Princess Sumaya University for Technology
King Abdullah II School of Engineering

EE27355
Communication Principles
Quiz #6
Sunday 3/5/2026

Name:………………………………………………………………… [ ] Section 1

Q.1) A modulating signal m(t) is given by m(t)=cos(200t)+2cos(600t).

a) **Sketch the spectrum of m(t).**

b) **Find and sketch the spectrum of the DSB-SC signal 2m(t) cos(1000t).**

c) **From the spectrum obtained in *b*, suppress the LSB spectrum to obtain the USB spectrum.**

d) **Knowing the USB spectrum in *c*, write the expression Φ_{USB} for the USB signal.**

e) **Repeat *c* and *d* to obtain the LSB signal Φ_{LSB}.**

Hint:

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

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

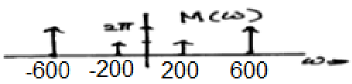
$$\cos(x)\cos(y) = \frac{1}{2}\left[\cos(x-y) + \cos(x+y)\right]$$

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

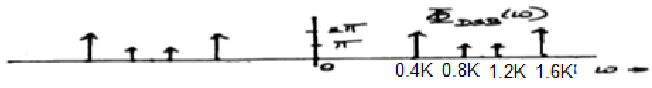
Solution: [10-Points]

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

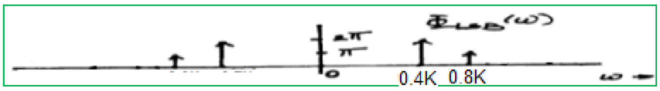
$m(t) = \cos 200t\ + 2\cos 600t$



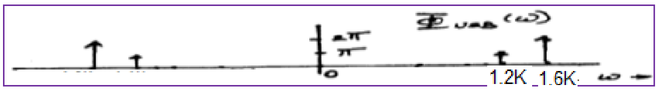
$2m(t)\ \cos 1000t$



$\varphi_{LSB}(t) = 2\cos 400t\ + \cos 800t$



$\varphi_{USB}(t) = \cos 1200t + 2\cos 1600t$



Q.2) Find $\Phi_{USB}(t)$ for the modulating sil m(t)= 8000 sinc(8000t) and carrier frequency ω_c=10000 and sketch $\Phi_{USB}(t)$ in the frequency domain.

Hint:

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

<u>Solution:</u> [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)= 8000sinc(8000t)

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

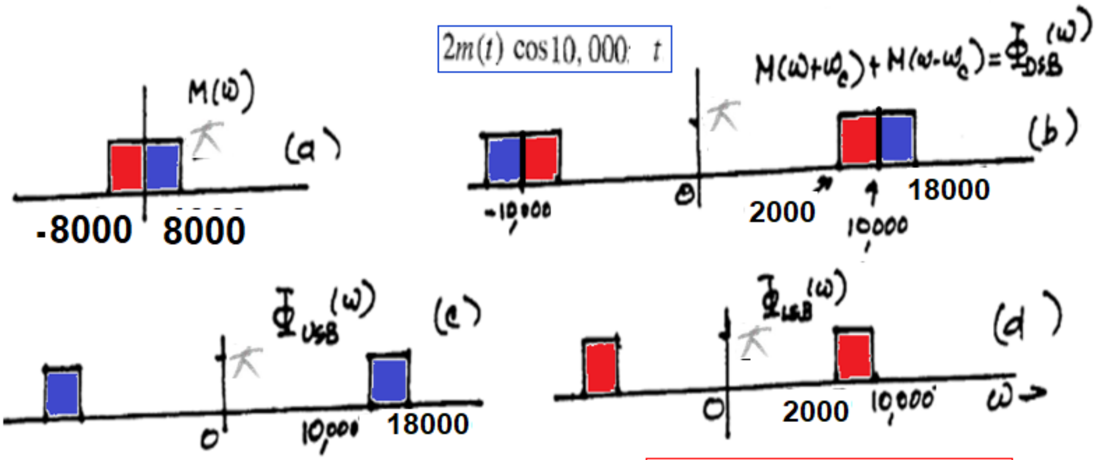
$$\frac{\tau t}{2} = 8000t$$

$$\tau = 16000$$

$$\frac{16000}{2} \text{ Sinc } 8000t \xrightarrow{\mathcal{F}} \frac{2\pi}{2} \text{ rect}\left(\frac{\omega}{16000}\right)$$

$$8000 \text{ Sinc}(8000t) \xrightarrow{\mathcal{F}} \pi \text{ rect}\left(\frac{\omega}{16000}\right)$$

$$8000 \text{ Sinc}(8000t) \xrightarrow{\mathcal{F}} \pi \text{ rect}\left(\frac{\omega}{16000}\right)$$



$\varphi_{USB}(t)$ = 8000 sinc(4000t) cos (14000)t

$\varphi_{LSB}(t)$ = 8000 sinc(4000t) cos (6000)t

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	$te^{-at}u(t)$	$\frac{1}{(a+j\omega)^2}$	$a>0$
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	$\operatorname{sgn} t$	$\frac{2}{j\omega}$	
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	$\operatorname{rect}\left(\frac{t}{\tau}\right)$	$\tau\operatorname{sinc}\left(\frac{\omega\tau}{2}\right)$	
18	$\frac{W}{\pi}\operatorname{sinc}(Wt)$	$\operatorname{rect}\left(\frac{\omega}{2W}\right)$	
19	$\Delta\left(\frac{t}{\tau}\right)$	$\frac{\tau}{2}\operatorname{sinc}^2\left(\frac{\omega\tau}{4}\right)$	
20	$\frac{W}{2\pi}\operatorname{sinc}^2\left(\frac{Wt}{2}\right)$	$\Delta\left(\frac{\omega}{2W}\right)$	
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	$\int_{-\infty}^{t} g(x)\,dx$	$\frac{G(\omega)}{j\omega}+\pi G(0)\delta(\omega)$