

國立中正大學
113 學年度碩士班招生考試
試題

[第 1 節]

科目名稱	電磁學
系所組別	電機工程學系-電磁晶片組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

1. (25%) The impedance matching network shown in Fig. 1 is to match a lossless line having characteristic impedance $Z_0=50 \Omega$ with a load impedance Z_L . A quarter-wave line having characteristic impedance $Z_1=80 \Omega$ is connected to Z_L . Two stubs having characteristic impedance of $80\text{-}\Omega$ each are connected to this quarter-wave line. One is a short-circuited (S.C.) stub of length 0.25λ and the other is an open-circuited (O.C.) stub of length 0.5λ . Assume that Z_L is pure resistance. Please answer the following questions:

- (a) (5%) Find Z_A
- (b) (5%) Find Z_B
- (c) (5%) Find Z_L when the impedance matching is achieved.
- (d) (5%) If we remove the matching network (quarter-wave line and two stubs) and directly connect Z_L to Z_0 , what is the standing wave ratio (SWR)?
- (e) (5%) Continue with (d), what percentage of the input power is transmitted to the Z_L ?

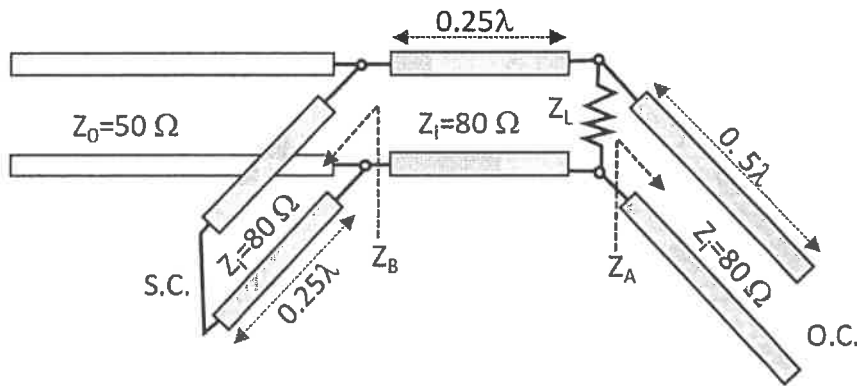
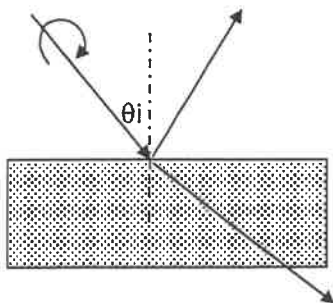


Fig. 1

2. (16%) A circular-polarized wave strikes a dielectric at incident angle θ_i as shown in Fig. 2. Please determine the polarizations of the transmitted wave and reflected wave when: 1) $\theta_i = \text{critical angle } (\theta_c)$; 2) $\theta_i = \text{Brewster angle } (\theta_B)$. Answer the questions in the order of (a), (b), (c), and (d) as indicated in the table below.



	Polarization	
	$\theta_i = \theta_c$	$\theta_i = \theta_B$
Transmitted Wave	(a)	(b)
Reflected Wave	(c)	(d)

Fig. 2

3. (9%) A wave traveling in a lossless, non-magnetic medium has an E-field amplitude of 26 V/m and an average power density of 4.5 W/m^2 . Determine the propagation velocity of this wave.

國立中正大學 113 學年度碩士班招生考試試題

科目名稱：電磁學

本科目共 3 頁 第 2 頁

系所組別：電機工程學系-電磁晶片組

4. (10%) A 5.0 cm diameter solid nickel wire, centered on the z -axis, conducts current with a density $\mathbf{J} = 5r \text{ A/cm}^2 \mathbf{a}_z$ (where r is in cm). Find:
- (5%) The magnetic field intensity in the wire.
 - (5%) The internal inductance per unit length for the wire.

5. (20%) Two conducting planes of infinite extent in the z direction as shown in Fig. 3 are arranged at an angle of $\alpha = 30^\circ$ and are bounded by cylindrical surfaces at $r_1 = 1 \text{ cm}$ and $r_2 = 2 \text{ cm}$. One plate is held at a potential of $V_0 = 20\pi \text{ V}$ and the other is grounded. Between the plates is a charge-free dielectric of dielectric constant $\epsilon_r = 2$. Neglecting the fringing fields at the conductor edges, find:
- (5%) The Laplace's equation between the plates in appropriate coordinate system.
 - (5%) The potential distribution between the plates.
 - (5%) The polarization vector between the plates.
 - (5%) The capacitance per unit length of the structure.

