國立中央大學通訊工程學系 103 學年度碩士在職專班入學筆試

【通訊概論】試卷

考試地點：通訊館一樓 E1-109 室　　考試時間：100 分鐘　　試題總分：１００分

1. (**12 pt**) Consider a sinusoidal signal with random phase, defined as

$$x(t) = A \cdot \cos(2\pi f_c t + \Theta)$$

where A and f_c are constants and Θ is a uniformly distributed random variable over the interval $[-\pi, \pi]$, given by

$$f_\Theta(\theta) = \begin{cases} \frac{1}{2\pi}, & -\pi \le \theta \le \pi \\ 0, & \text{elsewhere} \end{cases}$$

(a) (**6 pt**) Find the autocorrelation function of $x(t)$.

(b) (**6 pt**) Find the power spectral density of $x(t)$.

2. (**22 pt**) Consider a square-law detector whose transfer characteristic is defined as

$$y(t) = a_1 x(t) + a_2 x^2(t)$$

where a_1 and a_2 are constants, $x(t)$ is the input signal, and $y(t)$ is the output signal. Assume that the input signal $x(t)$ is a modulated signal, given by

$$x(t) = A_c(1 + k_a m(t))\cos(2\pi f_c t)$$

where $m(t)$ is a baseband message signal, A_c and k_a are constants, and f_c is the carrier frequency.

(a) (**4 pt**) What is the modulation scheme used for the input signal $x(t)$.

(b) (**6 pt**) Plot the spectrum of the modulated signal $x(t)$, if the spectrum of the message is given by $M(f) = \begin{cases} 1, & -W \le f \le W \\ 0, & \text{otherwise} \end{cases}$.

(c) (**6 pt**) Evaluate the output signal $y(t)$.

(d) (**6 pt**) Find the condition for which the message signal can be recovered from $y(t)$.

3. (**30 pt**) Consider a binary pulse-code modulation signal with signaling interval $0 \le t \le 1$, given by

$$s(t) = \begin{cases} +A \cdot g(t), & \text{if symbol "1" was sent} \\ -A \cdot g(t), & \text{if symbol "0" was sent} \end{cases}$$

where the pulse shaping function $g(t)$ is given by

$$g(t) = \begin{cases} 1, & 0 \le t \le 1 \\ 0, & \text{otherwise} \end{cases}$$

Assume the channel noise is modeled as additive white Gaussian noise $w(t)$ with zero mean and power spectral density $N_0/2$. Consider a receiver structure used to perform decision making for the received signal $x(t) = s(t) + w(t)$ in Figure 1.

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(a) (**4 pt**) Explain the advantage of adopting the matched filter.
(b) (**6 pt**) Find the matched filter with respect to the pulse shaping function.
(c) (**6 pt**) Sketch the matched filter output with respect to the pulse shaping function.
(d) (**8 pt**) Calculate the error probability, conditional on sending symbol "0", with respect to the decision threshold λ.
(e) (**6 pt**) Find the optimal decision threshold λ_{opt}. for achieving the minimum symbol error probability, when symbols "0" and "1" are sent with an equal probability.

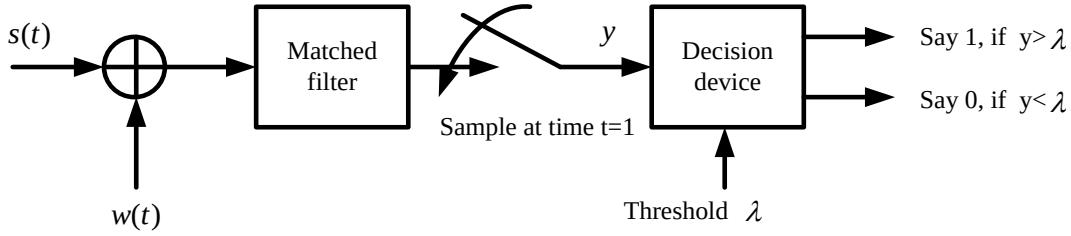

Figure 1

4. (**36 pt**) Consider optimum data detection for quadrature phase-shift keying (QPSK) with the constellation in Figure 2, where the signal vectors are given by $\mathbf{s}_1 = [+1, +1]^{\mathrm{T}}$, $\mathbf{s}_2 = [-1, +1]^{\mathrm{T}}$, $\mathbf{s}_3 = [-1, -1]^{\mathrm{T}}$, and $\mathbf{s}_4 = [+1, -1]^{\mathrm{T}}$.

(a) (**6 pt**) Label the QPSK constellation with Gray mapping.
(b) (**6 pt**) Define the likelihood function and describe the maximum likelihood (ML) decision rule.
(c) (**6 pt**) Show that the ML decision rule is equivalent to a minimum distance decision rule.
(d) (**6 pt**) Find and draw the optimum decision regions for QPSK.
(e) (**6 pt**) Describe the maximum a posteriori probability (MAP) decision rule.
(f) (**6 pt**) Explain why the MAP decision rule is usually a better choice than the ML decision rule, and under what condition the two decision rules are equivalent.

