1. (10 %) True or False

$$v_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \triangleq (1,0,0), \quad v_2 = (0,1,0), \quad M = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

(a) v_1 and v_2 are linear independent.

(b) (v_1, v_2) is a basis of R^2.

(c) The eigenvalues of a symmetric matrix are real.

(d) The column space and nullspace are orthogonal.

(e) The line passing through $(0,1)$ and $(1,0)$ is a subspace of R^2.

(f) Let A be a positive definite matrix. A is invertible.

(g) Similar matrices have the same eigenvalues and eigenvectors.

(h) $rank(M) + trace(M) \geq 20$

(i) $|M| = |M^T|$ and $|M| \cdot |M^{-1}| = 1$

(j) The inverse of a symmetric matrix is symmetric.

2. (5%) Please determine the column space and nullspace of A:

$$A = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix}$$

3. (5%) Find an orthonormal basis of the column space of A:

$$A = \begin{bmatrix} 1 & 2 \\ 1 & 1 \\ 0 & 1 \end{bmatrix}, \quad b = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

Please also determine the projection of b onto the column space of A.

4. (5%) Please determine $|A|$, A^{-1}, and $|A^{-1}|$:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ -2 & 1 & 0 \\ -4 & 0 & 1 \end{bmatrix}$$

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5. (5%) Let $A = \begin{bmatrix} 0.8 & 0.3 \\ 0.2 & 0.7 \end{bmatrix}$. It can be represented that $A = S\Lambda S^{-1}$, where Λ is a diagonal matrix and the diagonal entries of Λ are the eigenvakues of A. Please determine S and Λ. Please also determine A^{20} in terms of the derived S and Λ.

6. (5%) Let $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$. It can be represented that $e^{At} = \alpha_1 A + \alpha_2 I$, where I is a 2×2 identity matrix. Please determine α_1 and α_2.

7. (5%) Please determine the eigenvalues and the unit eigenvectors of A:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

8. (5%) Suppose a linear T transforms $(1,1)$ to $(2,2)$ and $(2,0)$ to $(0,0)$. Given $v = (3,2)$, please determine $T(v)$.

9. (5%) Please determine the singular value decomposition (SVD) of A:

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 6 \end{bmatrix}$$

10. (10%) Solve $x^2 y'' - 5xy' + 9y = 0$

11. Given $y'' + 3y' + 2y = u(t-1) - u(t-2)$, $y(0) = 0, y'(0) = 0$
   (a) (10%) solve $y(t)$
   (b) (5%) plot $u(t-1)-u(t-2)$ and $y(t)$

12. (10%) $y_1 = x$ is one solution of $(x^2 - x)y'' - xy' + y = 0$, find another solution y_2 where y_1 and y_2 are linearly independent.

13. (a) (10%) Find the Fourier series of the function

$$f(x) = \begin{cases} 0 & if & -2 < x < -1 \\ k & if & -1 < x < 1 \\ 0 & if & 1 < x < 2 \end{cases} \quad f(x) = f(x+4)$$

(b) (5%) Use this example to explain Gibb phenomenon

說明：本份試題共二頁，包含線性代數與機率兩大題，各佔 50 分，作答時請將題號標示清楚，並請勿將線性代數與機率交錯作答。

一、線性代數 (共 50 分)

1. (10 %) True or False

$$v_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \triangleq (1,0,0), \quad v_2 = (0,1,0), \quad M = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

(a) v_1 and v_2 are linear independent.

(b) (v_1, v_2) is a basis of R^2.

(c) The eigenvalues of a symmetric matrix are real.

(d) The column space and nullspace are orthogonal.

(e) The line passing through $(0,1)$ and $(1,0)$ is a subspace of R^2.

(f) Let A be a positive definite matrix. A is invertible.

(g) Similar matrices have the same eigenvalues and eigenvectors.

(h) $rank(M) + trace(M) \geq 20$

(i) $|M| = |M^T|$ and $|M| \cdot |M^{-1}| = 1$

(j) The inverse of a symmetric matrix is symmetric.

2. (5%) Please determine the column space and nullspace of A:

$$A = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix}$$

3. (5%) Find an orthonormal basis of the column space of A:

$$A = \begin{bmatrix} 1 & 2 \\ 1 & 1 \\ 0 & 1 \end{bmatrix}, \quad b = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

Please also determine the projection of b onto the column space of A.

4. (5%) Please determine $|A|$, A^{-1}, and $|A^{-1}|$:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ -2 & 1 & 0 \\ -4 & 0 & 1 \end{bmatrix}$$

5. (5%) Let $A = \begin{bmatrix} 0.8 & 0.3 \\ 0.2 & 0.7 \end{bmatrix}$. It can be represented that $A = S \Lambda S^{-1}$, where Λ is a diagonal matrix and the diagonal entries of Λ are the eigenvakues of A. Please determine S and Λ. Please also determine A^{20} in terms of the derived S and Λ.

6. (5%) Let $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$. It can be represented that $e^{At} = \alpha_1 A + \alpha_2 I$, where I is a 2×2 identity matrix. Please determine α_1 and α_2.

7. (5%) Please determine the eigenvalues and the unit eigenvectors of A:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

8. (5%) Suppose a linear T transforms $(1,1)$ to $(2,2)$ and $(2,0)$ to $(0,0)$. Given $v = (3,2)$, please determine $T(v)$.

9. (5%) Please determine the singular value decomposition (SVD) of A:

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 6 \end{bmatrix}$$

二、 機率 (共5題，每題10分，共50分)

10. Let the moment-generating function of a random variable X is given by

$$M_X(t) = E(e^{tX}) = \frac{1}{3}e^t + \frac{4}{15}e^{3t} + \frac{2}{15}e^{4t} + \frac{4}{15}e^{5t}.$$

(1) Find the probability mass function of X.　(5%)

(2) Find the variance of X.　(5%)

11. Let X be a uniform random variable over the interval $(0, 1)$ and $Y = X^2$.

(1) Find the probability density function of Y.　(5%)

(2) Find the correlation coefficient $\rho(X, Y)$.　(5%)

12. For an ordinary deck of 52 cards we draw cards at random with replacement, and successively until a King is drawn.

(1) What is the probability that exactly n draws are needed?　(5%)

(2) What is the probability that at least 10 draws are needed?　(5%)

13. There are five boys and six girls in a class. For an oral exam, their teacher calls them one by one and randomly.

(1) What is the probability that the boys and the girls alternate?　(5%)

(2) What is the probability that the boys are called first?　(5%)

14. The time between consecutive earthquakes in Hualien, X, and the time between consecutive earthquakes in Kaohsiung, Y, are independent and exponentially distributed with mean $1/\lambda_1$ and $1/\lambda_2$, respectively.