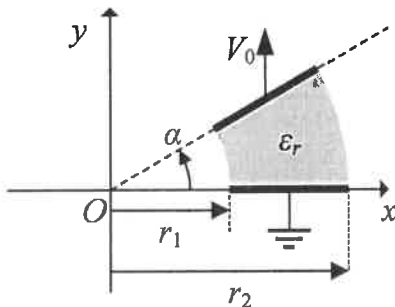


Fig. 3

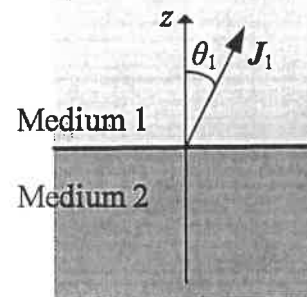


Fig. 4

6. (12%) The xy -plane ($z = 0$) serves as the interface between two different media as shown in Fig. 4. The current density \mathbf{J}_1 in medium 1 ($\sigma_1 = 50 \text{ S/m}$, $\epsilon_{r1} = 8.0$) for $z > 0$ is 40 A/m^2 . It makes an angle of $\theta_1 = 30^\circ$ with respect to the normal at the interface. Medium 2 has a conductivity of $\sigma_2 = 5 \text{ S/m}$ and a dielectric constant of $\epsilon_{r2} = 4$.
- (4%) What is the current density \mathbf{J}_2 in medium 2?
 - (4%) What is the angle does current density in medium 2 make with the normal?
 - (4%) What is the surface charge density at the interface?
7. (8%) A triangular wire loop has its vertices at the points $(3, 0, 0)$, $(0, 4, 0)$ and $(0, 0, 5)$, with dimensions in meters. A time-varying magnetic field is given by $\mathbf{B} = 6t \mathbf{a}_y \text{ Wb/m}^2$ (t in seconds). If the wire has a total distributed resistance of 4Ω , calculate the induced current and indicate its direction in a carefully drawn sketch.

國立中正大學 113 學年度碩士班招生考試試題

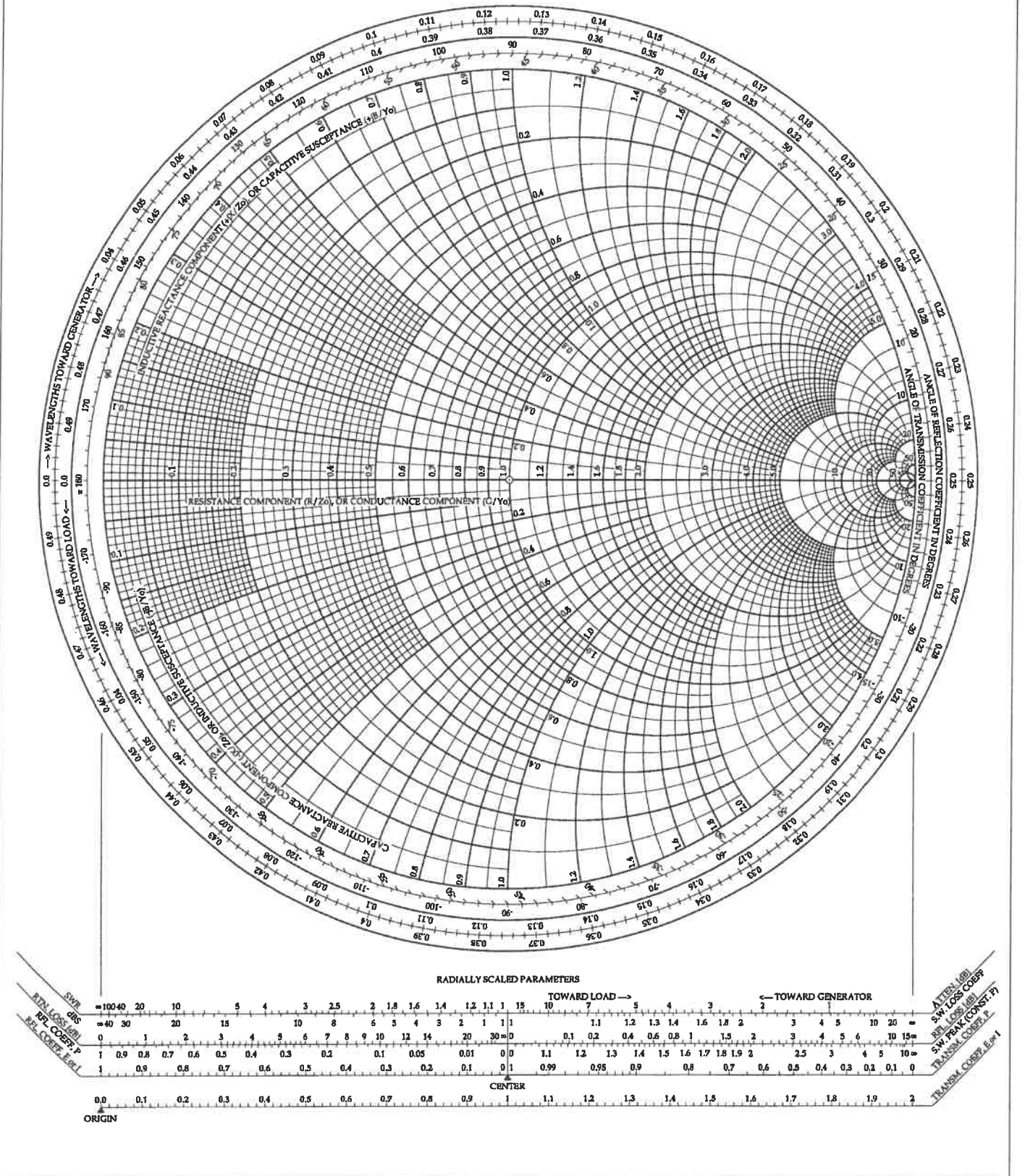
科目名稱：電磁學

本科目共 3 頁 第 3 頁

系所組別：電機工程學系-電磁晶片組

The Complete Smith Chart

Black Magic Design



國立中正大學

113 學年度碩士班招生考試

試題

[第 1 節]

