國立中正大學
114學年度碩士班招生考試
試 題

[第 4 節]

科目名稱	電子學
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

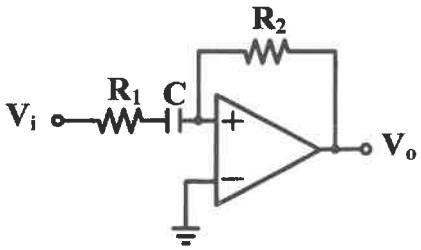
－作答注意事項－

※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。

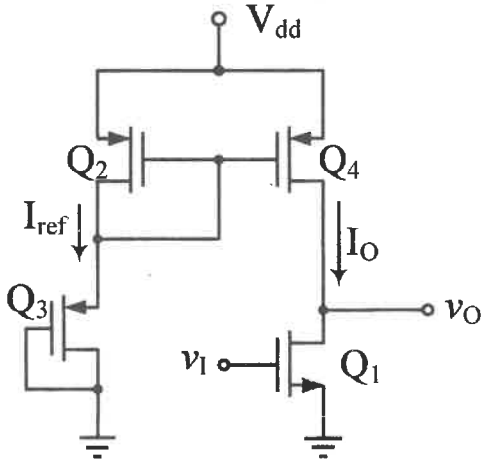
1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。
2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。
3. 入場後於考試開始 40 分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

1. (20%) For an operation in triode region, the NMOS transistor is biased with v_{DS}=0.3V, it conducts 48μA for v_{GS}=2V and 96μA for v_{GS}=3V, respectively.
   (a) (5%) What is the possible threshold voltage V_{TN} ?
   (b) (5%) This transistor is manufactured by 0.18μm process technology and the related k_n' ($=\mu_n C_{ox}$) is 20μA/V^2, what is the aspect ratio (W/L) for it?
   (c) (5%) How much current can be expected to flow through it with v_{GS}=2.85V and v_{DS}=0.25V?
   (d) (5%) If the device operates at v_{DS}=2V, for what value of v_{GS} will the drain-end of the MOSFET channel just become pinch-off .

2 (20%) As shown in the right-hand-side OP-amp circuit,
   (a) (5%) Does it behave like low-pass or high-pass? Please show it by deriving the transfer function.
   (b) (5%) What's the high frequency gain ?
   (c) (5%) What's the 3-dB frequency?
   (d) (5%) At what frequency does the magnitude of high frequency gain reduce to unity?



3 (20%) A MOSFET amplifier with active load is biased with V_{dd} =3 V. The transistor parameters are V_{TN} = 0.5V, V_{TP} = −0.5 V, k'_n= 100μA/V^2, k'_p= 50μA/V^2, and λ_n =λ_p =0.02V^{-1}. The quiescent values are V_O = 1.5 V and V_I = 1.2 V. Q_2 and Q_4 are identical.
   (a) (5%) Taking the channel length modulation effect into considerations to design the required W/L ratio of Q_1, Q_2, Q_4 and Q_3 such that $I_O = I_{ref}$ = 100μA.
   (b) (5%) Please calculate the output resistances (r_{o1} and r_{o4}) of Q_1 and Q_4.
   (c) (5%) Please calculate the transconductance g_{m1} of Q_1.
   (d) (5%) Determine the small-signal voltage gain (v_O/v_I).



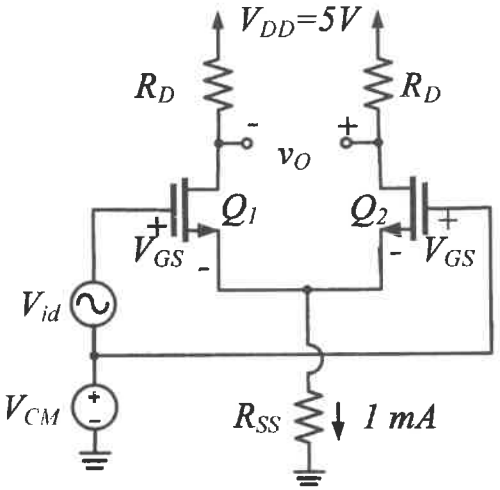
4 (20%) A differential amplifier using a 1kΩ resistor R_{ss} to establish a 1mA dc biased current. The transistors Q_1 and Q_2 are with the properties of k'_n (W/L) = 4mA/V^2, V_{TN}=0.8V. Skip the channel length modulation effect.

