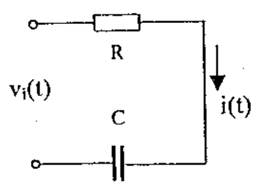
國立中山大學九十三學年度碩士班招生考試試題

科目：工程數學（光電所）

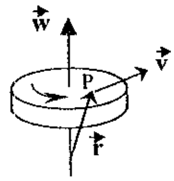
1. Please find the radius of convergence of the series: $\sum_{m=0}^{\infty}\frac{m}{3^m}(x-2)^m$. (8%)
2. Please find the f(t) if its Laplace transformation is: $\frac{1}{s^2}(\frac{s-1}{s+1})$. (8%)
3. What are the eigenvalues and corresponding eigenvectors of the matrix $\underline{A}$? (8%)

$$\underline{A}=\begin{bmatrix}-2 & 2 & -3\\ 2 & 1 & -6\\ -1 & -2 & 0\end{bmatrix}$$

4. Please find the unit normal vector of the cone of revolution $z^2=4(x^2+y^2)$ at point (1, 0, 2). (8%)
5. By applying the Kirchhoff's law, please find the current i(t) in the RC circuit (given in the figure of question 5) if $v_i(t) = V_0 \sin\omega t$. (8%)

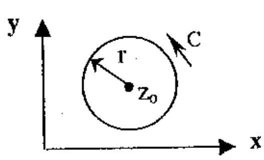


Question 5



Question 6

6. What is the curl of the velocity field $\vec{v}$ of the rotating body shown in the figure of question 6. (10%)
7. Please show that the integral of z^{-3} around the unit circle is zero. (10%)
8. Please find $\int_C (z-z_o)^3\,dz$, where z_o is a constant and the integration path C is shown in figure of question 8 (15%)



Question 8

9. Please solve the initial value problem consisting of equations:

$$\dot{y}_1 = 5y_1 + 8y_2 + 1$$
$$\dot{y}_2 = -6y_1 - 9y_2 + t$$

, where $y_1(0) = 4$, and $y_2(0) = -3$. (15%)

10. What are the solutions of $f(x) = x^3 + x - 1 = 0$? (10%)

National Sun Yat-Sen University,
Institute of Electro-Optical Engineering
2004 Entrance Examination
Engineering Electromagnetics

[*25points*]

1. (a) Please state Gauss's law.
   (b)Explain why the electric field inside a conductor is zero under steady conditions.
   (c)A conductor is placed in free space. If some positive charges are introduced inside of the conductor at the beginning, what are the boundary conditions under steady state at the interface between conductor and free space. Explain how you get the answers.
   (d)continue (c), if a conductor is spherical with radius R and some charges Q are stored inside, what is the charge density on the surface of the conductor ? To calculate the electric fields outside of the conductor, could we treat the fields produced by a point charge Q placed in the center of the spherical conductor ? why ?
   (e)continue (c) and (d), some charges Q introduced in the center of spherical at the beginning, the charges will then exert themselves until the steady state. What are the factors determining the speed of this so-called relaxation processing? Explain.

[*25points*]

2.A time-harmonic electromagnetic plan wave propagates in a lossless medium of permittivity ε_1 ($\varepsilon_1 = \varepsilon_{1r} \cdot \varepsilon_0$). The electric field of the wave is $\vec{E}_i(z,t) = \hat{x} \cdot E_a \cdot \cos(k \cdot z - \omega \cdot t) + \hat{y} \cdot E_b \cdot \cos(k \cdot z - \omega \cdot t + \phi)$. Please answer the following questions.
   (a) Define the polarization. And what is the polarization of the wave if $\phi = 0$ and $\phi = \pi / 2$? Explain.
   (b) What is the wavelength ? And what is the phase velocity?
   (c) Find the magnetic field if $E_b = 0$. State and explain any details you give.
   (d) As shown in figure 1, the wave $\vec{E}_i(z,t)$ is incident to the interface of medium ε_1 and medium ε_2. If $E_b = 0$, find the transmitted wave $\vec{E}_t(z,t)$ and the reflected wave $\vec{E}_r(z,t)$. State and explain any details you give.
   (e) Following the power conservation, $|\vec{E}_i(z,t)|^2 = |\vec{E}_t(z,t)|^2 + |\vec{E}_r(z,t)|^2$ at z=0 and if $E_b = 0$. Is it right? Please state your reasons.