(1) What is the probability that the next earthquake occurs in Kaohsiung? (5%)

(2) Find the probability density function of $X + Y$. (5%)

本試卷共二頁 (1/2)

Linear Algebra (50%)

1. (10 %) True or False

$$v_1 = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix} \triangleq (1,0,0), \quad v_2 = (0,1,0), \quad M = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

(a) v_1 and v_2 are linear independent.

(b) (v_1, v_2) is a basis of R^2.

(c) The eigenvalues of a symmetric matrix are real.

(d) The column space and nullspace are orthogonal.

(e) The line passing through $(0,1)$ and $(1,0)$ is a subspace of R^2.

(f) Let A be a positive definite matrix. A is invertible.

(g) Similar matrices have the same eigenvalues and eigenvectors.

(h) $rank(M) + trace(M) \geq 20$

(i) $|M| = |M^T|$ and $|M| \cdot |M^{-1}| = 1$

(j) The inverse of a symmetric matrix is symmetric.

2. (5%) Please determine the column space and nullspace of A:

$$A = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix}$$

3. (5%) Find an orthonormal basis of the column space of A:

$$A = \begin{bmatrix} 1 & 2 \\ 1 & 1 \\ 0 & 1 \end{bmatrix}, \quad b = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$$

Please also determine the projection of b onto the column space of A.

4. (5%) Please determine $|A|$, A^{-1}, and $|A^{-1}|$:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ -2 & 1 & 0 \\ -4 & 0 & 1 \end{bmatrix}$$

5. (5%) Let $A = \begin{bmatrix} 0.8 & 0.3 \\ 0.2 & 0.7 \end{bmatrix}$. It can be represented that $A = S\Lambda S^{-1}$, where Λ is a diagonal matrix and the diagonal entries of Λ are the eigenvakues of A. Please determine S and Λ. Please also determine A^{20} in terms of the derived S and Λ.

6. (5%) Let $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$. It can be represented that $e^{At} = \alpha_1 A + \alpha_2 I$, where I is a 2×2 identity matrix. Please determine α_1 and α_2.

7. (5%) Please determine the eigenvalues and the unit eigenvectors of A:

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

8. (5%) Suppose a linear T transforms $(1,1)$ to $(2,2)$ and $(2,0)$ to $(0,0)$. Given $v = (3,2)$, please determine $T(v)$.

9. (5%) Please determine the singular value decomposition (SVD) of A:

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 6 \end{bmatrix}$$

Differential Equations (50%)

10. (10%) Please determine the solution of $x^2 y'' + 2xy' + y = x$

11. (10%) Please determine the solution of
$$y'' + 2ay' + a^2 y = e^{-2x}, \quad 1 < a < 3, y(0) = 0, y'(0) = 0$$

12. (10%) Consider a series RC circuit with pulse input voltage source, i.e.,
$$v_s(t) = 2u(t-2) - 2u(t-3).$$
Please determine the voltage response of the capacitor $v_c(t)$ for $t > 0$.

13. (10%) Given $y'' - 2y' - 3y = e^{-t}$, $\quad y(0) = 1, \quad y'(0) = 2$,
Please determine the solution by using the Laplace Transform method.

14. (10%) Please determine the solution of the following partial differential equation,
$$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2} \quad , \text{B.C. } u(0,t) = 0, u(L,t) = 0, \forall t; u(x,0) = g(x), \quad 0 \leq x \leq L$$

1. The circuit of a four-stage bipolar op amplifier is shown in Fig.1. Assume

   $|V_{BE}| = 0.7$ V, $\beta = 100$, and the thermal voltage $V_T \cong 25mV$.

   (a) Calculate the quiescent power dissipation in the circuit. (4 %)

   (b) What is the input common-mode range of the amplifier. (4 %)

   (c) Find the input differential resistance R_{id}. (4 %)

   (d) Find the output resistance R_o. (4 %)
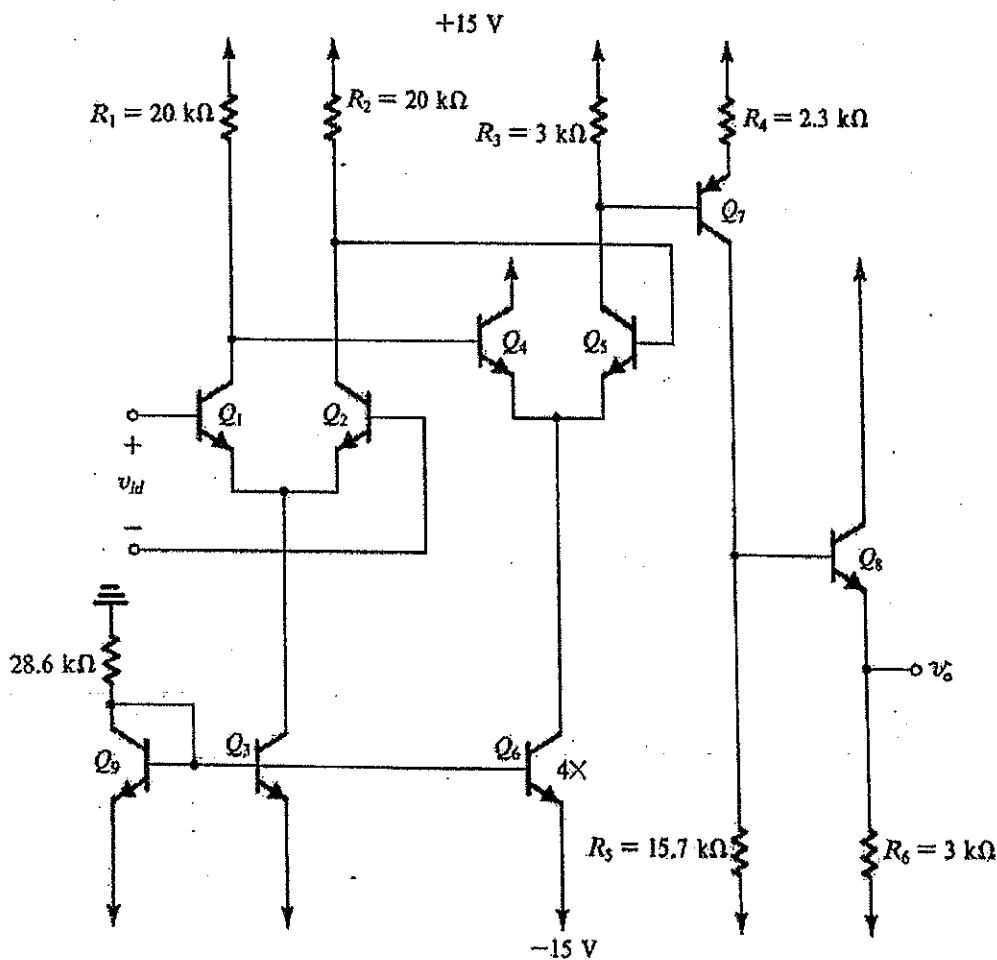
   (e) Calculate the overall voltage gain v_o / v_{id}. (5 %)