(a) (5%) Define the required value of V_{CM}.

(b) (5%) Define the value of R_D so as to get a differential gain A_d of 10 V/V.

(c) (5%) What's the drain voltage over Q_1.

(d) (5%) Determine the common-mode gain $\Delta V_{D1}/\Delta V_{CM}$.



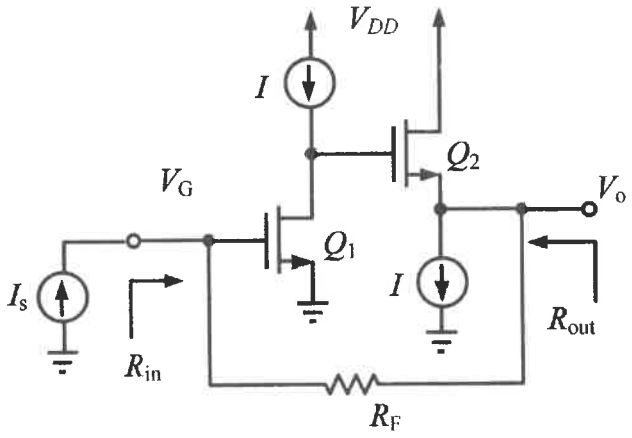
5 (20%) A feedback transresistance amplifier utilizes two identical MOSFETs biased by an ideal current sources I = 0.4 mA. The MOSFETs are sized to operate at V_{OV} = 0.2 V and have V_{TN} = 0.5 V and V_A = 16 V. The feedback resistance R_F = 10 kΩ.

(a) (5%) What's the dc voltage at the input of Q_1?

(b) (5%) What are g_m and r_o of Q_1 and Q_2?

(c) (5%) Derive the open-loop gain in terms of g_{m1}, r_{o1}, g_{m2}, r_{o2} and R_F

(d) (5%) Please express the gain-with-feedback (A_f)



國立中正大學
114學年度碩士班招生考試
試 題

[第4節]

科目名稱	線性代數與微分方程
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

－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 114 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

線性代數 (每一題 10 分)

1. (10%) A matrix B is said to be a square root of a matrix A if $BB=A$. (1) Find square roots of $A = \begin{bmatrix} 5 & 5 \\ 5 & 10 \end{bmatrix}$. (2) Prove that for a 2×2 matrix A whose determinant is negative, then A has no real square root.

2. (10%) Show that the following matrices form a basis for M_{22}.

$$\begin{bmatrix} 3 & 4 \\ 3 & -4 \end{bmatrix}, \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}, \begin{bmatrix} 0 & -8 \\ -12 & -2 \end{bmatrix}$$

3. (10%) Are there values of r and s for which

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & r-2 & 2 \\ 0 & s-1 & r+2 \\ 0 & 0 & 3 \end{bmatrix}$$

has rank 1? Has rank 2? Has rank 3? Has rank 4?

4. (10%) Find a matrix S such that $S^2 = A$, given that $A = \begin{bmatrix} 1 & 3 & 5 \\ 0 & 4 & 5 \\ 0 & 0 & 9 \end{bmatrix}$

5. (10%) In R^3, consider the line l given by the equations

$$x = -1, y = t, z = -t$$

and the line m given by the equations

$$x = 2s, \quad y = 1 + s, z = s$$

Let P be a point on l and Q be a point on m, find the values of t and s such that $\|P - Q\|^2$ is minimized.

