國立臺灣海洋大學 101 學年度研究所碩士班暨碩士在職專班入學考試試題

考試科目： 通訊原理

系所名稱： 電機工程學系碩士班通訊與訊號處理組

1.答案以橫式由左至右書寫。2.請依題號順序作答。

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1. A nonlinear amplifier is characterized by $y = K_0 + K_1 x + K_2 x^2$, where x and y denote the input and output signals respectively.
   (a) If $x(t) = A_1 \cos w_1 t + A_2 \cos w_2 t$ is inputted to the amplifier, find the harmonic and intermodulation distortions of the output signal. (10 %)
   (b) An amplitude-modulated signal, $x(t) = A[1 + m(t)]\cos w_c t$, firstly passes through the nonlinear amplifier and then a product detector (a mixer cascaded with an ideal low-pass filter), where the message $m(t)$ has a bandwidth of 100 Hz. The carrier $\cos w_c t$ with a carrier frequency of 1000 Hz is used in the mixer. In order to extract the message $m(t)$, evaluate the allowable minimum and maximum cutoff frequencies for the ideal low-pass filter. (10%)
2. An input signal $x(t)$, consisting of a sine-wave (deterministic) signal $s(t) = A\cos w_0 t$ plus white noise, is inputted to a RC low-pass filter with the transfer function $H(w) = 1/(1 + jwRC)$. The white noise has the two-sided power spectral level $N_o / 2$.
   (a) Find the output signal-to-noise ratio of the low-pass filter. (10%)
   (b) Find the value of the RC product such that the output signal-to-noise ratio will be a maximum. (10%)
3. A complex envelope is given by $g(t) = A[m(t) + j\hat{m}(t)]$, where $\hat{m}(t)$ denotes the Hilbert transform of the message $m(t)$. In the following, which is the valid modulation type using the complex envelope? (10%)
   (a) Double Sideband; (b) Single Sideband; (c) Vestigial Sideband

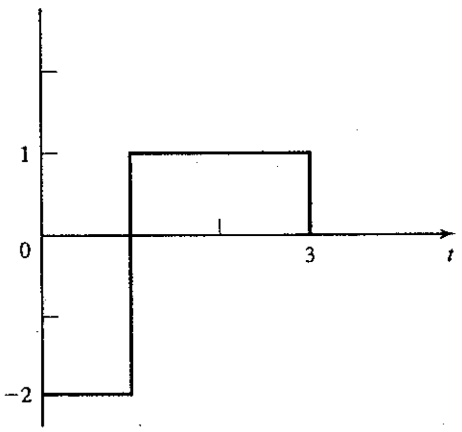
4. (15%) An analog signal with a bandwidth of 10 kHz is digitized using an l-bit PCM and then transmitted through an m-PSK modulator.

   (a) (5%) Determine the minimal required sampling frequecy for the analog signal so that no aliasing occurs.

   (b) (5%) Using the result in (a), determine two combinations of l and m so that the symbol rate for the modulator can be 80k symbols/sec.

   (c) (5%) For the two combinations you found in (b), which one can result in a higher bit rate? Draw the signal constellation and the decision boundaries of the m-PSK for this combination.

5. (15%) A signal $s(t)$ is transmitted through an additive white Gaussian noise (AWGN) channel. The power spectral density of the AWGN noise $n(t)$ is $N_0/2$ W/Hz. A matched filter is used in the receiving end to detect the signal $s(t)$. The impulse response of the matched filter, say, $h(t)$, is shown in the following figure.



   (a) (5%) Draw the waveform of the signal $s(t)$.

   (b) (5%) Determine the maximum value of the matched filter output when there is no noise.

   (c) (5%) Determine the maximum signal-to-noise ratio (SNR) at the output of the matched filter.

6. (20%) Consider designing a 4QAM communication system.

   (a) (5%) Draw the block diagram of your 4QAM modulator.

   (b) (5%) Draw the block diagram of your 4QAM demodulator.

   (c) (5%) Draw the signal constellation and the decision boundaries for the 4QAM.

   (d) (5%) Design a Gray code for the 4QAM symbols.