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EE27355

Communication Principles

Quiz #6

Monday 4/5/2026

Name:.....



Section 2

Q.1) A modulating signal $m(t)$ is given by $m(t)=\cos(100t)+2\cos(300t)$.

- Sketch the spectrum of $m(t)$.**
- Find and sketch the spectrum of the DSB-SC signal $2m(t) \cos(1000t)$.**
- From the spectrum obtained in *b*, suppress the LSB spectrum to obtain the USB spectrum.**
- Knowing the USB spectrum in *c*, write the expression Φ_{USB} for the USB signal.**
- Repeat *c* and *d* to obtain the LSB signal Φ_{LSB} .**

Hint:

$$\sin(x) \cos(y) = \frac{1}{2} [\sin(x+y) + \sin(x-y)]$$

$$\cos(x) \sin(y) = \frac{1}{2} [\sin(x+y) - \sin(x-y)]$$

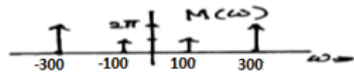
$$\cos(x) \cos(y) = \frac{1}{2} [\cos(x-y) + \cos(x+y)]$$

$$\sin(x) \sin(y) = \frac{1}{2} [\cos(x-y) - \cos(x+y)]$$

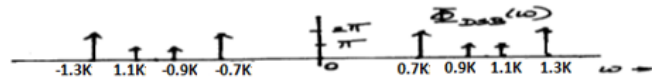
Solution: [10-Points]

$$\cos \omega_0 t \iff \pi [\delta(\omega + \omega_0) + \delta(\omega - \omega_0)]$$

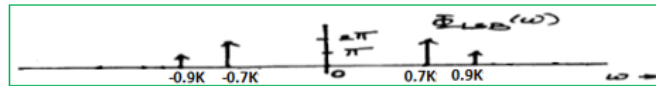
$$m(t) = \cos 100 t + 2 \cos 300 t$$



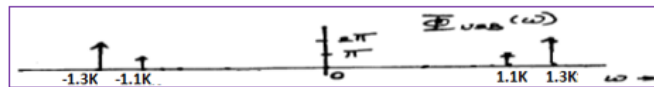
$$2m(t) \cos 1000 t$$



$$\varphi_{\text{LSB}}(t) = 2 \cos 700 t + \cos 900 t$$



$$\varphi_{\text{USB}}(t) = \cos 1100 t + 2 \cos 1300 t$$



Q.2) Find $\Phi_{\text{USB}}(t)$ for the modulating signal $m(t)=4000\text{sinc}(4000t)$ and carrier frequency $\omega_c=10000$ and sketch $\Phi_{\text{USB}}(t)$ in the frequency domain.

Hint:

$$\tau \text{sinc}\left(\frac{\tau t}{2}\right) \Longleftrightarrow 2\pi \text{rect}\left(\frac{\omega}{\tau}\right)$$

Solution: [10-Points]

$$\underbrace{\tau \text{sinc}\left(\frac{\tau t}{2}\right)}_{G(t)} \Longleftrightarrow \underbrace{2\pi \text{rect}\left(\frac{-\omega}{\tau}\right)}_{2\pi g(-\omega)} = 2\pi \text{rect}\left(\frac{\omega}{\tau}\right)$$

$$m(t)=4000\text{sinc}(4000t)$$

$$\gamma \text{sinc}\left(\frac{\gamma t}{2}\right) \xrightarrow{F} 2\pi \text{rect}\left(\frac{\omega}{\gamma}\right)$$

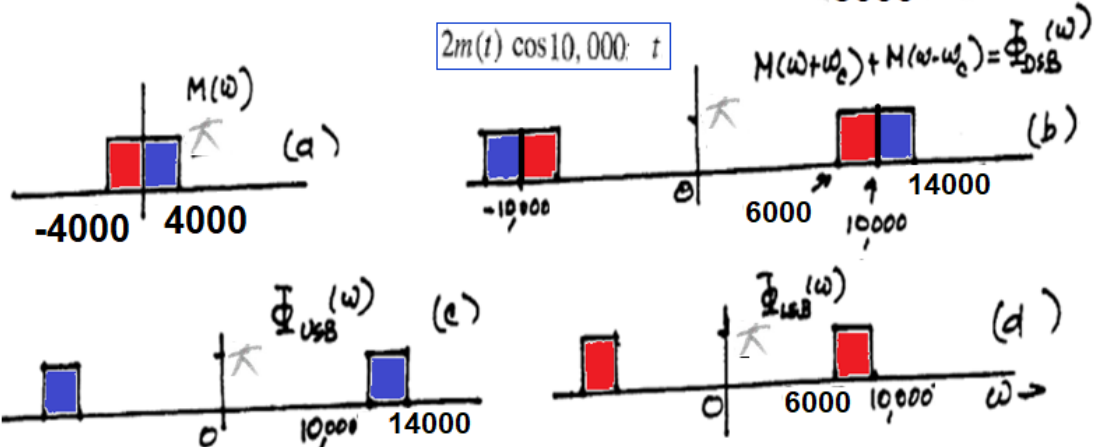
$$\frac{\gamma t}{2} = 4000t$$

$$\gamma = 8000$$

$$\frac{8000}{2} \text{sinc}(4000t) \xrightarrow{F} \frac{2\pi}{2} \text{rect}\left(\frac{\omega}{8000}\right)$$

