國立雲林科技大學 112 學年度 碩士班招生考試試題

系所：電子系

科目：工程數學(2)

本試題共 7 題，每題得分如各題中所示，共計 100 分，請依題號作答並將答案寫在答案卷上，違者不予計分。

1. Please solve for $y = y(x)$.

   (a) (05%) $xy' + 3y = 2x$

   (b) (05%) $y'' + 5y' + 6y = 0$

   (c) (05%) $x^2y'' + 1.5xy' - 0.5y = 0$

2. (15%) Find the integration factor and solution of the ODE equation

$$(3x^2y + 6xy + \frac{y^2}{2})dx + (3x^2 + y)dy = 0$$

3. (10%) Solve ODE solution of $y'' + 2y' + y = xe^{-x}$

4. (10%) Laplace equation:

   (a) If $f(t) = (t+2)^2$, $t \geqq 0$, please find $L[f(t)]$

   (b) $F(S) = \frac{3}{(S+3)} + \frac{3S}{S^2+5}$, please find $L^{-1}[F(S)]$ 。

5. A transform $T: \mathcal{R}^4 \to \mathcal{R}$ is defined as follows,

$$T\left(\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}\right) = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} \cdot \begin{bmatrix} 2 \\ 0 \\ 2 \\ 1 \end{bmatrix}$$

   (a) (10%) Prove that T is a linear transformation.

   (b) (05%) Find the transformation matrix $\mathbf{A}$ to make $T(\mathbf{x}) = \mathbf{Ax}$.

   (c) (05%) Find the kernel of $\mathbf{A}$.

6. (10%) Let $\mathbf{A} = \begin{bmatrix} 1 & -6 & 4 \\ -3 & 8 & -2 \\ 4 & 7 & h \end{bmatrix}$, find the value of h to make $\mathbf{A}$ invertible.

7. Given $\mathbf{A} = \begin{bmatrix} 0.4 & -0.3 \\ 0.4 & 1.2 \end{bmatrix}$,

   (a) (10%) Find an invertible matrix $\mathbf{P}$ and a diagonal matrix $\mathbf{D}$ to make $\mathbf{A} = \mathbf{PDP^{-1}}$.

   (b) (05%) Find $\lim_{n\to\infty} \mathbf{A}^n$.

   (c) (05%) Find the eigenvalues of $\mathbf{A^{-1}}$

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系所：電子系

科目：計算機概論(4)

本試題共 8 題，每題得分如各題中所示，共計 100 分，請依題號作答並將答案寫在答案卷上，違者不予計分。

1. (10 pt.) Convert the following 2's complement binary numbers to decimal.

(a) 1010

(b) 0110

(c) 01011010

(d) 11111110

(e) 0011100111010011

2. (10 pt.) Convert the following unsigned binary numbers to hexadecimal.

(a) 1101 0001 1010 1111

(b) 001 1111

(c) 1111 1111

(d) 1

(e) 1110 1101 1011 0010

3. If the Y is output and A, B is input, the XOR function can be shown as follows:

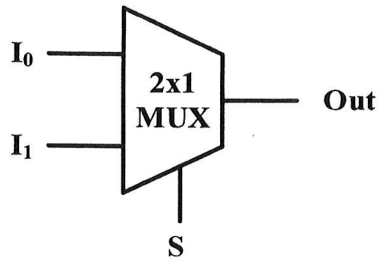
$$Y = \overline{A}B + A\overline{B}$$

Implement the XOR function by means of:

(a) (10 pt.) NAND gates only.

(b) (10 pt.) NOR gates only.

4. (10 pt.) A symbol of 2-to-1 MUX is shown in Fig. 4. Please draw the gate-level circuit of 2-to-1 mux.



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科目：計算機概論(4)

5. (10 pt.) Assume that the scheduling of a processor is shown in the following table. There are three procedures to be done. Procedure P1 is the first to be processed, procedure P2 is the last to arrive, and procedure P3 arrived between them. The execution time of the procedures is 15, 9, and 12 milliseconds (ms), respectively. Based on a first-come, first-serve (FCFS) basis, what is the average waiting time for a processor?

Procedures	Orders of arrival	Execution time
P1	1	15
P2	3	9
P3	2	12

6. (8 pt.) Show the single precision representation to the decimal number 5.75 $_{(10)}$

7. William always encrypts texts using RSA encryption when communicating with Judy. At this time, William selects p =3, q = 11, and e =3

(a).(10 pt.) What is the value of public key d ?

(b).(10 pt.) Assume that the encrypted information is 2, what is the original information?

8. Describe the Open Systems Interconnection (OSI) model.

(a). (5 pt.)How many layers of the OSI model are there?

(b). (7 pt.)Briefly describe the purpose of each layer.