Fig.1

2. The circuit of a D/A converter is shown in Fig. 2. Assume $\beta \gg 1$ for all transistors.

   (a) Verify that $I_i \cong 2I_{i+1}$, where $i = 1, 2, ..., N-1$. (7 %)

   (b) Design a circuit for each switch S_i and explain the operation. (6 %)

Fig.2

3. A block diagram representation of the internal circuit of the 555 integrated-circuit timer is shown in Fig.3.

   (a) Draw a circuit for a monostable multivibrator based on the 555 timer, and explain the operation of the monostable multivibrator.(8 %)

   (b) Draw a circuit for an astable multivibrator based on the 555 timer, and explain the operation of the stable multivibrator. (8 %)

Fig. 3

4. (a) Sketck a CMOS circuit which performs the Boolean expression

$$Y = \overline{A(B+CD)}. (5\%)$$

(b) Explain why the statistic power dissipation of the CMOS circuit is zero(leakage effect is negligible). (5 %)

5. Explain and describe the following power conversion terminology:

(a) Hard switching (5%)

(b) soft switching (5%)

6. (a) Draw a forward converter circuit. (3%)

(b) Describe the operational principle of this converter. (5%)

(c) Derive transfer ratio of output- input voltage. (2%)

7. Describe difference performances between power factor correction and active power filter.(10%)

8. Draw schematic diagram of half-bridge series resonant parallel load inverter for electronic ballast and describe operation when the inverter is operated in below resonant mode. (10%)

1. Assuming the op amp to be ideal, find the output voltage and the input resistance of the circuit in Fig. 1. (10 %)
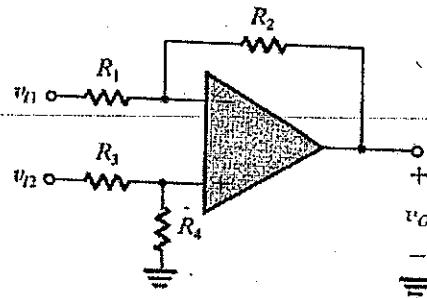

Fig. 1

2. Assume that each of the zener diodes in Fig.2(a) has the $i - v$ characteristic as shown in Fig.2(b). Draw the v_I - v_o transfer characteristic for the circuit.(14 %)
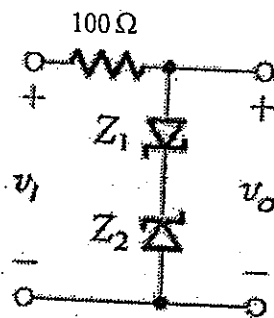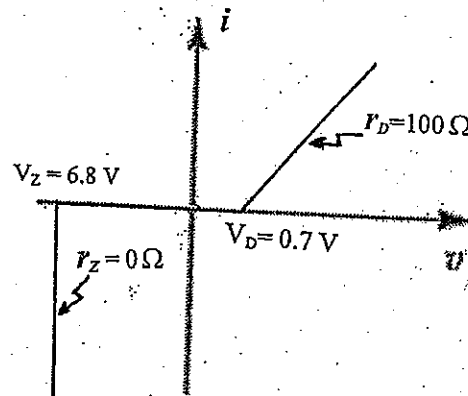

Fig.2(a)　　　　　Fig.2(b)

3. The NMOS and PMOS transistors in the circuit of Fig.3 are matched with $k'_n(W_n / L_n) = k'_p(W_p / L_p) = 1$ mA/V^2 and $V_{tn} = -V_{tp} = 1$ V. Assuming $\lambda = 0$ for both devices, find the drain currents i_{DN} and i_{DP}, as well as the voltage v_o, for $v_I = 0$ V and 2.5 V. (16 %)
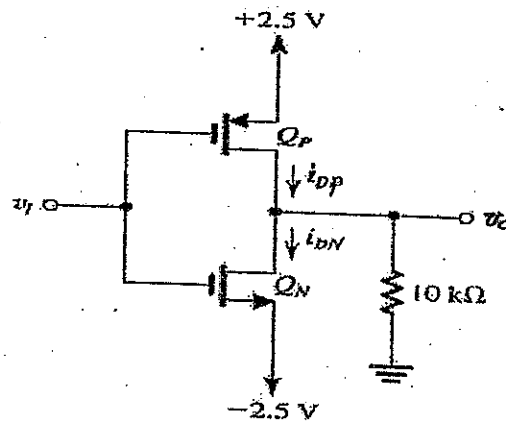

Fig.3

4. The circuit of a four-stage bipolar op amplifier is shown in Fig.4. Assume $|V_{BE}| = 0.7$ V, $\beta = 100$, and the thermal voltage $V_T \cong 25mV$.

   (a) Calculate the quiescent power dissipation in the circuit. (4 %)
   (b) What is the input common-mode range of the amplifier. (4 %)
   (c) Find the input differential resistance R_{id}. (4 %)
   (d) Find the output resistance R_o. (4 %)
   (e) Calculate the overall voltage gain v_o / v_{id}.(5 %)
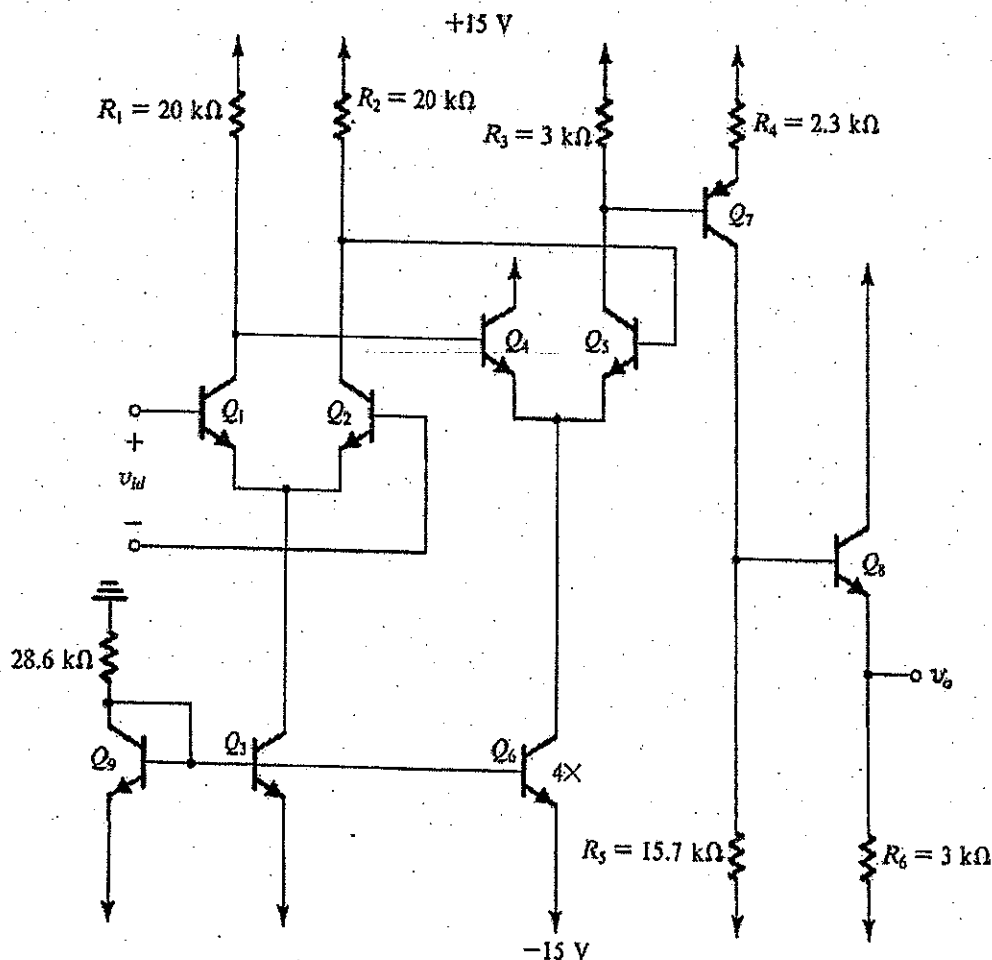