微分方程 (每一題 10 分)

6. 利用 Laplace Transform 求解以下 IVP 問題。(10%)

$$y'' + 4y' + 13y = \delta(t - \pi) + \delta(t - 3\pi),$$
$$y(0) = 1, y'(0) = 0$$

7. 利用 Euler's method 計算 $y(0.2)$ 之近似值， $y(x)$ 為以下 IVP 問題之解。

$$y'' + xy' + y = 0, \quad y(0) = 1, \quad y'(0) = 2.$$

使用步階大小(step size)為 h=0.1。(10%)

8. 利用參數變異法(Variation of Parameters)求解以下 IVP 條件為 $y(0)$=1，$y'(0)$=0 的問題。(10%)

$$y'' - 4y' + 4y = (12x^2 - 6x)e^{2x}$$

9. 求解以下 IVP 問題。(10%)

$$\mathbf{X}' = \begin{pmatrix} 6 & -1 \\ 5 & 4 \end{pmatrix}\mathbf{X}, \quad \mathbf{X}(0) = \begin{pmatrix} -2 \\ 8 \end{pmatrix}$$

10. 利用 Laplace Transform 求解以下 IVP 問題。(10%)

$$y'' + 16y = f(t), \quad y(0) = 0, \quad y'(0) = 1, \text{ where}$$

$$f(t) = \begin{cases} \cos 4t, & 0 \le t < \pi \\ 0, & t \ge \pi \end{cases}$$

國立中正大學
114學年度碩士班招生考試
試 題

[第3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。

國立中正大學 114 學年度碩士班招生考試試題

科目名稱：電磁學　　本科目共 2 頁　第 1 頁

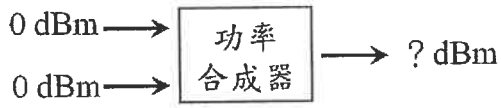
系所組別：電機工程學系-電磁晶片組

1. **(10%)** (a) 若 $f=x^6y^2z^3+3y$，求 $\nabla^2 f$。

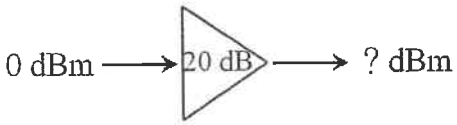
   (10%) (b) 若 $\overrightarrow{F}=3x\hat{x}+(y-z^2)\hat{y}+(xz^3)\hat{z}$，求 $\nabla\cdot\overrightarrow{F}$。

   (10%) (c) 半徑 2cm 球體的電荷密度 $\rho_v=4\cos^2\theta\,(\mathrm{C/m^3})$，此球體的全部電量 Q 是多少？

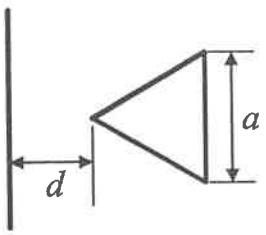
2. **(10%)** (a)當一個 0 dBm 功率的信號和另一個 0 dBm 功率的信號進入功率合成器後，輸出的功率是幾 dBm？



   (10%) (b) 一個功率 0 dBm 的信號通過一個 20 dB 的放大器，請問輸出為幾 dBm？



3. **(8%)** Determine the mutual inductance between a very long, straight wire and a conducting equilateral triangular loop.

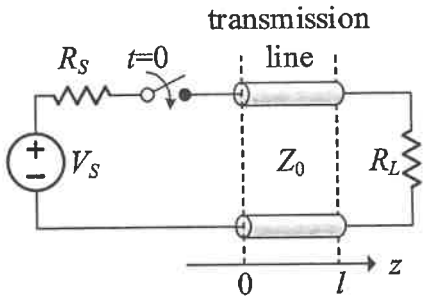


4. **(10%)** A parallel-plate capacitor is made using two circular plates of radius a, with the bottom plate on the xy plane, centered at the origin. The top plate is located at $z = d$, with its center on the z axis. Potential V_0 is on the top plate; the bottom plate is grounded. The dielectric having radially-dependent permittivity fills the region between plates. The permittivity is given by $\epsilon(r) = \epsilon_0(1 + 2r^2/a^2)$. Find:
   (a) (6%) The electric potential V and the electric flux density $\boldsymbol{D}$ between plates.
   (b) (4%) The capacitance C.

