國立中山大學九十三學年度博士班招生考試試題

科目：半導體物理與元件【電機系甲組】

1) For a non-uniform p-type doped semiconductor, assume the doping profile is linear increasing, i.e. $dp/dx<0$, and thermal equilibrium at high temperature, Choose and explain the corrective answer (a) $dE_c/dx>0$, (b) $dE_c/dx<0$, (c) $dE_c/dx=0$, (d) $dE_f/dx>0$, (e) $dE_f/dx<0$, (f) $dE_f/dx=0$,(g) none of above (10 %)

2) Describe and explain : how to distinguish the GaAs and Si wafer" by using electrical and optical measurements? (20%)

3) Describe and explain, for the n-type Silicon－aluminum contact at 300 k,

(a) what is the condition required for forming an "Schottky contact ". (10%)

(b) How to get an ohmic contact properties (tunneling characteristics) for n-type Si -Au (gold) contact (10%),

(c) for (b) case, assume n-type Si is non-degenerate semiconductor, calculate(1) the maximum doping concentration, and(2) the space charge width at the point where the potential is 0.5 Φ_{BO} below the peak value (neglect the barrier lowing effect).(10%)

(Work function: aluminum = 4.28 eV; Work function: Gold (Au) = 5.1 eV; For Si; electron affinity = 4.01 eV; $m_p^* = 0.56\ m_o$; $m_n^* = 1.08\ m_o$; Eg(Si) = 1.1 eV; assume $N_C = 2.8\times10^{19}\ cm^{-3}$ and $N_V = 1.04\times10^{19}\ cm^{-3}$ at 300 K)

4) Describe and plot the space-charge density distribution, electric field, electrical potential and energy band for the uniformly doped p-i-n junction assuming abrupt junction approximation in thermal equilibrium (10%)

5) Describe and explain : how to know the quality of oxide layer in the MOS device. (20%)

6) Brief description on the future trend of semiconductor industry in Taiwan. (10%)

國立中山大學九十三學年度博士班招生考試試題

科目：控制系統【電機系乙組】

[1] Explain. (40%)

(1) What is feedback and What are its effects?

(2) State-Transition Matrix

(3)Controllability.

(4)Observability.

(5)Asymptotic stability.

(6)The type of the control system.

(7) steady-state error and it cause on the control system.

(8) Nyquist Stability

(9) PID controller

(10) Minimum-Phase Transfer Function

2. Find the transfer Y_7/Y_1 and Y_2/Y_1 of the SFGs shown in Fig 1 (20%)

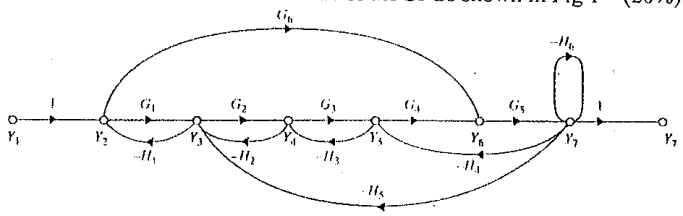


Fig 1

3. Given the system (20%)

$$\frac{dx(t)}{dt} = Ax(t) + Bu(t) \qquad y(t) = Cx(t)$$

where

$$A = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} \quad B = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \quad C = [\,1 \quad 1\,]$$

(a) Determine the state controllability and observability of the system.

(b) Let u(t)=-Kx(t), where $K = [k_1 \;\; k_2]$, and k_1 and k_2 are real constants. Determine if and how controllability and observability of the closed-loop system are affected by the elements of K.

4 (20%)

(a) Draw a state diagram for the following state equations:

$$\frac{dx_1}{dt} = -2x_1(t) + 3x_2(t)$$

$$\frac{dx_2}{dt} = -5x_1(t) - 5x_2(t) + 2r(t)$$

(b) Find the characteristic equation of the system.

(c)Find the transfer functions $X_1(s)/R(s)$ and $X_2(s)/R(s)$

國立中山大學九十三學年度博士班招生考試試題

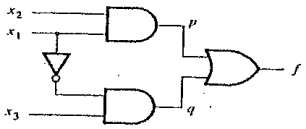
科目：計算機概論【電機系丙組】

1. Prove that a binary tree of height n has at most 2^n leaves. (20%)

2. Find a regular expression for the language
   $L=\{w \in \{a,b\}^*: n_a(w)$ is even and $n_b(w)$ is odd$\}$. (20%)

3. Amdahl's law.
   (a) Describe the definition of Amdahl's law. (10%)
   (b) Suppose we enhance a machine making all floating-point instructions run five times faster. If the execution time of some benchmark before the floating-point enhancement is 60 seconds, what will the speedup be if three-forth of the 60 seconds are spent executing floating-point instructions? (20%)

