國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：工程數學甲【電機系碩士班甲組、丁組、己組】　　題號：431002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

Problem 1 (20%)

Let u be a solution to the heat equation: $\dfrac{\partial u}{\partial t} = \dfrac{\partial^2 u}{\partial x^2}$

with boundary conditions: $u(0,x) = f(x),\ 0 \le x \le 1$, and $\dfrac{\partial u}{\partial x}(t,0) = \dfrac{\partial u}{\partial x}(t,1) = 0,\ 0 \le t < \infty$.

(a) (10%) Define the thermal energy $\mathcal{T}(t) = \displaystyle\int_0^1 u(t,x)dx$. Show that under the above assumptions, $\mathcal{T}(t)$ is constant in time; i.e., $\mathcal{T}(t) = \mathcal{T}(0) = \displaystyle\int_0^1 f(x)dx$, for all $t \ge 0$.

(b) (10%) Let $f(x) = \cos(\pi x)$. Find the solution u.

Problem 2 (25%)

Let $\mathbf{F} = (y^2 + axz + yz)\mathbf{i} + (z^2 + bxy + xz)\mathbf{j} + (x^2 + cyz + xy)\mathbf{k}$.

(a). (10%) Find the values of the constants $a,\ b,\ c$ for which $\mathbf{F}$ is conservative.

(b). (15%) For the values found in (a), find a surface S with the following property: the path integral $\displaystyle\int_P^Q \mathbf{F}\cdot d\mathbf{r}$ is equal to 0 for any two points $P,\ Q$ (connected by any curve C) on the surface S.

Problem 3 (13%)

下面的問題共有(a)~(c)三個子題；**每個子題都只要寫出提問的答案即可**(不須寫出答案背後的推導)。

Let $\alpha \neq 0$ and $A \in \mathbb{R}^{n\times n}$, and let $\Lambda(A)$ denote the set of all eigenvalues of A.

(a) Suppose $I+\alpha A$ is nonsingular, thus, for any nonzero scalar α, $\Omega_\alpha := (I-\alpha^{-1}A)(I+\alpha A)^{-1}$ is a well-defined $\mathbb{R}^{n\times n}$ matrix. Then we know from knowledge of eigensystem of a square matrix that, corresponding to any $\lambda \in \Lambda(A)$, there is a $\mu \in \Lambda(\Omega_\alpha)$. What is the mathematical relation between λ and μ? (3%)

(b) If Ω_1, that is $(I-A)(I+A)^{-1}$, is an orthogonal matrix, then what mathematical relation between A and A^T can be derived? (5%)

(c) If Ω_α is an idempotent matrix, then what are all possible values of $\det A$? (5%)

Problem 4 (12%)

本問題共有(a)、(b)兩個子題，**每個子題都只要寫出提問的答案即可**(不須寫出答案背後的推導)。

(a) Write out the set

$S := \left\{ P = \begin{bmatrix} \alpha & \beta \\ 0 & \gamma \end{bmatrix} \in \mathbb{R}^{2\times 2} \;\middle|\; [\alpha\ \beta\ \gamma]^T \in N([1\ -2\ -1])\ \textit{but}\ [\alpha\ \beta\ \gamma]^T \notin \left(R\left([1\ 0\ -1]^T\right)\right)^{\perp} \right\}$, where $N(\bullet)$ and $R(\bullet)$ indicate the null space and the range of a matrix, respectively. (5%)

(b) Consider the inner product space $V = \left(\mathbb{R}^{2\times 2}, \langle \bullet, \bullet \rangle\right)$, where $\langle A, B\rangle := tr(A^T B)$ for A and B in $\mathbb{R}^{2\times 2}$. Describe $S^{\perp}$ as the span of a set of orthonormal vectors in $\mathbb{R}^{2\times 2}$. (7%)

Problem 5 (15%)

Let C be a circle $|z|=2$ described in the counterclockwise direction.

(a)(5%) Compute the following integral

$$\oint_C \frac{e^{kz^n}}{z} dz, \quad n \text{ is a positive integer}$$

(b)(10%) Suppose the answer you obtained in Part (a) is $jn\pi$. Use Part (a) to evaluate

$$\int_0^{2\pi} e^{2k\cos(n\theta)} \sin\left(2k\sin(n\theta)\right) d\theta .$$

Problem 6 (15%)

Define the Fourier transform of a signal $f(t)$ as $F(j\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t} dt$, and its inverse Fourier transform is $f(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(j\omega)e^{j\omega t} d\omega$. It is already known that the Fourier transform of signal $x(t) = \sin(at)/(\pi t)$ is

$$X(j\omega) = \begin{cases} 1, & |\omega| < a \\ 0, & |\omega| > a \end{cases}$$

and $\mathcal{F}\{tf(t)\} = j\frac{d}{d\omega}F(j\omega)$. Compute the Fourier transform of the signal

$$x(t) = t\left(\frac{\sin(t)\sin(t/2)}{\pi t^2}\right).$$

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：半導體概論【電機系碩士班甲組】　　題號：431008

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共1頁第1頁

Dielectric constant: Si = 11.9 ; SiO_2 = 3.9

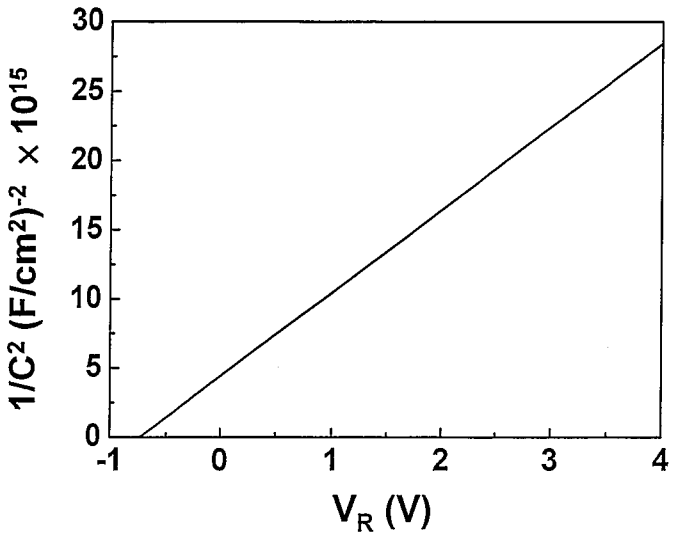
1. An unknown semiconductor has bandgap of 1.36 eV. It is doped with 3×10^{15} cm^{-3} donors. The effective density of states in the conduction band and the valance band are the same. The Fermi level is 0.2 eV below the bottom of the conduction band. Assume that 30% of total electrons are still in the donor states. Find the intrinsic carrier density in the material at $T = 300$ K. (20%)

2. The electron concentration in a semiconductor material is given by

$$n = 5\times10^{16}\left(2-\frac{x}{L}\right) \text{ cm}^{-3} \text{ for } 0 \le x \le L$$

The length of the material L is 100 μm. The electron mobility is 1500 cm^2/V-s at 300 K. An electric field is applied such that the total electron current density is a constant over the given range of x and is $J_n = -95$ A/cm^2. Determine the required electric field versus distance function. (20%)

3. The measured junction capacitance of a p^+-n junction biased at $V_R = 2$ V is 0.15 pF under $T = 300$ K. The intercept of the $1/C^2$ versus V_R curve is –0.735 V. The cross-sectional area is $A = 2\times10^{-5}$ cm^2. Calculate the doping concentrations.



