國立雲林科技大學
95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 solution of the following differential equations:

(1) $\frac{d^2y}{dx^2} + 9y = 2\cos^2 x$ (10%)

(2) $2\frac{d^3y}{dx^3} + \frac{d^2y}{dx^2} - 13\frac{dy}{dx} + 6 = (e^{-2x} - 1)^2$ (10%)

(3) $x^2\frac{d^2y}{dx^2} - 2x\frac{dy}{dx} + 2y = 2x^3\cos x$, and y(0)=0, y($\pi$/2)=0 (15%)

(4) $(ax + b)^2\frac{d^2y}{dx^2} - 3(ax + b)\frac{dy}{dx} + 4y = x + 1$, where a and b are constants. (15%)

2. $(2x^2 - 3xy)dy + (3y - 2y^2)dx = 0$ (10%)

3. Please calculate $\oint_C \frac{z}{z^2+9}dz$, where C is the circle $|z-2i|=4$. (10%)

4. Please find the general solution of the P. D. E.

$$\frac{\partial^2 z}{\partial x^2} - \frac{\partial^2 z}{\partial y^2} - \frac{\partial z}{\partial x} + \frac{\partial z}{\partial y} = 0$$ (10%)

5. If $Z_1=i$, $Z_2=1-\sqrt{3}i$, please find (1) $\arg\left(\frac{Z_1}{Z_2}\right)$ and (2) $\arg(Z_1Z_2)$ (10%)

6. $y^2\frac{dx}{dy} + 2yx = x^4$ (10%)

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系所：光電所
科目：半導體元件

1. (a) Write down the relation of mobility, electric field, and the average carrier drift velocity. (5%)
   (b) If only lattice scattering exists, how does the mobility change with temperature? Explain the reason. (5%)
   (c) If only ionized impurity scattering exists, how does the mobility change with temperature? Explain the reason. (5%)
   (d) If μ_I is the mobility due to the ionized impurity scattering process and μ_L is the mobility due to the lattice scattering process, what is the net mobility μ? (5%)

2. (a) Describe the excess minority carrier distribution in a pn junction structure when a forward bias is applied. (10%)
   (b) Explain the physical meaning of *diffusion length* of the minority carriers. (10%)

3. (a) For an n-type semiconductor, what is the condition to form a Schottky barrier contact? (5%)
   (b) What is the Schottky effect? Explain. (10%)
   (c) The current-voltage relationship of a Schottky diode is $J = J_{sT}\left[\exp\left(\frac{eV_a}{kT}\right)-1\right]$. How do temperature and Schottky barrier height affect J_{sT}? (5%)

4. Consider the low-frequency common-base current gain of a bipolar junction transistor:
   (a) Explain the definition of emitter injection efficiency factor. (5%)
   (b) Explain the definition of base transport factor. (5%)
   (c) Explain the definition of recombination factor. (5%)
   (d) Explain why the emitter doping concentration must be higher than the base doping concentration. (5%)

5. Consider the ideal C-V characteristics of an MOS capacitor:
   (a) Draw the energy-band diagram through the MOS capacitor for the depletion mode. (5%)
   (b) Draw the differential charge distribution at depletion for a differential change in gate voltage, and find the capacitance per unit area. (10%)

6. Describe the substrate bias effect in an n-channel MOSFET. (5%)

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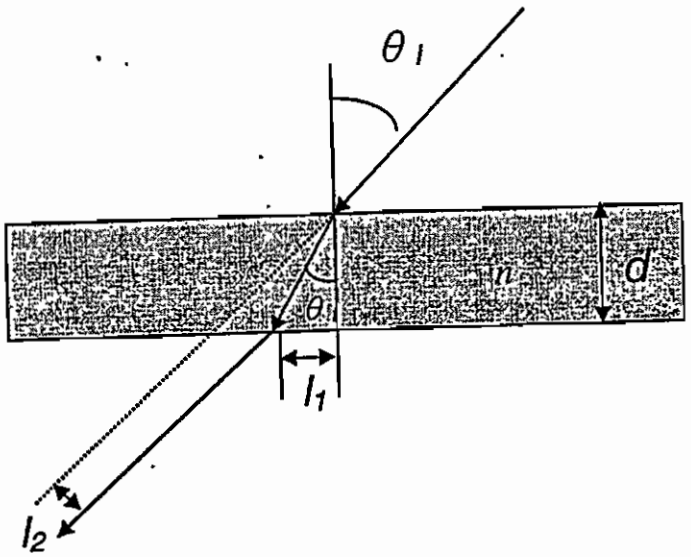
系所：光電所
科目：電磁學

可用參數：$\varepsilon_0=(1/36\pi)\times10^{-9}$(F/m)，$\mu_0=4\pi\times10^{-7}$(H/m)

1. 在真空中的平面電磁波的磁感應強度 $\vec{B}$ (magnetic induction or magnetic flux density)由下式決定:
$\vec{B}(x,y,z,t)=10^{-6}(\hat{x}+2\hat{y}+B_z\hat{z})\cos(\omega t+3x-y-z)$ ，$\hat{x},\hat{y},\hat{z}$ 為直角座標系基底向量(Base vectors)，式中各量均採用 SI 單位制。請決定以下各量: (a) 傳播方向(4%)； (b) 波長(4%)； (c) 角頻率(4%)； (d) 磁感應強度的 z 方向分量 B_z (4%)； (e) 該電磁波的電場(4%)。

2. 一束雷射光的功率為 20 瓦，光束的直徑為 1 毫米。計算此雷射的電場強度 **E** 和磁感應強度 **B** 的峰值。(15%)

3. 有一光線斜向入射於折射率 n，厚度為 d 之透明板上，如圖(一)。其入射角是 θ_i。求(a) 折射角θ_t(5%)； (b) 射出點 l_1 的距離(5%)； (c) 橫向位移 l_2(5%)。



圖(一)

4. 請敘述向量場的司鐸克斯定理（Stokes's theorem）(5%)，並以向量函數 $\mathbf{F}=a_\varphi 3\sin(\varphi/2)$，半徑為 4 的碗形半球面及碗緣驗證（10%）。

5. 有一 10 m 長的同軸電纜，中心金屬的半徑為 2 mm，外部包覆之金屬層之半徑由軸心算起為 2 cm，中間填充之介質為具有相對介電數 $\varepsilon_r = 3.0$，電導率 $\sigma = 10^{-10}$ (S/m) ，請計算此同軸電纜線的電容 C 與漏電阻 R 分別為多少？(20%)

6. (a) 有一半徑 $r_0 = 2$ mm 之無限長直導線，攜帶電流為 10 (A)。離此導線中心軸距離 $r = 5$ mm 處，其磁通量密度 **B** (magnetic flux density)為多少？(5%)
   (b) 在所有滿足 $\mathbf{B} = \nabla \times \mathbf{F}$ 之向量場 **F** 中，請寫出靜磁理論中選擇唯一向量磁位能 **A** 之條件與其名稱。(5%)
   (c) 若以導体表面為參考位能 0，寫出導線外離中心軸距離為 r 之向量磁位能 **A** 之表示式(5%)。