UNIVERSITY OF CALIFORNIA, LOS ANGELES
CS M117

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Pre-laboratory Home Work # 1 (Due 10/15)

(HW and theoretical calculations in lab manual must be typed)

Section A
(T, Chapter 1; pg. 1-54)
Communication Networks

1. (2) What are two reasons for using layered protocols?

Using layered protocols allows us to (1) work on individual layers independently without the possibility of obstructing another layer's functionality and (2) debug or implement solutions to a problem within a single layer without having to handle all layers, since we can assume other layers are functional by abstraction.

2. (2) What is the principal difference between connectionless communication and connection-oriented communication?

In connection-oriented communication, data is only sent and received after a connection has been negotiated and established between the two parties. On the other hand, data can be sent at any time in a connectionless communication.

3. Which of the OSI layers handles each of the following?
(a) (1) Dividing the transmitted bit stream into frames.
(b) (1) Determining which route through the subnet to use.

(a) Data Link Layer, or DLL
(b) Network Layer

4. (2) A system has an n-layer protocol hierarchy. Applications generate messages of length M bytes. At each of the layers, an h-byte header is added. What fraction of the network bandwidth is filled with headers?

At each of the n layers, there is an additional h-byte header overhead. Therefore, there is a total of n*h bytes worth of headers. The final size of the messages, headers included, is M+n*h. The fraction of headers to the entire transmission is then n*h/(M+n*h), or nh/(M+nh).

5. (2) List ways in which the OSI reference model and the TCP/IP reference model are the same, now list two ways in which they differ.

Both OSI and TCP/IP are based on a stack of independent protocols, like application, transport, and network layers. Both offer reliable transport in the form of end-to-end byte streams. Nevertheless, OSI protocols have become popular, and the OSI model is very useful for describing computer networks. In contrast, TCP/IP protocols are widely used but the TCP/IP model is neglected. The number of layers in OSI and TCP/IP differs as well. Unlike OSI, TCP/IP does not have a separate presentation layer.

Section B

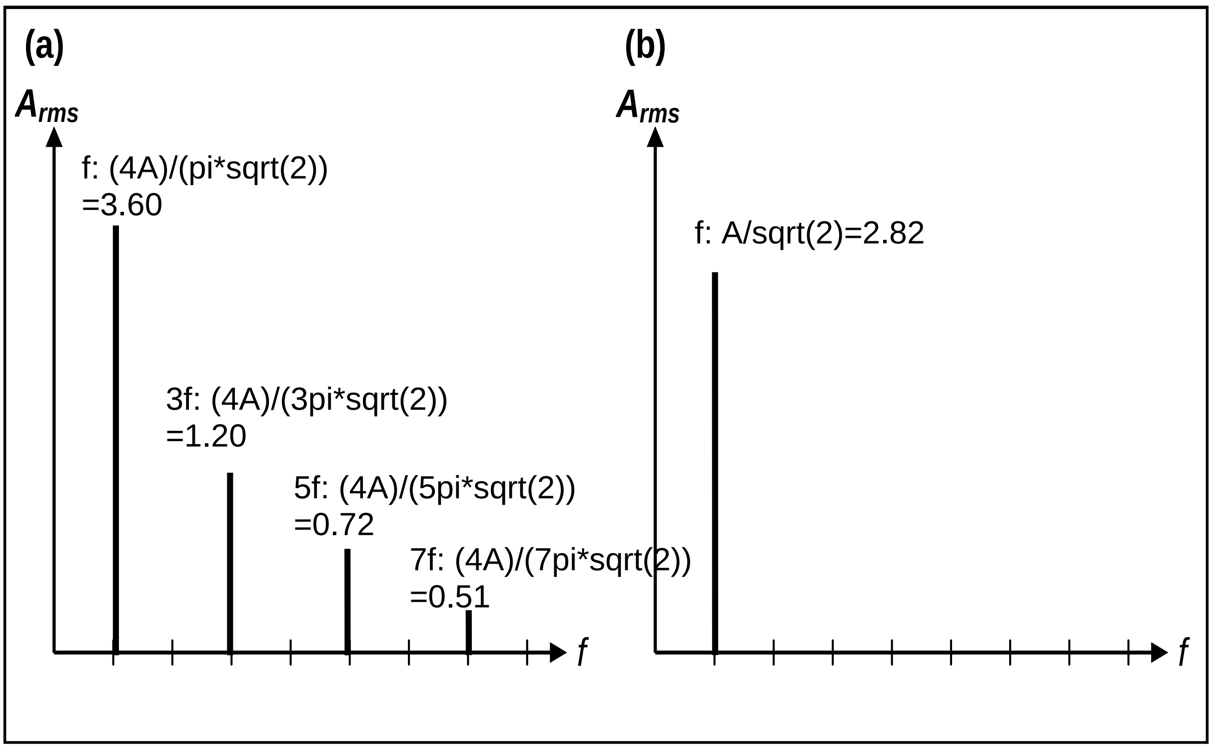
Amplitude Modulation and Frequency Modulation

A rectangular waveform signal has a value of +*A* for some continuous interval during the period (the "mark"), and has a value of -*A* for the remainder of the period (the "space"). The "duty cycle" *d* of the rectangular wave is defined as the length of the positive interval divided by the period.

1) The effective amplitude spectrum of a signal is built from the RMS voltages of each frequency represented in the Fourier series for that signal.

(a) (1) If the amplitude of square wave signal is A_{max} = 4V, and frequency is *f* ; draw the effective amplitude spectra (through the 8th harmonic) for functions.

(b) (1) If the amplitude of sinusoidal wave signal is A_{max} = 4V and frequency is *f*; draw the effective amplitude spectra.



