國立雲林科技大學
97 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. (15%) Show that the matrices $A=\begin{pmatrix}0&1&0\\0&0&0\\0&0&0\end{pmatrix}, B=\begin{pmatrix}0&0&0\\0&0&1\\0&0&0\end{pmatrix}, C=\begin{pmatrix}0&0&1\\0&0&0\\0&0&0\end{pmatrix}$

satisfy the commutation relation (a) (5%) $[A,B]=C$
(b): (5%) $[A,C]=0$
(c): (5%) $[B,C]=0$

2. (15%) A function $f(x)=e^{-a|x|}(a>0)$, find (a) (10%) Fourier Integral of $f(x)$ and (b) (5%) calculate $\int_0^\infty \frac{\cos(2x)}{x^2+4}dx$

3. (10%) Please solve $x^2y''-13xy'+49y=0$

4. (10%) Please evaluate $\lim_{x\to 0}\frac{1-\cos x}{x^2}$

5.(12%) If $z_1=i$, $z_2=1-\sqrt{3}i$, please find (1)$\arg\left(\frac{z_1}{z_2}\right)$ and (2)$\arg(z_1z_2)$

6.(12%)
In problems (a), express e^z in the form $a+ib$
(a)$z=-\pi+\frac{3\pi}{2}i$
In problems (b), express $\ln z$ in the form $a+ib$
(b)$z=-2+2i$

7.(13%) Please solve $y^2\frac{dx}{dy}+2yx=x^4$

8.(13%) Please find the general solution of the P.D.E. $\frac{\partial^2 Z}{\partial x^2}-\frac{\partial^2 Z}{\partial y^2}-\frac{\partial Z}{\partial x}+\frac{\partial Z}{\partial y}=0$

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說明：本試卷共六大題，總分共計１００分。

1. The current I (A) flows from a point charge Q(t) at the origin to infinity along a semi-infinitely long, straight wire occupying the positive z-axis, and find $\oint_C \vec{H} \bullet d\vec{l}$ where C is a circular path of radius a lying in the xy-plane and centered at the point charge, as shown in Fig.1. (15%)

2. In Fig. 2, the region x < 0 is a perfect conductor, the region 0 < x < d is a perfect dielectric of $\varepsilon = 4\varepsilon_0$ and $\mu = \mu_0$, and the region x > d is free space. The electric and magnetic fields in the region 0 < x < d are given at a particular instant of time by

$$\mathbf{E} = E_1 \cos \pi x \sin 2\pi z \, \mathbf{a}_x + E_2 \sin \pi x \cos 2\pi z \, \mathbf{a}_z$$

$$\mathbf{H} = H_1 \cos \pi x \sin 2\pi z \, \mathbf{a}_y$$

Find (a) ρ_s and $\mathbf{J}_s$ on the surface x = 0 (7%) and (b) **E** and **H** for x = d+ (8%), that is immediately adjacent to the x = d - plane and on the free-space side, at that instant of time.

3. A current I (A) flows with uniform volume density $\mathbf{J} = J_0 \, \mathbf{a}_z$ (A/m^2) along an infinitely long, solid cylindrical conductor of radius a and returns with uniform surface density in the opposite direction along the surface of an infinitely long, perfectly conducting cylinder of radius b (> a) and coaxial with the inner conductor. Try to find the internal inductance per unit length of the inner conductor. (See Fig.3) (20%)

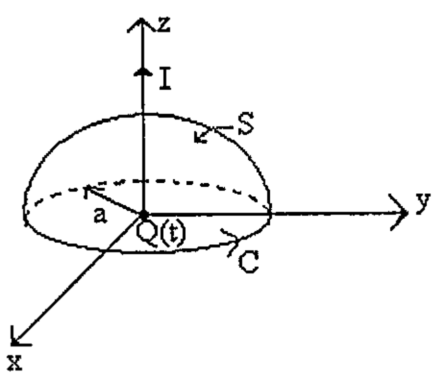

Fig.1.

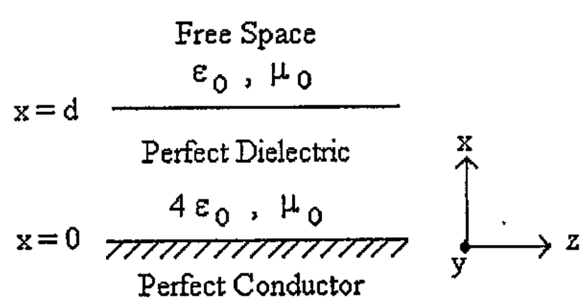

Fig.2.

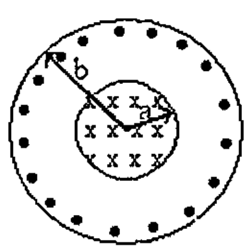

Fig.3.

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4. (a) State the Divergence theorem. (2%)

   (b) Prove the Divergence theorem by the vector function $\mathbf{A} = \mathbf{a}_r r^2 + \mathbf{a}_z 3z$, enclosed in the cylindrical region of $r = 5$, $z = 0$ and $z = 4$. (10%)

   (c) Give an electromagnetic example which uses the Divergence theorem to solve the problem (3%)

5. A positive charge Q was placed in the ceter of a dielectric shell with inner radius R_i and outer radius R_o. The relative permittivity of the shell was ε_r.

   (a) Determine the electric field intensity **E**, the electric potential V, the electric displacement **D**, and the polarization vector **P** as the function of radial distance R. (12%)

   (b) Write down the relation between **E**, **D**, and **P**. (3%)

6. A long cylindrical conducting wire, with a radius a and conductivity σ, was coated on the surface with the material which has a conductivity 0.1σ.

   (a) Calculate the thickness of the coating sheath material needed to get the whole coated wire resistance per length 50% lower? (8%)

   (b) Suppose the total current in the coated wire is I, calculate the current density **J** and electric field intensity **E** distributed in the core and the outer coating sheath, respectively. (12%)

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系所：光電所
科目：半導體元件

1. Explain the following terms:
   (a) Acceptors in a semiconductor (5%)
   (b) Carrier mobility (5%)
   (c) Fermi level in a semiconductor (5%)
   (d) Zener tunneling (5%)

2. Explain the formation of the depletion region in a semiconductor p-n junction diode. (15%)

3. Explain the thermionic emission mechanism in a Schottky-barrier diode. (15%)

4. Consider a p-type silicon substrate doped to 1×10^{17} cm^{-3}, and the thickness of silicon dioxide t_{ox} = 200Å. ($n_i = 1.5\times10^{10}\ cm^{-3}$, $\varepsilon_s = 11.7\varepsilon_0$, $\varepsilon_{ox} = 3.9\varepsilon_0$, $\varepsilon_0 = 8.85\times10^{-14}$ and $Eg = 1.12$ eV)
   (a) Calculate the gate voltage of an ideal MOS structure with n^+ poly-silicon gate when the surface potential $\phi_s = (3/2)\phi_{fp}$. (8%)
   (b) As problem (a) find the capacitance C/cm^2 (6%)
   (c) And the threshold voltage. (6%)

5. Draw the high- and low-frequency C-V characteristics of the n-type substrate. And indicated the correspond voltages to flat-band, weak inversion, accumulation, depletion and strong inversion mode. (15%)

6. Draw the minority carrier distributions for n-p-n bipolar transistor in cut off, saturation and forward active mode, respectively. (15%)