

國立中山大學95學年度碩士班招生考試試題

科目：工程數學【光電所碩士班】

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1. Solve $xy' = y + xy^2$ (10%)

2. Determine general solution to $y''' - y'' - 8y' + 12y = 7e^{2x}$ (15%)

3. (A) Show that $\int_0^{\infty} e^{-x^2} dx = \frac{\sqrt{\pi}}{2}$ (10%) (B) Show that $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$ (5%)

4. Diagonalizes A, $A = \begin{bmatrix} 5 & 2 & 2 \\ 3 & 6 & 3 \\ 6 & 6 & 9 \end{bmatrix}$ (15%)

5. Find the point (x, y, z) on the given plane $x - y + 2z = 4$, that is close to the point $A(2, 0, -1)$, and the shortest distance. (15%)

6. Compute the line integral $\int_C \vec{F}(r) \cdot d\vec{r}$, where $\vec{F}(r) = y^2\vec{i} - x^2\vec{j}$
C is a straight-line segment from $(0,0)$ to $(1,2)$. (15%)

7. Solve the partial differential equation: $\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$, $0 < x < \pi$, $t > 0$,
I.C. $u(x, 0) = x$ and B.C. $\frac{\partial u}{\partial x}(0, t) = \frac{\partial u}{\partial x}(\pi, t) = 0$ (15%)

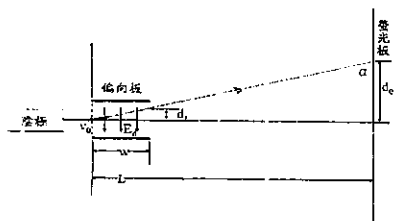
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科目：電磁學【光電所碩士班】

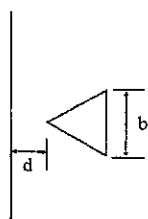
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一、填充題(每格四分，共十格)40%

1. 如下圖一， v_0 為正向入設偏向時之初速， d_1 為離開偏向板之橫移距，在螢光板螢幕上 α 角與偏射電場強度 E_0 之間的關係 (a)；當 $d_1 = d_0/20$ 時， w 與 L 之間的關係為 (b)。
2. 有一中心在原點邊長為 L 的正立方非導體。其極化方向為 $P = P_0(a_x x + a_y y + a_z z)$ 。請問面電荷密度為 (c)、體電荷密度為 (d)。
3. 有一點電荷 Q 位於一半徑為 b 的導電球殼內且距該球心之距離為 $d (b > d)$ 。請求出感應在球殼內表面上的電荷密度為 (e)。
4. 有一半徑為 a 的長直導線高於地面 h 且平行地面。假設地面為一理想導體，請問兩者間單位長度之電容為 (f)。
5. 一個長 1 公里，半徑為 0.5mm 的導線兩端，外加 6 伏特的直流電壓而產生 1/6 安培的電流。請問導線的導電係數為 (g)；導線中的電場強度 (h)；消耗在導線中之功率 (i)。
6. 如下圖二，一無限長之鉛直導線與一導線等邊三角形迴路之互感為 (j)。



圖一



圖二

二、簡答題 35%

1. 請說明並列出何謂 Maxwell's equation。(9%)
2. 接續 1，以圓柱座標改寫並列出對應之純量方程式。(8%)
3. 接續 1，以球座標改寫並列出對應之純量方程式。(8%)
4. 何謂布魯斯特角(Brewster angle)，並說明只有何種偏極方存在布魯斯特角(10%)

三、計算題 25%

一個窄頻信號傳播於損耗介電質中。此介電質對於該信號的負載頻率(500kHz)之損耗角正切為 0.2，其介電常數為 2.5。試求衰減常數 α 、相位常數 β 、相速度 u_r 、群速度 u_g 及試討論該介質是否為色散。
 $\gamma_0 = \sqrt{\frac{\mu_0}{\epsilon_0}} \cong 120\pi \cong 377 \Omega$

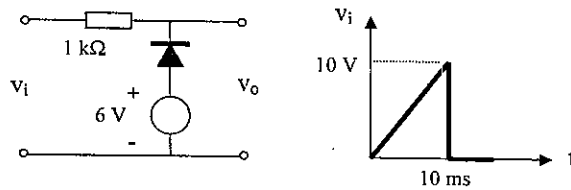
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科目：電子學【光電所碩士班選考】

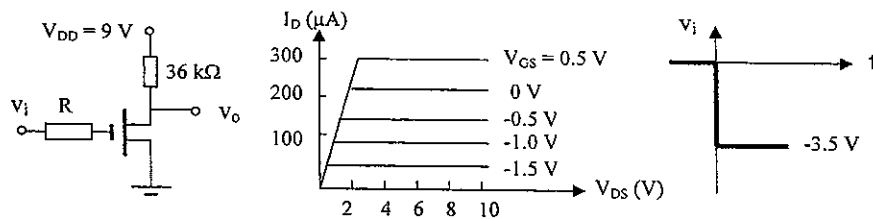
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Answer the following questions:

1. A Si layer with a donor and an acceptor concentration of 10^{15} cm^{-3} and $5 \times 10^{14} \text{ cm}^{-3}$ is used as a conducting line on an IC. Assuming the two different types of dopants are fully ionized. What is the conductivity of this sample? The intrinsic carrier density, the mobility of electron and the mobility of hole of the layer are $1.45 \times 10^{10} \text{ cm}^{-3}$, $1500 \text{ cm}^2/\text{V}\cdot\text{sec}$ and $450 \text{ cm}^2/\text{V}\cdot\text{sec}$. (10%)
2. Please draw the charge density, electric field intensity, and electrostatic potential for electrons in the depletion region of a pn junction. (10%)
3. For the given circuit, please find the output v_o as a function of input v_i . What is the breakpoint of this circuit? The cut-in voltage and forward resistance of the diode is 0.6 V and 10Ω . (10%)



4. Please draw the physic structures of an IC pnp bipolar transistor and an p-channel MOSFET including substrate, isolation island and contacts. (10%)
5. The characteristics of a MOSFET are given in the following figure. Please draw the output waveform of the circuit. (15%)

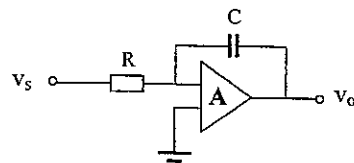


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科目：電子學【光電所碩士班選考】

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6. Please find the output v_o when $v_s = 5 \sin 10^6 t$, $R = 1k \Omega$ and $C = 2 \text{ nF}$. (10%)

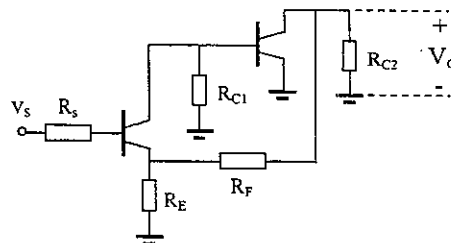


7. The return ratio of a three-pole amplifier is

$$T(s) = \frac{T_o}{(1 + s/10^6)(1 + s/10^7)(1 + s/10^8)}$$

What is the phase margin for $T_o = 10^4$? (15%)

8. Please draw the equivalent circuit without feedback of the following Series-shunt feedback pair. What is the β of this circuit? (20%)



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科目：近代物理【光電所碩士班選考】

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1. Incident photons strike a sodium surface having a work function $E_0=2.2\text{eV}$ causing photoelectric emission. When a stopping potential $V_0 = 5.0\text{ V}$ is imposed, there is no photocurrent. What is the wavelength of the incident photons? (10 points)
2. An atom absorbs a photon having a wavelength of 375nm and immediately emits another photon having a wavelength of 580nm. How much energy (in eV) was absorbed by the atom in this process? (10 points)
3. Solar radiation falls on the earth at a rate of $2.0\text{ cal/cm}^2\cdot\text{min}$. How many photons/cm²·min is this, assuming an average wavelength of 550nm? (10 points)
4. A mass spring system has a mass $m = 1.0\text{kg}$. The spring constant of the system is $k = 20\text{ N/m}$. The system oscillating with an amplitude of 5mm. (a) what is the quantum number n of the system? (b) If n changes by 1 unit, what fractional change in energy occurs? (20 points)
5. The rest energy of a particle is 620MeV. (a) What is the rest mass of the particle? (b) If the particle is accelerated to $0.75\cdot c$ ($c = 3 \times 10^8\text{ m}\cdot\text{s}^{-1}$ is light speed), what is the Einsteinian kinetic energy of the particle? (c) If the accuracy of the experimental system for the speed measurement is 0.010%, with what fundamental accuracy can we locate the position of the particle? (30 points)
6. The wave function for the description of an electron in the ground state in an atom is given as

$$\psi = \frac{1}{\sqrt{\pi a^3}} e^{-r/a},$$

where a is a constant. (a) Show that the probability P_r that the electron lies within a sphere of radius r_0 is given by

$$P_r = 1 - e^{-2r_0/a} \left(\frac{2r_0^2}{a^2} + \frac{2r_0}{a} + 1 \right).$$

(b) What can you expect if $r_0 \rightarrow 0$? (20 points)

Useful Constants

$$1\text{eV} = 1.602 \times 10^{-19}\text{J}$$

$$h = 6.626 \times 10^{-34}\text{J}\cdot\text{s}$$

$$1\text{ electronic charge } e = 1.602 \times 10^{-19}\text{ coulomb}$$

$$1\text{cal} = 4.18\text{J}$$