科目名稱	計算機組織
系所組別	電機工程學系- 計算機工程組 晶片系統組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學 113 學年度碩士班招生考試試題

科目名稱：計算機組織

本科目共 2 頁 第 1 頁

系所組別：電機工程學系-計算機工程組、晶片系統組

1. (20%) Assume compiler A runs a program with a dynamic instruction count of $1.0E9$ and spends 1.1 s, and compiler B runs the same program with a dynamic instruction count of $1.3E9$ and computing time of 1.2 s.
 - (a). (10%) What is the average CPI for each compiler with a clock cycle time of 0.5 ns.
 - (b). (10%) A new compiler is that uses only $5.0E8$ instructions and has an average CPI of 1.2. What is the speedup of this new compiler comparing to compilers A and B?

2. (30%) As in the table, an MIPS CPU is designed with instructions and latencies. Assume the multiplexors, control unit, PC accesses, and sign extension unit have no delay.
 - (a). (10%) What is the critical path if the CPU is working as a single-cycle processor? Why?
 - (b). (10%) What is the minimum clock speed of the single-cycle processor?
 - (c). (10%) What is the minimum clock speed if the CPU is working as a multi-cycle processor?

Instructions	Instruction fetch	Register read	Control	Memory access	Register write	ALU
sub	300ps	100 ps	200ps		100 ps	100ps
sw	300ps	100 ps	200ps	300ps		100ps
add	300ps	100 ps	200ps		100 ps	100ps
beq	300ps	100 ps	200ps			250ps

3. (20%) Consider a segment MIPS code as below.
 - (a). (10%) Find the hazards in the preceding code segment.
 - (b). (10%) Reorder the instructions to avoid any pipeline stalls.

```

lw $s1, 0($t0)
lw $s2, 4($t0)
add $a3, $s1, $s2
sw $a3, 12($t0)
lw $s5, 8($t0)
add $a5, $s1, $s5
sw $a5, 16($t0)
    
```

