The Johns Hopkins University
Department of Electrical and Computer Engineering

505.460 — Introduction to Linear Systems — Spring 1996

Quiz No. 3.

Answer any four of the following five questions. All four questions are worth 25% of the final grade

1. The following picture describes a Quadrature amplitude modulation scheme. What are the missing signals $m_1(t)$, $m_2(t)$, $m_3(t)$ and $m_4(t)$? Describe what this scheme does and how it does it.

2. The signal with the amplitude frequency spectrum shown below

   is to be sampled using an ideal sampler.

   (a) Sketch the spectrum of the resulting signal for $|\omega| \leq 120\pi$ rad/s when sampling at rates of 15 Hz, 20 Hz, and 40 Hz.

   (b) Which of the sampling frequencies is acceptable for use if the signal is to be reconstructed using an ideal low-pass filter?

3. (a) Sketch the magnitude $|H_h(\Omega)|$ of a discrete-time ideal high-pass filter (make sure that you cover at least $\Omega \in [-4\pi, 4\pi]$).

   (b) Briefly describe how the impulse response for this filter can be obtained from that of a low-pass filter $h_l[n]$.

4. Consider the *discrete-time* signal

$$x[n] = \left(\frac{1}{2}\right)^{|n|}$$

   (note the absolute value sign!) Find the Discrete-Time Fourier Transform of the signal.

5. Consider the discrete-time signal:

$$x[n] = \delta[n-2] + 2\delta[n-1] + 3\delta[n] + 2\delta[n+1] + \delta[n+2]$$

Answer True or False: [+5 pts for a correct answer, -2 pts for an incorrect answer]. **Hint:** You can answer all the questions *without* computing the DTFT.

(a) $\text{Re}\{X(\Omega)\} = 0$.

(b) $\text{Im}\{X(\Omega)\} = 0$.

(c) $\int_{-\pi}^{\pi} X(\Omega) d\Omega = 0$.

(d) $X(\Omega)$ is periodic.

(e) $X(0) = 0$.