جامعة بيرزيت

BIRZEIT UNIVERSITY

Faculty of Engineering and Technology

Department of Electrical and Computer Engineering

Second Semester, 2018/2019

COMMUNICATION SYSTEMS, ENEE339

First Exam, March 26, 2019

Time Allowed: 80 Minutes.

Name: ....

ID: ....

Section: ....

Question #	SOC	Max Grade	Achieved
1		20	
2		20	
3		10	
Total		50	

Opening Remarks:

- This is a 80-minutes exam. Calculators are allowed. Books, notes, formula sheets, and other aids are not allowed.
- You are required to show all your work and provide the necessary explanations everywhere to get full credit.

Problem#1 [20 Points]

Consider the signal $x(t) = cos(2000\pi t) + 2cos(4000\pi t) + 0.5cos(8000\pi t)$. If this signal passes through a channel with amplitude spectrum and phase spectrum as shown in figure 1. Assuming $y(t)$ is signal at the output of the channel, answer the following questions:

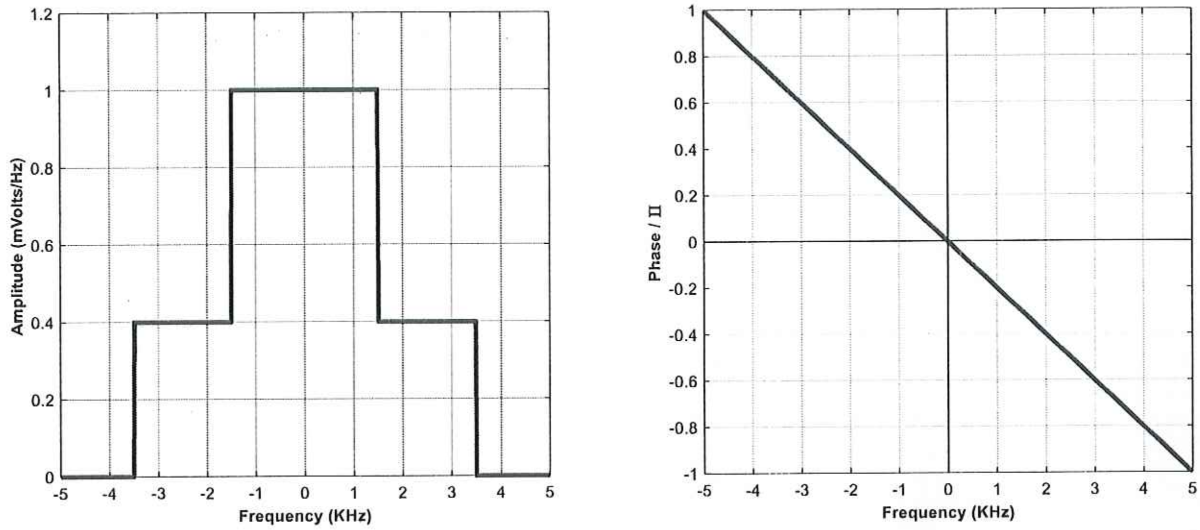
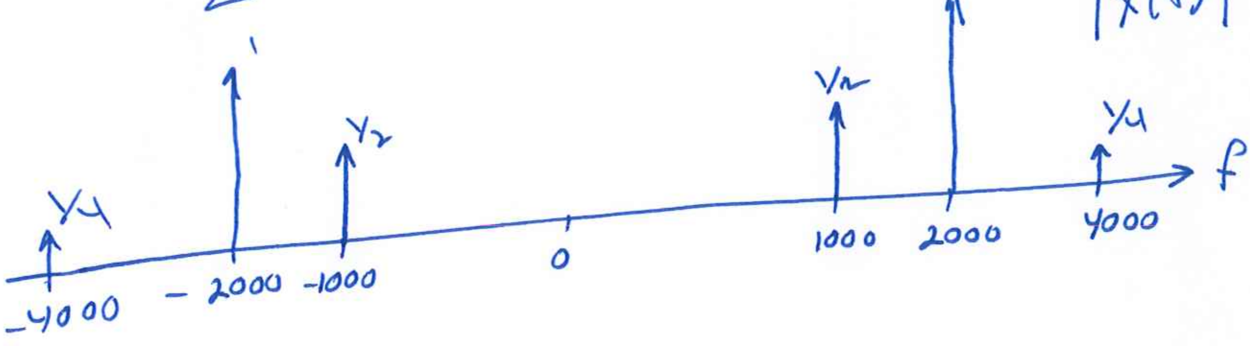