5. **(12%)** A 50-V/m, 200-MHz uniform plane wave is traveling in free space and is incident normal to the surface of a lossless material having $\epsilon_r = 25$ and $\mu_r = 16$. The electric field vector is in the x direction and the wave is propagating in the $+z$ direction.
   (a) (6%) Write complete expressions for the incident, reflected, and transmitted magnetic fields.
   (b) (6%) Determine the average power density in free space.

6. **(10%)** A positive charge q of mass m is injected with a velocity $\boldsymbol{u}_0 = \hat{a}_x u_0$ into the $x > 0$ region where a uniform magnetic field $\boldsymbol{B} = \hat{a}_z B_0$ exists.
   (a) (5%) Obtain the equation of motion of the charge.
   (b) (5%) Express the path that the charge follows.

7. **(10%)** Consider the transmission line circuit shown below with $V_S = 20$ V, $R_S = 25\ \Omega$, $R_L = 100\ \Omega$, $Z_0 = 50\ \Omega$, and $l = 30$ cm. The phase velocity of the line is $0.5c$, where c is the velocity of light in a vacuum. Sketch the voltage at the load end of the transmission line from $t = 0$ to $t = 12$ ns.



國立中正大學
114學年度碩士班招生考試
試 題

[第3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 114 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

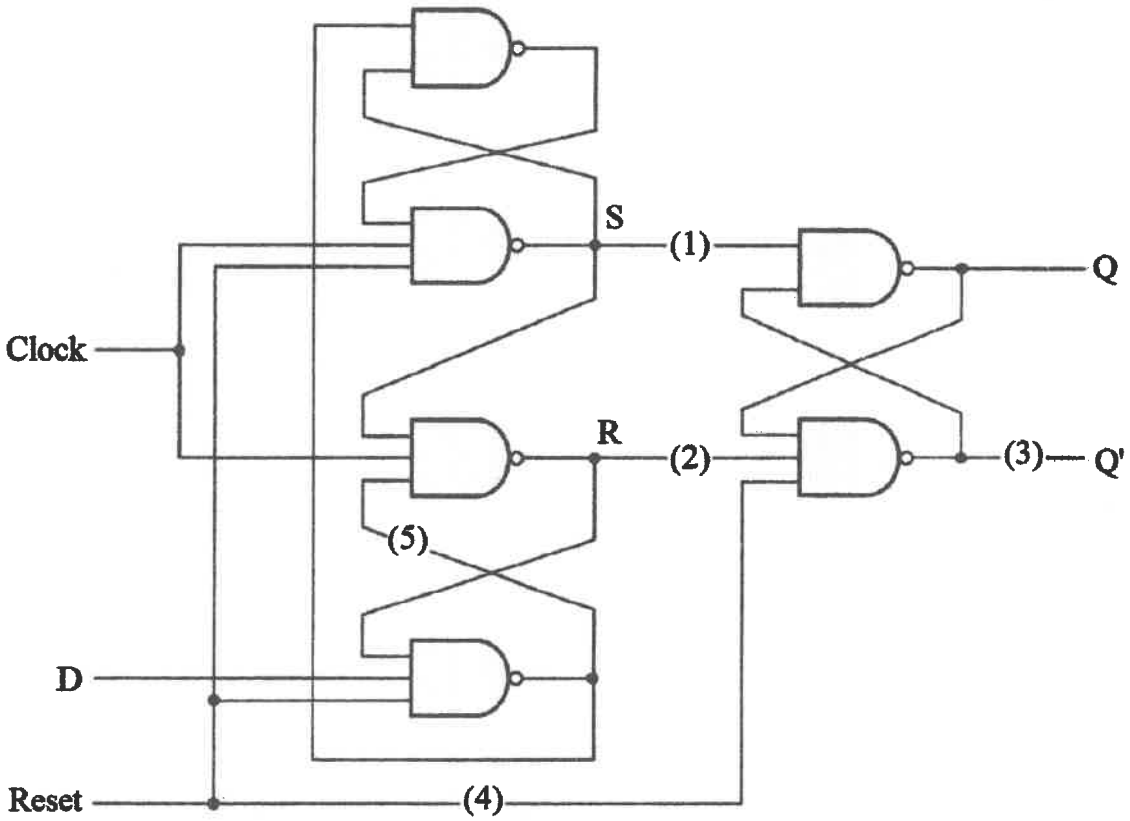
1. (20%) Assume the MIPS CPU's register is designed as in the diagram below. Please write down the data at (1), (2), (3), (4), and (5) with the conditions for:

   (a) (5%) Normal condition D= 0, Clock= 1 steady, then changes to D= 1, Clock= 0.

   (b) (5%) Normal condition D= 1, Clock= 1 steady, then changes to D= 0, Clock= 1.

   (c) (5%) D= 1, Clock= 1 steady, then reset the register.

   (d) (5%) (Q, Q') = (1, 1) in the beginning, next D= 0, Clock = 1 steady.



2. (20%) Consider two different implementations of the same instruction set architecture. The instructions can be divided into four classes according to their CPI (class A, B, C, and D). P1 with a clock rate of 2.5 GHz and CPIs of 1, 2, 3, and 3, and P2 with a clock rate of 3 GHz and CPIs of 2, 2, 2, and 2. Given a program with a dynamic instruction count of 1.0E6 instructions divided into classes as follows: 10% class A, 20% class B, 50% class C, and 20% class D.

   (a) (10%) What is the global CPI for each implementation?

   (b) (10%) Find the clock cycles required in both cases.

3.(20%) Consider the following MIPS loop as:

```
LOOP:  slt $t2, $0, $t1
       beq $t2, $0, DONE
       subi $t1, $t1, 1
       addi $s2, $s2, 2
       j LOOP
DONE:
```

(a). (10%) Assume that the register **$t1** is initialized to the value 10. What is the value in register **$s2** assuming the **$s2** is initially zero?

(b). (10%) For each of the loops above, write the equivalent C code routine. Assume that the registers **$s2**, **$t1**, and **$t2** are integers **B**, **i**, and **temp**, respectively.

4. (20%) Please calculate follows in binary and then represent in IEEE 754 single precision binary formats:

(a). (10%) -0.4375×0.75, (b). (10%) 2.75 / 0.125.

5. (20%) we assume that the following MIPS code is executed on a pipelined processor with a 5-stage pipeline, full forwarding, and a predict-taken branch predictor:

```
        lw r2, 0(r1)
label1: beq r2, r0, label2 # not taken once, then taken
        lw r3, 0(r2)
        beq r3, r0, label1 # taken
        and r1, r3, r1
label2: sw r1, 0(r2)
```

(a). (10%) Draw the pipeline execution diagram for this code, assuming there are no delay slots and that branches execute in the EX stage.

(b). (10%) Repeat question (a), but assume that delay slots are used. In the given code, the instruction that follows the branch is now the delay slot instruction for that branch.

