國立雲林科技大學 111 學年度
碩士班招生考試試題

系所：電子系
科目：工程數學(2)

1. (15%) A differential equation is as follows,

$$x^3y^4 + (x^4y^3 + 2y)\frac{dy}{dx} = 0$$

   (a) Find its solution.
   (b) Verify your solution in (a).

2. (15%) A 2nd-order differential equation is as follows,

$$y'' + 9y' + 20y = -36e^{-t}, y(0) = 0, y'(0) = 0$$

   (a) (05%) Find the general solution of the homogeneous equation.
   (b) (05%) Find a particular solution of the non-homogeneous equation.
   (c) (05%) Find the final particular solution of this non-homogeneous equation.

3. (20%) A differential equation system is as follows,

$$\mathrm{y}' = \begin{bmatrix} 2 & -2 \\ -1 & 3 \end{bmatrix}\mathrm{y} + \begin{bmatrix} 4 \\ 2 \end{bmatrix} e^{2t}, y(0) = 0$$

   (a) (05%) Find the Laplace transform of e^{2t}.
   (b) (10%) Find the solution of this differential equation system using Laplace transform.
   (c) (05%) Determine the stability of this system and explain your reason.

4. (15%) Perform the indicated operation, give that:

$$A = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 1 & 3 \end{bmatrix} \quad B = \begin{bmatrix} 2 & 1 & 0 \\ 0 & 3 & 4 \end{bmatrix} \quad C = \begin{bmatrix} -1 & 2 \\ 3 & 4 \\ 0 & 1 \end{bmatrix} \quad D = \begin{bmatrix} 0 & 1 \\ -1 & 0 \\ 2 & 1 \end{bmatrix}$$

   (a) $(A+B)^T$ (b) (2A-B)(C+D) (c) If $2X+3(A-B)=0$, Find X

5. (10%) Solve the system using either Gaussian elimination with back-substitution.

$$0x + 4y - 2z = 2$$
$$6x - 2y + z = 29$$
$$4x + 8y - 4z = 24$$

6. (15%) If $\vec{A} = \vec{i} - 3\vec{j} + 2\vec{k}$, $\vec{B} = 3\vec{i} - 2\vec{j} + 3\vec{k}$, Find (a) $\vec{A} \bullet \vec{B}$ (b) $\vec{A} \times \vec{B}$ (c) The projection of $\vec{A}$ on $\vec{B}$

7. (10%) Find the eigenvalues and eigenvectors of A.

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

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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, $\ln 10 \approx 2.3$, $\varepsilon_{Si} = 12 \times 8.85 \times 10^{-14}$ F/cm, $n_i = 10^{10}$ cm^{-3}

1. Explain the following terms: (a) Lattice vibration (b) Vacancy (10%)
2. What kind of impurity atom can be added to make the following intrinsic materials to become *n*-type semiconductors? (a) Si (b) GaAs (10%)
3. GaAs is more suited than Si for use in optical 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) Plot the curve of $f_F(E)$ vs. E for T_1. (5%)
   (b) Plot the curve of $f_F(E)$ vs. E for T_2. (5%)
5. The Hall effect can be used to distinguish whether a semiconductor is *n*-type or *p*-type. Please describe its principle. (10%)
6. Explain or define the following terms:
   (a) Miller indices (5%)
   (b) Low injection level (5%)
   (c) Strong inversion condition of MOS structure (5%)
7. Explain the dominant current is electron or hole current of p^+n, n^+p, Np and Pn junctions, where N and P mean wider energy gap and + means high doping concentration. (15%)
8. A silicon *pin* junction has the doping profile shown in Fig. 1. The "*i*" corresponds to an ideal intrinsic region in which there is no impurity doping concentration. A reverse-bias voltage is applied to the *pin* junction so that the total depletion width extends from −1.5 μm to +1.5 μm as shown in follow. (a) Calculate the magnitude of the electric field at $x = 0$. (b) Sketch the electric field through the *pin* junction. (c) Calculate the reverse bias that must be applied. (20%)