Fig.4

5. The circuit of a D/A converter is shown in Fig. 5. Assume $\beta \gg 1$ for all transistors.
   (a) Verify that $I_i \cong 2I_{i+1}$, where $i = 1, 2, ..., N-1$.(7 %)
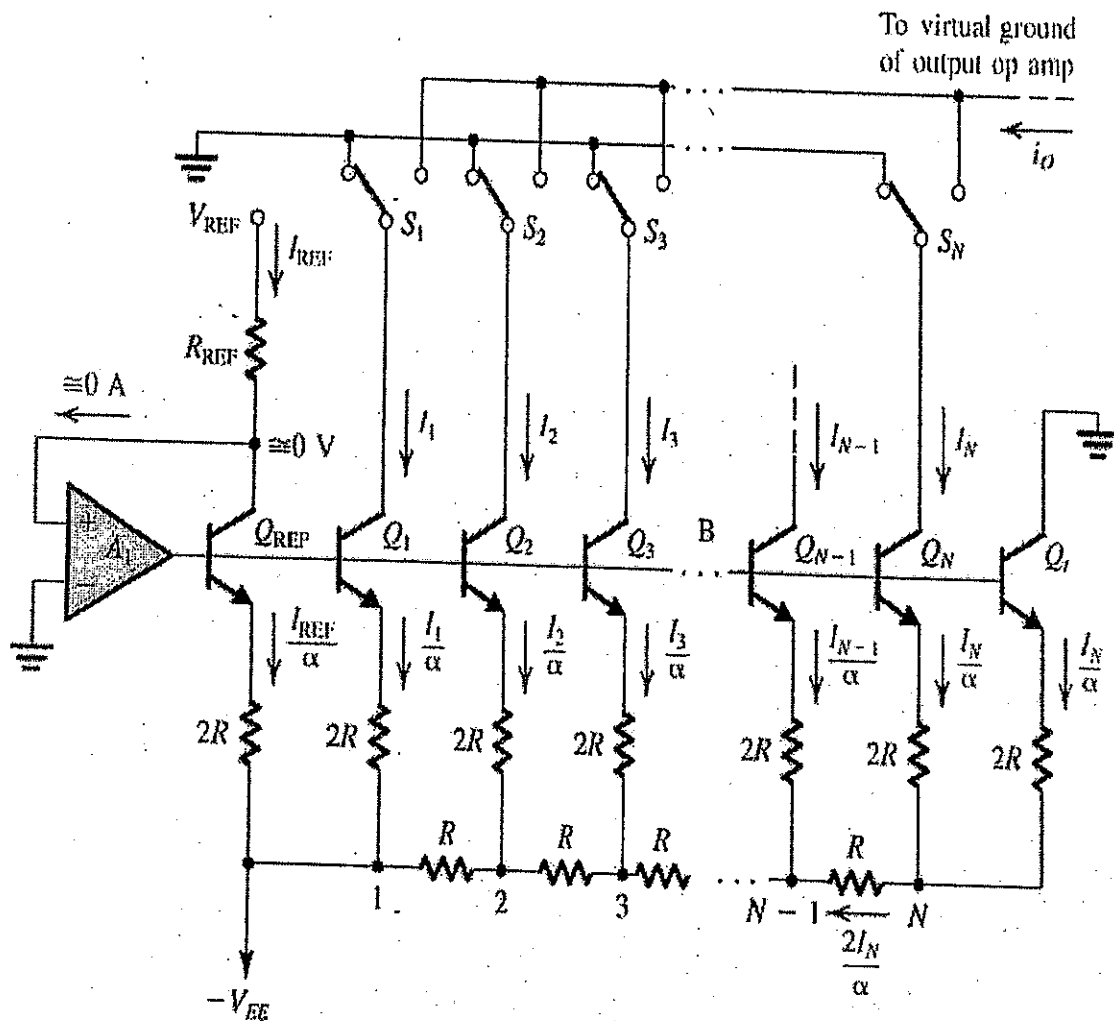   (b) Design a circuit for each switch S_i and explain the operation. (6 %)

Fig.5

6. A block diagram representation of the internal circuit of the 555 integrated-circuit timer is shown in Fig.6.

  (a) Draw a circuit for a monostable multivibrator based on the 555 timer, and explain the operation of the monostable multivibrator.(8 %)

  (b) Draw a circuit for an astable multivibrator based on the 555 timer, and explain the operation of the stable multivibrator. (8 %)
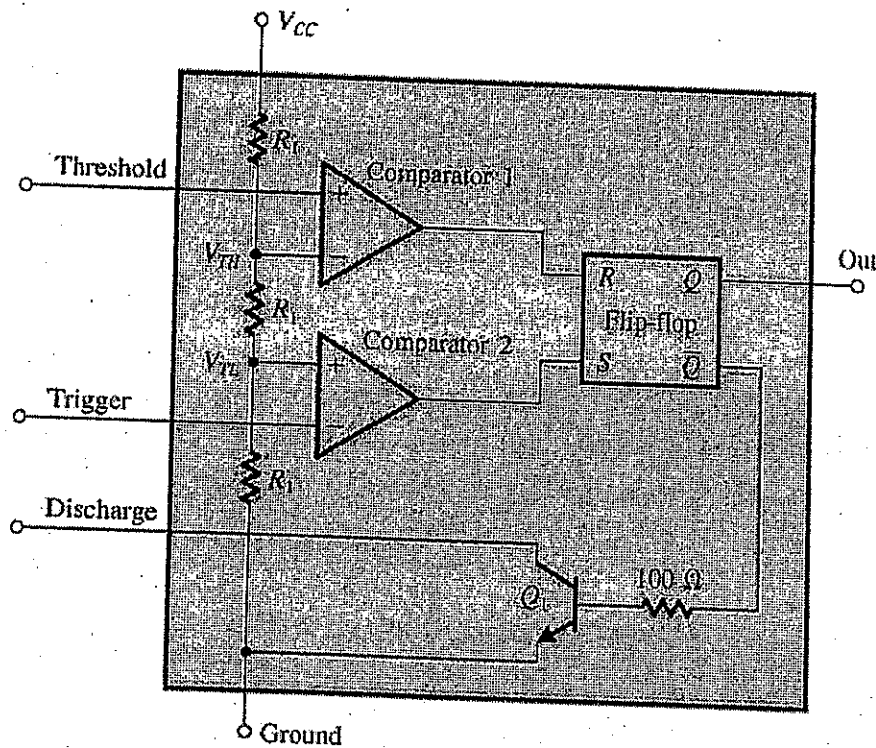
Fig. 6