(20%)

4. Consider an n-channel Si MOSFET with $N_A = 3.5\times10^{15}$ cm^{-3} at $T = 300$ K. The oxide is SiO_2 with a thickness of 300 Å. The threshold voltage is found to be $V_T = 0.7$ V when an applied source-to-body voltage $V_{SB} = 2.5$ V. What is the threshold voltage at $V_{SB} = 5$ V ? (20%)

5. A silicon p-n-p transistor has following impurity concentrations.

	emitter	base	collector
N_A or N_D (cm^{-3})	3×10^{18}	2×10^{17}	2×10^{16}

The base width is 1.5 μm and the device cross-sectional area is 0.3 mm^2. When the device is operated in the active mode, the emitter-base junction is forward biased to 0.7 V and the base-collector junction is reverse biased to 6 V. Calculate the neutral base width. (20%)

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：工程數學乙【電機系碩士班乙組】　　題號：431001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

Problem 1 (25%)

Consider the differential equation: $\dot{x}(t) = ax(t) + u(t)$, with initial condition $x(0) = x_0$.

(a) (10%) Show that the solution of the equation is $x(t) = e^{at}x_0 + \int_0^t e^{a(t-\tau)}u(\tau)d\tau$, $t \geq 0$.

(b) (10%) Suppose $a < 0$. Show that for any bounded u and any initial condition x_0, the corresponding solution x is bounded.

(c) (5%) Suppose $a > 0$ and $u(t) = \sin(t)$. Find the initial condition x_0 such that the corresponding solution x is bounded. In this case, what is x?

Problem 2 (20%)

本問題係由兩個小題所組成，此兩小題共含有(a)~(f)六個子題；**每個子題都只要寫出提問的答案即可**(不須寫出答案背後的推導)。

• (5%) Consider the set $S := \{ A \in \mathbb{R}^{2\times 2} \mid A = A^T \text{ and } tr(A) = k \}$.

(a) What are all possible values of k so that S is a subspace of $V := \{ A \in \mathbb{R}^{2\times 2} \mid A = A^T \}$? (2%)

(b) Consider the inner product space $(S, \langle \bullet, \bullet \rangle)$ with $\langle A, B \rangle := tr(A^T B)$ for A and B in S. Find an orthogonal basis for S. (3%)

• (15%) Let $\alpha \neq 0$ and $A \in \mathbb{R}^{n\times n}$, and let $\Lambda(A)$ denote the set of all eigenvalues of A.

(c) What is the condition on $\Lambda(A)$ so that $I + \alpha A$ is nonsingular? (2%)

(d) Suppose $I + \alpha A$ is nonsingular, thus, for any nonzero scalar α, $\Omega_\alpha := (I - \alpha^{-1}A)(I + \alpha A)^{-1}$ is a well-defined $\mathbb{R}^{n\times n}$ matrix. Then we know from knowledge of eigensystem of a square matrix that, corresponding to any $\lambda \in \Lambda(A)$, there is a $\mu \in \Lambda(\Omega_\alpha)$. What is the mathematical relation between λ and μ? (3%)

(e) If Ω_1, that is $(I - A)(I + A)^{-1}$, is an orthogonal matrix, then what mathematical relation between A and A^T can be derived? (5%)

(f) If Ω_α is an idempotent matrix, then what are all possible values of $\det A$? (5%)

Problem 3 (25%)

本問題共有(a)~(d)四個子題，除了(b)子題裡的 **discuss** 之外，**每個子題都只要寫出提問的答案即可**(不須寫出答案背後的推導)。

(a) Describe the set of all $\mathbb{R}^{3\times 1}$ vectors $[\alpha \ \beta \ \gamma]^T$ that satisfy the two conditions $[\alpha \ \beta \ \gamma]^T \in N([1 \ -2 \ -1])$ and $[\alpha \ \beta \ \gamma]^T \notin \left(R\left([1 \ 0 \ -1]^T\right)\right)^\perp$, where $N(\bullet)$ and $R(\bullet)$ indicate the null space and the range of a matrix, respectively. (5%)

(b) Now denote the set $S := \left\{ P = \begin{bmatrix} \alpha & \beta \\ 0 & \gamma \end{bmatrix} \in \mathbb{R}^{2\times 2} \mid [\alpha \ \beta \ \gamma]^T \in N([1 \ -2 \ -1]) \text{ but } [\alpha \ \beta \ \gamma]^T \notin \left(R\left([1 \ 0 \ -1]^T\right)\right)^\perp \right\}$ in terms of solution of (a). Write out the set S *and* **discuss** if the closure property of vector addition holds for set S, i.e. whether the implication "$P_1, P_2 \in S \Rightarrow P_1 + P_2 \in S$" holds for any P_1 and P_2. (1+5%)

(c) Consider the inner product space $V = \left(\mathbb{R}^{2\times 2}, \langle \bullet, \bullet \rangle\right)$, where $\langle A, B \rangle := tr(A^T B)$ for A and B in $\mathbb{R}^{2\times 2}$. Describe $S^\perp$ as the span of a set of orthonormal vectors in $\mathbb{R}^{2\times 2}$. (7%)

(d) Now let $T := Span\left(\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}\right)$ be a subspace of V and let P be any vector of S. What is the distance of P to T? (7%)

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：工程數學乙【電機系碩士班乙組】　　題號：431001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

Problem 4 (15%)

Let C be a circle $|z|=2$ described in the counterclockwise direction.