國立中正大學
114學年度碩士班招生考試
試 題

[第4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

一作答注意事項一

※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 114 學年度碩士班招生考試試題

科目名稱：資料結構　　本科目共 1 頁　第 1 頁

系所組別：電機工程學系-計算機工程組

1. Hashing

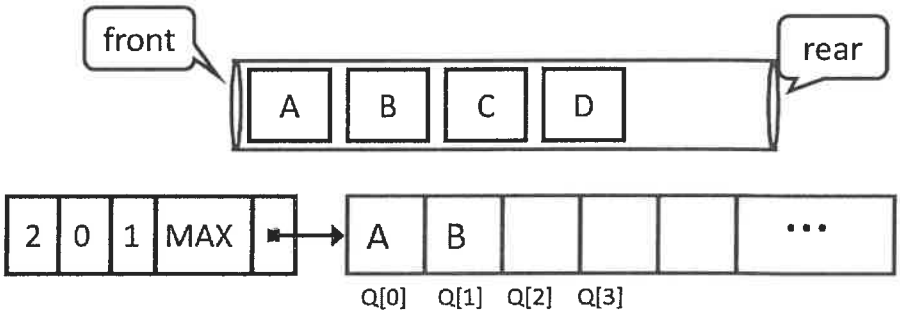
i. (10 points) Consider hashing IP addresses (IPv4 4-byte addresses). Design a hash table with a hash function and a storage. Explain what is a reasonable size of the table and also the effectiveness of the hash function which you propose. State your rationale with examples.

ii. (10 points) Define the hash function and the probing function for your proposal above. Be sure to define the function name, parameter list, return value, local variables, and calling method. Use C or pseudo code to complete your answer.

iii. (10 points) Analyze the time complexity of the hashing procedure above and show the result in the Big-O notation. Be sure to show the steps in analysis and the associated detail calculation. Explain what may be average complexity and what may be worst.

2. Queues

Consider the following concept of a priority queue where the elements, A, B, C, and D, are integers and the largest value is always at the front. An example of design using an array is given below. The queue head contains five fields, the element count, the index number of the front, the index number of the rear, the maximum size of the array storage, and the pointer to the array storage. Answer the following by writing C code or pseudo code.



i. (5 points) Define the data structures to the queue head and the queue storage shown above.

ii. (20 points) Construct the Enqueue function and the Dequeue function for this priority queue.

iii. (15 points) Analyze the time complexity of both the Enqueue procedure and the Dequeue procedure for time complexity and show the results in the Big-O notation. Be sure to show the steps in analysis and the associated detail calculation.

3. Sorting.

i. (15 points) Define a **merge sort** function which sorts the integer data in an ascending order. Use C or pseudo code to complete your answer. Be sure to define data structures, function headers, and local variables clearly.

ii. (15 points) Analyze the time complexity of the merge 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.

國立中正大學
114學年度碩士班招生考試
試 題

[第3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 114 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%) The forward-path transfer function of a unity feedback control system is

$$G(s)=\frac{K}{(s-1)(s^2+4s+7)}$$

(a) (10%) Sketch the root loci of the control system and determine the range of K for stability.

(b) (10%) Check the answer in part (a) with the Routh-Hurwitz criterion.

2. (20%) The forward-path transfer function of a unity feedback control system is

$$G(s)=\frac{K}{s(s+6.54)}$$

(a) (10%) Find the value of K and the peak time of the unit-step input for the damping ratio of the closed-loop system being equal to 0.327.

(b) (10%) Determine the resonance peak M_r and resonance frequency w_r of the closed-loop system according to the result of part (a).

3. (30%) The forward-path transfer function of a unity feedback control system with a PD (proportional-derivative) controller is

$$G(s)=\frac{10(K_P+K_Ds)}{s^2}$$

(a) (10%) Select the value of K_P so that the parabolic-error constant is 100.

(b) (10%) Determine the range of K_D for stability by the Nyquist criterion according to the result of part (a).

(c) (10%) Find the value of K_D so that the phase margin of the system is 45° according to the result of part (a).

4. (30%) Consider the following dynamic equation of a system:

$$\frac{dx(t)}{dt}=\begin{bmatrix}0 & 1\\ 1 & 0\end{bmatrix}x(t)+\begin{bmatrix}0\\ 1\end{bmatrix}u(t)$$

$$y(t)=\begin{bmatrix}-1 & 1\end{bmatrix}x(t)$$

(a) (10%) Determine the stability of the system. Check for the BIBO stability and asymptotic stability, respectively.

(b) (10%) Determine the controllability and observability of the system.

(c) (10%) Assume that the initial state vector is a zero vector. Find the output $y(t)$ when the input is $u(t)=1$ for $t\geq 0$.