國立中正大學 113 學年度碩士班招生考試試題

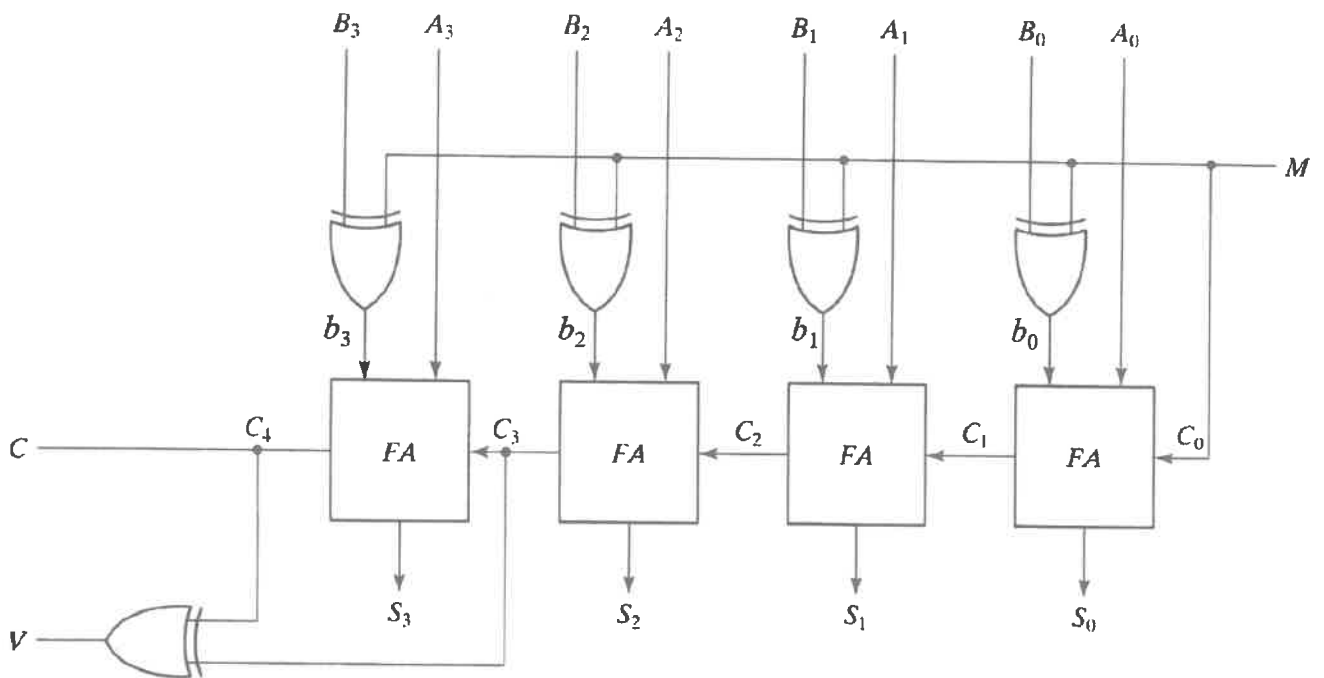
科目名稱：計算機組織

本科目共 2 頁 第 2 頁

系所組別：電機工程學系-計算機工程組、晶片系統組

4. (30%) Assume an adder-subtractor CPU circuit is composed of full-adder (FA) as in the figure. Please find the value for:

- (a). (10%) Find value at (A_1, b_2, C_1, V, M) for $A-B = 0-0$.
- (b). (10%) Find value at (b_0, C_1, A_2, S_2, M) for $A-B = -1-(-2)$.
- (c). (10%) Find value at (A_1, B_2, C_3, S_1, M) for $A-B = 0-2$.



國立中正大學
113 學年度碩士班招生考試
試題

[第 1 節]

科目名稱	電路學
系所組別	電機工程學系-電力與電能處理甲組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學 113 學年度碩士班招生考試試題

科目名稱：電路學

本科目共 2 頁 第 1 頁

系所組別：電機工程學系-電力與電能處理甲組

1. To find the value of load resistor R_L for maximum power transferring as shown in Fig. 1. (20%)

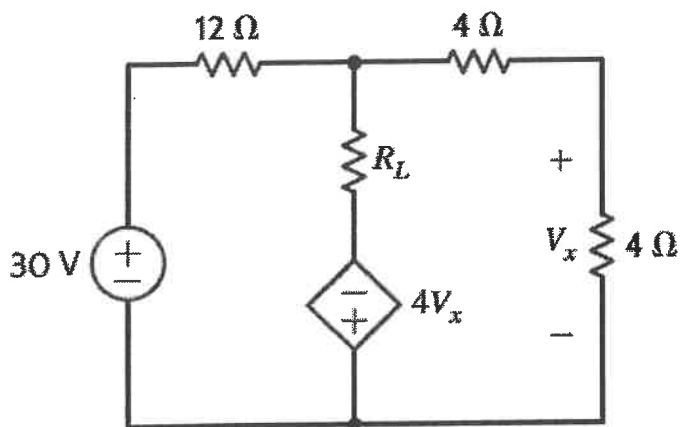


Fig. 1.

2. To find the output voltage V_o in Fig. 2; assume that the operational amplifier is ideal. (20%)

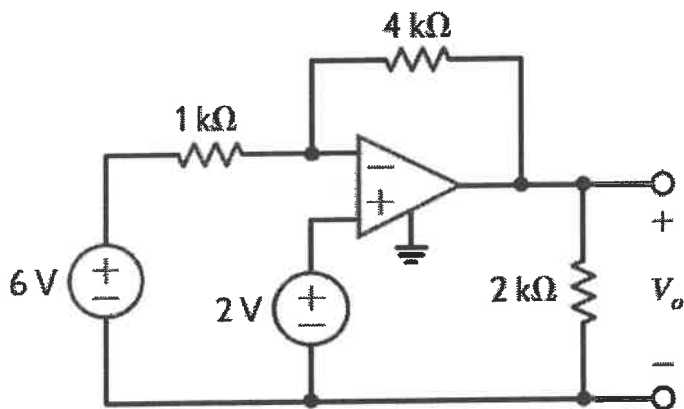


Fig. 2.

3. As shown in Fig. 3; to determine the value of C if the energy stored in the capacitor equals the energy stored in the inductor L ($L=0.1H$). (Hint: steady state) (20%)

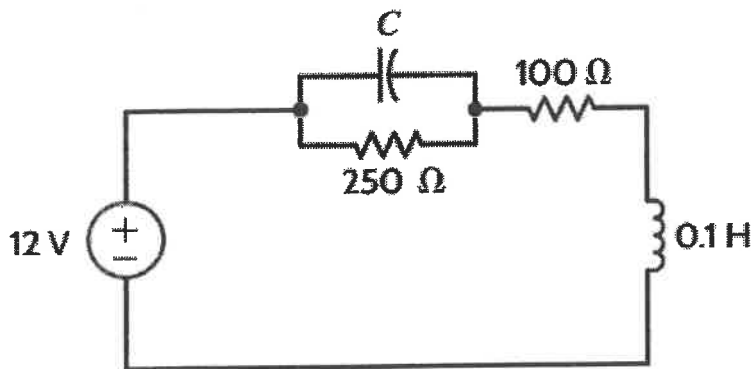


Fig. 3.