Figure 1: amplitude spectrum and phase spectrum of problem 1

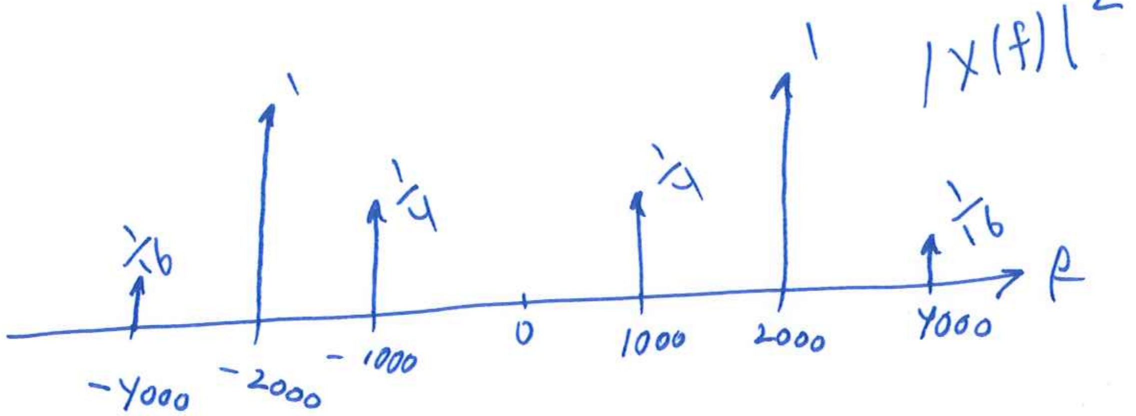
a. Determine and plot the Amplitude Spectrum of $x(t)$.

$$X(f) = \frac{\delta(f-1000) + \delta(f+1000)}{2} + 2\left[\frac{\delta(f-2000) + \delta(f+2000)}{2}\right]$$

$$+ 0.5\left[\frac{\delta(f-4000) + \delta(f+4000)}{2}\right]$$



b. Plot the Power Spectral Density of $x(t)$.



c. Determine the average power of $x(t)$.

$$P_{av} = 2\times\frac{1}{4} + 2\times 1 + 2\times\frac{1}{16} = 2.625 \text{ watts.}$$

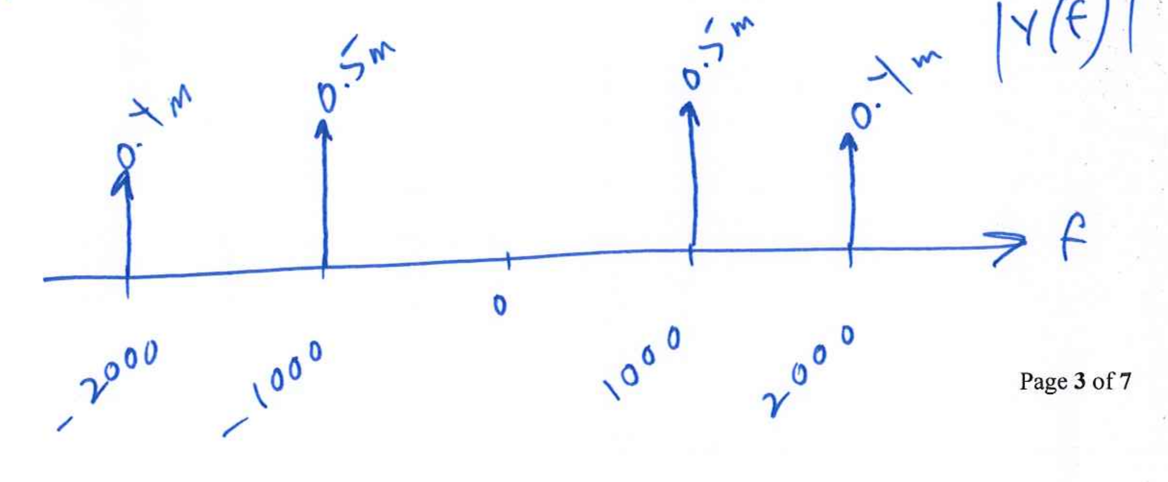
d. Determine the absolute bandwidth of $x(t)$.