$$4000 \text{sinc}(4000t) \xrightarrow{F} \pi \text{rect}\left(\frac{\omega}{8000}\right)$$

$$4000 \text{sinc}(4000t) \xrightarrow{F} \pi \text{rect}\left(\frac{\omega}{8000}\right)$$



$$\varphi_{\text{LSB}}(t) = 4000 \text{sinc}(2000t) \cos(12000t)$$

$$\varphi_{\text{USB}}(t) = 4000 \text{sinc}(2000t) \cos(8000t)$$

Hint:

Table 3.1

Short Table of Fourier Transforms

	$g(t)$	$G(\omega)$	
1	$e^{-at} u(t)$	$\frac{1}{a + j\omega}$	$a > 0$
2	$e^{at} u(-t)$	$\frac{1}{a - j\omega}$	$a > 0$
3	$e^{-a t }$	$\frac{2a}{a^2 + \omega^2}$	$a > 0$
4	$t e^{-at} u(t)$	$\frac{1}{(a + j\omega)^2}$	$a > 0$
5	$t^n e^{-at} u(t)$	$\frac{n!}{(a + j\omega)^{n+1}}$	$a > 0$
6	$\delta(t)$	1	
7	1	$2\pi\delta(\omega)$	
8	$e^{j\omega_0 t}$	$2\pi\delta(\omega - \omega_0)$	
9	$\cos \omega_0 t$	$\pi[\delta(\omega - \omega_0) + \delta(\omega + \omega_0)]$	
10	$\sin \omega_0 t$	$j\pi[\delta(\omega + \omega_0) - \delta(\omega - \omega_0)]$	
11	$u(t)$	$\pi\delta(\omega) + \frac{1}{j\omega}$	
12	$\text{sgn } t$	$\frac{2}{j\omega}$	
13	$\cos \omega_0 t u(t)$	$\frac{\pi}{2} [\delta(\omega - \omega_0) + \delta(\omega + \omega_0)] + \frac{j\omega}{\omega_0^2 - \omega^2}$	
14	$\sin \omega_0 t u(t)$	$\frac{\pi}{2j} [\delta(\omega - \omega_0) - \delta(\omega + \omega_0)] + \frac{\omega_0}{\omega_0^2 - \omega^2}$	
15	$e^{-at} \sin \omega_0 t u(t)$	$\frac{\omega_0}{(a + j\omega)^2 + \omega_0^2}$	$a > 0$
16	$e^{-at} \cos \omega_0 t u(t)$	$\frac{a + j\omega}{(a + j\omega)^2 + \omega_0^2}$	$a > 0$
17	$\text{rect}\left(\frac{t}{\tau}\right)$	$\tau \text{sinc}\left(\frac{\omega\tau}{2}\right)$	
18	$\frac{W}{\pi} \text{sinc}(Wt)$	$\text{rect}\left(\frac{\omega}{2W}\right)$	
19	$\Delta\left(\frac{t}{\tau}\right)$	$\frac{\tau}{2} \text{sinc}^2\left(\frac{\omega\tau}{4}\right)$	
20	$\frac{W}{2\pi} \text{sinc}^2\left(\frac{Wt}{2}\right)$	$\Delta\left(\frac{\omega}{2W}\right)$	
21	$\sum_{n=-\infty}^{\infty} \delta(t - nT)$	$\omega_0 \sum_{n=-\infty}^{\infty} \delta(\omega - n\omega_0)$	$\omega_0 = \frac{2\pi}{T}$
22	$e^{-t^2/2\sigma^2}$	$\sigma\sqrt{2\pi} e^{-\sigma^2\omega^2/2}$	

Table 3.2
Fourier Transform Operations

Operation	$g(t)$	$G(\omega)$
Addition	$g_1(t) + g_2(t)$	$G_1(\omega) + G_2(\omega)$
Scalar multiplication	$kg(t)$	$kG(\omega)$
Symmetry	$G(t)$	$2\pi g(-\omega)$
Scaling	$g(at)$	$\frac{1}{ a } G\left(\frac{\omega}{a}\right)$
Time shift	$g(t - t_0)$	$G(\omega)e^{-j\omega t_0}$
Frequency shift	$g(t)e^{j\omega_0 t}$	$G(\omega - \omega_0)$
Time convolution	$g_1(t) * g_2(t)$	$G_1(\omega)G_2(\omega)$
Frequency convolution	$g_1(t)g_2(t)$	$\frac{1}{2\pi} G_1(\omega) * G_2(\omega)$
Time differentiation	$\frac{d^n g}{dt^n}$	$(j\omega)^n G(\omega)$
Time integration	$\int_{-\infty}^t g(x) dx$	$\frac{G(\omega)}{j\omega} + \pi G(0)\delta(\omega)$