(a)(5%) Compute the following integral

$$\oint_C \frac{e^{kz^n}}{z} dz, \quad n \text{ is a positive integer}$$

(b)(10%) Suppose the answer you obtained in Part (a) is $jn\pi$. Use Part (a) to evaluate

$$\int_0^{2\pi} e^{2k\cos(n\theta)} \sin\left(2k\sin(n\theta)\right) d\theta .$$

Problem 5 (15%)

Define the Fourier transform of a signal $f(t)$ as $F(j\omega)=\int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt$, and its inverse Fourier transform is $f(t)=\frac{1}{2\pi}\int_{-\infty}^{\infty} F(j\omega)e^{j\omega t}d\omega$. It is already known that the Fourier transform of signal $x(t)=\sin(at)/(\pi t)$ is

$$X(j\omega)=\begin{cases}1, & |\omega|<a\\ 0, & |\omega|>a\end{cases}$$

and $\mathcal{F}\{tf(t)\}=j\frac{d}{d\omega}F(j\omega)$. Compute the Fourier transform of the signal

$$x(t)=t\left(\frac{\sin(t)\sin(t/2)}{\pi t^2}\right).$$

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：電子學【電機系碩士班甲組、乙組、戊組、電波領域聯合】　　題號：431006

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

1. (15%) Figure 1 shows the inverting configuration voltage amplifier with R = 1 kΩ. (a) Please find the close loop gain of V_O/V_I if the operational amplifier (op amp) is ideal. (b) Please find the close loop gain of V_O/V_I if the open loop gain of op amp is 10 V/V. (c) If the op amp is a low-pass STC with $A(f)=\frac{10}{1+\frac{j2\pi f}{1000}}$, please find the high frequency close loop gain of V_O/V_I at f = 1 GHz. (5%, 5%, 5%)

2. (25%) Consider the voltage amplifier of Figure 2 with a BJT device having β =100 when it is biased in the active region, the AC signal voltage V_{sig}, signal resistance R_{sig} = 10kΩ and coupling capacitors C_{C1} and C_{C2} which can block DC component and pass AC component. The voltage supplies V_{CC} = 10V and the thermal voltage V_T = 25mV. The constant voltage drop 0.7V approximation can be used for the turn-on of a p-n junction, and the constant voltage drop V_{CE} ~ 0.2V approximation can be used when the BJT is biased in the saturation region. In addition, other resistances are also included, such like R_1 = 2MΩ, R_2 = 2MΩ, R_E = 5kΩ, R_C = 5kΩ, R_L = 5kΩ. Please come out following parameters: (a) transconductance g_m, (b) input resistance R_{in}, (c) overall AC voltage gain V_o/V_{sig}. (d) Please describe the advantages of the existing of emitter resistance R_E compared with no R_E. (5%, 5%, 5%, 10%)

3. (30%) Figure 3 is the two-stage CMOS op amp configuration. All NMOSFETs have the same W/L = 10μm/0.5μm, V_{tn} = 0.5V, $\mu_n C_{ox}$ = 200 μA/V^2. All PMOSFETs have the same W/L = 40μm/0.5μm, V_{tp} = -0.5V, $\mu_p C_{ox}$ = 50 μA/V^2. $|V_A|$ (for all devices) = 10V, V_{DD} = V_{SS} = 3V, I_{REF} = 100μA. Neglect the effect of V_A on bias current. Please find (a) the transconductance g_m and r_o of Q_2, (b) the voltage gain of the first stage A_1 and the second stage A_2, (c) the input common-mode range, and (d) the output voltage range. (10%, 10%, 5%, 5%)

4. (30%) Figure 4 shows a CC-CE amplifier with R_{sig} = R_L = 5 kΩ, I_1 = I_2 = 1mA, and identical transistors with β = 100, f_T = 500 MHz, C_μ = 5pF, and C_C = 2μF. The thermal voltage V_T = 25mV. For simplicity, neglect r_o and r_x effect. Please find (a) the input resistance R_{in}, (b) the midband gain A_M, (c) the C_π of the BJTs, and (d) 3-dB frequency of the upper end of the midband, f_H (using open-circuit time-constants method). (5%, 5%, 5%, 15%)

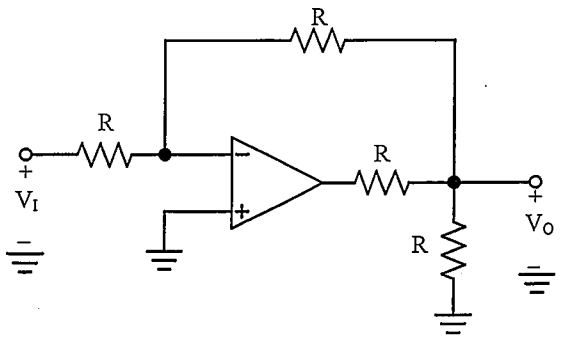


Figure 1.

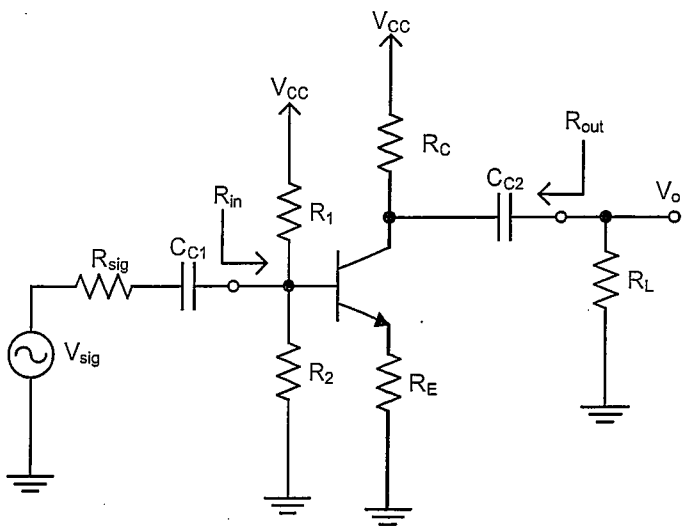


Figure 2.