國立中正大學
114學年度碩士班招生考試
試 題

[第3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 114 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. Given the network in Fig. 1, find the power dissipated in the 3-Ω resistor and the energy stored in the capacitor 2F. (15 points)
2. Find the input/output relationship (i.e. i_{in}/i_o) in term of R_F, R_L, R_I for the current amplifier shown in Fig. 2. (15 points)
3. Use the differential equation approach to find Vo(t) for t > 0 in the network in Fig. 3. (15 points)
4. Find the equivalent impedance Zeq for the circuit in Fig. 4. (15 points)
5. Find $i_C(t)$ and i(t) in the network in Fig. 5. (20 points)
6. Given the network in Fig. Fig. 6, find the average power supplied and the average power absorbed by each element. (20 points)

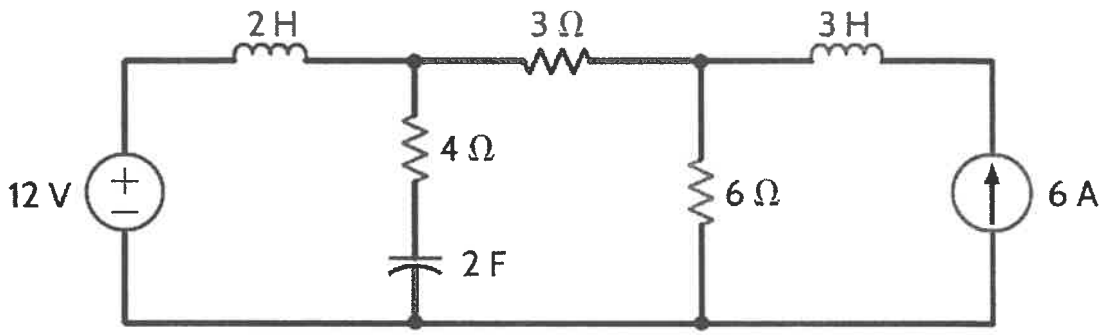


Fig. 1. To find the power dissipated in the 3-Ω resistor and the energy stored in the capacitor.

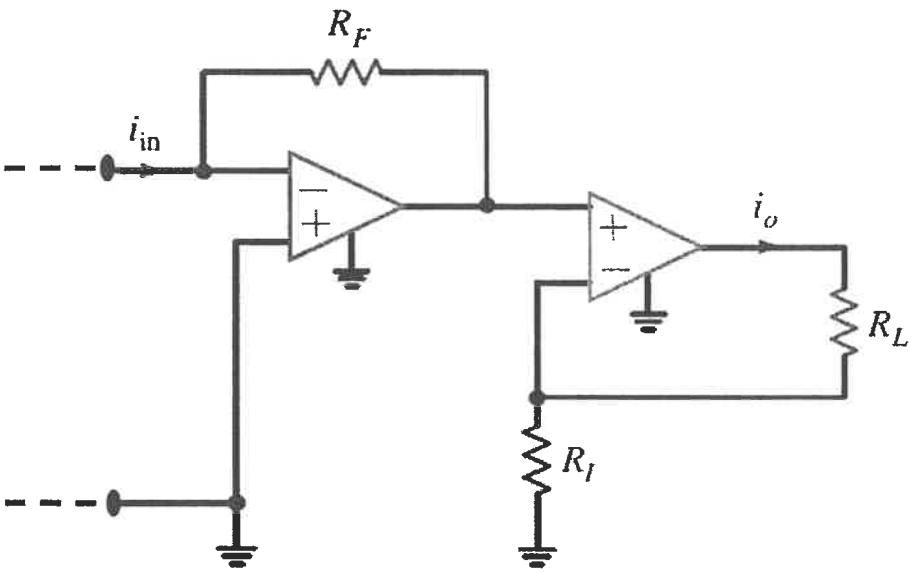


Fig. 2. Find the input/output relationship (i_{in}/i_o) for the current amplifier.