科目名稱：電路學

系所組別：電機工程學系-電力與電能處理甲組

4. To quantitatively describe the output voltage $v_o(t)$ for $t > 0$ in the circuit in Fig. 4. (20%)

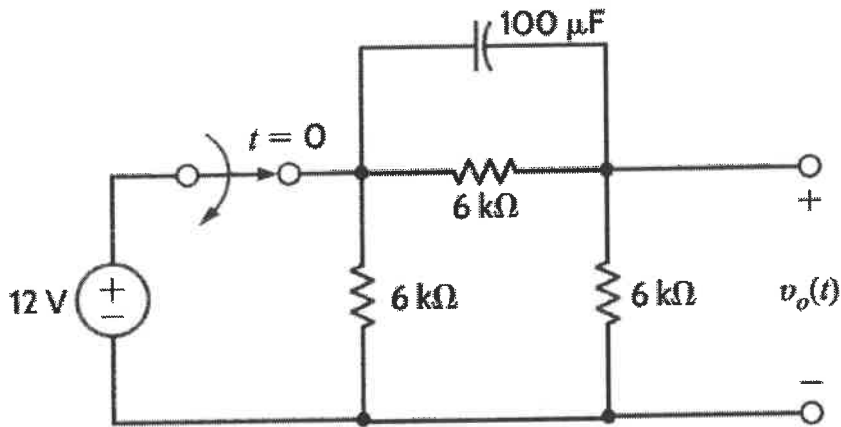


Fig. 4.

5. To find the electric current I_o in the circuit in Fig. 5. (20%)

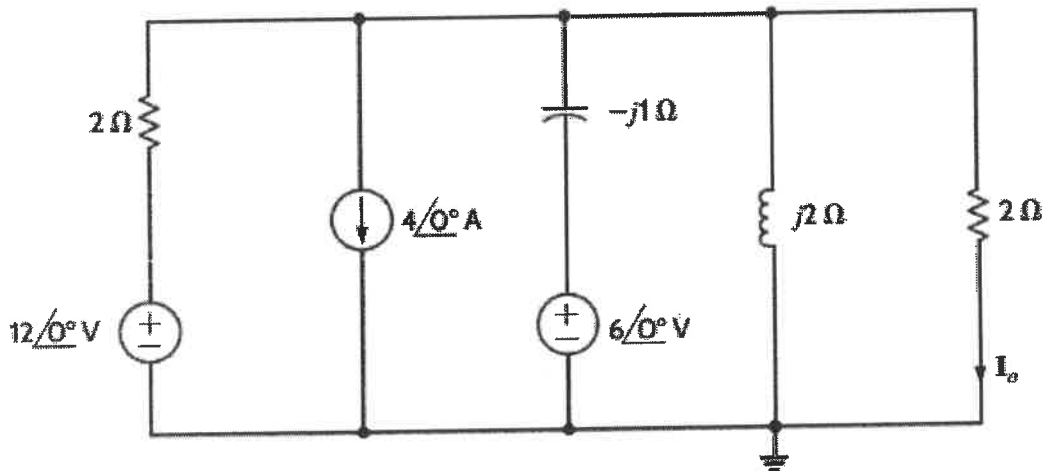


Fig. 5.

國立中正大學

113 學年度碩士班招生考試

試題

[第 1 節]

科目名稱	控制系統
系所組別	電機工程學系-電力與電能處理甲組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學 113 學年度碩士班招生考試試題

科目名稱：控制系統

本科目共 1 頁 第 1 頁

系所組別：電機工程學系-電力與電能處理甲組

1. (20 %) Consider the SFG shown in Fig. 1.

- (a) Find the gain between y_1 and y_2 using the gain formula.
 (b) Find the gain between y_2 and y_6 using the gain formula.

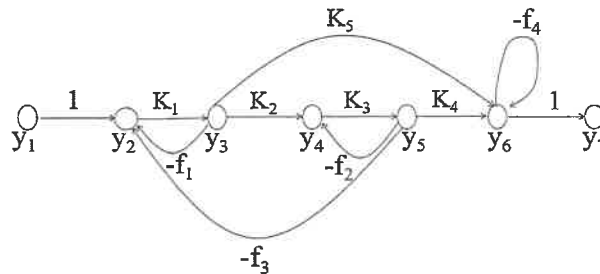


Fig. 1

2. (20%) Fig. 2 shows a PI control system with $F(s) = F_1 + \frac{F_2}{s}$ and $G(s) = \frac{100}{s^2 + 10s + 100}$.

- (a) Find the value of F_2 so that the steady state error to unit ramp input is 10%.
 (b) Construct the root loci for $F_1 \geq 0$ with the value of F_2 determined in part (a).