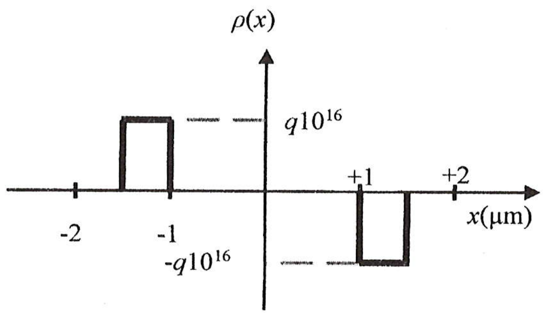

Fig. 1

國立雲林科技大學 111 學年度
碩士班招生考試試題

系所：電子系
科目：基本程式設計

1. ( ) In C language, the semicolon (;) is used to mark the (A)start (B)end (C)separator (D)nothing of a statement. (10 pts)
2. ( ) What type of loop always executes at least once? (A)for (B)while (C)switch/case (D) do/while. (10 pts)
3. ( ) What is the value of sum after the following code has executed? (A)55 (B)45 (C) 10 (D) none of these. (10 pts)

```
for(sum=0,i=1;i<=10;i++) sum+=i;
```

4. ( ) How to do an infinite loop? (A) int n=1; while(n!= 0) ++n; (B)while('indefinite'); (C) while(1); (D) while(0). (10 pts)
5. Change this program so that it uses "*switch...case*" command instead of "*if-else*". (10 pts)

```
if (month = = 4 || month = = 6 || month = = 9 ||month = = 11)
    printf("Month has 30 days.\n");
else if (month = = 1 || month = = 3 ||month = = 5 || month = = 7 ||month = = 8 || month = = 10 || month = = 12)
    printf("Month has 31 days.\n");
else if (month = = 2)
    printf("Month has 28 or 29 days.\n");
else
    printf("Don't know that month.\n");
```

6. Write a program to do bubble sort to sort n numbers in an array Arr. You can use any programming language or pseudo language. What is the time complexity of bubble sort? (12.5 pts)
7. Write a program to do matrix multiplication for a r1*c1 matrix and a c1*c2 matrix, resulting in a r1*c2 matrix. What is the time complexity of your algorithm? (12.5 pts)
8. Write a program to find the index of a number X in a sorted array of length n. What is the time complexity of your algorithm? (12.5 pts)
9. Write a program to find the greatest common divisor of two positive integers a and b. (12.5 pts)

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碩士班招生考試試題

系所：電子系
科目：電子學

本試題共五題，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 分) As shown in Fig. P1, a first-order low-pass active filter performs a low-pass STC function. Derive the transfer function and show the DC gain is ($-R_2/R_1$) and the 3 dB frequency $\omega_o = 1/\ CR_2$.

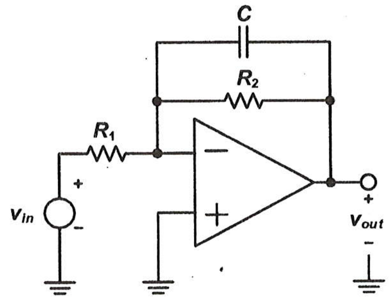

Fig. P1

2. In the capacitor coupled attenuator circuit shown in Fig P2, I is a DC current that varies from 0 mA to 1 mA, D1 and D2 are diodes with $n = 1$, and C_1 and C_2 are large coupling capacitors. For very small input signals,
   (a) (10 分) find the value of the ratio $v_{out}\ /\ v_{in}$ for I equal to 10 μA.
   (b) (5 分) find the value of the ratio $v_{out}\ /\ v_{in}$ for I equal to 100 μA.
   (c) (5 分) find the value of the ratio $v_{out}\ /\ v_{in}$ for I equal to 500 μA.

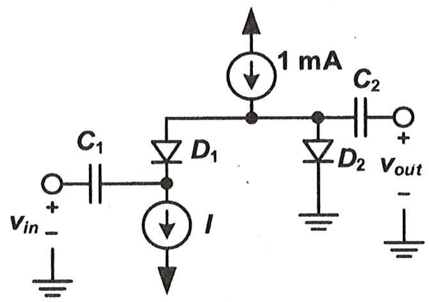

Fig. P2

3. As Fig. P3 shows, using $V_{DD} = 6$ V with an NMOS for which $V_t = 1.2$ V, $k_n'\ W/L = 2.0$ mA/V^2 and $\lambda = 0$, provide a design which biases the transistor at $I_D = 2$ mA, with V_{DS} large enough to allow saturation operation for a 2 V negative signal swing at the drain. Use a 26 MΩ resistor as the R_{G2}, then:
   (a) (10 分) find the value of R_D.
   (b) (10 分) find the value of R_{G1}.
   ($\sqrt{2} = 1.414,\ \sqrt{3} = 1.732,\ \sqrt{5} = 2.24$)