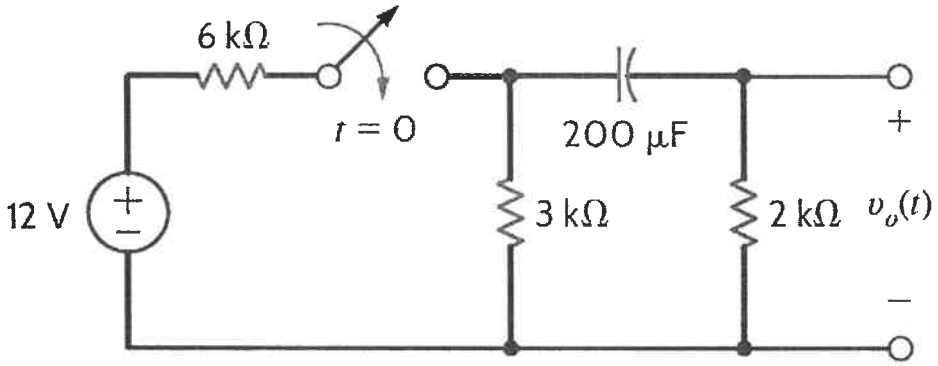


Fig. 3. Use the differential equation approach or Laplace transform to find Vo(t) for t > 0 in the network.

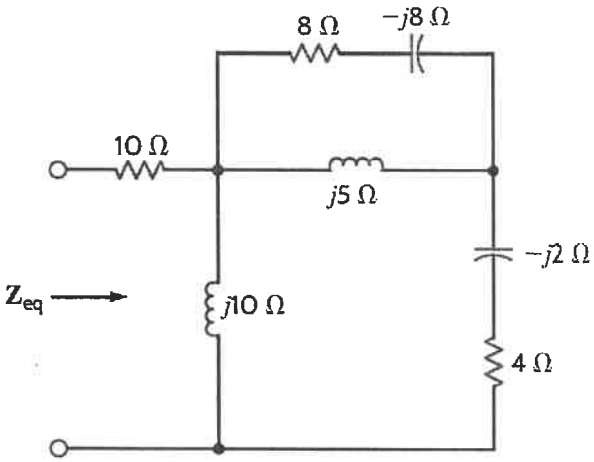


Fig. 4. Find the equivalent impedance Zeq.

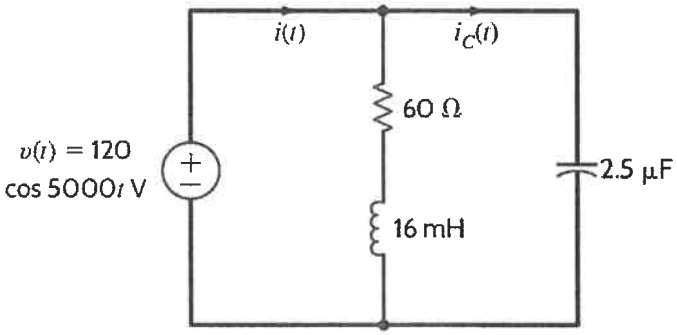


Fig. 5. Find $i_C(t)$ and i(t) in the network.

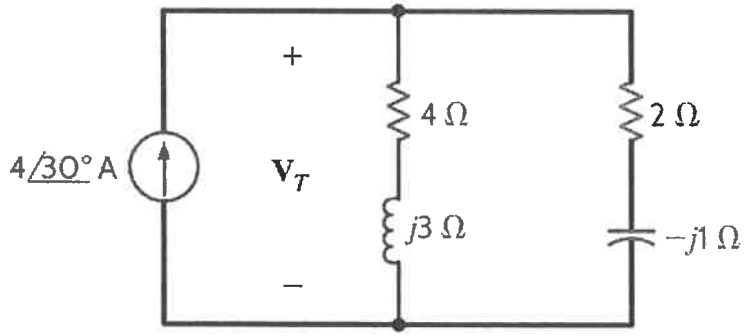


Fig. 6. To find the average power supplied and the average power absorbed by **each element**.