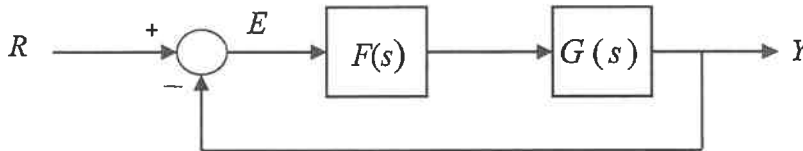


Fig. 2

3. (40%) The transfer function of a unity-feedback control system with positive gain F is

$$G(s) = \frac{F}{s(s+1)^2}$$

- (a) Apply the Nyquist criterion to determine the range of F for stability.
 (b) Check the answer in part (a) with the Routh-Hurwitz criterion.
 (c) Find the value of F so that the gain margin of the system is 10 dB.
 (d) If $F=1$, find the phase margin of the system.

4. (20%) Fig. 3 shows a circuit where the $u(t)$ is an input and the voltage of the R_y is output.

- (a) Find the state equations when the inductor current and the capacitor voltage are the state variables.
 (b) Determine the conditions that the system is stable and controllable.

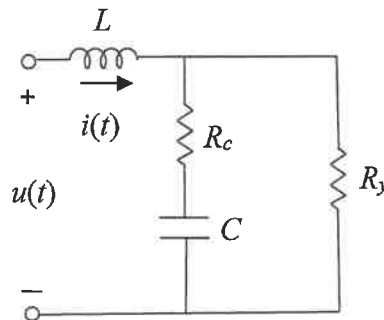


Fig. 3

國立中正大學
113 學年度碩士班招生考試
試題

[第 2 節]

科目名稱	電子學
系所組別	電磁晶片組 電機工程學系- 計算機工程組 晶片系統組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學 113 學年度碩士班招生考試試題

科目名稱：電子學

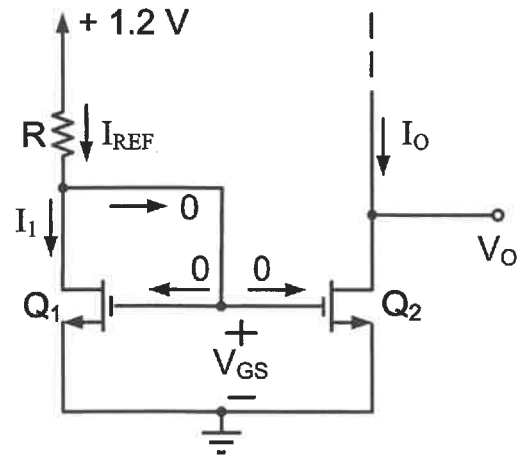
本科目共 2 頁 第 1 頁

系所組別：電機工程學系-電磁晶片組、計算機工程組、晶片系統組

If a parameter un-given in the question, you can specify it in the answer sheet.

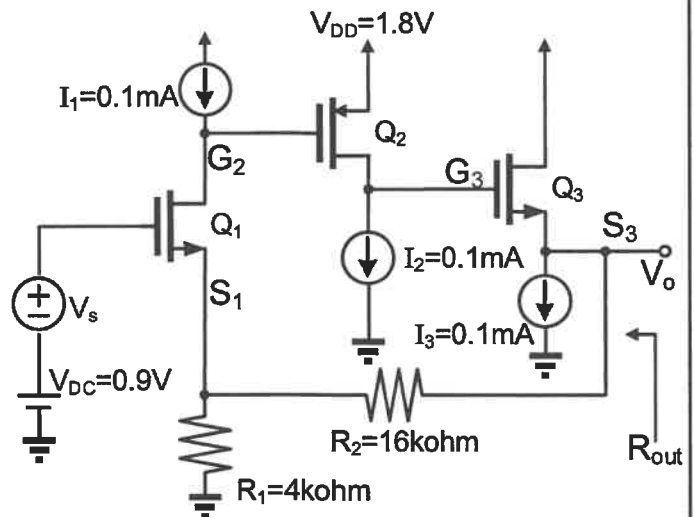
1. (20%) For an output current whose nominal value is $100 \mu\text{A}$, and Q_1 and Q_2 are matched with channel length of $0.5 \mu\text{m}$, channel widths of $5 \mu\text{m}$, $V_t=0.4 \text{V}$ and $k'_n=500 \mu\text{A}/\text{V}^2$. Early voltage is $5 \text{V}/\mu\text{m}$.

- (a) (5%) What is the required value of R ?
 (b) (5%) What is the lowest possible value of V_o ?
 (c) (5%) Find the output resistance of current source.
 (d) (5%) Find the change in output current resulting from a $+0.5 \text{V}$ change in V_o .



2. (20%) Three MOSFETs are sized to operate at $|V_{ov}|=0.3\text{V}$. Let $|V_t|=0.5\text{V}$ and $|V_A|=20\text{V}$, the current sources utilize single transistors and thus have output resistances equal to r_o .

- (a) (5%) If V_s has a zero dc component, find the dc voltages at nodes S_1 , G_2 , S_3 , and G_3 . Verify that each of the current sources has the minimum required dc voltage across it for proper operation.
 (b) (5%) Calculate the gain of each of these three stages and the overall voltage gain, A .
 (c) (5%) Find $A_f = V_o/V_s$.
 (d) (5%) Find the output resistance.