7. (a) Sketck a CMOS circuit which performs the Boolean expression

$$Y = \overline{A(B+CD)} \quad .(5\%)$$

(b) Explain why the statistic power dissipation of the CMOS circuit is zero(leakage effect is negligible). (5 %)

Communications

本試卷共一頁

1. (10 pts) Compare the difference between
   (1) analog signal and digital signal,
   (2) analog communication systems and digital communication systems.

2. (15 pts) Consider an AM communication system with sinusoidal input signal and 0.8 modulation index. If the frequency of the input signal is 1KHz, the amplitude of the input signal is 5 volts, the carrier frequency is $f_c = 1$MHz.
   (1) Plot the time waveform and the frequency spectrum of the signal at the transmitter output,
   (2) Plot the block diagram of the AM receiver,
   (3) If the recovered carrier frequency is 1.001MHz, please find the receiver output signal.

3. (15 pts) For SSB communication systems implemented with Hilbert Transform,
   (1) Describe the definition of the Hilbert Transform,
   (2) Derive and express the upper SSB (USSB) signal in terms of Hilbert Transform,
   (3) Find the SNR at the output of the USSB receiver for the AWGN channel.

4. (15 pts) For FM communication system with AWGN channel,
   (1) Plot the block diagrams of the FM transmitter and the receiver,
   (2) Derive the noise power spectral density at FM discriminator output,
   (3) Describe the uses of the preemphasis filter and the deemphasis filter and their purposes in the FM system.

5. (15 pts) In the digital communication systems, most of the received signals have InterSymbol Interference (ISI).
   (1) Describe the ISI phenomenon,
   (2) Define the ISI in terms of related signals,
   (3) Describe the methods to reduce the ISI.

6. (15 pts) Draw the sequence 00101001110110001 with graph of following schemes,
   (1) NRZ,
   (2) NRZ-L,
   (3) Manchester code,
   (4) AMI,
   (5) 2B1Q.

7. (15 pts) For QPSK communication system,
   (1) Compare the difference between BPSK and QPSK,
   (2) Plot the block diagrams of the QPSK transmitter and its receiver,
   (3) Find the BER (Bit Error Rate) of the QPSK system in terms of E_b/N_0 for the AWGN channel.

說明：計算題、推導題及證明題須有詳細過程，解釋題及問答題務必詳細說明。

1. Consider an LTI system described by the difference equation $y[n]=0.25x[n]+0.5x[n-1]+0.25x[n-2]$ where $y[n]$ is system output and $x[n]$ is system input.

   (a) Find the impulse response $h[n]$, transform function $H(z)$ and ROC. (12%)

   (b) Do you think $h[n]$ is a lowpass, bandpass or highpass filter? Please explain your answer in detail. (8%)

2. Let two signals $x_1(t)$ and $y_1(t)$ be given in Fig.1 (a) and Fig. 1(b) respectively.

   (a) Find the convolution of $x_1(t)$ and $y_1(t)$. (10%)

   (b) Find the Fourier transform of the nonperiodic signal $x_1(t)$. (6%)

Fig.1 (a)　　　　Fig. 1(b)　　　　　　　　　　　　　　　Fig. 2
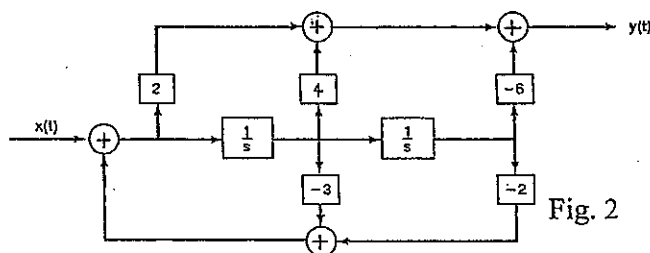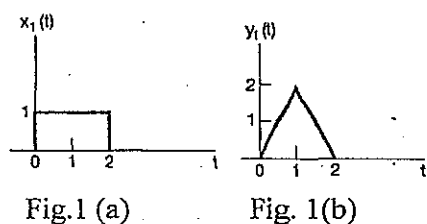
3. The input $x(t)$ and output $y(t)$ of a causal LTI system are related through the block diagram representation shown in Fig. 2.

   (a) Find the system function $H(s)$, ROC and the impulse response $h(t)$. (12%)

   (b) Determine a differential equation relating $y(t)$ and $x(t)$. (8%)

   (c) Can the system be both stable and causal? (4%)

4. A discrete-time periodic signal $x[n]$ is real valued and has a fundamental period $N=5$. The nonzero Fourier series coefficients for $x[n]$ are $a_0=2$, $a_2=a_{-2}^{*}=2e^{j\pi/6}$, $a_4=a_{-4}^{*}=e^{j\pi/3}$. Express $x[n]$ in the form $x[n]=A_0+\sum_{k=1}^{\infty}A_k\sin(\omega_k n+\phi_k)$. (10%)

5. Impulse-train sampling of $x[n]$ is used to obtain $g[n]=\sum_{k=-\infty}^{\infty}x[n]\delta[n-kN]$. If $X(e^{j\omega})=0$ for $3\pi/7\le|\omega|\le\pi$, determine the largest value for the sampling interval N which ensures that no aliasing takes place while sampling $x[n]$. (10%)

6. Show a discrete-time LTI system is stable if the system's impulse response $h[n]$ is absolutely summable ($\sum_{n=-\infty}^{\infty}|h[n]|<\infty$). (10%)

7. Consider a continues-time ideal lowpass filter S whose frequency response $H(j\omega)$ is zero for $|\omega|>100$. When the input to this filter is a signal $x(t)$ with fundamental period $T=\pi/6$ and Fourier series coefficients a_k. It is found that the system output $y(t)=x(t)$. For what value of k is it guaranteed that $a_k=0$. (10%)

1. 解釋名詞(詳細說明以下各小題之義意、原理與用途，可使用數學式、方塊圖、曲線、文字等說明)：(每小題 4%，共 40%)

