國立雲林科技大學
96 學年度碩士班入學招生考試試題

系所：光電所
科目：工程數學

1. Find the eigenvalues and eigenvectors of matrix

$$A=\begin{bmatrix}1 & 0 & 0\\ 0 & 0 & 1\\ 0 & 1 & 0\end{bmatrix}. \qquad (15\%)$$

2. Find the shortest distance from the origin to the plane x-2y-2z=3. (10%)
3. Find the directional derivative of $\varphi=x^2y+xz$ at (1,2,-1) in the direction

$$\vec{A}=2\hat{i}-2\hat{j}+\hat{k} \qquad (10\%)$$

4. Please solve the equation: $\dfrac{d^2x(t)}{dt^2}+2K\dfrac{dx(t)}{dt}+\omega_0^2x(t)=G\cos(\omega t)$,

   Here K, w_0, G and w are constants (15%)

5. Given $u(x,y) = 2x^2-y^2$, can you find a real –valued function v(x,y) such that f(z) = u(x,y) + iv(x,y), where z = x + iy, is analytic on C? (If yes, find v(x,y); if no, disprove it !) (10%)

6. Express all values of the following complex numbers in the form, a+bi, where a,b are real. (10%)
   (a) $(2i)^{3i}$ (b) $(1+i)^{1-i}$

7. Please find the general solution of the P.D.E. $y\dfrac{\partial z}{\partial x}+x\dfrac{\partial z}{\partial y}=z-1$ (10%)

8. Please find the solution (10%)

   P.D.E. $u_t = ku_{xx}$ $0 < x < \ell$, $t > 0$
   I.C $u(x,0) = f(x)$
   B.C. $u(0,t) = u(\ell,t) = 0$

9. Please use the Forurier integral transforms to solve the given boundary-value problem. Make assumptions about bounded ness where necessary. (10%)

$$k\frac{\partial^2 u}{\partial x^2}=\frac{\partial u}{\partial t}, \qquad -\infty < x < \infty,\ t > 0$$

$$u(x,0)=e^{-|x|}, \qquad -\infty < x < \infty$$

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系所：光電所
科目：半導體元件

1. Please explain the electron concentration and conductivity versus inverse temperature for silicon. **(20%)**

2. (a) Please shows the depletion layer capacitance of a $P^{+}N$ junction. **(15%)**
   (b) Please plot that the inverse capacitance squared is a function of applied reversed-biased voltage. **(15%)**

3. A silicon pn junction diode biased at $V_a = 0.6$ V and $T = 300$ K has the following parameters:
   $N_d = 1 \times 10^{17}$ cm^{-3}, $N_a = 8 \times 10^{15}$ cm^{-3}, $D_n = 25$ cm^2/s, $D_p = 10$ cm^2/s, $\tau_{n0} = 1 \times 10^{-6}$ s, $\tau_{p0} = 1 \times 10^{-7}$ s. The cross-sectional area is 10^{-3} cm^2.
   (a) Calculate the total number of excess electrons in the p region. **(10%)**
   (b) Calculate the minority electron diffusion current at the space charge edge. **(10%)**

4. Consider a bipolar junction transistor:
   (a) Explain the definition of the base transport factor and the base transit time. **(10%)**
   (b) Derive the formulation of the base transit time. **(10%)**

5. Consider an n-channel MOSFET with $W = 10$ μm, $L = 2$ μm, and $C_{ox} = 7 \times 10^{-8}$ F/cm^2. Assume that the drain current in the nonsaturation region for $V_{DS} = 0.10$ V is $I_D = 40$ μA at $V_{GS} = 1.5$ V and $I_D = 80$ μA at $V_{GS} = 2.5$ V. Determine the inversion carrier mobility. $T = 300$ K. **(10%)**

Constants

Boltzmann's constant: $k = 1.38 \times 10^{-23}$ J/K = 8.62×10^{-5} eV/K
Intrinsic carrier concentration for silicon: 1.5×10^{10} cm^{-3}

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96學年度碩士班入學招生考試試題

系所：光電所
科目：電磁學

說明：本試卷共六大題，總分共計100分。
可用參數： $\varepsilon_0 = (1/36\pi)\times10^{-9}$(F/m)，$\mu_0 = 4\pi\times10^{-7}$(H/m)

1. Consider a metallic rectangular box with sides a and b and height c. The side walls and the bottom surface are grounded. The top surface is isolated and kept at a constant potential V_0. Determine the potential distribution inside the box. (20%)

2. Determine the mutual inductance between a very long, straight wire and a conducting circular loop, as shown in Fig. 1. (15%)

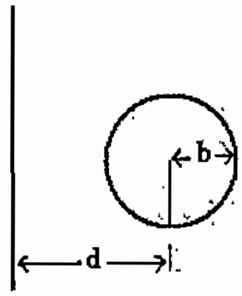

Fig.1.

3. For a harmonic uniform plane wave propagating in a simple medium, both $\vec{E}$ and $\vec{H}$ vary in accordance with the factor $\exp(-i\vec{k}\cdot\vec{R})$ as the indicated in $\vec{E} = \vec{E}_0 \exp(-i\vec{k}\cdot\vec{R})$. Show that the four Maxwell's equations for uniform plane wave in a source-free region reduce to the following:
$$\vec{k}\times\vec{E} = \omega\mu\vec{H},\ \vec{k}\times\vec{H} = -\omega\varepsilon\vec{E},\ \vec{k}\cdot\vec{E} = 0,\ \vec{k}\cdot\vec{H} = 0 \quad (15\%)$$

4. Please state divergence theorem（5%），and verify it by the vector field $\vec{F} = \hat{a}_R\left(\cos^2(\varphi)\right)\big/R^3$ existing in the region between two spherical shells defined by $R = 2$ and $R = 3$（10%）.

5. Find the resistance between two concentric spherical surfaces of radii R_1 and R_2 ($R_1 < R_2$) if the space between the surfaces is filled with a homogeneous and isotropic material having a conductivity σ (20%).

6. (a) The polarization vector in a dielectric sphere of radius R_0 is $\vec{P} = \hat{a}_x P_0$. Calculate the equivalent polarization surface and volume charge density, respectively (10%).
   (b) Calculate the electric field $\vec{E}$ inside the sphere (5%).