Birzeit University
Faculty of Engineering and Technology
Department of Electrical and Computer Engineering
Communication Systems ENEE 3309
Midterm Exam

Instructors: Dr. Wael Hashlamoun, Dr. Ashraf Rimawi Date: Nov. 18, 2021

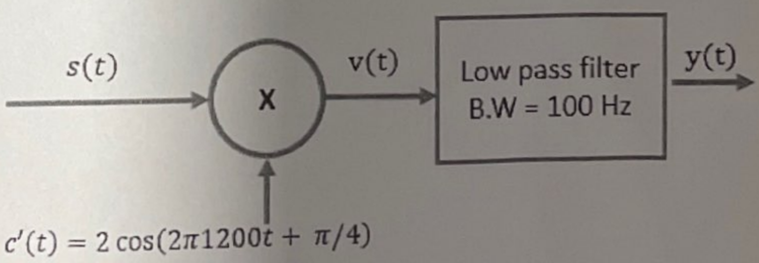
Problem 1: 25 Points

Consider the normal AM signal $s(t) = A_c\,[1 + \mu\cos(2\pi 150t)]\,cos2\pi(1500)t$.
When $\mu = 0.42$, s(t) has a total average power of 47.3 W.

a. Find the power efficiency η
b. Find the bandwidth of s(t)
c. Calculate the average power in the carrier
d. Calculate the average power in the upper sideband.

Problem 2: 25 Points

The message signal $m(t) = 3\cos(2\pi 60t) + 6\cos(2\pi 120t)$ along with the carrier signal $c(t) = 4\cos(2\pi 1200t)$ are applied to a modulator that generates the double sideband suppressed carrier signal s(t). The demodulator is as shown in the figure below. It consists of a multiplier followed by a low pass filter, where the locally generated signal is $c'(t) = 2\cos(2\pi 1200t + \pi/4)$ and the bandwidth of the low pass filter is 100 Hz.



a. Find the bandwidth of m(t).
b. Find the time-domain expression of the modulated signal s(t).
c. Find the total average transmitted power.
d. Find the signal at the demodulator output.

Problem 3: 25 Points

Consider the double sideband suppressed carrier signal

$$s(t) = 2\cos(2\pi 140t)\cos(2\pi 1750t)$$

An upper single sideband signal g(t) is to be generated from s(t) using the filtering method

a. Find g(t), assuming an ideal bandpass filter is used.
b. Find the best choice for the center frequency of the bandpass filter used to produce g(t)
c. Draw the block diagram of the receiver used to recover m(t) from g(t) without distortion identifying the details and properties of each block.
d. What will be the output of the diagram of part c?

Problem 4: 25 Points

The audio signal $m(t) = A_m\cos(2\pi(100)t)$ frequency modulates the carrier $c(t) = \cos 2\pi(1000)t$. The resulting FM signal is

$$s(t) = \cos[2\pi(1000)t + \beta sin 2\pi(100)t].$$

When $A_m = 1.8$, s(t) shows a peak frequency deviation of 320 Hz.

a. Find the FM modulation index
b. Use Casron's rule to estimate the bandwidth of s(t)
c. Find k_f , the sensitivity of the FM modulator in Hz/V
d. If A_m changes to 3.2 V, find the new frequency modulation index.

Good Luck

TABLE A6.4 Trigonometric Identities

$\exp(\pm j\theta) = \cos\theta \pm j\sin\theta$

$\cos\theta = \frac{1}{2}[\exp(j\theta) + \exp(-j\theta)]$

$\sin\theta = \frac{1}{2j}[\exp(j\theta) - \exp(-j\theta)]$

$\sin^2\theta + \cos^2\theta = 1$

$\cos^2\theta - \sin^2\theta = \cos(2\theta)$

$\cos^2\theta = \frac{1}{2}[1 + \cos(2\theta)]$

$\sin^2\theta = \frac{1}{2}[1 - \cos(2\theta)]$

$2\sin\theta\cos\theta = \sin(2\theta)$

$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$

$\cos(\alpha \pm \beta) = \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$

$\tan(\alpha \pm \beta) = \frac{\tan\alpha \pm \tan\beta}{1 \mp \tan\alpha\tan\beta}$

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

$\cos\alpha\cos\beta = \frac{1}{2}[\cos(\alpha - \beta) + \cos(\alpha + \beta)]$

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

TABLE A6.2 Fourier-Transform Pairs

Time Function	*Fourier Transform*
$\text{rect}\left(\frac{t}{T}\right)$	$T\,\text{sinc}(fT)$
$\text{sinc}(2Wt)$	$\frac{1}{2W}\text{rect}\left(\frac{f}{2W}\right)$
$\exp(-at)u(t), \quad a > 0$	$\frac{1}{a + j2\pi f}$
$\exp(-a\|t\|), \quad a > 0$	$\frac{2a}{a^2 + (2\pi f)^2}$
$\exp(-\pi t^2)$	$\exp(-\pi f^2)$
$\begin{cases} 1 - \frac{\|t\|}{T}, & \|t\| < T \\ 0, & \|t\| \ge T \end{cases}$	$T\,\text{sinc}^2(fT)$
$\delta(t)$	1
1	$\delta(f)$
$\delta(t - t_0)$	$\exp(-j2\pi f t_0)$
$\exp(j2\pi f_c t)$	$\delta(f - f_c)$
$\cos(2\pi f_c t)$	$\frac{1}{2}[\delta(f - f_c) + \delta(f + f_c)]$
$\sin(2\pi f_c t)$	$\frac{1}{2j}[\delta(f - f_c) - \delta(f + f_c)]$
$\text{sgn}(t)$	$\frac{1}{j\pi f}$
$\frac{1}{\pi t}$	$-j\,\text{sgn}(f)$
$u(t)$	$\frac{1}{2}\delta(f) + \frac{1}{j2\pi f}$
$\sum_{i=-\infty}^{\infty} \delta(t - iT_0)$	$\frac{1}{T_0}\sum_{n=-\infty}^{\infty} \delta\left(f - \frac{n}{T_0}\right)$