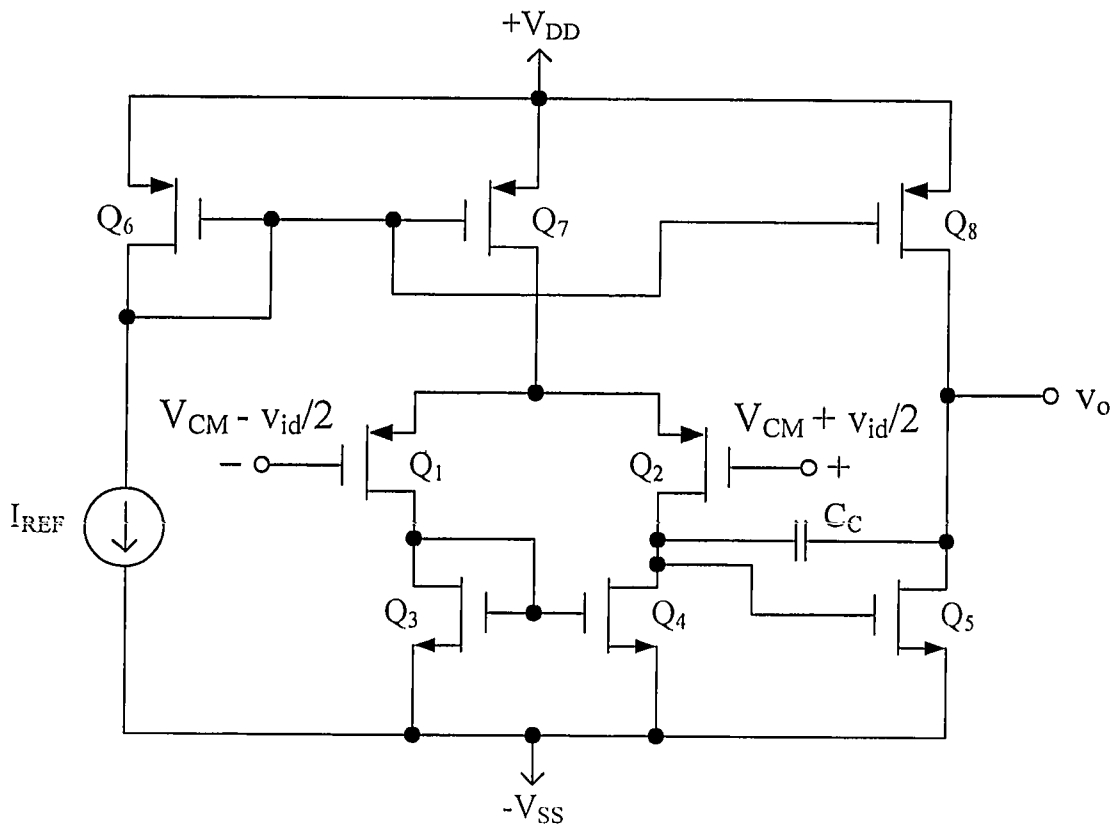


Figure 3.

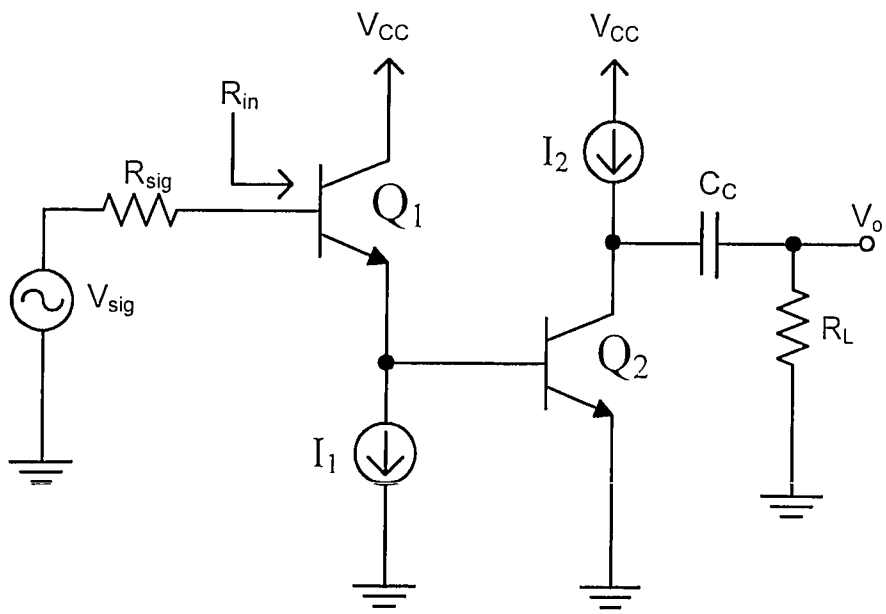


Figure 4.

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：控制系統【電機系碩士班乙組】　　題號：431009

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

Question 1. (20%、5% for each sketch)

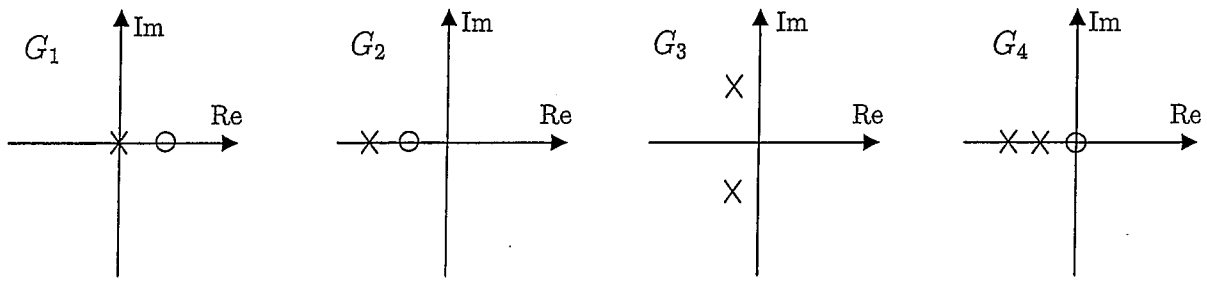


Figure 1: pole/zero plots for Question 1.

The pole/zero plots of four transfer functions $G_1(s)$ to $G_4(s)$ are shown in Figure 1. Sketch the step response of each transfer function. On your sketches, you should show important details of the responses, such as the overshoot, undershoot, steady state, etc. if any. Missing any important detail will result in mark deduction.

Question 2 (30%)

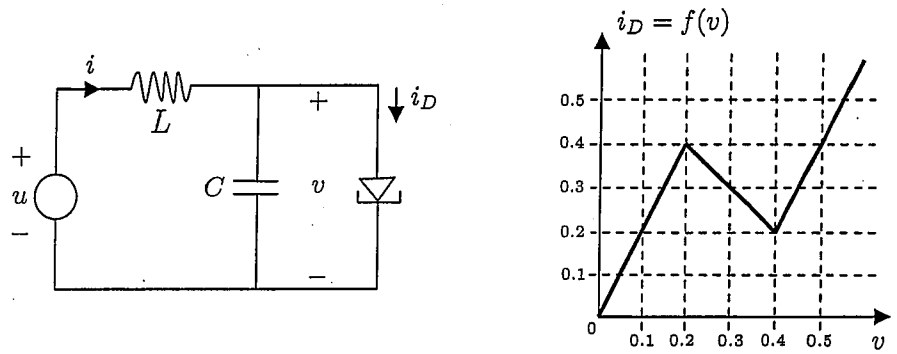


Figure 2: tunnel diode circuit for Question 2.

The left-hand side of Figure 2 shows the schematic model of an electronic circuit involving a tunnel diode. At time $t \geq 0$, let $u(t)$ denote the source voltage, $i(t)$ denote the inductor current and $v(t)$ denote the voltage across the capacitor (and thus the tunnel diode). For the sake of argument, suppose that the static non-linear current-voltage characteristic $i_D(t) = f(v(t))$ of the tunnel diode is as shown on the right in Figure 2, that the inductance $L = 1$ and that the capacitance $C = 1$. Applying Kirchoff's voltage and current laws yields the following differential equations:

$$\frac{di}{dt} = u(t) - v(t); \quad \frac{dv}{dt} = i(t) - f(v(t))$$

(a) (10%) Determine all triples (u_q, v_q, i_q) that are consistent with an equilibrium inductor current $i_q = 0.3$, where u_q and v_q denote equilibrium values for the source voltage and the capacitor voltage.