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系所：電子系

科目：電磁學

本試題共 **8** 題，每題得分如各題中所示，共計 100 分，請依題號作答並將答案寫在答案卷上，違者不予計分。

Useful physical constants: $\varepsilon_0 \approx \frac{10^{-9}}{36\pi}$ (F/m); $\mu_0 = 4\pi \times 10^{-7}$ (H/m)

1. 請寫出電磁學的 4 個 Maxwell's equations 的積分與微分型式，並解釋其物理意義。(12 分)

2. 若可見光的真空波長範圍取 390 nm 至 760 nm，其對應的頻率範圍是多少？目前手機的 5G 無線通訊波長，在大氣中大約多少微米 (μm)？(6 分)

3. 請說明解靜電問題時，對於一個良好導體，若帶有電荷，為何必在邊界形成面電荷密度 ρ_s，而不是體電荷密度 ρ_v？其內部電場 **E**，在邊界的平行方向電場 $\mathbf{E}_T$ 及垂直方向電通密度 $\mathbf{D}_N$，必須符合的條件各是什麼？(12 分)

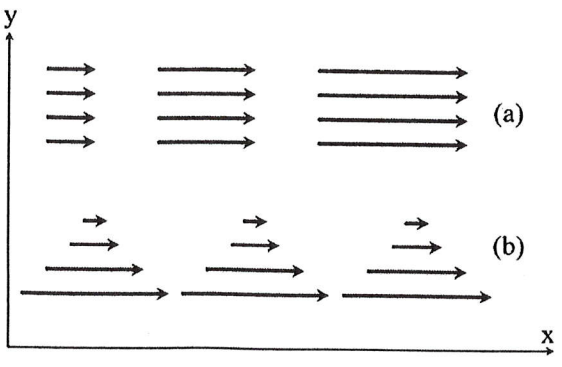
4. 請用面積與間距兩個因素，說明為何電解質電容可以超越其他方式的電容，達成很高的電容值？其在電路上使用的限制條件為何？(8 分)

5. 有一個相對介電係數 $\varepsilon_r = 11.8$, 電導係數 $\sigma = 4.4 \times 10^{-4}$ (S/m) 的純矽材料。今測得其內部電位的分布為 $V = 15\,xy^2$ (V)。求相對應的電場 **E**、極化向量 **P**、電通密度 **D** 與電流密度 **J**。(12 分)

6. 一個電磁波的電場函數為 $E(z,t) = 100.e^{-0.01z}\cos\left(2\pi \times 10^7 t - \pi z - \frac{\pi}{4}\right)$ (V/m)，求 (1)波的傳遞方向；(2)衰減常數；(3)頻率；(4)波長；(5)相速度 (phase velocity)。(20 分)

7. 在 z 軸上有一無限長的細導線，其電流為 4π (A)，方向為 $+\mathbf{a}_z$。請計算在 (0 , 2 m, 0) 的磁場強度(含大小及方向)。 (16 分)

8. 請預測右圖中(a)和(b)兩個向量場的旋度 (curl)的方向。如果旋度為 0，請註明。(14 分)



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本試題共 5 題，每題得分如各題中所示，共計 100 分，請依題號作答並將答案寫在答案卷上，違者不予計分。

1. Assuming that diodes D_1 and D_2 are ideal, find the following V_{out} of the circuit shown in Fig. P1 for different V_{in} ranges.

(a) (4 分) for -1 V ≤ V_{in} ≤ 1 V
(b) (3 分) for V_{in} ≤ -1 V
(c) (3 分) for V_{in} ≥ 1 V

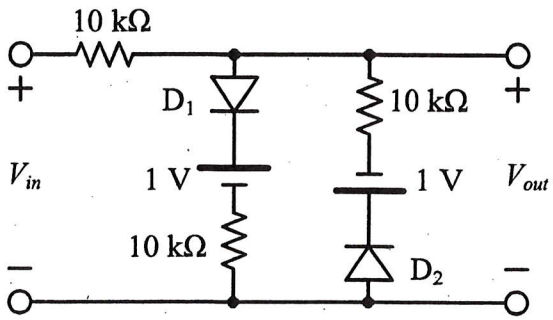

Fig. P1

2. The circuit in Fig. P2(a)(b) utilizes an ideal operational amplifier A. Derive the following corresponding voltage gain A_V formulas.

(a) (10 分) for Fig. P2(a).
(b) (10 分) for Fig. P2(b).

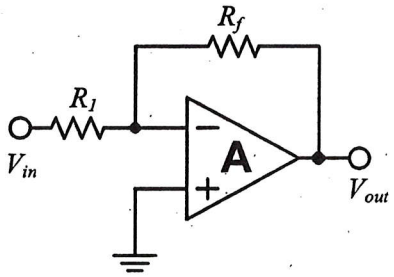

Fig. P2(a)

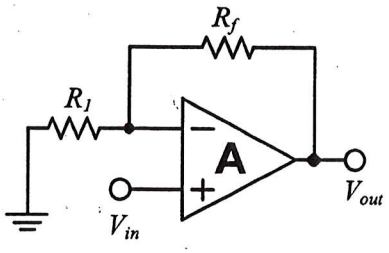

Fig. P2(b)

3. The NMOS transistors in the circuit of Fig. P3 have V_t = 1 V, $\mu_n C_{ox}$ = 100 μA/V², λ = 0, and channel length $L_1 = L_2 = L_3$ = 1 μm.