$$BW_{abs} = 4000 \text{ Hz}.$$

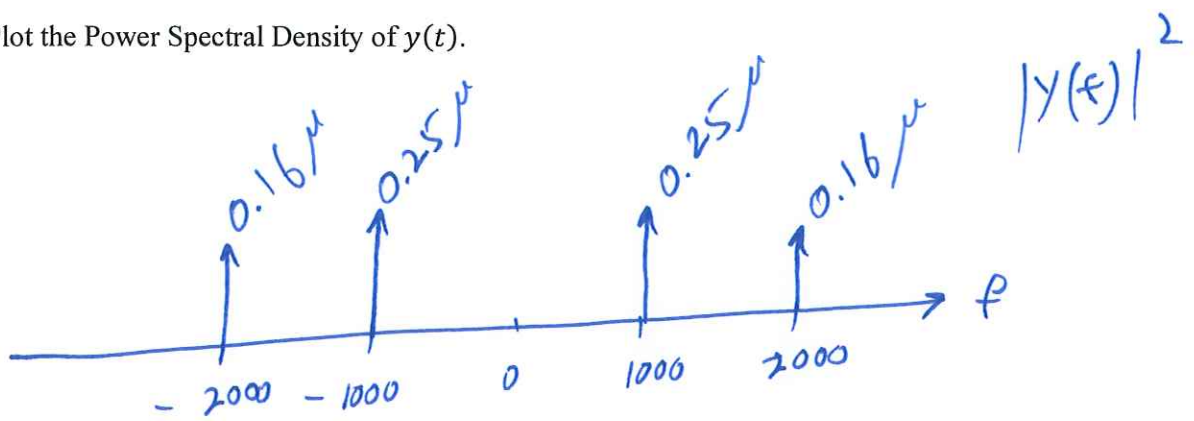
e. Determine and plot the Amplitude Spectrum of $y(t)$.

$$Y(f) = \frac{\delta(f-1000) + \delta(f+1000)}{2} + 0.4\left[\frac{\delta(f-2000) + \delta(f+2000)}{2}\right]$$

in mVolts.



f. Plot the Power Spectral Density of $y(t)$.



g. Determine the average power of $y(t)$.

$P_{av} = 2 \times 0.25 + 2 \times 0.16 = 0.82\mu$ Watts.

h. Determine the absolute bandwidth of $y(t)$.

$BW_{ABS} = 2000\ Hz$

i. Is this a distortionless transmission? Explain briefly.

No,
- Different harmonics are multiplied by different coefficients.
- The harmonic with $f = 4000\,Hz$ is totally distorted (disappeared).

Problem#2 [20 Points]

For the Amplitude Spectrum of the signal $g(t)$ shown in figure 2, answer the following:

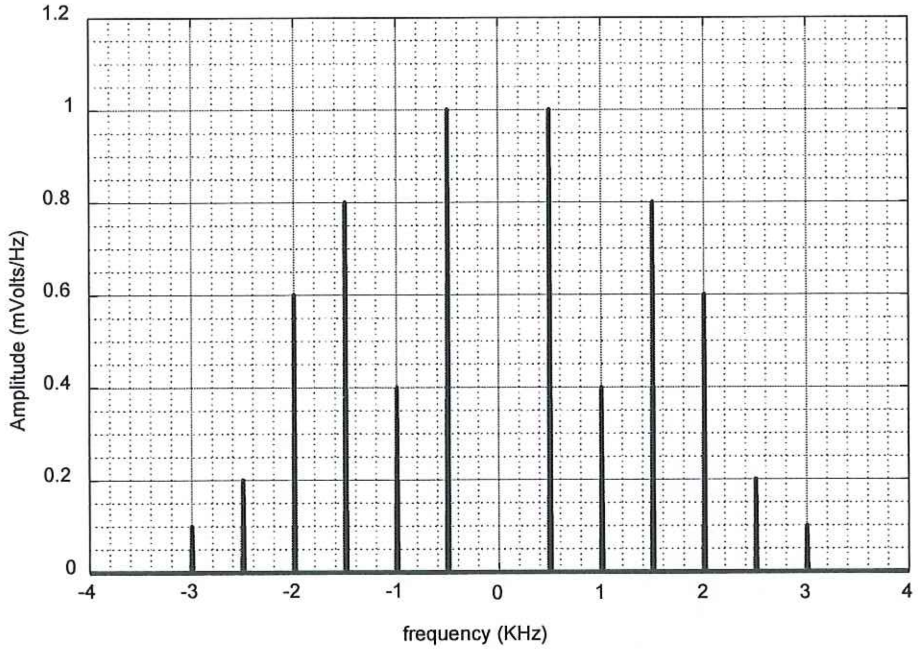


Figure 2: Amplitude Spectrum of $g(t)$

a. Determine the 90% power bandwidth of $g(t)$.