(b) (10%) For the equilibrium $(u_q, v_q, i_q) = (0.5, 0.5, 0.4)$, linearize the governing equations and derive a transfer function model to relate the Laplace transform $\Delta_v(s)$ of $\delta v(t) = v(t) - v_q$ (as an output) and the Laplace transform $\Delta_u(s)$ of $\delta u(t) = u(t) - u_q$ (as an input). Is the transfer function stable?

(c) (10%) For the transfer function identified in (b), calculate the response of the transfer function when $\delta u(t) = \sin(t)$.

Question 3 (10%)

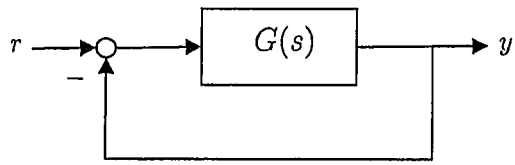


Figure 3: a feedback system for Questions 3.

Consider a standard negative feedback system shown in Figure 3, where $G(s) = \dfrac{2}{s(s+\sqrt{3})}$. Determine how many seconds loop delay $\tau > 0$ can be tolerated if a phase margin of more than 45° is required in the presence of such delay.

Question 4 (15%)

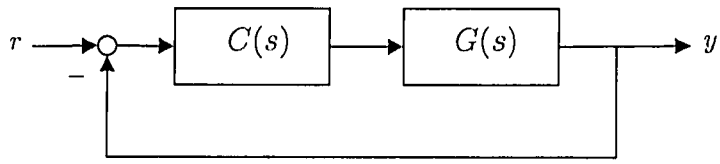


Figure 4: a feedback system for Questions 4 and 5.

Consider a standard negative feedback system shown in Figure 4, where the plant $G(s) = \dfrac{1}{s^2+5s+6}$ and the compensator $C(s) = \dfrac{K(s+10)}{s+4}$. Find the positive compensator parameter values $K > 0$, such that the following conditions both hold: (i) the closed-loop is *STABLE*; and (ii) the closed-loop impulse response has a mode that decays *SLOWER* than e^{-t}.

Question 5 (25%)

Consider the feedback system shown in Figure 4 again. Suppose now the plant has the transfer function $G(s) = \dfrac{1}{s^2-1}$.

(a) (10%) Explain why a lag compensator (e.g., a PI controller) can *NEVER* stabilize G.

(b) (15%) Find a *PROPER* controller C such that the following conditions both hold: (i) the closed-loop is *STABLE*; and (ii) the response of the closed-loop system to any step input always has *ZERO* steady state error.

End of Examination

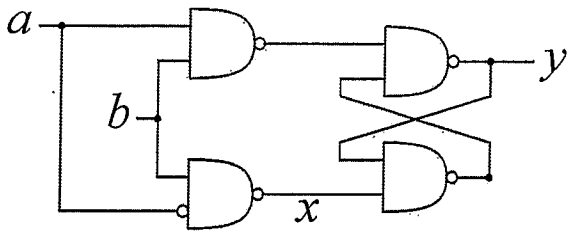
國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：計算機概論【電機系碩士班丙組】　　題號：431003

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（選擇題）　　

注意：(1) 所有題目皆為「單選」選擇題；每題僅有一個答案為正確；每題五分，答錯不倒扣，共 20 題。(2) 答案不得寫在試題紙上。

1. The following graph shows the circuit, called D-latch, where a small circle means "not." Then what are the values of x and y when $a = 0$ and $b = 1$?



(A) $x = 0, y = 0$; (B) $x = 0, y = 1$; (C) $x = 1, y = 0$; (D) $x = 1, y = 1$.

2. Given an integer $n \geq 0$, the Fibonacci number $F(n)$ is defined as follows.

$$F(n) = \begin{cases} 1 & \text{if } n = 0 \text{ or } 1 \\ F(n-1) + F(n-2) & \text{if } n \geq 2 \end{cases}$$

Whether the problem of finding a Fibonacci number $F(n)$ is NP-complete? (A) Yes, because there exists a recursive program whose running time (in units of instruction) is at least 1.618^n; (B) No, because we can use an iterative approach to derive $F(n)$ such that the running time (in units of instruction) is about $n+1$; (C) Yes, because we can use an iterative approach to derive $F(n)$ such that the running time (in units of instruction) is about $n+1$; (D) No, because there exists a recursive program whose running time (in units of instruction) is at least 1.618^n.

3. The following shows a function written by C programming language. Please tell us the returned value of **f(4)**?

```
int f(int n) {
  if (n == 0)
     return 1;
  else
     return 3*n + f(n-1);
}
```

(A) 35; (B) 46; (C) 48; (D) 31.

4. Which two addresses should a computer have in order to access the Internet? (A) DHCP address and IP address; (B) MAC address and IP address; (C) IP address and TCP address; (D) DHCP address and ARP address.

5. Assume that a multi-programming operating system uses the paging scheme to allocate memory. Assume that the available memory is 60 M bytes and divided into 12 frames; besides, each frame size is 5 M bytes. Now, suppose that we want to execute two programs, the first one needs 23 M bytes and the second one needs 11 M bytes. Then how many frames are needed in order to execute these two programs? (A) 6 frames; (B) 7 frames; (C) 8 frames; (D) 9 frames.

6. Let's continue to consider the above question. How much memory is wasted? In other words, how much memory is not used by those two programs and cannot be used by other programs? (A) 6 M bytes; (B) 1 M bytes; (C) 26 M bytes; (D) 20 M bytes.

7. Assume that a machine cycle consists of three phase: fetch, decode, and execute; besides, the time to execute each phase is T. Then how long do we need to execute n instructions when using the pipelining technique? Note that we assume that these n instructions are independent. (A) $3nT$; (B) nT; (C) $n + 2T$; (D) $(n + 2)T$.

8. The following shows a program written by C language. Please tell us the value of **sum** when the **for** loop terminates.

```
void main(void) {
 int k, sum = 10;
 int a[5]={5, 4, 3, 2, 1}, b[5]={6, 7, 8, 9, 10};
 for (k = 0; k < 5; k++)
   sum = sum + a[4-k]*b[k];
}
```

(A) 110; (B) 120; (C) 130; (D) 140.

9. Which one is *not* the necessary condition for processes to result in a deadlock in an operating system? (A) hold and wait; (B) circular wait; (C) mutual exclusion; (D) preemption.

10. Which one of the following protocols will be executed when we want to automatically obtain an IP address? (A) DHCP; (B) DNS; (C) ARP; (D) TCP.

11. What is the first high-level programming language in the world? (A) machine language; (B) assembly language; (C) C; (D) FORTRAN.

12. What is the hexadecimal equivalent of the octal number $(4116)_8$? (A) $(2126)_{10}$; (B) $(201032)_4$; (C) $(100001001110)_2$; (D) $(84E)_{16}$.

13. Please tell us the exection result of the following program written by C programming language?

```
#include <stdio.h>
void main(void) {
int k;

for (k=1; k<=9 && k!=3 && k!=5; k++)
   printf("%d ", k);  // print the value of k
}
```

(A) 1 2; (B) 3 5; (C) 1 2 3 4; (D) 1 2 4 6 7 8 9.

