ELEC 470 Communication and Information Systems Fall 2014

Homework Assignment #3 – due in BRKI 368 at 5 pm Wednesday, Nov. 12, 2014

***Instructions, notes, and hints*:**

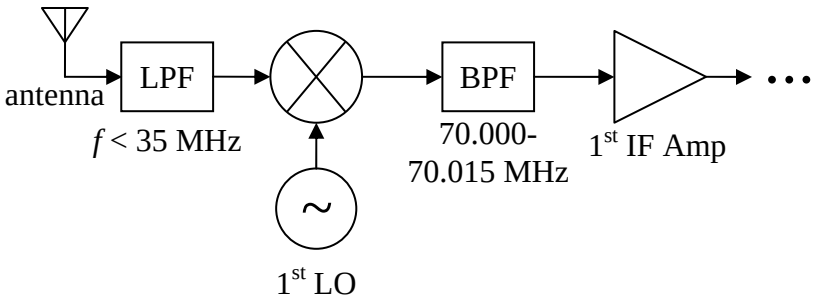
You may make reasonable assumptions and approximations in order to compensate for missing information, if any. Provide the details of all solutions, including important intermediate steps. You will not receive credit if you do not show your work.

***Assignment*:**

Probs. 5.4-3, 5.6-1, and 5.6-3 (make LO range as high as possible), plus the following additional problems:

1. The FM broadcast band spans the 88-108 MHz frequency range. The most common FM receiver architecture uses a first IF of 10.7 MHz and an LO range of 98.7-118.7 MHz. With this arrangement, the image band lies in the range 109.4-129.4 MHz, and it is therefore necessary to employ a tunable band-pass filter in the first stage of the receiver. Suppose you have decided to form a new company that will marker FM receivers with a higher first IF to relax the front-end filter requirements. What first IF and LO range would you need to move the image band to the range 300-320 MHz? Choose an architecture that uses an LO range between the FM broadcast band and the image range.

2. *Up-conversion* is a superheterodyne receiver architecture in which the IF is above the frequency range of interest. A primary advantage is that the first filter after the antenna can be a low-pass filter rather than a band-pass filter (although such a wide pass band allows many strong signals to enter the receiver, which could cause intermodulation distortion.) Up-conversion architectures are widely used in modern shortwave receivers. A common choice is to place the IF filter center frequency around 70 MHz, as shown in the diagram below. Suppose you are designing an HF receiver to tune signals in the 1-30 MHz range. Specify the first LO ranges you would need if you were planning to use (a) the sum frequency output of the first mixer and (b) the difference frequency output. Which option is most likely to result in the best image rejection performance if the front-end filter is a low-pass type with a cutoff frequency of 35 MHz? (The "front end" encompasses the first few circuit stages in a receiver. The front end is important because is important because it determines many of the performance metrics of the receiver.)



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3. Refer to the block diagram of the Armstrong indirect FM transmitter shown in Fig. 5.10 of the textbook. Note that a series of frequency multipliers is placed between the NBFM generation section and the frequency converter (mixer), and a second series of multipliers is located between the frequency converter and the amplification chain. Suppose that the NBFM section operates at a center frequency of 500 kHz and can produce a maximum frequency deviation of 50 Hz. The designers want the LO to operate somewhere in the 8-9 MHz band. Specify the total multiplication factors required in the first and second frequency multiplier sections (call them x_1 and x_2; the first is before the mixer, and the second is after) and the local oscillator frequency f_{LO} required for the frequency converter in order to generate a WBFM signal with a center frequency of 100.1 MHz and a peak deviation of 75 kHz. Note that the multiplying factors x_1 and x_2 for the frequency multiplier stages must be integer values. Avoid multiplying factors that are prime numbers above 3, if possible. (It is much easier to construct a series of multipliers with factors of 2, 3, and maybe 5 or so than a single multiplier with larger factor.)