國立雲林科技大學
99學年度碩士班暨碩士在職專班招生考試試題

系所：電子系、光電所
科目：工程數學(3)

1. Suppose a tank contains 200 gallons of brine (salt mixed with water), in which 100 pounds of salt are dissolved. A mixture consisting of $\frac{1}{8}$ pound of salt per gallon is flowing into the tank at a rate of 3 gallons per minute, and the mixture is continuously stirred. Meanwhile, brine is allowed to empty out of the tank at the same rate of 3 gallons per minute. How much salt is in the tank at any time? (10%)

2. Given $6x^2y+12xy+y^2+(6x^2+2y)y'=0$
   (a) show that the differential equation is not exact .
   (b) find an integrating factor .
   (c) find the general solution (perhaps implicitly defined). (15%)

3. Find the solution of the equation:
   $x^2y''-5xy'+8y=2\ln x$, $x>0$ (10%)

4. Use Laplace Transform technique，find the initial value problem:
   $y''-8ty'+16y=3$; $y(0)=y'(0)=0$. (15%)

5. $A=\begin{bmatrix}-3 & 2\\ 1 & -4\end{bmatrix}$ Compute (a) A^2 (b) A^{60} (10 分)

6. Find a unit normal vector $\vec{n}$ of the cone of revolution $z^2=3(x^2+y^2)$ at the point P:(1,0,2) (10 分)

7. $A=\begin{bmatrix}-2 & 2 & -3\\ 2 & 1 & -6\\ -1 & -2 & 0\end{bmatrix}$
   (a) Find eigenvalues and eigenvctors of Matrix A
   (b) Compute $A^4+2A^3-20A^2-66A-45I=0$ (15 分)

8. If $\vec{F}=2x^2\vec{i}+2y^2\vec{j}+2z^2\vec{k}$, $f=2x^3-2yz^2$, Find the value at point(1,1,1) (a) $\bar{\nabla}\cdot(\bar{\nabla}f)$ (b) $\bar{\nabla}\cdot(f\vec{F})$ (c) $\bar{\nabla}(\bar{\nabla}\cdot\vec{F})$ (15 分)

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系所：光電所
科目：半導體元件

$h = 6.63\times10^{-34}$ J-s, Eg(Si)=1.1eV, $k=8.62\times10^{-5}$ eV/K, $m_e=9.11\times10^{-31}$ kg, $n_i=1.5\times10^{10}$ cm^{-3}
(計算結果可以函數形式來表示)

1. Explain (a) Fermi energy level, (b) direct semiconductor, and (c) extrinsic semiconductor. (10%)

2. The Hall measurement is applied on a Si simple with the following geometry: d = 1μm, W = 1cm and L = 1cm. The following parameters are measured: I_x = 1.75 mA, V_x = 10V, V_H = −8mV, and B_z = 750 gauss = 0.75 tesla. Determined (a) the conductivity type, (b) the majority and minority carrier mobilities, and (c) the majority and minority carrier concentrations. (10%)

3. Assume a silicon p^+n junction at T = 300K. Assume that the intercept of the curve in Fig. 1 gives V_{bi} = 0.82 V and that the slope is 1.5×10^{15} (F/cm^2)$^{-2}$ V^{-1}. To determine the impurity concentrations in this p^+n junction (15%)

4. A silicon p-i-n junction has the doping profile shown in the Fig.2a. The "i" corresponds to an ideal intrinsic region in which there is no impurity doping concentration. A reverse-bias voltage is applied to the p-i-n junction so that the total depletion width extends from −1.5μm to +1.5μm as shown in Fig. 2b. (a) Calculate the magnitude of the electric field at x = 1μm. (b) Sketch the electric field through the p-i-n junction. (c) Calculate the reverse bias that must be applied. (15%)

5. Consider a silicon pn junction at T = 300 K with doping concentrations of N_a = 10^{16} cm^{-3} and N_d = 5×10^{15} cm^{-3}. Calculate the space charge width and the maximum electrical field in this pn junction at thermal equilibrium and reversed bias of 1V. (20%)

