Indian Institute of Space Science and Technology
AV312 - Digital Communication
Department of Avionics

Class Test for **Semester V** on **31/09/2015**

Note to the student

1. There are **10 questions** in this question paper.
2. You will get one mark for each correct answer.
3. One mark will be deducted for each wrong answer.
4. For each question there is only one correct answer.
5. Use a pen to draw a circle around your preferred choice for an answer.
6. If there are multiple choices circled, your answer for that question would not be evaluated.

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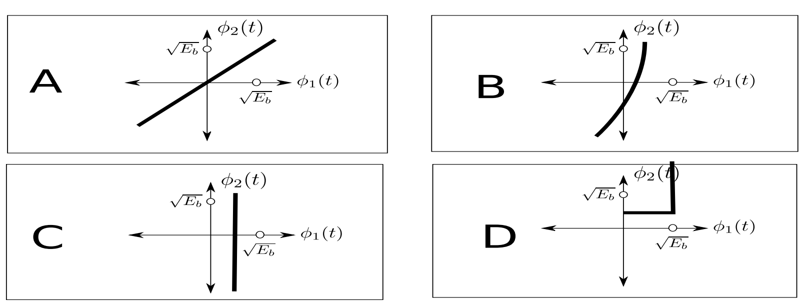
1) Consider a BFSK system which transmits using two frequences f_1 and f_2. Suppose the symbol duration $T_s = 2$ ms. If $f_1 = 10$ kHz, for what value of f_2 (in kHz) is the BFSK system a CPFSK system?

(A) 9.6 (B) 9.5 (C) 9.7 (D) None

2) For the BFSK system in (1) suppose the energy per bit is E_b. Suppose we assume that the receiver noise is modelled using an AWGN process of PSD $\frac{N_0}{2}$. Then the symbol error rate for the BFSK system is

(A) $erfc\left(\frac{E_b}{N_0}\right)$ (B) $\frac{1}{2}erfc\left(\sqrt{\frac{E_b}{N_0}}\right)$ (C) $\frac{1}{2}erfc\left(\frac{E_b}{N_0}\right)$ (D) $\frac{1}{2}erfc\left(\sqrt{\frac{E_b}{2N_0}}\right)$

3) Consider the correlation receiver for demodulating the above BFSK signal. Note that the correlation receiver for the BFSK waveform will produce an error vector (w_1, w_2) which was assumed to be normally distributed in the discussion in class. But suppose w_1 and w_2 are IID with pdf $f_W(w) = Ke^{-|w|}$ (where K is a normalization constant). Qualitatively, Which one of the following decision boundaries would be used by a ML decoder?



4) Suppose $x(t)$ is a voice (voltage) signal such that $x(t)$ is bandlimited to 4kHz. Suppose we convert $x(t)$ to a discrete time signal by sampling it at a rate of f_s samples per second. What is the minimum value of f_s such that we can recover $x(t)$ from its samples?

(A) 4kHz (B) 2kHz (C) 8kHz (D) None

5) Consider $x(t)$ as in (4). Assume that $x(t) \in [0, 10]$. The samples of $x(t)$ obtained in (4) are now converted into a digital signal via quantization. Suppose we use a quantizer characterized by a quantization noise model (as discussed in class) with noise power $\frac{1}{12}$. How many bits would you use for representing the output level of the quantizer so that there is no saturation/clipping distortion.

(A) 3 bits (B) 4 bits (C) 5 bits (D) None

6) A communication scheme which uses narrowband FM modulation is allocated spectrum in the range $10MHz$ to $20Mhz$. Suppose we assume that baseband voice signals are bandlimited to 10kHz. Ideally, what is the maximum number of such baseband voice signals that can be transmitted simultaneously utilizing frequency division multiplexing?

(A) 200 (B) 2000 (C) 1000 (D) None

7) Suppose U_1 and U_2 are two independent uniformly distributed random variables in the range $[0, 1]$. What is $Pr\left(max(U_1, U_2) > 0.3\right)$?

(A) 0.09 (B) 0.49 (C) 0.91 (D) None

8) Suppose for a PAM transmission scheme on a channel without ISI, we use a pulse shape which results in the following pulse shape at the receiver

$$p(t) = sin\left(2\pi \frac{t}{T_s}\right), 0 \leq t \leq T_s.$$

Which one of the following impulse responses (within $[0, T_s]$) for the receive filter will lead to the maximum signal energy per T_s seconds at the receive filter output which is sampled every T_s seconds?

(A) $cos\left(2\pi \frac{t}{T_s}\right)$ (B) $cos\left(4\pi \frac{t}{T_s}\right)$ (C) $sin\left(4\pi \frac{t}{T_s}\right)$ (D) $sin\left(6\pi \frac{t}{T_s}\right)$

9) Consider a baseband bandlimited channel with one sided bandwidth $\frac{W}{2}$. Which one of the following pulse shapes (at the output of the receive filter) leads to the samples being not contaminated with ISI?

(A) $sinc(Wt)$ (B) $sinc(2Wt)$ (C) $Rect(Wt)$ (D) None

10) Suppose X and Y are two independent normally distributed random variables, each with mean 1 and variance 1. Let $U = X + Y$ and $V = X - Y$. What is $f_{U,V}(u = 1, v = 2)$? (Here $f_{U,V}(u, v)$ is the jointly Gaussian distribution of U and V.)

(A) 0.0456 (B) 0.1239 (C) 0.0965 (D) None