$f = \pm 0.5 KHz \longrightarrow P_{0.5K} = 2 \times 1^2 = 2 \mu watts.$

$f = \pm 1 KHz \longrightarrow P_{1K} = 2 \times 0.4^2 = 0.32 \mu watts.$

$f = \pm 1.5 KHz \longrightarrow P_{1.5K} = 2 \times 0.8^2 = 1.28 \mu watts$

$f = \pm 2 KHz \longrightarrow P_{2K} = 2 \times 0.6^2 = 0.72 \mu watts.$

$f = \pm 2.5 KHz \longrightarrow P_{2.5K} = 2 \times 0.2^2 = 0.08 \mu watts.$

$f = \pm 3 KHz \longrightarrow P_{3K} = 2 \times 0.1^2 = 0.02 \mu watts.$

$P_{total} = P_{0.5K} + P_{1K} + P_{1.5K} + P_{2K} + P_{2.5K} + P_{3K} = 4.42 \mu watts.$

① ⇒ $\frac{P_{0.5K}}{P_{total}} = \frac{2\mu}{4.42\mu} = 45.248\% < 90\%$.

② ⇒ $\frac{P_{0.5K} + P_{1K}}{P_{total}} = \frac{2.32\mu}{4.42\mu} = 52.49\% < 90\%$.

③ ⇒ $\frac{P_{0.5} + P_{1K} + P_{1.5K}}{P_{total}} = \frac{3.6\mu}{4.42\mu} = 81.45\% < 90\%$.

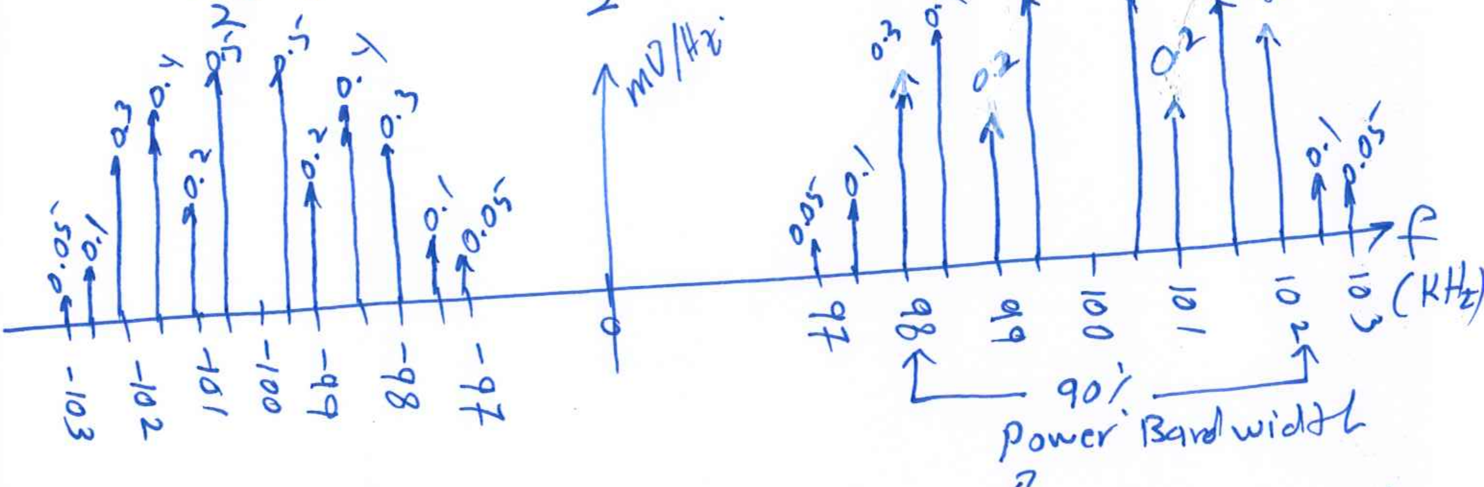
④ $\frac{P_{0.5} + P_{1K} + P_{1.5K} + P_{2K}}{P_{total}} = \frac{4.37\mu}{4.42\mu} = 97.77\% > 90\%$

so 90% Power Bandwidth is 2KHz.

b. Plot the Amplitude Spectrum of $s(t) = g(t) \times cos(2\pi 10^5 t)$.