2). (2) The carrier signal $S_c(t) = A_c \cos(2\pi f_c t)$ is amplitude modulated by a baseband square wave signal $S_m(t)$ with amplitude $A_m = A_c$ (varies between $+A_c$ and $-A_c$) and frequency f_m. Write the Fourier series for the modulated signals $S(t)$, for DSBTC AM (where the baseband DC offset is equal to $+A_c$) and DSBSC AM. Include the AM constructional coefficient K_{AM}.

DSBTC

$$S(t) = \frac{A_c^2}{K_{AM}}\cos(2\pi f_c t) - \frac{A_c^2}{K_{AM}}\left(\frac{1}{3}\right)[cos(2\pi(f_c - 3f_m)t) + co\,s(2\pi(f_c + 3f_m)t)]$$
$$+ \frac{A_c^2}{K_{AM}}\left(\frac{1}{5}\right)[cos(2\pi(f_c - 5f_m)t) + co\,s(2\pi(f_c + 5f_m)t)] + \cdots$$

DSBSC

$$S(t) = -\frac{A_c^2}{K_{AM}}\left(\frac{1}{3}\right)[cos(2\pi(f_c - 3f_m)t) + co\,s(2\pi(f_c + 3f_m)t)]$$
$$+ \frac{A_c^2}{K_{AM}}\left(\frac{1}{5}\right)[cos(2\pi(f_c - 5f_m)t) + co\,s(2\pi(f_c + 5f_m)t)] + \cdots$$

3) (1) Write the formula (using Bessel functions) for the frequency modulated signal when the baseband signal is $S_m(t) = A_m \sin(2\pi f_m t)$ and the carrier signal is:

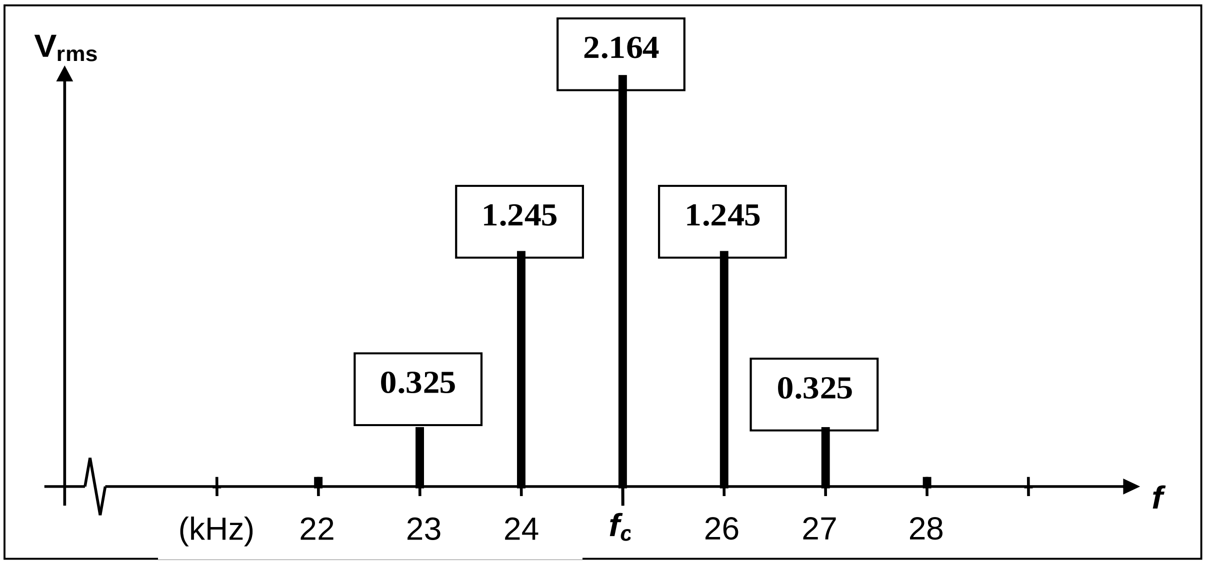
$$Sc(t) = A_c \cdot \cos(2\pi f_c t + \phi),$$

$$S(t) = A_c J_0(k_f)\cdot\cos(2\pi f_c t)$$
$$+ A_c \sum_{n=1}^{\infty} J_n(k_f)\cdot[\cos\left(2\pi(f_c - nf_m)t + \frac{n\pi}{2}\right)$$
$$+ \cos\left(2\pi(f_c + nf_m)t + \frac{n\pi}{2}\right)]$$

4) (2) Write the formula for the frequency modulation index k_f with baseband signal $S_m(t) = A_m \cos(2\pi f_m t)$, and calculate k_f when A_m = 4V, f_m = 1000 Hz and $K_{FM} = 2\pi$ x 340.

$$k_f = \frac{K_{FM}\cdot A_m}{2\pi\cdot f_m} = \frac{2\pi\cdot 340\cdot 4V}{2\pi\cdot 1000\,Hz} = \frac{340}{250} = 1.36$$

5) (2) Using the formula obtained in question (3) above and the Bessel function table given in the course reader, calculate and plot the power spectrum (amplitudes and frequencies) for the frequency modulated signal with a sinusoidal carrier signal (A_c = 4V and f_c = 25 kHz) and a sinusoidal baseband signal (A_m = 3V and f_m = 1000 Hz). Assume the generator has FM constructional coefficient $K_{FM} = 2\pi$ x 340. Use these figures as the theoretical prediction in Part D of the experiment.



6) (1) What is a useful approximation for the bandwidth of an FM signal in terms of k_f and the bandwidth of the baseband signal?

This approximation is called Carson's Rule. B is the baseline signal bandwidth.

$$B_{FM} = 2 \cdot B \cdot (k_f + 1)$$