EE 4501 - Sample Questions

The following are sample questions for Part A (each worth 2 points). Part B will be similar in style to the mid-term exam. Solutions are posted separately.

1. Compute the power of the signal $x(t)$ in Figure 1 ($x(t)$ is a periodic signal and extends from $-\infty$ to $\infty$ in time).

   **Figure 1:**

   ![Figure 1](image_url)

2. Let $y(t) = \begin{cases} x(t) & \text{if } 0 \leq t \leq 2 \\ 0 & \text{otherwise} \end{cases}$, where $x(t)$ is as defined in Figure 1.

   What is the Fourier Transform of $y(t)$, that is, $\mathcal{F}[y(t)]$?
3. Consider the filter with frequency response $H(f) = \Pi \left( \frac{f}{2F_c} \right)$. This filter is not practically realizable because (place a ✓ mark beside all reasons that apply, there might be more than one):

□ The impulse response has a finite value at $t < 0$, which makes it non-causal
□ The filter is not linear-phase
□ The impulse response is of infinite duration
□ The impulse response has very large or infinite values at certain points of time

4. Let $m(t)$ be an audio signal and $s(t)$ an AM signal modulated according to $m(t)$. Assume that an AM receiver receives $as(t)$ (for some constant $a > 0$) and demodulates this using a synchronous demodulator with a unit-amplitude carrier, at the same carrier frequency (in the MHz range) but with a constant phase mismatch of $\phi$. The receiver does not amplify the received or demodulated signal. Assume that the system has no noise or outside interference.

If $\phi = 0$, the output of the demodulator will be (place a ✓ beside the statement that is true):

□ the same as the transmitted audio signal, but with volume (amplitude) proportional to $a$
□ the same as the transmitted audio signal and the volume (amplitude) is independent of $a$, as long as $a$ is not too small

If $0 < \phi < \pi/2$ and $a = 1$, the output of the demodulator will be (place a ✓ beside the statement that is true):

□ the same as the transmitted audio signal, but the volume (amplitude) depends on $\phi$
□ completely unrecognizable and different from the transmitted audio signal, since $\phi \neq 0$

5. Consider the system in Figure 2. Let $m(t)$ have bandwidth 500 KHz and $-1 \leq m(t) \leq 1$. $y_2(t)$ will be an FM signal. What is its center frequency $f_c$ and Carson-rule bandwidth?

![Figure 2:](image)

\[ f_c = \text{_______________} \]

Bandwidth = \text{_______________}
6. Let \( x(t) = 1 + \cos(2\pi(500)t) + \cos(2\pi(1500)t) \). \( x(t) \) is sampled at the minimum rate such that it can be reconstructed without distortion, and each sample is then uniformly quantized (over the range of values \( m(t) \) can take), using 2 bits per sample. Write out the quantized bits that represent the first three samples. Assume that the first sample begins at time \( t = 0 \). Given: \( \cos(\pi/3) = 1/2 \), \( \cos(2\pi/3) = -1/2 \).

7. What is the essential bandwidth of an On/Off line code that transmits \( p(t) = \Delta \left(\frac{t}{2T_b}\right) \) to represent the bit 1, and a 0v signal to represent the bit 0? The signal representing each bit is transmitted every \( T_b \) seconds, and the essential bandwidth is defined as the first value of \( f > 0 \) such that the PSD is zero.
8. A Let $p_1(t)$ be a raised-cosine pulse and $p_2(t)$ be a duo-binary pulse. State true/false (no need to explain why, although adding an explanation might earn you partial credit if your answer is wrong):

(a) $p_1(t)$ will suffer from ISI, while $p_2(t)$ will not. True/False?
(b) $p_1(t)$ has less bandwidth when compared to $p_2(t)$. True/False?

9. Sketch the eye-diagram for a bi-polar line code using a rectangular pulse. That is, a 0v signal is sent to represent the bit 0, $p(t) = \Pi (t/T_b)$ is sent to represent every even occurrence of the bit 1, and $-p(t)$ is sent to represent every odd occurrence of the bit 1. A pulse is sent every $T_b$ seconds.

10. Consider a digital communication system which transmits $a_n \cos(2\pi f_c t) + b_n \sin(2\pi f_c t)$ in the time interval $nT \leq t < (n+1)T$, for $n = 0, 1, 2, \ldots$

    Figure 3:

    ![Figure 3](image)

    $a_n$ and $b_n$ are as defined in Figure 3 for 2 schemes. State true/false (no need to explain why, although adding an explanation might earn you partial credit if your answer is wrong):

(a) Both Schemes I and II have the same power AND bandwidth requirements. True/False?
(b) For both Schemes I and II, the receiver needs to accurately know the phase of the received signal to decode the bits correctly. True/False?
(c) Both Schemes I and II communicate at the same data rate. True/False?
(d) Both Schemes I and II have the same probability of error, assuming that the noise power is the same for both. True/False?