（橫書式）

國立中山大學八十七學年度碩博士班招生考試試題

科 目：半導體物理与元件　　　　電機工程學系 共 / 頁 第 頁

1. Consider a sample of silicon at 400°K doped with boron at a concentration of 1.5×10^{15} cm^{-3} and with arsenic at a concentration of $7\times10^{14}cm^{-3}$. Assume all impurities are ionized. Determine the electron and hole concentration. (for silicon: $n_i=1.5\times10^{10}cm^{-3}$ at 300°K, kT=0.0259 eV at 300°K and E_g=1.12eV)(16%)

2. An abrupt silicon ($n_i = 1.5\times10^{10}$ cm^{-3}, $\epsilon_s = 11.8\ \epsilon_o$, $\epsilon_o = 8.85\times10^{-14}\ F/cm^2$) pn junction at zero bias has dopant concentration of $N_a=10^{15}$ cm^{-3} and $N_d = 2\times10^{17}$ cm^{-3} at T = 300°K. Determine(17%)

   (a) The build in voltage V_{bi}.

   (b) The depletion width W.

   (c) maximum electric field $\mathcal{E}_{max}$.

3. A solar cell with a dark saturation current I_{th} = 1.5 nA is illuminated such that the short circuit current is I_{sc} = 100 mA. Determine the maximum power output of the cell at this illumination. (16%)

4. Assume that a p-n-p bipolar junction transistor is doped such that the emitter doping is 15 times that in the base, the minority carrier mobility is 0.6 times that in the base, and the base width is 1/12 times the minority carrier diffusion length. The carrier lifetimes are equal. Calculate α and β for this transistor. (17%)

5. The Schottky barrier height, ϕ_{Bn}, of a metal-n-GaAs MESFET is 0.9 volts. The channel doping is $N_d=1.5\times10^{16}cm^{-3}$ and the channel thickness is a=0.5μm. T=300K. Calculate the pinch off voltage V_p and determine the FET is enhancement type or depletion type.($\epsilon = 13.1\epsilon_o$, $N_c = 4.7\times10^{17}cm^{-3}$) (17%)

6. Derive the expression of the drain current I_d, for a NMOS transistor with gate capacitance C_o, channel length L, and width W. Assume the threshold voltage V_T is a constant and the mobility is dependent on the electric field E as

$$\mu(E) = \frac{\mu_o}{1+\frac{\mu_o E}{v_s}}$$

, where μ_o is the low field mobility and v_s is the saturation velocity.(17%)

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科 目：控制系統 電機工程學系 共1頁 第1頁

[1] Consider a unity-feedback system with open-loop transfer function given by

$$P(s)=\frac{60\cdot K}{(s+1)(s+2)(s+5)}.$$

10% (a) Using Routh-Hurwitz criterion, find the range of K, $K \geq 0$, such that the closed-loop system is stable.

20% (b) Draw the root locus for the system when $K \geq 0$. Show all important feature of the locus.

10% (c) Draw the Nyquist plot of $P(s)$ when $K=1$ and check if the closed-loop system is stable.

10% (d) From the Nyquist plot of part (c), determine approximately the range of K, $K \geq 0$, such that the closed-loop system is stable.

[2] Consider the following linear time-invariant system $\Sigma := [A, B, C, D]$:

$$\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\\ \dot{x}_3(t)\end{bmatrix}=\begin{bmatrix}1 & 0 & 1\\ 0 & 2 & 0\\ 0 & 0 & -3\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\\ x_3(t)\end{bmatrix}+\begin{bmatrix}1\\ 1\\ 0\end{bmatrix}u(t),$$

$$y(t)=\begin{bmatrix}1 & 0 & 1\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\\ x_3(t)\end{bmatrix},\quad t \geq 0.$$

10% (a) Is the system completely controllable?

10% (b) Is the system completely observable?

10% (c) Is it possible to find a linear state feedback $u(t)=-Kx(t)+v(t)$, where v is the new input, such that the closed-loop system is (exponentially) stable?

10% (d) Find the transfer function of the system.

10% (e) What eigenvalues of the open-loop system are canceled in the transfer function? why?

國立中山大學八十七學年度碩博士班招生考試試題

1. [20] Suppose the probability that a student passes a course is 1/3, and fails with probability 2/3 (this is reasonable, i.e., 60/100).

   (a) Calculate the probability that a student passes one course before taking the course no more than 4 times.

   (b) How many times should a student take a course before he/she makes sure that the probability of passing the course is greater than 0.8?

2. [15] Consider the case of an English-speaking traveler visiting an European country where the native language is not English. He is told that, statistically speaking,

   (a) One out of 10 natives speaks English.

   (b) One out of five persons encountered is likely to be a tourist.

   (c) One out of two tourists speaks English.

   Please infer the following quantities of interest:

   (a) The probability that a person speaks English, regardless of whether she/he is a native or a tourist.

   (b) The probability that a person is a native and speaks English.

   (c) The probability that a person is a native, given that she/he speaks English.

3. [20] Consider a computer with main memory to store 32K words of 12 bits in each word, and a cache of storing up to 512 memory words at any given time.

   (a) How many bits are required in the CPU address?

   (b) Describe the structure of the cache, i.e., how many bits for each field, if using the associative mapping organization.