6. Determine the position of the Fermi level with respect to the valence band energy in p type GaAs at T = 300 K. The doping concentrations are $Na = 5\times10^{16}$ cm^{-3} and $N_d = 4\times10^{15}$ cm^{-3}. (20%)

7. For a particular silicon semiconductor device at T = 300 K, the required material is n type with a resistivity of 0.10 Ω-cm. Determine the required impurity doping concentration. (10%)

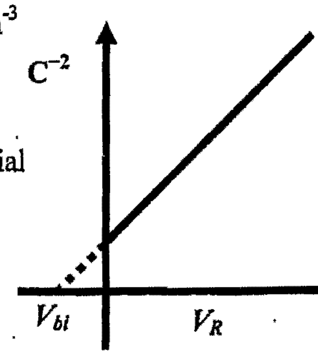

Fig. 1

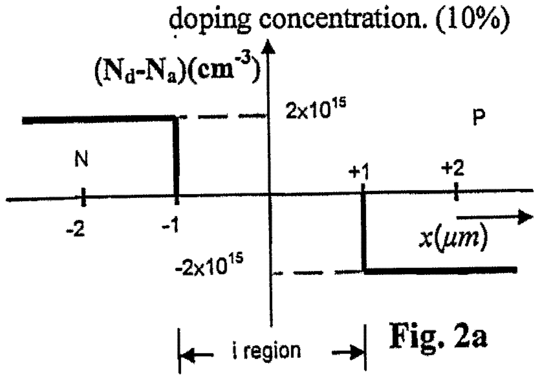

Fig. 2a

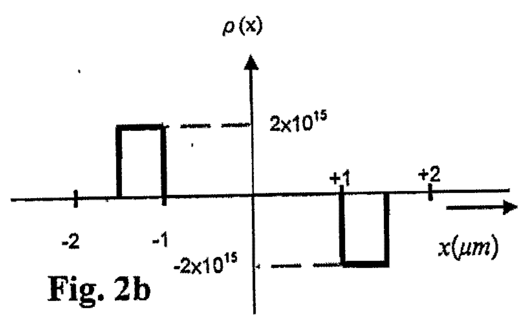

Fig. 2b

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系所：光電所
科目：電磁學

總分 100 分 共 7 題

1. (a) If $\vec{R} = x\hat{a}_x + y\hat{a}_y + z\hat{a}_z$，then $\nabla \times \vec{R} = ?$ (b) If $\vec{A} = \dfrac{\vec{R}}{|\vec{R}|^3}$ then $\nabla \bullet \vec{A} = ?$

   [15 %]

2. Given a vector field $\vec{A} = r\hat{a}_r + z\hat{a}_z$, find the total outward flux over a circular cylinder around the z-axis with a radius 2 and a height 4, and its base coinciding with the *xy*-plane. [15%]

3. A line charge of uniform density ρ_L in free space forms a semi-circle of ***d***. Find the electric potential at the center of the semicircle. [15%]

4. A long power transmission line, 1 (cm) in radius, is parallel to and situated 10 (m) above the ground. Assuming the ground to be an infinite flat conducting plane, find the capacitance per meter of the line with respect to the ground. [15%]

5. An infinite length coaxial cable exists along the z-axis, with an inner shell of radius ***a*** carrying current ***I*** in the +z direction and outer shell of radius ***b*** carrying the return current. Find the magnetic flux passing through an area of length ***L*** along the z-axis bounded by radius between ***a*** and ***b***. [15%]

6. Show the Maxwell's equations (in differential form) and the physical meanings. [10%]

7. Given that $\vec{E}(x, z; t) = \vec{a}_y 2 \sin(10\pi x) \cos(6\pi 10^9 t - \beta z)$ (V/m) in air, find $\vec{H}(x, z; t)$ and β. [15%]