Communication Systems 3 Tutorial 4

1. A given radar station operates at a frequency of 2.80 GHz and using the superheterodyne principle has a local oscillator frequency of 2.86 GHz. Determine the intermediate frequency of the receiver. A second radar station operates at the image frequency and interference results in the signal from the first station. What is the carrier frequency of the second station? If you were to redesign the radar receiver, what is the minimum intermediate frequency you would choose to prevent image-frequency problems across the 2.80 to 3.00 GHz radar band?

2. Take the form of a DSB-LC signal as a modulated sinusoid

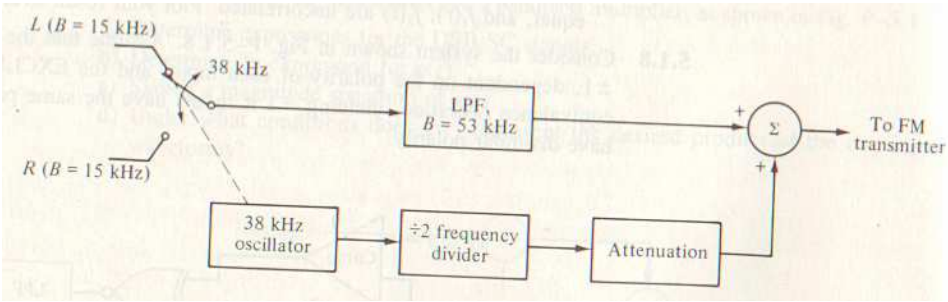
$$\phi_{\mathrm{AM}}(t) = A(1 + m\cos\omega_m t)\cos\omega_c t$$

   Find the Fourier transform of this signal and sketch its line spectrum. In an envelope detector, this signal is passed through a diode. If we assume a perfect diode then all negative parts of the signal become zero. We can simulate this by multiplying with a square wave which oscillates between the values of 1 and 0, with frequency ω_c. Find the spectrum of the resulting signal. What further step will reproduce our original modulating signal $\cos\omega_m t$?

3. Using Carson's rule for wideband FM, how many sidebands are significant for a modulating frequency ν_m=1 kHz, a peak frequency deviation $\Delta\nu$=75 kHz and a carrier frequency ν_c=100 MHz? Hence, what is the bandwidth of the modulated signal? What is the equivalent AM modulation index if this signal is demodulated with a high-pass *RC* filter discriminator?

4. Calculate the carrier frequency ν_c and the peak frequency deviation $\Delta\nu$ of the output of an indirect (Armstrong) FM transmitter for an input NBFM waveform of frequency ν_1=200 kHz and peak frequency deviation $\Delta\nu_1$=25 Hz, input into a frequency multiplier with $n_1 = 64$, followed by a frequency convertor which mixes the signal with a sinusoid at ν_2=10.8 MHz and finally another frequency multiplier with $n_2 = 48$.

5. Show that the chopper system shown below will produce essentially the correct signals for FM stereo transmission.



6. For each of the digital modulation schemes shown in the constellation diagrams below: (a) describe the modulation scheme, (b) identify the number of bits per symbol, and (c) state the ratio of the bit rate to the symbol (baud) rate.