   (1)短路比(short-circuit ratio, SCR)，(2)磁滯(hysteresis)，(3)有載分接頭(on-load tap changer)，(4)次暫態電抗(subtransient reactance)，(5)行駛繞組(running winding)，(6)磁阻(reluctance)，(7)等面積法則(equal-area criteria)，(8)負載匯流排(load bus)，(9)氣隙功率(air-gap power)，(10)串激式直流電機(series DC machine)。

2. 試繪出單相降壓變壓器交付至高壓側的等效電路，並說明如何以短路與開路實驗決定此等效電路中各元件的參數。(10%)

3. 一個 8 極三相感應電動機，線對線電壓為 11,400V、額定輸出 4,000kW、電源頻率 60Hz。若此感應電動機在轉差率為 1% 運轉，求：(1)定子同步旋轉磁場轉速 rpm，(2)轉子對定子轉速 rpm，(3)轉子感應電壓頻率，(4)轉子感應旋轉磁場對轉子轉速 rpm，(5)轉子感應旋轉磁場對定子轉速 rpm。(15%)

4. 一個三相同步電機額定 20kV、容量 20MVA，以此為基準值得到的戴維寧輸出電抗為 0.2 標么。若基準值修正為 22kV、30MVA，試計算新的電抗標么值。(10%)

5. 在圖 1 系統中，試繪出計算各式故障電流所需的正、負、零相序電路，在此相序電路圖中傳輸線阻抗忽略，但需考量所有變壓器與發電機之相序阻抗，並請在此相序電路上標出對應的 P、Q、F 與 R 點。(10%)
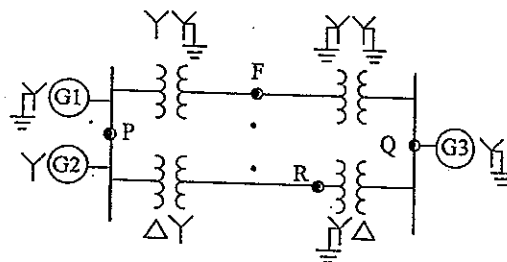

圖1.

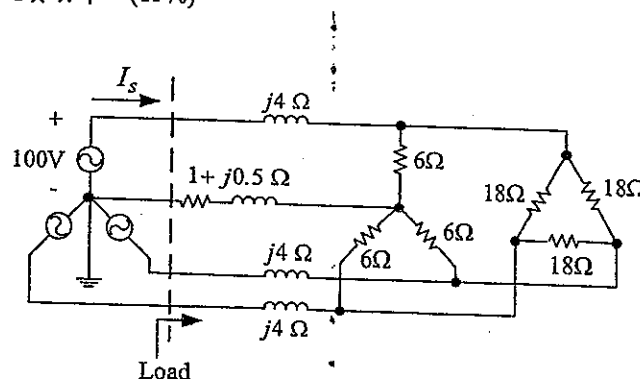6. 在圖2之三相平衡電路中，電源相電壓100伏，試計算：(1)電源線電流 I_S，(2)自電源看至負載的功率因數，(3)負載吸收總實功率。(15%)

圖2.

1. Notation conversion: (30%)
    (a) Convert each of the following base ten representations to its equivalent two's complement representation in which each value is represented in eight bits:
        (1) −79　(2) −112
    (b) Convert each of the following base ten representations to its equivalent binary representation:
        (1) $7\frac{5}{8}=$　(2) $27\frac{13}{64}=$
    (c) Use <u>octal</u> notation to represent the following bit patterns:
        (1) 1011001011110110110110110110　(2) 1111010011110001000010101
    (d) What bit patterns are represented by the following hexadecimal patterns?
        (1) 43CD1　(2) FA13C
    (e) Convert each of the following binary representations to its equivalent base ten representation:
        (1) 1010.101
    (f) Convert each of the following two's complement representations to its equivalent base ten representation:
        (1) 1101101
2. (a) Convert −0.0234375 to IEEE 32-bit Excess_127 floating-point format. (7%)

    (b) The bit pattern (11000011001000011110000000000000) is stored in memory in IEEE 32-bit Excess_127 floating-point format. What the value of the number is in decimal notation? (8%)

Language Description Table

Op-code	Operand	Description
1	RXY	LOAD the register R with the bit pattern found in the memory cell whose address is XY.
2	RXY	LOAD the register R with the bit pattern XY.
3	RXY	STORE the bit pattern found in register R in the memory cell whose address is XY.
4	0RS	MOVE the bit pattern found in register R to register S.
5	RST	ADD the bit patterns in registers S and T as though they were two's complement representations and leave the result in register R.
6	RST	ADD the bit patterns in registers S and T as though they represented values in floating-point notation and leave the floating-point result in register R.
7	RST	OR the bit patterns in registers S and T and place the result in register R.
8	RST	AND the bit patterns in register S and T and place the result in register R.
9	RST	EXCLUSIVE OR the bit patterns in registers S and T and place the result in register R.
A	R0X	ROTATE the bit pattern in register R one bit to the right X times. Each time place the bit that started at the low-order end at the high-order end.
B	RXY	JUMP to the instruction located in the memory cell at address XY if the bit pattern in register R is equal to the bit pattern in register number 0. Otherwise, continue with the normal sequence of execution.
C	000	HALT execution.

3. The following is a routine encoded in the machine language described in the above language description table. Explain (in a single sentence) what the routine does. (Explain what the entire routine does as a unit rather than reciting what each instruction does.) (10%)

    210F
    12A0
    8212
    32A0

4. Using the above **language description table,** write programs to perform each of the following tasks: (20%)

   (a) Copy the bit pattern stored in memory location 66 into memory location BB.

   (b) Copy the least significant four bits from memory location A5 into the least significant four bits of location A6 while leaving the other bits at location A6 unchanged.

5. Describe the machine cycle. (5%)

6. What is the CSMA/CD protocol in Ethernet network? Please describe it in detail. And what is the guarantee time that if the collision does not occur in this time duration, it will not happen in the consecutive data transmission? (10%)

7. Explain the following techniques? (10%)
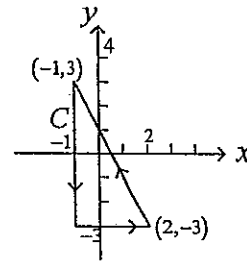
    (a) Time sharing　　　　　(b) Virtual memory

本試題共計一頁，各子題計分為該題總分之平均

1. In the cylindrical coordinate system with $\{a_r, a_\phi, a_z\}$ being the basis vectors, please calculate (a) $\dfrac{\partial a_r}{\partial \phi}$, and (b) $\dfrac{\partial a_\phi}{\partial \phi}$. (20%)

2. A close path is shown beside. Given $A = x^2 a_x + 3yz a_y + 2xy a_z$, please calculate (a.) $\nabla \times A$, and (b.) $\oint_C A \cdot d\underline{l} = ?$ (20%)

3. Consider a system consists of three charges Q_1 at position $(x,y) = (-1,0)$, Q_2 at position $(x,y) = (1,0)$, and Q_3 at position $(x,y) = (0,2)$. Assuming $Q_1 = Q_2 = q$, and $Q_3 = -2q$, what is the work required to assemble this three-charge system? (20%)

4. A spherical capacitor consisting of an inner spherical conductor of radius a and a outer shell of radius b and a dielectric of constant ε is filled in between.