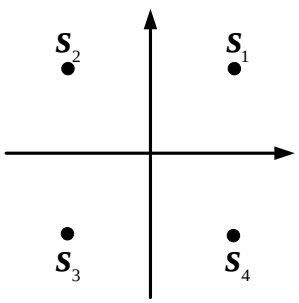

Figure 2

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【計算機概論】試卷

考試地點：通訊館一樓 E1-109 室　　考試時間：100 分鐘　　試題總分：１００分

Part I. (50%) Please choose the right answer for each question below:

1. (5%) Which of the following has the highest speed to be accessed? (A) main memory (B) cache (C) hard disk
2. (5%) For a disk system, which of the following indicates the sum of the seek time and rotation delay? (A) transfer rate (B) access time (C) latency time
3. (5%) Which of the following is the hexadecimal notation of the bit pattern “01001011”? (A) 4A (B) 4B (C) 4C
4. (5%) For the base ten representation -17, which of the following is the equivalent two’s complement form using patterns of 8 bits? (A) 10010101 (B) 10101101 (C) 11101111
5. (5%) The result of XORing the patterns 10011010 and 11001001 is (A) 01010011 (B) 10001000 (C) 11011011
6. (5%) Which of the following is not a component of an operating system? (A) shell (B) file manager (C) utility (D) dispatcher
7. (5%) Lempel-Ziv-Welsh (LZW) encoding belongs to the group of (A) dictionary encoding (B) lossy schemes (C) differential encoding
8. (5%) The operation JUMP of machine instructions is classified into (A) the data transfer group (B) the arithmetic/logic group (C) the control group
9. (5%) Which of the following contains the address of the next instruction to be executed by the CPU? (A) general-purpose register (B) instruction register (C) program counter
10. (5%) The boot loader is stored in a machine’s (A) read-only memory (B) volatile memory (C) hard disk

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Part II. (50%) Please explain the following items clearly. Your score will depend on the correctness and completeness of your answers.

1. (10%) Direct memory access (DMA).
2. (10%) Virtual memory.
3. (10%) Carrier Sense, Multiple Access with Collision Detection (CSMA/CD)
4. (10%) Peer-to-peer (P2P) communication.
5. (10%) Public-key encryption.

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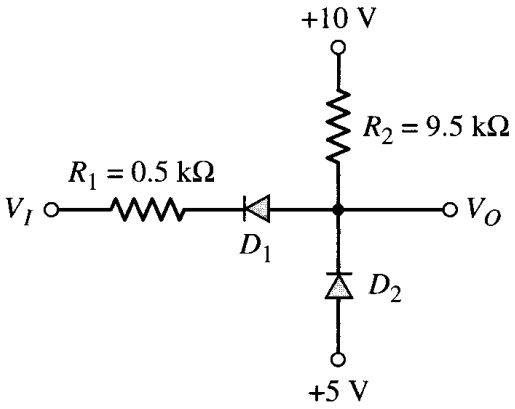
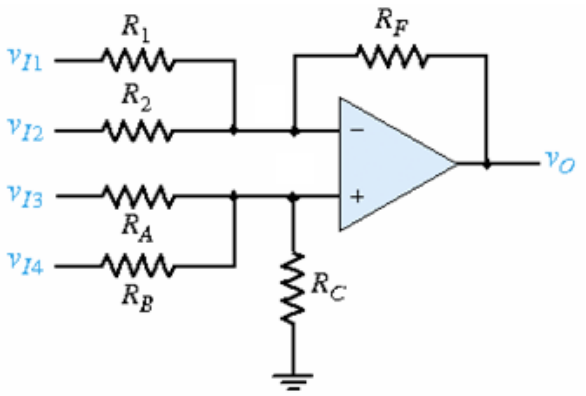
【電子學】試卷

考試地點：通訊館一樓 E1-109 室　　考試時間：100 分鐘　　試題總分：１００分

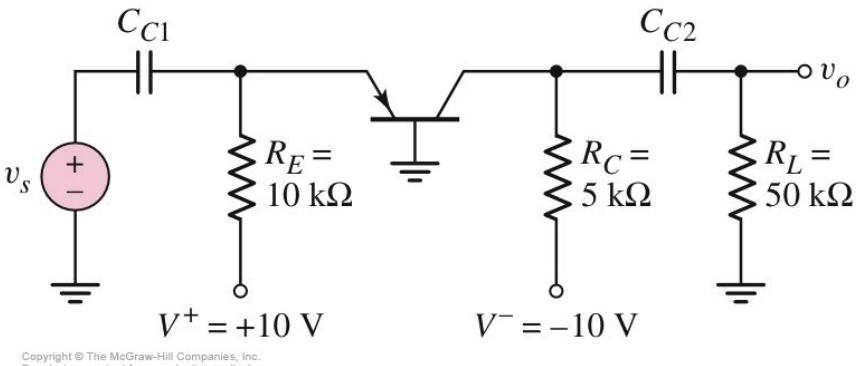
1. (**20%**) Consider the circuit shown as the below, in which the diode cut-in voltages are $V_\gamma = 0.6V$. Plot v_O versus v_I for $0 \le v_I \le 10V$.



2. (**25%**) Derive v_O in relation of v_{I1}, v_{I2}, v_{I3}, and v_{I4}.



3. (**25%**) The transistor parameters are $\beta = 100$ and $V_A = \infty$.
   (a) Determine I_{CQ} and V_{ECQ}. (10%)
   (b) Find the small-signal voltage gain $A_v = v_o / v_s$. (15%)



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4. (**30%**) The transistor has parameters $\beta = 120, V_{BE(ON)} = 0.7V$, and $V_A = 80V$.
   (a) If $R_2 = 85\text{k}\Omega$, find the resistance R_1 such that $I_{CQ} = 1mA$. (10%)
   (b) Determine the output resistance R_o. (10%)
   (c) What is the lower 3 dB corner frequency? (10%)