Prof. Y. Nasser **American University of Beirut** **Fall 2013-2014**
Department of Electrical and Computer Engineering
EECE 442 – Communication Systems

Homework 3 (Due October 22, 2013)

Objective of this HW: get familiar with Fourier transform, Autocorrelation Function, AM modulation; hands-on experience on Matlab and signal processing for communications.

Estimated time: ??? minutes

Problem 1: consider the signal $x(t) = cos(2\pi f_0 t)$

a) Derive the Fourier transform of $x(t)$;
b) Suppose f_0 = 10Hz, and that the signal is sampled at sampling rate of 30 samples per second. Sketch the frequency response of the sampled signal and show how a low-pass filter can recover the original signal.
c) Now suppose that the signal is sampled at a rate of 15 samples per second; sketch the frequency response of the sampled signal.

Note: In your sketches, you can limit yourselves to a bandwidth of 40Hz.

Problem 2:

You are asked to design a DSB-SC modulator to generate a modulated signal $km(t)\cos(\omega_c t+\theta)$, where $m(t)$ is a signal band-limited to B Hz. Figure P4.2-3 shows a DSB-SC modulator available in the stockroom. The carrier generator available generates not $\cos \omega_c t$, but $\cos^3 \omega_c t$. Explain whether you would be able to generate the desired signal using only this equipment. You may use any kind of filter you like.

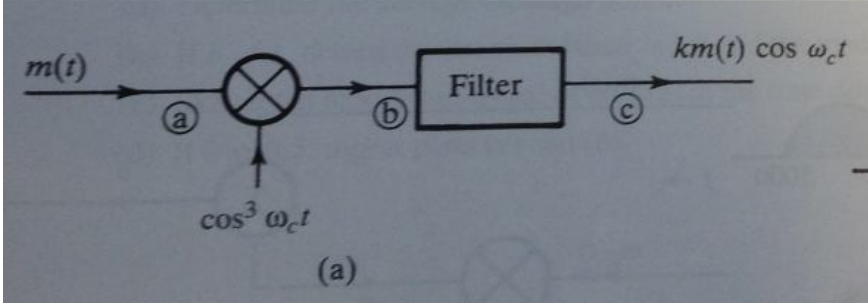
(a) What kind of filter is required in Fig. P4.2-3?

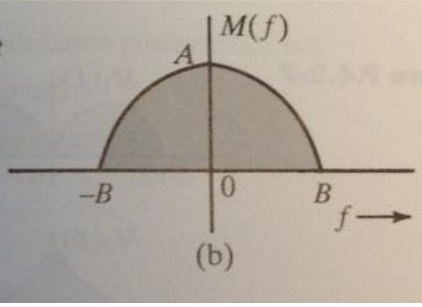
(b) Determine the signal spectra at points b and c, and indicate the frequency bands occupied by these spectra.

(c) What is the minimum usable value of ω_c?

(d) Would this scheme work if the carrier generator output were $\sin^3 \omega_c t$? Explain.

(f) Would this scheme work if the carrier generator output were $\cos^n \omega_c t$ for any integer $n \geq 2$?





Problem 3: Solve problem 4.11 of the textbook4
Problem 4: Solve Problem 4.18 of the textbook

Problem 5: Solve Problem 4.22 of the textbook

Problem 6: Solve Problem 4.26 of the textbook

Problem 7: Let the random process $X(t)$ be defined by $X(t) = A + Bt$, where A and B are independent random variables each uniformly distributed on [−1, 1]. Find $m_X(t)$ and $R_X(t_1, t_2)$.

Problem 8: Given a random variable X with a Rayleigh distribution

$$f_X(x) = \frac{x}{\sigma^2} e^{-\frac{x^2}{2\sigma^2}}, x \geq 0$$

Calculate the mean of *X*. Show the steps of your calculation

Problem 9: Given random variable *X* with a Gaussian distribution having mean and variance σ^2.

a- Determine the distribution of random variable *Y = 2X*.

b- Find its mean