$$\cos \omega_0 t = \frac{e^{j\omega_0 t} + e^{-j\omega_0 t}}{2}$$

$$= \frac{e^{j2\pi f t} + e^{-j2\pi f_0 t}}{2}$$

$$= \int_{-\infty}^{\infty} \left(\frac{e^{j2\pi f_0 t} + e^{-j2\pi f_0 t}}{2} \right) \times e^{-j2\pi f t}\, dt$$

$$= \frac{1}{2} \int_{-\infty}^{\infty} e^{-j2\pi(f-f_0)t} + e^{-j2\pi(f+f_0)t}\, dt$$

$$= \frac{1}{2}\left[\delta(f-f_0) + \delta[f+f_0) \right]$$



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Question No 3

same as Question 2

(PTO)

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Q-4

(a) Peak amplitude of carrier

$= A_c(1+U)$

$$A_c = \frac{V_{max} + V_{min}}{2} = \frac{20+4}{2} = 12$$

$$U = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{16}{24} = 0.66$$

$\downarrow$ modulation coefficient

$= 12(1+0.66) = 19.2.$

(b) Modulation coefficient, $U = 0.66$

Percent Modulation $= 66\%$

(c) Peak amplitude of upper and lower side frequencies

$$= \frac{A_c \times U}{2} = \frac{12 \times 0.66}{2}$$

$= 3.96.$

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Q-5

For full carrier amplitude modulation, the total power (P_t) includes the carrier power and the power of side bands.

Now, lets prove!

Let $m_1(t) = V_{m_1} \cos 2\pi f_{m_1} t$

$m_2(t) = V_{m_2} \cos 2\pi f_{m_2} t$

$$S(t)_{AM} = [V_c + V_{m_1} \cos 2\pi f_{m_1} t + V_{m_2} \cos 2\pi f_{m_2} t] \times \cos 2\pi f_c t$$

$$S(t)_{AM} = V_c \left[1 + \frac{V_{m_1}}{V_c} \cos 2\pi f_{m_1} t + \frac{V_{m_2}}{V_c} \cos 2\pi f_{m_2} t\right] \cos 2\pi f_c t$$

Let $\frac{V_{m_1}}{V_c} = m_1$, $\frac{V_{m_2}}{V_c} = m_2$

$$S(t)_{AM} = V_c [1 + m_1 \cos 2\pi f_{m_1} t + m_2 \cos 2\pi f_{m_2} t] \cos 2\pi f_c t$$

$$= V_c \cos 2\pi f_c t + V_c m_1 \cos 2\pi f_{m_1} t \cos 2\pi f_c t + V_c m_2 \cos 2\pi f_{m_2} t \cos 2\pi f_c t$$

$$= V_c \cos 2\pi f_c t + \frac{V_c m_1}{2} [\cos 2\pi (f_c + f_{m_1}) t + \cos 2\pi (f_c - f_{m_1}) t]$$

$$+ \frac{V_c m_2}{2} [\cos 2\pi (f_c + f_{m_2}) t + \cos 2\pi (f_c - f_{m_2}) t]$$

Since, $P_{Total} = P_{carrier(c)} + P_{side\,bands(SB)}$

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$$P_c = \frac{V_c^2}{2}$$

$$P_{SB} = 2\left(\frac{V_c m_1}{2\sqrt{2}}\right)^2 + 2\left(\frac{V_c m_2}{2\sqrt{2}}\right)^2$$

$$= \frac{V_c^2 m_1^2}{4} + \frac{V_c^2 m_2^2}{4}$$

$$= \frac{V_c^2}{2}\left[\frac{m_1^2}{2} + \frac{m_2^2}{2}\right]$$

$$P_{SB} = \frac{P_c}{2}(m_1^2 + m_2^2)$$

$$P_{SB} = P_c\left(\frac{m_1^2 + m_2^2}{2}\right)$$

$$\text{if} \quad m = \sqrt{m_1^2 + m_2^2}$$

$$P_{SB} = P_c \cdot \frac{m^2}{2}$$

$$P_T = P_c + P_{SB}$$

$$= P_c + P_c \cdot \frac{m^2}{2}$$

$$P_T = P_c\left[1 + \frac{m^2}{2}\right]$$

Hence proved.