3. (20%) An NMOS transistor operating in the triode region with $v_{DS}=0.3\text{V}$ conducts $50\mu\text{A}$ for $v_{GS}=2\text{V}$ and $100\mu\text{A}$ for $v_{GS}=3\text{V}$, respectively.

- (a) (5%) What is the corresponding value of threshold voltage V_{th} ?
 (b) (5%) If $k_n'=\mu_n C_{ox}=20\mu\text{A}/\text{V}^2$, what is the device aspect ratio?
 (c) (5%) What current would be expected to flow with $v_{GS}=2.8\text{V}$ and $v_{DS}=0.25\text{V}$?
 (d) (5%) If it operates at $v_{DS}=2\text{V}$, at what value of v_{GS} will the drain-end of the MOSFET channel just become pinch-off.

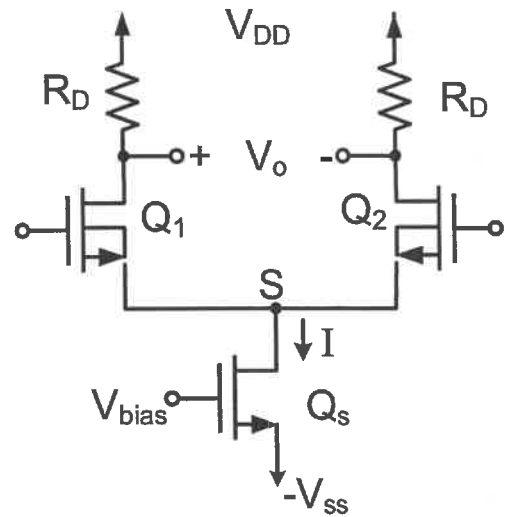
國立中正大學 113 學年度碩士班招生考試試題

科目名稱：電子學

本科目共 2 頁 第 2 頁

系所組別：電機工程學系-電磁晶片組、計算機工程組、晶片系統組

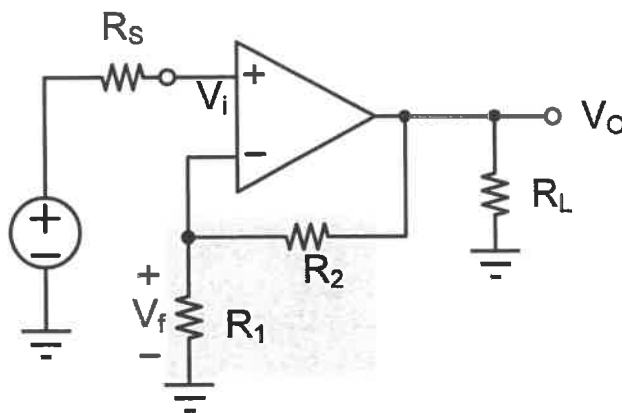
4. (20%) The current source in a MOSFET differential amplifier provides constant current $I=500 \mu\text{A}$ and its equivalent resistance R_{SS} and capacitance C_{SS} are $100 \text{ k}\Omega$ and 0.1 pF , respectively. The parameters of Q_1 and Q_2 are $V_A = 25 \text{ V}$, $C_{gs} = 30 \text{ fF}$, $C_{gd} = 5 \text{ fF}$, and $C_{db} = 5 \text{ fF}$. The drain resistor R_D is $30 \text{ k}\Omega$. Transistors are biased with overdrive voltage $V_{ov} = 0.3 \text{ V}$. Also, there is a 100 fF capacitive load (C_L) existed between each drain and ground.



- (5%) Find the mid-band differential gain A_d . (5%)
- (5%) If the series resistance (R_{sig}) of input signal source for each gate terminal is $20 \text{ k}\Omega$, please estimate the upper 3-dB frequency f_H by open-circuit time-constant method.
- (5%) Find the common-mode gain response $A_{cm}(j\omega)$.
- (5%) Which is the dominate corner frequency in CMRR response.

5. (20%) A noninverting op amp provides a direct implementation of the feedback loop. Assume that the op amp has infinite input resistance and zero output resistance.

- (5%) Find an expression for the feedback factor β .
- (5%) If the open-loop voltage gain $A = 10^5$, find R_2/R_1 to obtain a closed-loop voltage gain A_f of 10
- (5%) What is the amount of feedback in decibels?
- (5%) If $V_s = 1 \text{ V}$, find V_o , V_f , and V_i .



國立中正大學

113 學年度碩士班招生考試

試題

[第 2 節]

科目名稱	線性代數與微分方程
系所組別	電磁晶片組 電機工程學系- 計算機工程組 電力與電能處理甲組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學 113 學年度碩士班招生考試試題

科目名稱：線性代數與微分方程

本科目共 2 頁 第 1 頁

系所組別：電機工程學系-電磁晶片組、計算機工程組、電力與電能處理甲組

第一部分：線性代數

1. Let $C = \begin{bmatrix} a & b \\ 1 & 1 \end{bmatrix}$, $D = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$, $E = \begin{bmatrix} 0 & a \\ 1 & b \end{bmatrix}$. Answer the following questions with the appropriate matrix names (C , D or E). Note: No partial scores are given for each question.
 - a. (5 pts.) Identify matrices that are row equivalent when a is 1 and b is 0.
 - b. (5 pts.) Determine which matrix has $\{0\}$ as the orthogonal complement of its row space when a is 0 and b is 1.
 - c. (5 pts.) Which of these matrices satisfies the condition that the rank plus the nullity equals 2?
 - d. (5 pts.) Which matrix is not full-rank when a and b are 1's?

