國立臺灣科技大學

九十二學年度碩士班招生考試試題

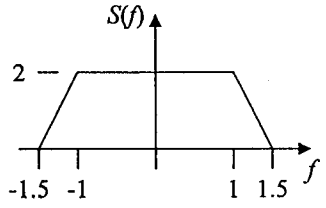
系所組別：電機工程系碩士班丙二組

科　目：通訊系統

總分100分

1. Show that if $y(t) \leftrightarrow Y(f)$ is a Fourier transform pair, then $y^*(-t) \leftrightarrow Y^*(f)$ is a Fourier transform pair. Notice that $(\cdot)^*$ denotes complex conjugate. (10 %)

2. A signal $s(t)$ has Fourier transform $S(f)$ as sketched below.



   (a) What is $s(0)$? (5 %)
   (b) Sketch the energy spectral density of $s(t)$. (5 %)
   (c) What is the energy content of $s(t)$. (5 %)

3. Consider a communication system with two equally likely messages m_1 and m_2 to be conveyed. Suppose the message m_0 is associated with a voltage level $+V$ and the message m_1 is associated with a voltage level $-V$. The transmitted voltage (either $+V$ or $-V$) is denoted by the random variable s. Consider the following two separate scenarios of how this transmitted voltage is received.
   (a) Two voltages are measured at the receiver and the model of the received voltages (denoted by y_1 and y_2) is as follows: (10 %)

$$y_1 = 2s + n_1$$
$$y_2 = s + n_1$$

   Here n_1 is a zero Gaussian random variable with unit variance that is independent of the transmitted voltage s. Derive the optimum detector.
   (b) The model for the two voltages received is as follows: (15 %)

$$y_1 = s + n_1 - n_2$$
$$y_2 = n_1 + n_2$$

   Here n_1 and n_2 are independent zero mean Gaussian random variables with unit variance that are jointly independent of the transmitted voltage s. Derive the optimum detector.

4. A telephone channel has a bandwidth W = 3000 Hz and a signal-to-noise ratio of 400 (26dB). Suppose we characterize the channel as a band-limited AWGN waveform channel with $P_{av}/WN_0 = 400$. What is the capacity of the channel in bits per second? (10 %)

5. Design a ***ternary*** Huffman code, using 0, 1, and 2 as letters, for a source with output alphabet probabilities given by {0.05, 0.1, 0.15, 0.17, 0.18, 0.22, 0.13}. What is the resulting average code-word length? Compare the average code-word length with the entropy of the source. (In what base would you compute the logarithms in the expression for the entropy for a meaningful comparison?) (20 %)

6. Consider the phase-locked loop (PLL) for estimating the carrier phase of a signal in which the loop filter is specified as

$$G(s) = \frac{K}{1+\tau s}$$

   (a) Determine the closed-loop transfer function $H(s)$ and its gain at $f = 0$. (10%)
   (b) For what range of values of τ and K is the loop stable? (10%)