4. Consider the circuit as follows. Does this circuit exhibit any hazards?(15%)



5. What is the significance of the TCP/IP protocols? (15%)

國立中山大學九十三學年度博士班招生考試試題

科目：電力工程【電機系丁組】

1. 兩相鄰匯流排，電壓分別為 $1.0\angle 0^{\circ}$，及 $0.969\angle -1.872^{\circ}$，匯流排間之線路阻抗為 (0.00744+j0.0372) p.u，線路充電電容量為 7.75MVAR，其中線路阻抗值係以 100MVA，230KV 當 base，計算該線路損失。(15%)

2. 有一電力系統如圖 1 所示，發電機以限流感抗 0.25/3 p.u 接地，計算當匯流排 3 發生單相短路故障時之故障電流值。(以 100MVA 為 base) (25%)

Item	Base MVA	Voltage Rating	X_1	X_2	X_0
G_1	100	20 kV	0.15	0.15	0.05
G_2	100	20 kV	0.15	0.15	0.05
T_1	100	20/220 kV	0.10	0.10	0.10
T_2	100	20/220 kV	0.10	0.10	0.10
L_{12}	100	220 kV	0.125	0.125	0.30
L_{13}	100	220 kV	0.15	0.15	0.35
L_{23}	100	220 kV	0.25	0.25	0.7125

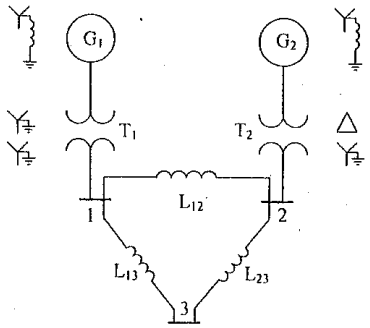


圖 1

3. 電力系統如圖 2 所示，利用牛頓拉弗森法，求解一次疊代後，匯流排 2 之電壓大小及角度。(所有單位皆為以 100MVA 為 base 之標么值，V_2 之初始值為 $1.0\angle 0^{\circ}$，無限匯流排 V_1 之電壓值為 $1.0\angle 0^{\circ}$) (25%)

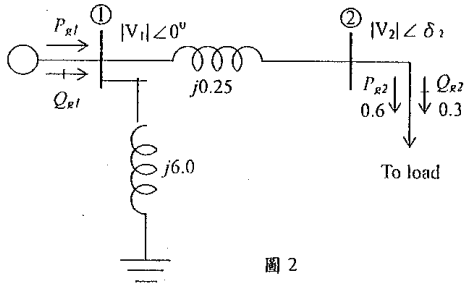


圖 2

4. 請說明各種電力品質發生之原因，對電力系統運轉之影響及改善方式。(15%)

5. 某一台三相旋轉電機中單獨由其中之 A 相電流所產生的空氣隙磁場強度可以表示爲 $H_a(\theta)=KI_a\cos(\theta)$；由其中之 B 相電流所產生的空氣隙磁場強度則可以表示爲 $H_b(\theta)=KI_b\cos(\theta+2\pi/3)$ ；而由其中之 C 相電流所產生的空氣隙磁場強度則可以表示爲 $H_c(\theta)=KI_c\cos(\theta-2\pi/3)$。若 $I_a=I_{max}\cos(\omega t)$，$I_b=I_{max}\cos(\omega t-2\pi/3)$，$I_c=I_{max}\cos(\omega t+2\pi/3)$，則：(20%)

   a. 試將此旋轉電機空氣隙中所產生的總旋轉磁場強度以數學式完整表示之。

   b. 而此旋轉磁場的轉動方向爲順時針或逆時針？

國立中山大學九十三學年度博士班招生考試試題

科目：電磁波及光電工程導論【電機系戊組】

本科共分「電磁波」與「光電工程導論」兩大部分，請任選一部分作答

電磁波 (Electromagnetic Waves)

1. (10%) Write the differential and integral forms of Maxwell's equations, and identify each equation with the proper experimental law. Are all Maxwell's equations independent? Explain.
2. (10%) State the boundary conditions of electromagnetic fields between two lossless media, and between a dielectric and a perfect conductor.
3. (10%) Write the nonhomogeneous wave equation for scalar potential V and for vector potential A. What is the Lorentz condition for these potentials? What is its physical significance?
4. (10%) What is meant by the skin depth of a conductor? How is it related to the attenuation constant? How does it depend on the frequency?
5. (10%) What is meant by the dispersion of a signal? Give an example of a dispersive medium.
6. (10%) Define Poynting vector. What is the SI unit for this vector? Also state Poynting's theorem.
7. (10%) Define propagation constant and characteristic impedance of a transmission line. Write their general expressions in terms of distributed parameters R,L,G, and C for sinusoidal excitation.
8. (10%) Describe the relation between normalized input impedance and reflection coefficient in the use of Smith chart.
9. (10%) Describe how to distinguish TEM, TM and TE mode. What is the dominant mode for a microstrip line?
10. (10%) Explain why single-conductor hollow or dielectric-filled waveguides cannot support TEM waves.