(a) (10 分) Find the required values of channel width for each of M_1, M_2, and M_3 to obtain the voltage and current values indicated in Fig. P3.
(b) (10 分) Shows which regions the transistors M_1, M_2, and M_3 work in, respectively.

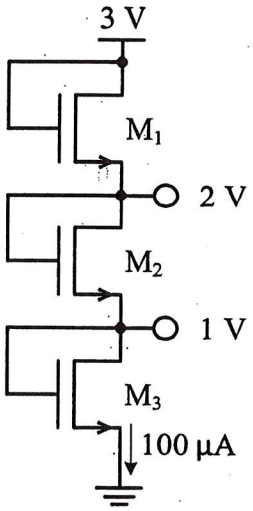

Fig. P3

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4. (40 分) The transistors operate in the saturation region. Calculate (a) g_{M1}, (b) R_{op}, (c) the low-frequency small-signal voltage gain, and (d) the output resistance of the amplifier. Some related parameters are: $\mu_n C_{ox} = 100 \times 10^{-6}\ {}^{A}/_{V^2}$, $(\frac{W}{L})_{M1,M2} = 40$, $\lambda_n = 0.1\ V^{-1}$, $\mu_p C_{ox} = 50 \times 10^{-6}\ {}^{A}/_{V^2}$, $(\frac{W}{L})_{M3,M4} = 50$, $\lambda_p = 0.14\ V^{-1}$, and $I_{D1,2,3,4} = 0.6\ mA$. Neglect the Body effect of MOS transistors.

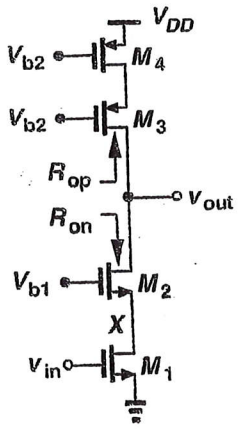

Fig. P4

5. (10 分) These MOS transistors operate in the saturation region. Neglect the Body effect of MOS transistors. Calculate R_{out}. Some related parameter values are: $g_{M1,3} = 1.0 \times 10^{-3}$ A/V, $g_{M2} = \sqrt{2} \times 10^{-3}\ A/V$, $r_{o1,3} = 20\ k\Omega$, $r_{o2} = 10\ k\Omega$, and the aspect ratio of all transistors is 10.

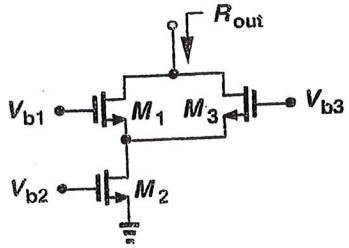

Fig. P5

國立雲林科技大學 112 學年度 碩士班招生考試試題

系所：電子系

科目：半導體元件

$h = 6.63 \times 10^{-34}$ J-s, $k = 8.62 \times 10^{-5}$ eV/K, $q = 1.6 \times 10^{-19}$ C, $\varepsilon_{Si} = 12 \times 8.85 \times 10^{-14}$ F/cm, $n_i = 10^{10}$ cm^{-3}, $\ln 10 \approx 2.3$

1. *Explain the following terms: (a) Impurity (b) Line dislocation* **(10%)**

2. *Explain the following terms: (a) Ternary compound semiconductor (b) Quaternary compound semiconductor* **(10%)**

3. *GaAs is more suited than Si for use in high-speed electronic devices. Please explain why.* **(10%)**

4. *Consider the Fermi-Dirac probability function $f_F(E)$, and E_F is the Fermi energy. Assume there are two temperatures $T_1 = 0$ K and $T_2 > 0$ K.*
   (a) *At T_1, will there be any electron having energy larger than E_F? Why?* **(5%)**
   (b) *At T_2, will there be any electron having energy larger than E_F? Why?* **(5%)**

5. *Consider a silicon semiconductor at room temperature in which the concentration of donor atoms is $N_d = 5 \times 10^{15}$ cm^{-3}. Calculate the thermal-equilibrium electron concentration and hole concentration.* **(10%)**

6. *Explain or define the following terms:*
   (a) *Quasi-Fermi energy* **(5%)**
   (b) *Flat band voltage* **(5%)**
   (c) *Lattice scattering* **(5%)**

7. *If temperature is increased about 50 degrees, how many order of current density for Si pn diode will be increased or decreased at small forward voltage ($<V_{on}$) and large forward biases ($\geqq V_{on}$), respectively? Explain the reason of these changes.* **(15%)**

8. *According* $n(E) = D_C(E) f(E)$ *where* $f(E) = \dfrac{1}{1+e^{(E-E_F)/kT}} \approx e^{-(E-E_F)/kT}$, $D_C(E) = A\sqrt{E-E_C}$ *and* $A = \dfrac{4\pi(2m_n^*)^{3/2}}{h^3}$, *find the energy E with maximum value of n(E). (Hint: the maximum value is occurred at dn(E)/dE =0.)* **(20%)**