14. What is the task of ARP (Address Resolution Protocol)? (A) The task of ARP is to translate the IP address to its corresponding MAC address; (B) The task of ARP is to translate the IP address to its corresponding binary format; (C) The task of ARP is to find out the device location of a given IP address; (D) The task of ARP is to translate the MAC address to its corresponding binary format.

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：計算機概論【電機系碩士班丙組】　　題號：431003

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（選擇題）　　

15. What is the minimum number of required bits to store an integer that is no less than 0 but no more than 1000? (A) 8; (B) 9; (C) 10; (D) 11.

16. What is the decimal value of the 8-bit two's complement binary number **11100110**? (A) -102; (B) -26; (C) 26; (D) 230.

17. One of the jobs of an operating system is to load a program from the hard disk into the memory. Obviously, an operating system itself can be a program initially stored in the hard disk. Then who loads the operating system into the memory when a computer powers on? (A) virtual machine; (B) bootstrap in ROM (or BIOS); (C) complier; (D) browser.

18. Let $X = (\mathbf{11011101})_2$ and $Y = (\mathbf{00010100})_2$ be two integers stored in 8-bit two's complement format. What is the two's complement format of $X - Y$?
(A) $(\mathbf{11110001})_2$; (B) $(\mathbf{11001000})_2$; (C) $(\mathbf{11001001})_2$; (D) Error, because of overflow.

19. Let $A(r)$ be the area of a circle with a radius r. Assume that the worst-case time $T(n)$ to execute a given program with input of size n is $T(n) = n \times A(n) = O(f(n))$. What is the function of $f(n)$? (A) n; (B) n^2; (C) n^3; (D) n^4.

20. When you are browsing the webpage of http://www.mit.edu, what protocol will be executed to find out the IP address of the web server of MIT? (A) ARP; (B) IP; (C) TCP; (D) DNS.

國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：電路學【電機系碩士班丁組】　　題號：431007

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共 1 頁第 1 頁

PROBLEM 1 (40%) Figure 1(b) shows the waveforms of the line-to-line voltage and the phase current of a three-phase motor (balanced Y-connected load) in Fig. 1(a). Answer the following questions.

(a) (10%) Estimate L and R.

(b) (10%) Estimate the average power consumed by the motor.

(c) (20%) Connect balanced Y-connected capacitors in parallel with the motor to increase the power factor. Determine the capacitance value in each phase so that the power factor is close to 1.

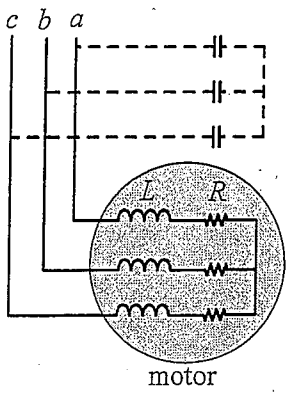


Fig. 1(a)

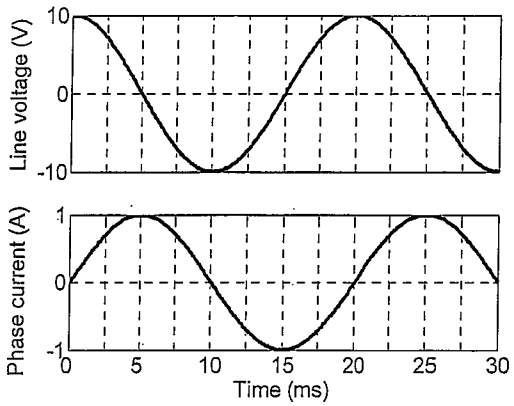


Fig. 1(b)

PROBLEM 2 (20%) Figure 2(b) displays the Bode magnitude plot of a lowpass filter in Fig. 2(a). Estimate the values of R and C.

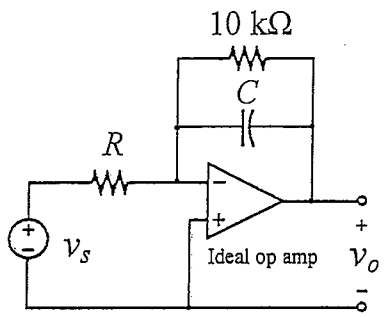


Fig. 2(a)

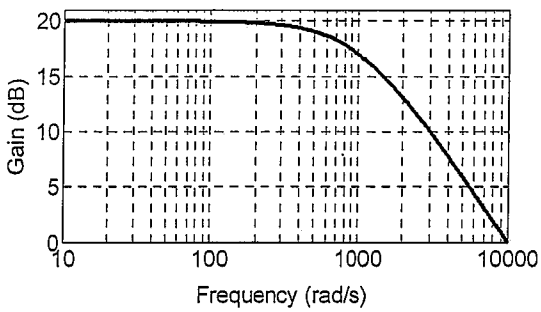


Fig. 2(b)

PROBLEM 3 (20%) Determine the values of R and C in Fig. 3 so that the average power dissipation on resistor R is maximized.

PROBLEM 4 (20%) The two inductors in Fig. 4 are unity coupled. Find the transfer function $I_2(s)/I_1(s)$.

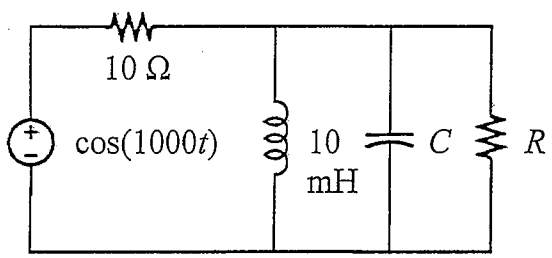


Fig. 3

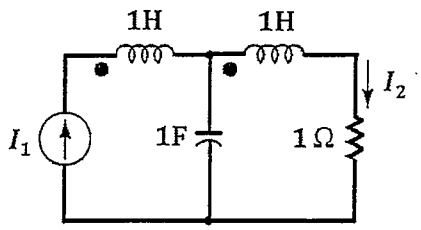


Fig. 4

國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：電力工程【電機系碩士班丁組】　　題號：431010

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）(問答申論題)　　

1. The impedance matrix (Z_{BUS}) for Fig.1 can be expressed as eq. (1). (25%)
   (a) Calculate the Z matrix after the line between Bus 2 and Bus 4 is removed; (15%)
   (b) Assuming the bus voltages before fault are all 1.0p.u. Calculate the short circuit current when a three-phase short-circuit fault occurred at Bus 3 for (a) and bus voltages after this fault. (10%)

$$\mathbf{Z}_{BUS} = j\begin{bmatrix} 0.71160 & 0.60922 & 0.53340 & 0.58049 \\ 0.60922 & 0.73190 & 0.64008 & 0.69659 \\ 0.53340 & 0.64008 & 0.71660 & 0.66915 \\ 0.58049 & 0.69659 & 0.66915 & 0.76310 \end{bmatrix} \quad (1)$$

