國立成功大學

112學年度碩士班招生考試試題

編　號：183

系　所：電腦與通信工程研究所

科　目：通信系統

日　期：0206

節　次：第 2 節

備　註：可使用計算機

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※ 考生請注意：本試題可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (20%) Consider a binary communication system that has one-dimensional signal $s_1 = d/2$ and $s_2 = -d/2$. The channel is characterized by the additive noise with density $f_N(n) = \frac{1}{2\sigma}\exp\left(-\frac{|n|}{\sigma}\right)$.

   (a) Determine the mean and variance of the noise n. [3 + 5 points]

   (b) Determine the optimal decision threshold in the case of equal a priori probabilities. Is there any difference from the Gaussian noise channel? [3 + 2 points]

   (c) Find the probability of a bit error for the case (b). [7 points]

2. (18%) Suppose that the following set of bi-orthogonal signal vectors are used on an AWGN channel with two-sided noise power spectral density of $N_0/2$ watts/Hz.

$$\mathbf{s}_i = \begin{cases} \sqrt{E}\mathbf{e}_i, & i = 1, \ldots, M/2 \\ -\mathbf{s}_{i-M/2}, & i = M/2+1, \ldots, M \end{cases}$$

   where the unit basis vectors $\mathbf{e}_i$ have length $M/2$, and $\mathbf{e}_i$ is a vector containing all 0's except for a 1 in the *i*-th coordinate.

   (a) Obtain a union bound on the probability of *symbol* error as a function of the received bit energy-to-noise ratio E_b/N_0. [10 points]

   (b) For the case $M = 4$, obtain an exact expression for the probability of symbol error as a function of the received bit energy-to-noise ratio E_b/N_0. [6 points]

   (c) Assuming a baud period of T seconds and $M = 8$, specify and/or sketch one possible set of bi-orthogonal waveforms $\{s_i(t)\}_{i=1}^{8}$. [2 points]

3. (12%) For each of the overall system responses in Fig. 1, $S_R(f) = G(f)H(f)C(f)$, where $G(f)$ is the transmit filter, $C(f)$ is the receive filter, and $H(f)$ is the channel. **For each channel**, determine if one can signal at a rate which would result in zero ISI, and if so what the signaling rate (bits/second) is.

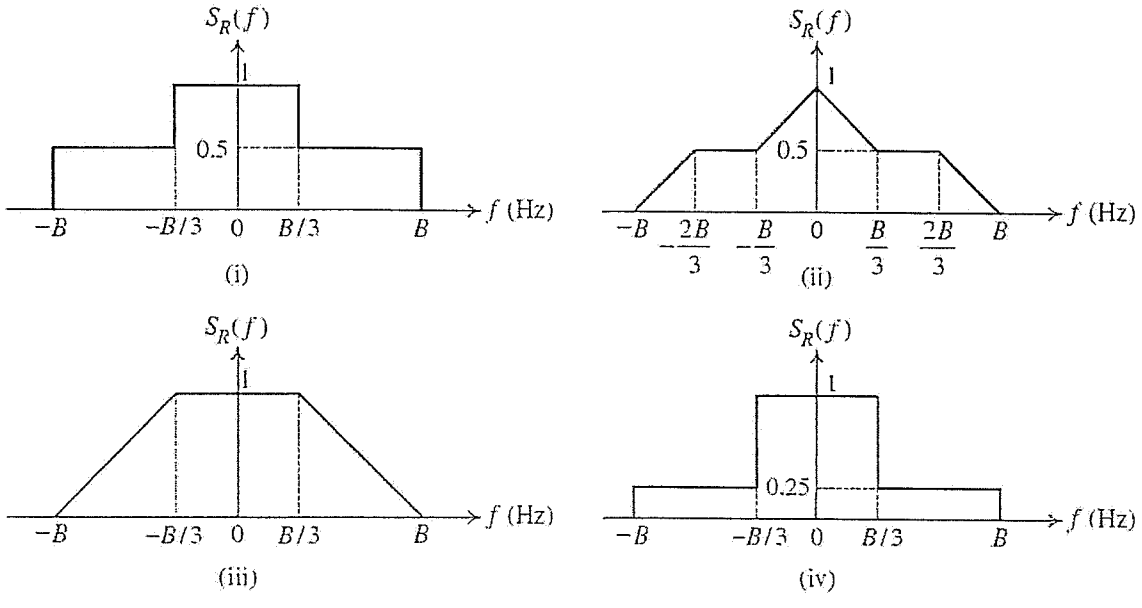

Fig. 1

4. (25%) A message signal $m(t) = \sin(2\pi t)$ is transmitted using amplitude modulation (AM). The modulated signal is given by $x_{AM}(t) = (1 + km(t)) \cdot \cos(20\pi t)$ where k denotes the modulation index. Answer the following questions.
   (a) Determine and sketch the spectrum of $x_{AM}(t)$, i.e., the continuous-time Fourier transform of the modulated signal. You need to label all the important quantities on the x- and y-axes. Does the bandwidth of $x_{AM}(t)$ depend on k? [10 points]
   (b) Suppose that k=1.5. Pass $x_{AM}(t)$ through the ideal envelope detector. [The ideal envelope detector outputs the envelope of its input signal.] Sketch the output of the envelope detector. Also give the mathematical expression of the output of the envelope detector. [10 points]
   (c) [continued from part (b)] Can the message signal *m(t)* be successfully demodulated by the ideal envelope detector? Explain briefly. [5 points]

5. (25%) Consider the following multi-path channel model:

$$y(n) = 0.5x(n) - 0.5x(n-1)$$

   where
   $x(n)$: input of the channel, and
   $y(n)$: output of the channel.
   (a) Is this a causal channel? Justify your answer. [5 points]]
   (b) Is this a memoryless channel? Justify your answer. [5 points]
   (c) Determine and plot the channel's unit impulse response. [5 points]
   (d) Determine the channel's frequency response. Plot the channel's magnitude response. [10 points]