$S(f) = F\{g(t) \times \cos(2\pi \times 10^5 t)\} = G(f) \underset{\text{conv}}{*} \left[\frac{\delta(f-100K) + \delta(f+100K)}{2}\right]$

$= \frac{1}{2} G(f - 100K) + \frac{1}{2} G(f + 100K)$



c. Determine the 90% power bandwidth of $s(t)$.

⇒ 90% Power Bandwidth = 2 × 2 Hz = 4 KHz

answer of part a.

Problem#3 [10 Points]

Determine and plot the amplitude spectrum of the signal $y(t)$ shown in figure 3.

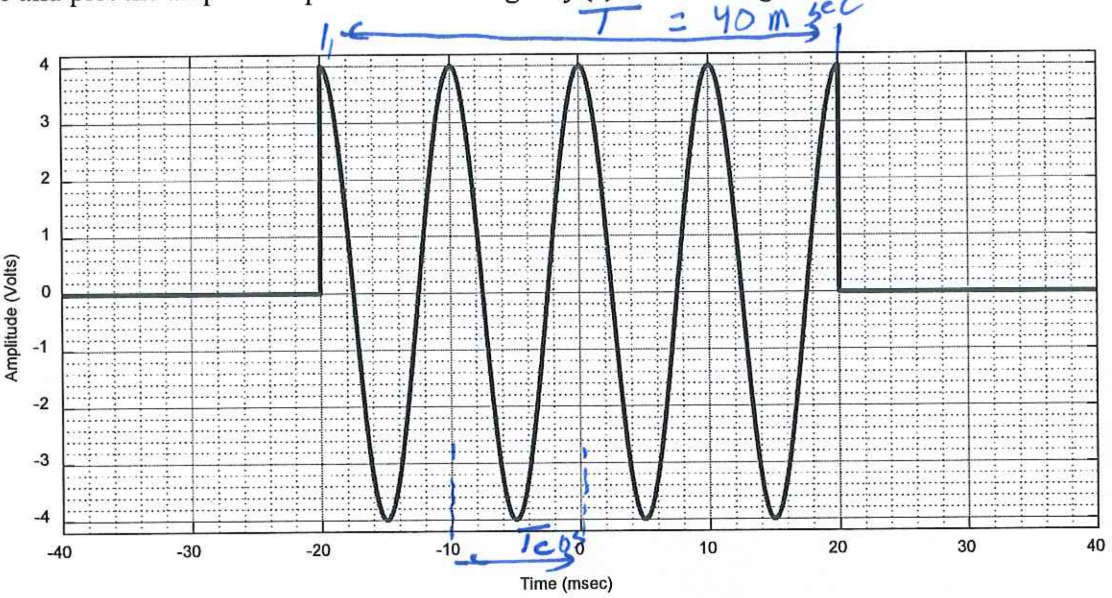


Figure 3: time domain plot of $y(t)$

$$y(t) = 4\cos\left(2\pi * \frac{1}{T_c} * t\right) \operatorname{rect}\left[\frac{t}{40m}\right]$$

$$\text{''} = 4\cos\left(2\pi * \frac{1}{10m} t\right) \operatorname{rect}\left[\frac{t}{40m}\right]$$

$$\text{''} = 4\cos(2\pi\, 0.1K t) \operatorname{rect}\left(\frac{t}{40m}\right)$$

$$Y(f) = 4\left[\frac{\delta(f-0.1K) + \delta(f+0.1K)}{2}\right] \underset{\text{conv}}{*} 40m \operatorname{sinc}(40m f)$$

$$= 0.16\left[\delta(f-0.1K) + \delta(f+0.1K)\right] \underset{\text{conv}}{*} \operatorname{sinc}(\underbrace{40m\, f}_{Tf})$$

$$\boxed{\frac{1}{T} = \frac{1}{40m} = 25}$$