(a) Capacitance $C = ?$

(b) In terms of C and the applied voltage V across the two conducting shells, please calculate the stored energy $W_e = ?$ (20%)

5. Consider a very long wire carrying current I and a rectangular loop as shown below. Please calculate the mutual inductance $L_{12} = ?$ (20%)
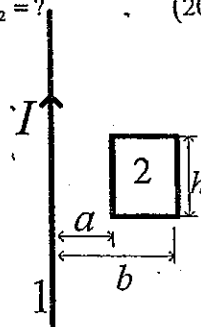
1. (10%) A system is given as

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

Let $x_1(t) = y(t)$, $x_2(t) = \frac{dy(t)}{dt}$, $x_3(t) = \frac{d^2y(t)}{dt^2}$ be the state variables.

   (a) (5%) Please determine the state space representation of the system.

   (b) (5%) Please determine the transfer function $\frac{Y(s)}{R(s)}$.

2. (20%) A system is given as

$$\dot{x}(t) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t)$$

where

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

   (a) (10%) Please determine $x(t)$ if $u(t)$ is a unit-step function, $x(0) = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$.

   (b) (10%) Find the matrices A_1 and B_1 such that the state equation can be represented as

$$\frac{d\bar{x}(t)}{dt} = A_1\bar{x}(t) + B_1u(t)$$

where $\bar{x}(t) = \begin{pmatrix} y(t) \\ x_1(t) \end{pmatrix}$.

3. (10%) A transfer function is given as $\frac{Y(s)}{R(s)} = \frac{1}{(s+2)(s+3)(s+4)}$. Please determine the dynamic equation according to the parallel decomposition.

4. (10%) A motor-load system is given as follows. Please write the torque equation of the system. Please also find the state equation representation.
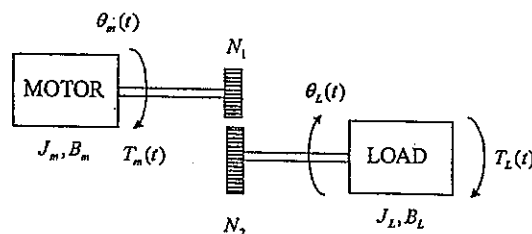
1

5. (10%) The forward-path transfer function of a unity-feedback system is given as $G(s) = \frac{4}{s(s+2)}$.

   (a) Please determine the maximum overshoot.

   (b) Please determine the steady-state error, if the input is $r(t) = t$, $t \geq 0$ and $r(t) = 0$, otherwise.

6. (10%) The forward-path transfer function of a unity-feedback system is give as follows

$$G(s) = \frac{K}{s(s+2)(s+10)}$$

Please construct the root loci, $-\infty < K < \infty$.

7. (10%) The characteristic equation of a closed-loop system is given as

$$s(s+1)(s+10) + K = 0$$

Let $K = 100$. Please construct the Bode plot. Please also identify the GM and PM.
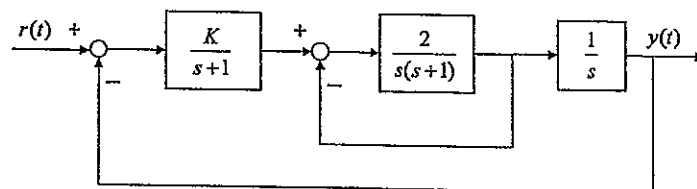
8. (10%) A system is given as

$$\dot{x}(t) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t)$$

where

$$A = \begin{pmatrix} 1 & 1 \\ 0 & -2 \end{pmatrix}, \quad B = \begin{pmatrix} 0 \\ 1 \end{pmatrix}, \quad C = \begin{pmatrix} 0 & 1 \end{pmatrix}$$

   (a) (5%) Please determine the controllability and observability.

   (b) (5%) Please find a 1×2 feedback gain vector K, $u(t) = Kx(t)$, such that the closed-loop system is stable.

9. (10%) A system is given as follows. Please detremine the stability region of K.

2

1. The notation $x_1 x_0$ represents a two-bit binary number that can have any value (00, 01, 10, 11); for example, when $x_1 = 1$ and $x_0 = 0$, the binary number is 10, and so on. Similarly, $y_1 y_0$ represents another two-bit binary number. Design a logic circuit, using x_1, x_0, y_1, y_0 inputs, whose output will be HIGH only when the two binary numbers $x_1 x_0$ and $y_1 y_0$ are equal. (20%)

2. Figure 1 shows the block diagram of a J-K flip-flop. Consider a counter circuit that contains six J-K flip-flops. (i.e., Q_5, Q_4, Q_3, Q_2, Q_1, Q_0, are outputs).
   (a) Determine the counter's MOD number. (5%)
   (b) Determine the frequency at the output of the last J-K flip-flop Q_5 when the input clock frequency is 1 MHz. (5%)
   (c) What is the ring of counting states for this counter? (5%)
   (d) Assume a starting state (count) of 000000. What will be the counter's state after 129 pulses? (5%)
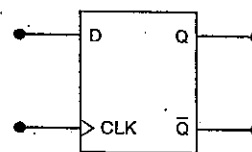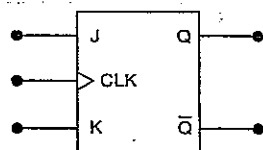

Fig. 1 The block diagram of a J-K flip-flop.　Fig. 2 The block diagram of a D flip-flop.

3. The shift-register counter means the output of the last D flip-flop (Fig. 2) in the register is connected back to the first D flip-flop,
   (a) Please draw a four-bit ring counter by using the D flip-flops, (7%)
   (b) Find the truth table, (6%)
   (c) Draw the state diagram. (7%)

4. Figure 3 shows how a multiplexer can be used to generate logic waveforms with any desirable pattern. The pattern is programmed using eight SPDT switches, and the waveform is repetitively produced by the MOD-8 counter. Draw the waveform at output Z for the given switch positions. (10%)
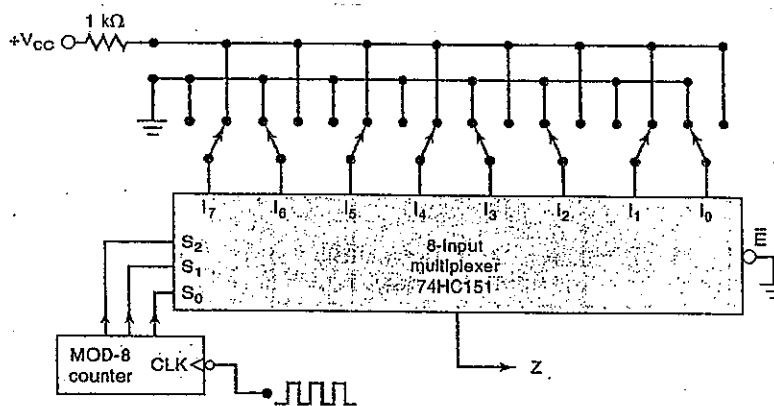

Fig. 3 An 8-input multiplexer.