2. (10 pts.) For a given matrix $A = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix}$, identify all possible matrices B , where the last row of B is 0 , such that the determinants of AB and BA are equal.

3. Let $T_1 : P_1 \rightarrow P_2$ be the linear transformation defined by $T_1(p(x)) = x \cdot p(x)$ and let $T_2 : P_n \rightarrow P_n$ be the linear operator defined by $T_2(p(x)) = p(x + 1)$, where $B = \{1, 2x\}$ and $B' = \{1, x, 2x^2\}$ are bases for P_1 and P_2 , respectively. Every case requires detailed information.
 - a. (10 pts.) Represent the linear transformation T_1 from P_1 to P_2 as the matrix $[T_1]_{B \rightarrow B'}$.
 - b. (10 pts.) Show the matrix representation of the composition of two linear transformations $[T_2 \circ T_1]_{B \rightarrow B'}$.

國立中正大學 113 學年度碩士班招生考試試題

科目名稱：線性代數與微分方程

本科目共 2 頁 第 2 頁

系所組別：電機工程學系-電磁晶片組、計算機工程組、電力與電能處理甲組

第二部分：微分方程

4. Select the correct answer (Single) for the following problems.

(1) The differential equation $y'' + 2yy' + 3y = 0$ is (5 pts.)

- a. first order linear
- b. second order linear
- c. third order linear
- d. first order nonlinear
- e. second order nonlinear

(2) The differential equation $(x^2 + y^2)y' = xy$ is (5 pts.)

- a. linear
- b. homogeneous
- c. separable
- d. exact
- e. Bernoulli

5. (10 pts.) Solve the DE problem by undetermined coefficients.

$$y'' + y = 8 \cos 2x - 4 \sin x, \quad y\left(\frac{\pi}{2}\right) = -1, \quad y'\left(\frac{\pi}{2}\right) = 0$$

6. (10 pts.) Use Laplace transform to solve the given initial-value problem.

$$y' + y = e^{-3t} \cos 2t, \quad y(0) = 0$$

7. (10 pts.) Solve the following DE by systematic elimination.

$$\frac{dx}{dt} = -5x - y$$

$$\frac{dy}{dt} = 4x - y$$

$$x(1) = 0, \quad y(1) = 1$$

8. (10 pts.) Solve the following DE problem by variation of parameters.

$$y''' + 4y' = \sec 2x$$

國立中正大學
113 學年度碩士班招生考試
試題

[第 2 節]

科目名稱	資料結構
系所組別	電機工程學系-計算機工程組

—作答注意事項—

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

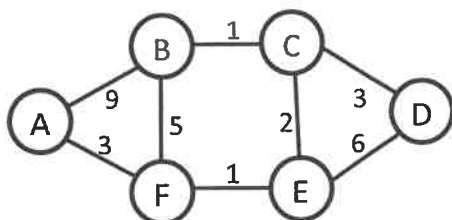
1. **Heap.**

- i. (10 points) Given an integer array, create a function to transform that array into a **heap**. Use C or pseudo code to complete your answer. Make sure no extra array is used besides the given array.
- ii. (5 points) Using your function above, process this array defined as `int myArray1[5] = {10, 3, 40, 5, 100}` to make it into the corresponding heap. Draw the result.
- iii. (15 points) Analyze the time complexity of the function above and show the result in the Big-O notation. Be sure to show the steps in analysis and the associated detail calculation along with your explanation.

2. **Sorting.**

- i. (15 points) Including the method above in constructing a heap, define a **heap sort** function which sorts the data in an ascending order. Use C or pseudo code to complete your answer. Make sure no extra array is used besides the given array.
- ii. (15 points) Analyze the time complexity of the heap sort function above and show the result in the Big-O notation. Be sure to show the steps in analysis and the associated detail calculation along with your explanation.

3. **Graphs.** Use the graph below to answer the questions.



- i. (10 points) Draw the **adjacent matrix** to represent the above graph. Use C or pseudo code to define the corresponding data structures.
- ii. (5 points) Show the **shortest paths** from the node A to each node as the destinations Show all five paths. Be sure to show the cost of each path. (Node A to Node B; Node A to Node C; Node A to Node D; Node A to Node E; and Node A to Node F).
- iii. (15 points) Given an adjacent matrix like above, construct a function which produces the costs of the shortest paths from one specific node to each of other nodes. Use C or pseudo code to complete your answer. The function needs to support up to 20 nodes.
- iv. (10 points) Analyze the time complexity of the function above and show the result in the Big-O notation. Be sure to show the steps in analysis and the associated detail calculation along with your explanation