

國立中山大學 101 學年度碩士暨碩士專班招生考試試題

科目：工程數學【光電所碩士班】

題號：4082
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1. (35%) Find respective general solutions for following equations

(a) $e^{-ay} dx + \frac{1}{x} dy = 0$ (5%)

(b) $(x^2 + 3y^2) dx - 2xy dy = 0$ (6%)

(c) $\frac{dy}{dx} = xe^{(x-y)}$ (6%)

(d) $\frac{dy}{dx} = \frac{y(1+2xy)}{x(xy-1)}$ (6%)

(e) $y''' - 2y' + y = x - 2$ (6%)

(f) Prove: $\nabla \cdot \left(\frac{\mathbf{r}}{r^3} \right) = 0$ (6%)

2. (10%) Evaluate following equation with boundary conditions $u(0, y) = e^{-y}$

$$\frac{\partial u(x, y)}{\partial x} + \frac{\partial u(x, y)}{\partial y} = u(x, y), \quad x > 0, y > 0.$$

3. (15%) For $z = x + iy$, solve following equations.

(a) $\oint \frac{dz}{z^2 - 2z + 2}$, $c: |z - (2 + i2)| = 2$. (7%)

(b) Let $f(z) = x^2 + iy^2$, evaluate $\int_c f(z) dz$, (8%)

where c is a curve $y = \cos x$ from $x = 0$ to $x = \pi/2$.

4. (10%) Find the inverse matrix for

$$S = TA,$$

$$\text{where } T = \begin{bmatrix} \cos \theta & \sin \theta \\ -\sin \theta & \cos \theta \end{bmatrix}, \quad A = \begin{bmatrix} \frac{\sqrt{2}}{2} & -\frac{\sqrt{2}}{2} \\ \frac{\sqrt{2}}{2} & \frac{\sqrt{2}}{2} \end{bmatrix}.$$

5. (15%) If $R(z) = u(x, y) + iv(x, y)$ is an analytic function, and $u(x, y) = \exp(3x) \cos 3y$, (a) find out $v(x, y)$ for $R(z)$ (7%), and (b) calculate R' (8%).

6. (15%) The distribution of surface energy of a thin film is

$$\sigma = x^2 + y^2 + 2xz.$$

At point $(2, 1, 0)$, find (a) energy gradient (5%), (b) the unit vector in the direction of the energy gradient (5%), (c) the curl of the surface force (5%).

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科目：電磁學【光電所碩士班】

題號：4083
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1. (5%) How to combine two orthogonal linearly polarized waves to a circularly polarized wave?
2. (10%) Please derive the reflection coefficient and transmission coefficient of a perpendicular polarization plane wave launched from medium 1 to medium 2. The impedances in media 1 and 2 are η_1 and η_2 , respectively. The incident and refractive angles are θ_1 and θ_2 , respectively.
3. (5%) (a) What is a phasor?
(5%) (b) What is the difference between a phasor and a vector?
4. (5%) (a) What is the skin depth (depth of penetration) of a conductor?
(5%) (b) Consider a typical conductive metal. How much does the skin depth of the metal change if there is a 4-fold increase of the EM wave frequency?
5. (5%) (a) What is the quality factor of a resonator?
(5%) (b) How does the quality factor of a resonator change if the material of the resonator is changed from copper to silver?
(5%) (c) Consider a hollow cubic cavity which has a dominant resonant frequency of 10(GHz). What should the size of the cavity be?
6. (15%) Consider a coaxial cylindrical capacitor with the inner cylinder conductor of radius a and outer cylinder conductor of radius b . The conductivity, permittivity and permeability of the inside material are σ , ϵ , and μ , respectively. The length of the capacitor is L .
(a) Find the potential difference between the inner and outer conductors. (5%)
(b) Find the capacitance per unit length. (5%)
(c) Find the inductance per unit length. (5%)
7. (5%) (a) What is a Hertzian dipole?
(10%) (b) Define the directive gain and directivity of an antenna.
8. (20%) Consider a lossless $50(\Omega)$ transmission line terminated in an unknown load impedance. The distance between successive voltage minima is 20 (cm), and the first minimum is located at 5 (cm) from the load. The standing-wave ratio on the lossless transmission line is found to be 3.0.
(a) Find the reflection coefficient Γ . (5%)
(b) Find the load impedance Z_L . (5%)
(c) Find the equivalent length and terminating resistance of a line such that the input impedance is equal Z_L . (10%)