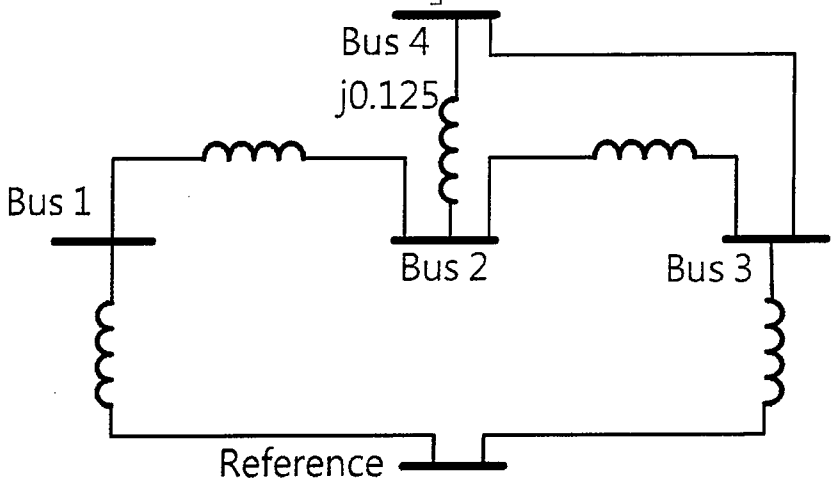


Fig. 1

2. A Y-connected load bank with a three-phase rating of 1000 kVA and 1150 V consists of three identical resistors of 1.3225 ohms. The load bank has the following applied voltages: $V_{ab} = 920\angle 82.8°$, $V_{bc} = 1380\angle -41.4°$, and $V_{ca} = 1150\angle 180°$ V. Determine (15%)
   (a) the zero-, positive- and negative-sequence line-to-neutral voltages V_{an0}, V_{an1}, and V_{an2}; (5%)
   (b) the zero-, positive- and negative-sequence line-to-line voltages V_{ab0}, V_{ab1}, and V_{ab2}; (5%)
   (c) the zero-, positive- and negative-sequence line currents I_{a0}, I_{a1},and I_{a2}. (5%)
   (All answers should be in p.u.)
3. Calculate the line flows and power flows from Bus *i* to Bus *j* and Bus *j* to Bus *i* for Fig. 2 and the line loss for this line (all values in Fig. 2 are in p.u.). (20%)

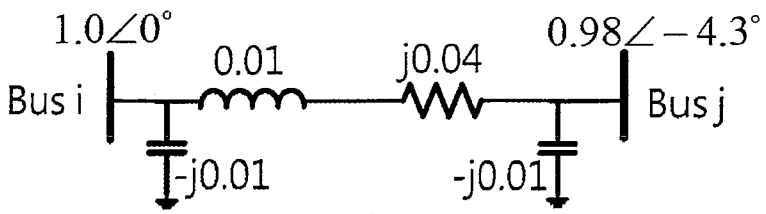


Fig. 2

4. The inertia constant (H) of a three-phase 60-Hz generator is 1.5 p.u.-s. The electrical power delivery by the generator (P_e) versus its power angle (δ) can be expressed as eq. (2). The mechanical power input to the generator (P_m) is 0.5 p.u. (25%)

$$P_e = 1.2319\sin(\delta) \quad (2)$$

   (a) Determine the swing equation and the initial operating power angle. (10%)
   (b) Calculate the critical clearing time for the generator when a three-phase bolted short-circuit at the generator terminals causes P_e=0. (15%)

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：電力工程【電機系碩士班丁組】　　題號：431010

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）(問答申論題)　　

5. Draw the phasor diagrams between the voltages and current of a synchronous generator of Fig. 3 at (a) unity power factor, (b) lagging power factor and (c) leading power factor. (15%)

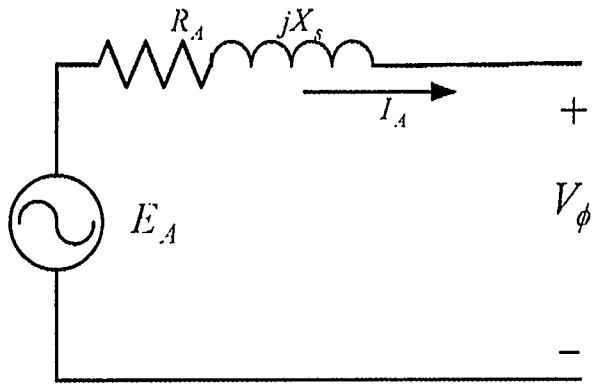


Fig. 3

國立中山大學104學年度碩士暨碩士專班招生考試試題

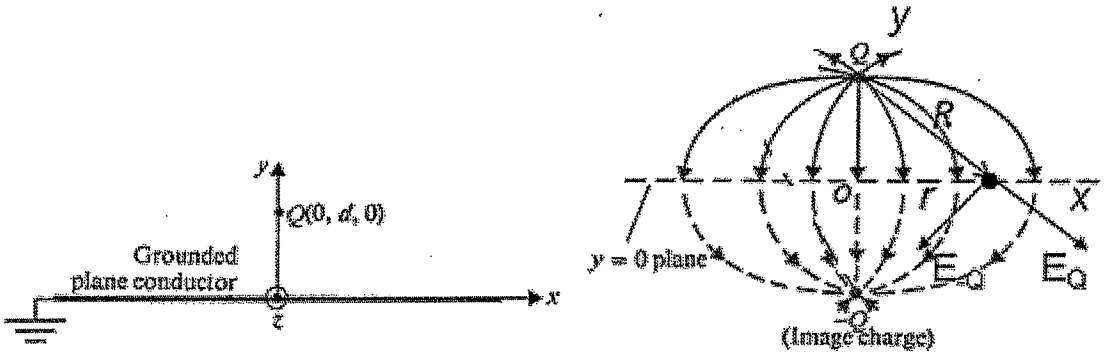
科目名稱：電磁學【電機系碩士班戊組、電波領域聯合】　　題號：431004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共2頁第1頁

Problem 1

a. (5%) A point charge Q exists at (0, *d*, 0) in space, as shown in Figure (a). Using Theory of image, a point charge of –Q exists at (0, -*d*, 0) symmetrically, as indicated in Figure (b). The dielectric constant of the space is ε_0. Write the electric intensities ($Ex|_{y=0}$, $Ey|_{y=0}$, and $Ez|_{y=0}$) for a point on the *ZX*-plane in terms of (*d* and *R*), or (*d* and *r*), as indicated in Figure (b).

b. (5%) What is the surface charge distribution on the *ZX*-plane? Sketch the distribution.