長庚大學九十八學年度研究所碩士班(含在職專班)招生考試試題

所別:電機工程所碩士班　　　　　　　　考試科目:邏輯設計

注意:請詳細閱讀下列試題,並請標明題號依試題順序將答案書寫於答案卷上。　（本試題共 二 頁,
此為第 2 頁）

5. Design a counter with the irregular binary count sequence shown in the state diagram of Fig 4. Please design the circuit by using J-K flip-flops (15%)
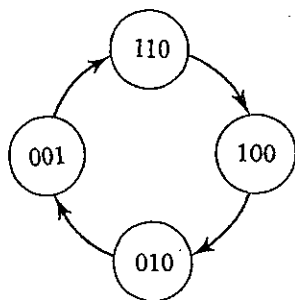

Fig. 4 The state diagram of the irregular binary count sequence.

6. Draw a logic symbol diagram of a MOD-5 ripple up counter. Use three J-K flip-flops and a two-input NAND gate. Show input clock (CLK) pulses and three output indicators labeled C, B, and A (C indicator is MSB). (15%)

(本份試題共計 2 頁，第一頁)

一、計算題五十五%(需詳列計算過程，共 2 題)

1. (35%)如圖 1 所示之三相平衡電路，試計算(a) I_{aA}，(b) V_{AB}，(c) I_{AB}，(d) 傳送至負載的有效電力及(e) 線路損失。

圖1.　　　　　電源　　　　　線路　　　　　負載

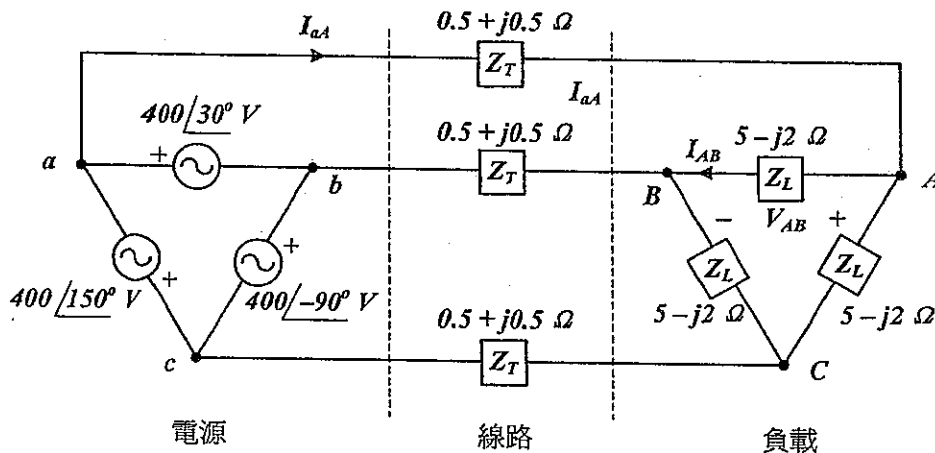2. (20%)一理想運算放大器電路如圖 2 所示：
   (a) 試計算其電壓增益 $v_{OUT}(s)/v_{IN}(s)$。(15%)
   (b) 判斷濾波器之型式及階數。(5%)
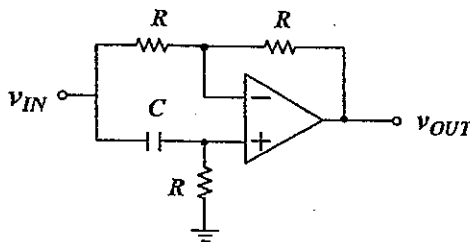
圖2.

二、選擇題四十五%(單選題，共 15 題，答錯不倒扣，每題 3 分)

1. 一串聯 RLC 電路：R=300Ω, L=10mH, C=1μF，試判斷其電路之阻尼特性：

   (A) 過阻尼　(B) 欠阻尼　(C) 臨界阻尼　(D) 以上皆非

2. 承 1 題，此電路之阻尼比為？

   (A) 0.1　(B) 1.0　(C) 1.5　(D) ∞ 無窮大

3. 十進位 97_{10} 的 BCD 碼為

   (A) 01100001_{BCD}　(B) 10010111_{BCD}　(C) 10010100_{BCD}　(D) 以上皆非

4. 一微處理器有 20 條位址線，其可存取多少記憶單位：

   (A) 128k (B) 512k (C) 1024k (D) 2048k units

（本份試題共計2頁，第二頁）

5. 某濾波器轉移函數為 $\dfrac{10s}{-2s^2+s+1}$ ，此濾波器屬於何種特性？

    (A) 低通(low-pass) (B) 高通(high-pass) (C) 帶通(band-pass) (D) 全通(all-pass)

6. 同5題，此濾波器之直流增益為？

    (A) 0 (B) 0.1 (C) 1 (D) 100

7. 一個電力電子元件編號為 IRF640，其功能為？

    (A) 電感器 (B) 電容器 (C) 二極體 (D) MOS 開關

8. 一陶瓷電容編號為 104，其容值為：

    (A) 0.1μF (B) 1.0μF (C) 10μF (D) 100μF

9. 如圖 3 所示，二極體為理想，若 $V_s=3V$，試求 V_o=？ (A) -1.5V

    (B) 0V (C) 1.5V (D) 3V

10. 續 9 題，此時 D1 及 D2 二極體工作於：

    (A) D1 導通,D2 導通 (B) D1 導通,D2 截止 (C) D1 截止,D2 導通

    (D) D1 截止,D2 截止

圖 3.

11. 在控制系統中 Windup 現象可使用何種方法解決？

    (A) 移除積分控制器 (B) 加入前饋控制(feedforward control) (C) 採用比例控制器

    (D) 加入微分控制器

12. 一用戶每月用電為 200 度，意即其每月用電：

    (A) 200 瓦 (B) 200 焦耳 (C) 200 千瓦小時 (D) 以上皆非

13. 現今最常用作發電機使用之電機機械為：

    (A) 同步機 (B) 感應機 (C) 直流機 (D) 變壓器

14. 三個容量均為 3 法拉的電容並聯後，其等效電容為多少法拉？

    (A) 1 (B) 2 (C) 6 (D) 以上皆非

15. 一電阻色碼為橙黑棕，其阻值為何？

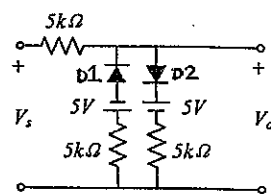   (A) 300Ω (B) 3000Ω (C) 400Ω (D) 4000Ω