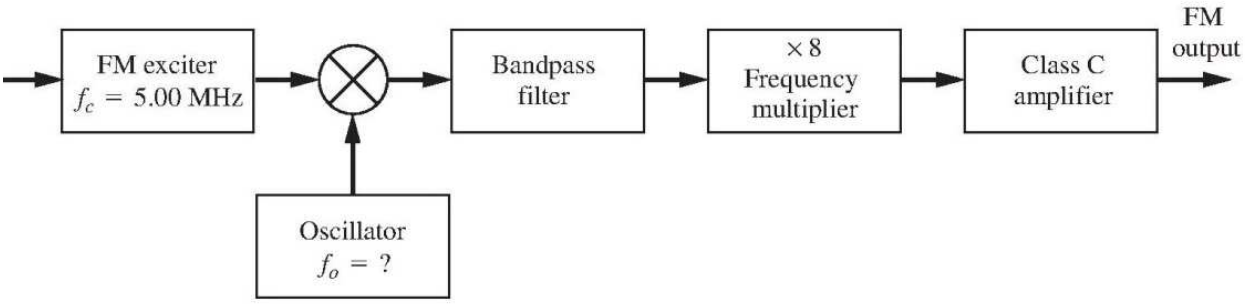
Assignment #6

Due: Mar. 15 (Fri.)**, 11:30am,** SITE C0136 (the tutorial). Hard copies only. Late/electronic/email submissions will **not** be accepted..

1) An AM-broadcast-band radio receiver is tuned to receive a 1100 kHz AM signal (the signal bandwidth is 9 kHz) and uses up-side LO frequency. The IF is 455 kHz. (a) Sketch the frequency response for the IF and RF filters. (b) What is the image frequency ? (c) Repeat (a) and (b) for a 1000 kHz AM signal and compare the results.

2) An FM radio broadcast transmitter has the block diagram shown in the figure below. The audio frequency response of the input is flat over the 20-Hz-to15-kHz audio band. The FM output signal is to have a carrier frequency of 103.7 MHz and a peak deviation of 75 kHz. (a) Find the bandwidth and center frequency for the bandpass filter. (b) Find the frequency f_0 of the oscillator. (c) What is the required peak frequency deviation of the FM exciter (modulator)?



3) Show that in a DSB-SC modulated signal, the envelope of the resulting bandpass signal is proportional to the absolute value of the message signal. This means that an envelope detector can be employed as a DSB-SC demodulator if we know that the message signal is always positive.

4) A frequency-division multiplexing system is used for FM broadcast of different stations in the frequency range of 80 – 110 MHz. If a baseband message signal has a maximum frequency of 20 kHz and the peak frequency deviation is 75 kHz, how many stations can fit in this frequency range? Assume that a safety margin of 10 kHz is used between the spectra of any 2 adjacent stations. Sketch a typical composite spectrum of broadcast signal for this FDM system.

5) Consider a BPSK signal $x(t) = 3\cos(\omega_c t + \Delta\varphi \cdot m(t))$ with the message being the square-wave 50% duty-cycle unipolar signal with the period of 1 ms (the message is symmetrical about t=0), the digital modulation index is 1, and the carrier frequency is 2 kHz. Sketch the BPSK signal for $-2T_c \le t \le 2T_c$ (T_c is the carrier period) and find the spectrum (FT) of x(t). If the carrier frequency is 2 MHz, find the null-to-null bandwidth of x(t) and compare with the null-to-null bandwidth for a random message discussed in the lecture. Are they the same?

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All spectra should be sketched as they would appear on a spectrum analyzer.
Please include in your solutions all the intermediate results and their numerical values (if applicable). **Detailed solutions with explanations are required**, not just the final answers/equations; **all symbols used must be defined**, including units used, if applicable (e.g. f = frequency [Hz]). Missing explanations, symbol definitions/units will be penalized. Your answers should demonstrate the full extent of your knowledge and the latter will determine your marks.

Plagiarism (i.e. "cut-and-paste" from a student to a student, other forms of "borrowing" the material for the assignment) is absolutely unacceptable and will be penalized. Each student is expected to submit his own solutions. If two (or more) identical or almost identical sets of solutions are found, each student involved receives 0 (zero) for that particular assignment. If this happens twice, the students involved receive 0 (zero) for the entire assignment component of the course in the marking scheme and the case will be send to the Dean's office for further investigation.

Please read appropriate chapters of the textbook first, study all the examples, attempt to do them with the closed book. Remember the learning efficiency pyramid!