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科目：近代物理【光電所碩士班選考】

題號：4084
共 1 頁 第 1 頁

一、 填充題:40%(每格五分)

1. 對 π 介子來說原始生命期為 0.26 秒，在加速器中產生的 π 介子其速度若達到 0.95 倍的光速，請問實驗室測量 π 介子的生命期是多久 a。
2. 兩太空船以相同速度(V)但相反方向接近，請問對太空船來說相對速度是多少 b。
3. 質量為 9.1×10^{-31} kg 的電子當其動能達 100eV 時 De Broglie 波長是 c。
4. 一個 linear harmonic oscillator 的能量考慮動能與位能可以表示為 $\frac{p_x^2}{2m} + cx^2/2$ ，如果以測不準原理的角度則可表示為 d。
5. Fine structure constant 大小為 e。
6. 光子自旋大小為 f。
7. 一個質量為 m 的粒子其 Compton wavelength 為 g。
8. 對一個侷限在(0,a)之無線位能井， $\langle x^2 \rangle$ 為 h。

二、 簡答與計算題: (60%)

1. 試透過波粒二相性的概念說明 Snell's Law (20%)
2. 請列出當 l 與 s 量子數分別為 2 與 1/2 時，量子數 J 與 m_j 有哪些可能(20%)
3. 請分別說明何為 Fluorescence (5%); Phosphorescence(5%); Raman effect(5%) 與 Phonon(5%)

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科目：電子學【光電所碩士班選考】

題號：4085
共 2 頁 第 1 頁

1. (40%) 請回答下列問題：(題號請標註清楚)
- A. 請說明 Early effect 及 Early voltage。(8%)
 - B. 請說明 body effect。(8%)
 - C. 請畫出 Schottky-Barrier diode 的結構圖，並說明其與 pn-junction diode 有何不同。(8%)
 - D. 考慮輸入電壓如 Figure 1(a)，請畫出 Figure 1(b)及 Figure 1(c)在 $0 \leq t \leq 3T$ 之輸出電壓 v_o 。假設 D 為理想 diode 且 $RC \gg T$ 。(8%)

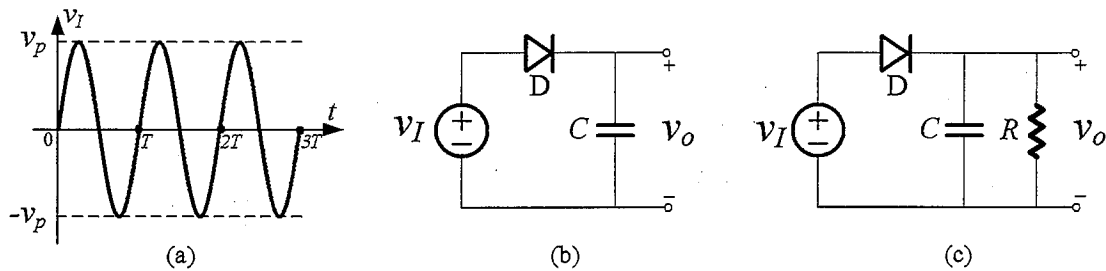


Figure 1.

- E. Figure 2 中 A 為一理想 operational amplifier。請以 v_1 、 v_2 、 v_3 及 v_4 表示 v_o 。(8%)

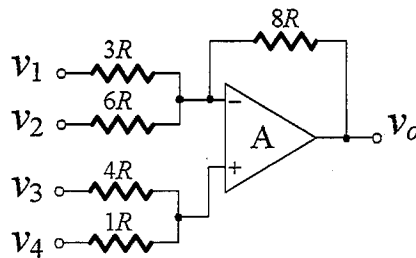


Figure 2.