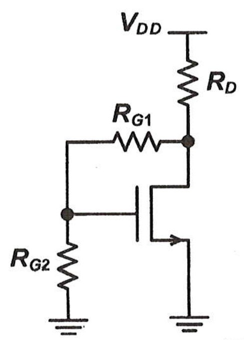

Fig. P3

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4. (20 分) The transistors operate in the saturation region. $R_{D1} = R_{D2}$ and $M_1 = M_2$. $V_{in} = V_{in1} - V_{in2}$. $V_{out} = V_{out2} - V_{out1}$. (a) Calculate the differential trans-conductance? (b) Neglect the channel-length modulation and body effect of MOS transistors. Calculate the low-frequency differential small-signal voltage gain. Some related parameters are: $R_{D1,2} = 2\ k\Omega$, $\mu_n C_{ox} = 100 \times 10^{-6}\ A/V^2$, $(\frac{W}{L})_{M1,M2} = 10$, and $I_{SS} = 1\ mA$.

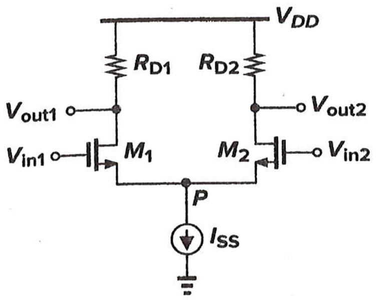

Fig. P4

5. (30 分) Both MOS transistors operate in the saturation region. Assuming neither transistor suffers from the body effect, Calculate the (a) low-frequency voltage gain of the amplifier, and (b) output resistance, and (c) 3dB bandwidth of the amplifier if $C_{out} = 20 \times 10^{-15}\ F$, while ignoring the parasitic capacitances of both transistors. Some related parameter values are: $R_D = 10\ k\Omega$, $g_{m1} = 1.0 \times 10^{-3}$ A/V, $g_{m2} = 0.5 \times 10^{-3}\ A/V$, $\lambda_1 = 0.1\ V^{-1}$, $\lambda_2 = 0\ V^{-1}$, and $I_{D1,2} = 1\ mA$.

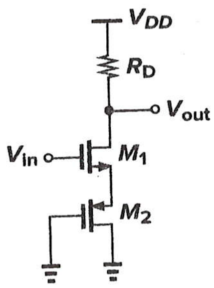

Fig. P5

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

1. (a) $\mathbf{A} = 3\mathbf{a}_x + 4\mathbf{a}_z$, $\mathbf{B} = 5\mathbf{a}_y$; (b) $\mathbf{A} = \mathbf{a}_\rho + 2\mathbf{a}_\phi + 4\mathbf{a}_z$, $\mathbf{B} = 2\mathbf{a}_\rho + 8\mathbf{a}_z$;
   求 $\mathbf{A} \times \mathbf{B}$。(10%)

2. 電通量密度 $\mathbf{D} = 20\mathbf{a}_\rho + 10\mathbf{a}_\varphi$ C/m^2，請計算通過以下曲面的電通量，
   曲面： $\rho = 6$ m，$0 \le \varphi \le 90^\circ$，與 $-1 \le z \le +1$ m。(10%)

3. 一個球體的電荷密度分布為 $\rho_v = \rho_a(r/a)$ 在 $0 \le r \le a$ 且 $\rho_v = 0$ 在 $r > a$. 請導出在所有空間（$r > 0$）的電通密度公式。(10%)

4. 在 $z = 1$ cm， x-y 平面無限大平板的電荷密度為 $\rho_s = +100$ nC/m^2，請計算在 $z = 0$ 位置有一接地的無限大金屬板，其感應電荷密度。(10%)

5. 請寫出 4 個 Maxwell's eq's 以及所代表的物理意義。 (10%)

6. 一個朝 +z 方向傳遞的波，其函數為 $A_0 \sin(10^8 t - \frac{1}{2} z)$，求相速度(phase velocity)，假設長度單位為公尺(m)。(10%)

7. 在 x-y 平面上有一無限延伸的電流平面，其電流密度為 $\mathbf{K} = 6\ \mathbf{a}_y$ A/m，請計算 $\mathbf{H}$ (3 m, 4 m, 5 m)。 (20%)

8. 假設磁場 $\mathbf{H} = 2xy^2\ \mathbf{a}_z$ A/m，請計算電流密度 $\mathbf{J}$ (2 m, 2 m, 3 m)。 (20%)