ITM1010 Assignment #3

Due time: 5:00pm on Friday, 7 November 2003 to the tutor or me.

Question 1.
(a) A radio station broadcasts a 15kHz bandwidth baseband signal using frequency modulation with a modulation index of 5. What is the maximum frequency deviation of the FM signal from its center frequency?
(b) Use Carson's rule to estimate the bandwidth occupied by the FM radio station in (a).
(c) What is the bandwidth occupied if AM were used instead of FM for the broadcast in (a)?
(d) Give two reasons why, in general, FM radio broadcasts have a better sound quality than AM radio broadcasts.
(e) A baseband signal varies between –5 volts and +4 volts. What is the maximum modulation sensitivity, K_a, that may be used without over-modulating the signal for an AM broadcast?
(f) A narrowband FM signal occupies a bandwidth of 15kHz. Estimate the bandwidth of the baseband signal that is carried on this FM signal.

Question 2.
(a) What is the Nyquist sampling rate for a signal that is bandwidth limited to 20kHz?
(b) When signals are sampled at too slow a rate, aliasing will occur. Explain what is aliasing and why sampling at a rate faster than the Nyquist rate will prevent aliasing.
(c) Calculate the minimum bit-rate needed to send an audio signal, which is bandwidth-limited to 5kHz if the number of levels used in the quantizer for each sample is 1024.
(d) What is the maximum rate of error free transmission over a communications channel, which has a bandwidth of 100kHz if the signal to noise ratio is 40dB?
(e) A telephone line can support a modem, which can transmit information at a rate of 56kbit/s. Does this mean that the telephone line has an analog bandwidth of 56kHz? Explain.

Question 3.
(a) Draw the block diagram of a PCM communication system. Sketch the frequency spectra at different points in your block diagram.
(b) List the differences between an analog signal and a digital signal with respect to time and amplitude.
(c) Explain how to re-construct the analog signal from a PCM signal.
(d) For each of the following communication technologies: (1) Amplitude Shift Keying; (2) Frequency-Division Multiplexing; and (3) Statistical Time-Division Multiplexing, give an example of communication system that employs the technology.