2. (15%) Figure 3 為一包含電晶體之電路，且 β 非常大。(a) bias current I_C 為？(5%)
(b) 請畫出 Figure 3 之小訊號等效電路(4%) (c) 請求出 v_{o1}/v_i 及 v_{o2}/v_i 的值(6%)

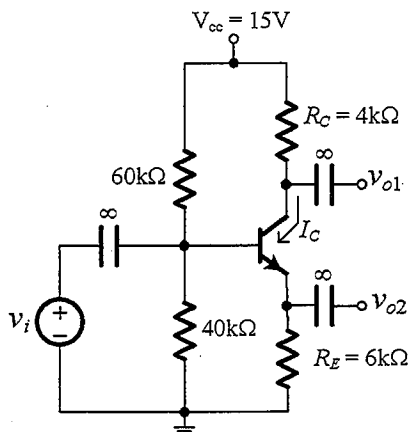


Figure 3.

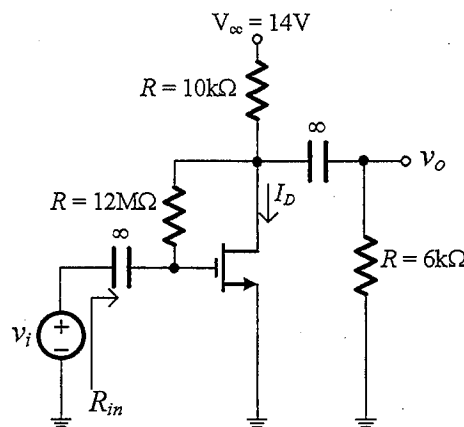


Figure 4.

3. (15%) 考慮 Figure 4 之電路，忽略 channel-length modulation effect。若電晶體 $V_t = 2V$ 、 $k'_n(W/L) = 0.2mA/V^2$ 以及 $V_A = 50V$ ，請求出 (a) dc current I_D (5%) (b) R_{in} (5%) (c) v_o/v_i (5%)

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4. (12%) Figure 5 之電路中，所有電晶體皆相同且 current gain 為 β 。(a) 請求出 I_{O1}/I_{REF} (6%) (b) 若 $I_{REF} = 6\text{mA}$ 、 $\beta = 50$ ，則 I_{O1} 為？ (6%)。

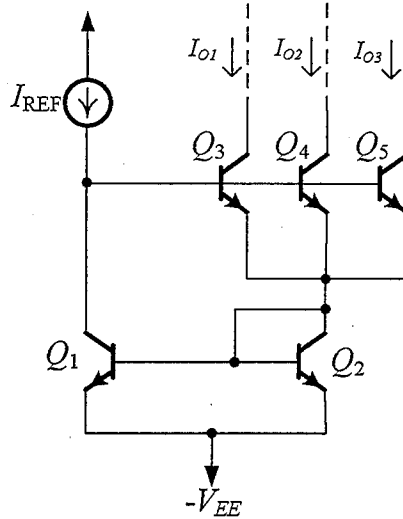


Figure 5.

5. (18%) 請求出 Figure 6 電路之 (a) loop gain $L(s)$ (8%) (b) loop gain 相位為零之頻率 (5%) (c) 此電路之振盪條件， R_2/R_1 必須為？ (5%)

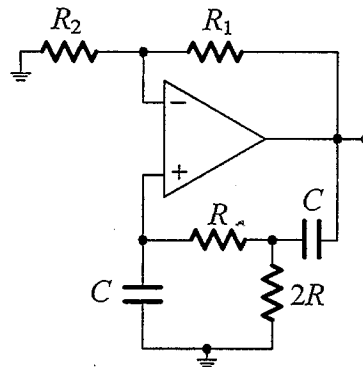


Figure 6.