   (c) Describe the structure of the cache, i.e., how many bits for each field, if using the direct mapping organization.

(d) Describe the structure of the cache, i.e., how many bits for each field, if using the two-way set-associative mapping organization.

4. [10] Consider a computer with cache access time of 100ns, a main memory access time of 1000ns, and a hit ratio of 0.9. What is the average access time of the computer?

5. [35] Suppose we have the following set of data:

86, 9, 136, 20, 90, 164, 36, 72

Answer the following questions.

(a) Use bubble sort to sort the set of data. Write the result after each iteration.

(b) Use quicksort to sort the set of data. Write the result after each iteration.

(c) Use heapsort to sort the set of data. Draw the tree after each step.

(d) Use merge sort to sort the set of data. Write the result after each iteration.

(e) Create a binary search tree for this set of data. Draw the tree after each step.

國立中山大學八十七學年度碩博士班招生考試試題

科　目：電力工程　　電機工程學系　　共 1 頁 第 1 頁

（可用中文或英文作答）

1. 電力系統中可能產生諧波電流失真的來源有那些？諧波失真對電力系統可能造成什麼負面的影響？試列舉說明。(40%)

2. 若已知一工廠之電力系統中諧波污染問題嚴重。試草擬一計畫，說明進行步驟，以協助解決諧波污染問題。(60%)

1. Medium 1, comprising the region $r<a$ in spherical coordinates is a perfect dielectric of permittivity ϵ_1, whereas medium 2, comprising the region $r>a$ is free space. The electric field intensities in the two media are

$$\vec{E}_1 = E_{01}(\hat{a}_r \cos\theta - \hat{a}_\theta \sin\theta)$$

$$\vec{E}_2 = E_{02}\left[\hat{a}_r\left(1+\frac{a^3}{r^3}\right)\cos\theta - \hat{a}_\theta\left(1-\frac{a^3}{2r^3}\right)\sin\theta\right]$$

respectively. Find ϵ_1. (25 %)

2. A cavity is bounded by conducting walls at $x=0, a$, $y=0, b$ and $z=0, h$. Assuming that h is very small compared to wavelength, so the fields in the cavity is independent of z. The characteristic fields can be found by solving the Helmholtz equation for E_z. Find the resonant frequencies and characteristic fields of the cavity. (25%)

3. For two media with $\mu_1 \neq \mu_2$ and $\epsilon_1 \neq \epsilon_2$, find the Brewster's angles for plane wave incidence on the interface of the two media, for both perpendicular and parallel polarizations (25%)

4. Briefly answer the following questions: (5% each)

(a) What is the physical significance of equation of continuity ?

(b) Explain the importance of displacement current.

(c) What is a boundary value problem ?

(d) Write down the SI units of the following quantities:
$\vec{E}$, $\vec{D}$, $\vec{H}$, $\vec{B}$, μ_0 and ϵ_0

(e) What is the Helmholtz theorem in vector analysis ?

1. Consider the LTI system that is initially at rest and that is characterized by

$$\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = \frac{dx(t)}{dt} + 2x(t)$$

(a) Find the frequency response and the impulse response of the LTI system.

(b) Suppose that input is $x(t) = e^{-t}u(t)$ (where u(t) is the unit step-function), please evaluate the frequency response $Y(\omega)$ and the output y(t). (20%)

2. Consider the second-order causal LTI system described by (20%)

$$y[n] - 2r\cos\theta\, y[n-1] + r^2 y[n-2] = x[n]$$

with $0 < r < 1$ and $0 \le \theta \le \pi$. (a) Find the frequency response for this system.

(b) For $\theta \neq 0$ or π, please find the impulse response of the system.

(c) For $\theta = 0$ or π, please find the impulse response of the system.

3. For a parallel combination of two systems as shown in Fig. 3(a). (20%)

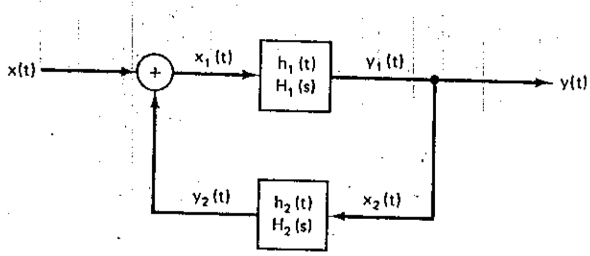

Figure Feedback interconnection of two LTI systems.

(a) Find the Y(s), the Laplace transform of y(t).

(b) Also find the system transfer function of this system in the Laplace transform domain.

4. Consider the Z-transform (20%)

$$X(z) = \frac{3 - \frac{5}{6}z^{-1}}{(1 - \frac{1}{4}z^{-1})(1 - \frac{1}{3}z^{-1})}, \qquad |z| > \frac{1}{3}$$

(a) What is the ROC (region of convergence) assoicated with X(z).

(b) What is the inverse transform of X(z), x[n], by the partial fraction expansion.

5. Consider the mapping between the S-plane and the Z-plane by the bilinear transformation specified by (20%)

$$s = \frac{2}{T}\frac{1 - z^{-1}}{1 + z^{-1}}$$

where T is the smapling period. (a) What is the relationship between the continous-time and discrete-time frequency variable .(b) Describe graphically the mapping characteristics of the bilinear transformation between the S-plane and Z-plane.