Figures (a) and (b) a single charge *Q* above a ground plane

Problem 2

A air-filled coaxial with dimensions as shown in the following figure,

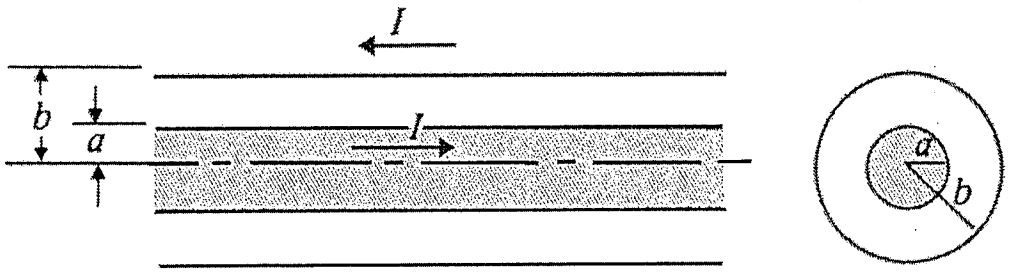


Figure (c) a coaxial transmission line with signal carrying conductor of radius *a* inside the surrounding ground of radius *b*.

The inductance per unit length is $L' = \frac{\Lambda'}{I} = \frac{\mu_0}{8\pi} + \frac{\mu_0}{2\pi}\ln\frac{b}{a}\left(\mathrm{H/m}\right)$. Here we have assumed that the current inside the signal-carrying conductor is uniformly distributed. And, the capacitance per unit length is $C' = \frac{2\pi\varepsilon_0}{\ln\left(\frac{b}{a}\right)}$ (F/m).

a. (5%) For the inductance, which term drops off at high frequencies? Why?

b. (5%) The characteristic impedance is defined as $Z_c = \sqrt{\frac{L'}{C'}}$, find out the characteristics impedance at high frequencies, and please indicate the unit for it.

國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：電磁學【電機系碩士班戊組、電波領域聯合】　　題號：431004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共 2 頁第 2 頁

Problem 3

a. (5%) The dielectric constant for Teflon is 2; it is a low one for a dielectric material. What is the dielectric constant for air?

b. (5%) What is the dielectric constant for a metal, for example, Copper?

c. (5%) The relative permeability for Steel is 100, and is frequency dependent. What is the relative permeability for Copper?

Problem 4

a. (5%) Why Curl of Gradient of a potential field is zero, that is, $\nabla \times (\nabla V) \equiv 0$?

b. (5%) Why Divergence of Curl of a vector field is zero, that is, $\nabla \cdot (\nabla \times \mathbf{A}) \equiv 0$?

c. (5%) Refer to the following figure and prove the law of Cosines, $C = \sqrt{A^2 + B^2 - 2AB\cos\alpha}$.

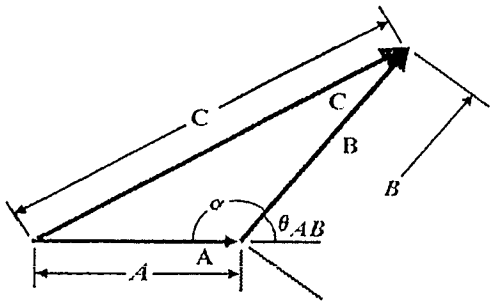


Figure (d) Illustrating example for Problem 4

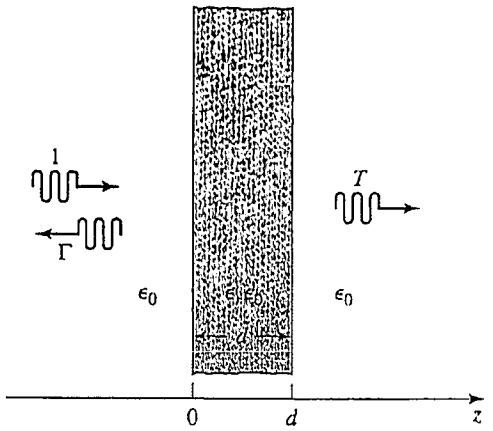


Figure (e) Illustrating example for Problem 5

Problem 5

(20%) A plane wave is normally incident on a dielectric slab of relative permittivity ε_r and thickness d, where $d = \lambda_0 / (4\sqrt{\varepsilon_r})$, and λ_0 is the free-space wavelength of the incident wave, as shown in Figure (e). If free-space exists on both sides of the slab, find the reflection coefficient of the wave reflected from the front of the slab.

Problem 6

(10%) A lossless transmission line is terminated with a 100 Ω load. If the standing wave ratio (SWR) on the line is 1.5, find the two possible values for the characteristic impedance of the line.

Problem 7

(20%) An average power of 1 (kW) at 10 (GHz) is to be delivered to an antenna at the TE_{10} mode by an air-filled metallic rectangular waveguide 1 (m) long and having sides a = 2.25 (cm) and b = 1 (cm). Assume that all the conductors are perfect electric conductors. Find the maximum values of the electric and magnetic field intensities within the waveguide.

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：計算機結構【電機系碩士班己組】　　題號：431005

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

[Problem 1] (20%) Explain and compare the following terminology pairs.

(a) (5%) TLB (Translation Lookaside Buffer) vs Page Table

(b) (5%) Interrupt-Driven I/O vs DMA

(c) (5%) VLIW vs Superscalar

(d) (5%) Multi-Core vs Cluster

[Problem 2] (20%) Consider a four-level memory hierarchy, M1, M2, M3, and M4, with access times T1= 10 nsec, T2 = 50 nsec, T3= 100 nsec, and T4 = 600 nsec. The cache hit ratio H1 = 085 at the first level, H2 = 0.90 at the second level and H3 = 0.95 at the third level. Calculate the effective access time of this memory system.

[Problem 3] (20%) IEEE-754 floating-point representation

(a) (10%) Using 32-bit floating-point format (8-bit exponent, exponent bias = 127, and base = 2) to represent **-1/64**.

(b) (10%) Using 64-bit floating-point format (11-bit exponent, exponent bias = 1023, and base = 2) to represent **-1/32**.

[Problem 4] (20%) Consider a 32-bit microprocessor that has an on-chip 16 Kbytes four-way set associative cache. Assume that the cache has a line size of four words (each word is 32 bits).

(a) (10%) Show the 32-bit physical address (Show how many tag bits, set bits, and offset bits).

(b) (10%) Where in the cache (by indicating the set number) is the double word from memory location ABCDE8F8 mapped?

[Problem 5] (20%)A non-pipelined processor has a clock rate of 2.5 GHz and an average CPI (cycles per instruction) of 4. An upgrade to this processor introduces a new processor with five-stage pipeline. However, due to internal pipeline delays, such as latch delay, the clock rate of the new processor has to be reduced to 2 GHz and an average CPI of 1.

(a) (10%) What is the speedup achieved for a typical program with 100 instructions?

(b) (10%) What is the MIPS rate for the two processors, respectively?

<Note>: MIPS = Million Instructions per Second.