光電工程導論 (Optics Fundamental)

1 (50%) Glass isosceles triangular prisms shown in Fig. 1 are used in optical instruments. Assuming $\varepsilon_r = 4$ for glass, calculate the percentage of the incident light power reflected back by the prism.

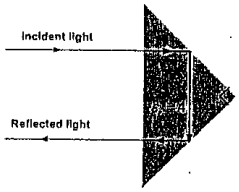


Fig. 1. Light reflection by a right isosceles triangular prism

2 (50%) Interferometer:

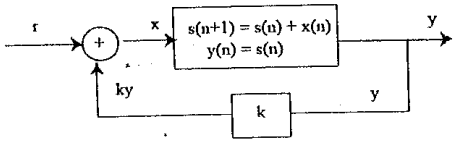
2.1 Please describe the setup of Mach-Zehnder interferometer and Sagnac interferometer?

2.2 Please compare their characteristics and differences?

Ph.D. Entrance Examination—2004

Signals and Systems

1. (18 points) The block diagram of a feedback composition of a discrete-time system is given below:



The state s, input signal x, and output signal y are related by the update equation:

$$s(n+1) = s(n) + x(n)$$
$$y(n) = s(n)$$

(a) Find the zero-state impulse response of this system. (6 points)

(b) Find the update equation for the feedback system with input signal r, output signal y and state s. (6 points)

(c) Given that the gain $k = -0.5$, find the zero-state impulse response for the feedback composition. (6 points)

2. (15 points) A LTI system with input signal x and output signal y is described by the differential equation

$$\frac{dy}{dt} + 0.5y(t) = x(t).$$

(a) Suppose the input signal is $\forall t,\ x(t) = e^{j\omega t}$, where ω is fixed. What is the output signal y? (5 points)

(b) What is the frequency response $H(\omega)$? (5 points)

(c) What is the magnitude and phase of the frequency response for $\omega = 0.5$ rad/sec? (5 points)

3. (12 points) A continuous-time signal is given by (t is in seconds)

$$x(t) = \cos(2\pi \times 60 + \pi/4) + 2\cos(2\pi \times 120 + \pi/8) + 3\cos(2\pi \times 180 + \pi/12)$$

(a) Is x periodic? If it is, what is its period? (4 points)

(b) The signal is input to a LTI system whose frequency response is

$$H(\omega) = \begin{cases} 1, & |\omega| < 2\pi \times 150, \\ 0.5, & \text{otherwise.} \end{cases}$$

What is the output signal y? Is y periodic? If it is, what is its period? (8 points)

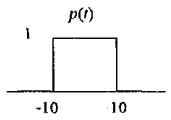
4. (15 points) Prove that the Laplace transform of the convolution of functions $f_1(t)$ and $f_2(t)$ is the multiplication of functions $F_1(s)$ and $F_2(s)$, where $F_1(s)$ and $F_2(s)$ are the Laplace transforms of $f_1(t)$ and $f_2(t)$, respectively.

5. (20 points) Specify and sketch the region of convergence for the following two sequences:

$$y_1(k) = a^k u(k) \qquad k \geq 0 \qquad \text{(Eq. 5-1)}$$

$$y_2(k) = -a^k u(-k-1) \qquad k < 0 \qquad \text{(Eq. 5-2)}$$

6. (20 points) Assume $x(t) = \cos(20\pi t)$, and $y(t) = x(t)p(t)$, where $p(t)$ is shown below:



(a) Write down expressions for the corresponding Fourier Transforms, $X(\omega)$, $P(\omega)$ and $Y(\omega)$. (5 points)

(b) Plot these Fourier Transforms. (Mark the values at $\omega = 0$. Also, on the ω-axis, indicate the frequencies where the Fourier Transform is not zero. (5 points)

(c) Suppose the signal $y(t)$ is sampled every 0.01s, i.e., the sampling frequency is 100 Hz. The sampled signal is $z(k) = y(0.01k)$. Write down an expression for the DTFT $Z(\omega)$ in terms of $Y(\omega)$. (5 points)

(d) Sketch a plot of $Z(\omega)$. (5 points)