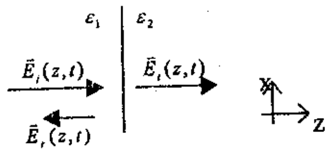


Figure 1

[25points]

3.(a)please state the reasons that there exists a vector potential $\vec{A}$ such that a magnetic flux density $\vec{B}$ can be expressed as $\vec{B} = \nabla \times \vec{A}$. Is this vector potential $\vec{A}$ unique for a specific $\vec{B}$? Why?

(b)define the Ampere's circuit law.

(c)using (a) and (b), derive the Biot-Savat's law.

(d)As shown in figure2, a circular loop with radius r carriers a current I (it is called a magnetic dipole) in a vacuum space. Please find the magnetic flux along the z-axis, i.e. the value of $\vec{B}$ at point P(0,0,z).

(e) plot the schematic magnetic lines on the x=0 plane.You should indicate the strength of $\vec{B}$ and explain why the strength of $\vec{B}$ is proportional to $1/R^3$ as the observation point is in the distant length R. (R>>r)

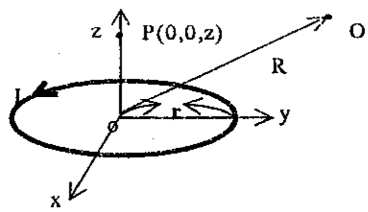


Figure 2

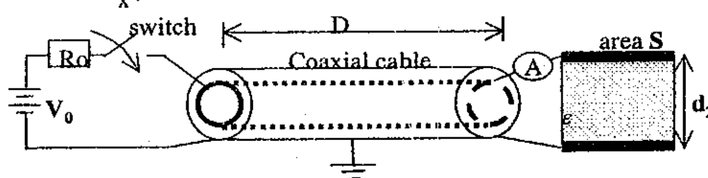


Figure 3

[25points]

4. As shown in figure3, a D.C. voltage source Vo is connected to a capacitor through a lossless coaxial cable. The voltage source with serial impedance Ro is triggered by an electrical switch, where the Ro is designed to match the coaxial cable. The coaxial cable is D long and the capacitance and inductance per unit length are C and L. The capacitor with area S and separation d_2 is filled by a medium of permittivity ε. At time = 0^+, the switch is triggered and a voltage Vo is sent to the cable and the capacitor. Please answer the following questions. **(You should explain or give any details about the answers you give.)**

(a) After reaching the steady state, how much charge is stored in the capacitor and cable.

(b) Express Ro in terms of C and L. And if there is no dispersion and loss effects in the cable, what is the velocity of electrical signal traveling inside the cable? You may follow the transmission line theory.

(c) Does the capacitor need time to approach the steady state? Or, as soon as the switch is triggered, the charge is stored immediately? If not, could you estimate how much time it needs?

(d) If an ideal ampere meter is placed just before the capacitance, is there any current flow detected during this measurement? Explain.

(e) If there is a small resistance **r** serial connected with capacitor, repeat problem (c) and (d).

國立中山大學九十三學年度碩士班招生考試試題

科目：電子學 (選考) 【光電工程研究所碩士班】 共 1 頁 第 1 頁

1. Express the logic output Y for the circuit shown in Fig. q1. (10 points)

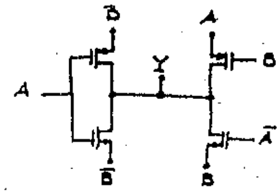


Fig. q1

2. For an OP amp with a finite Common-mode rejection ratio (CMRR), what is the v_o of the circuit shown in Fig. q2. (10 points).

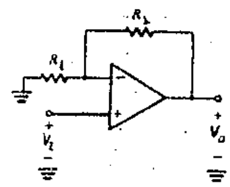


Fig. q2

3. For the Wilson circuit shown in Fig. q3, find the current gain i_o/i_I, assuming matched transistors. (20 points)

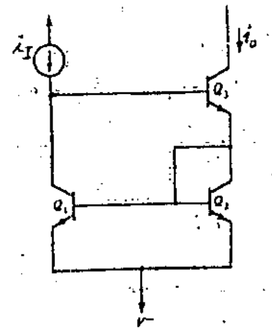


Fig. q3

4. For a single-ended ECL inverter shown in Fig. q4, find the input voltage at which the gain drops to unity. (20 points)

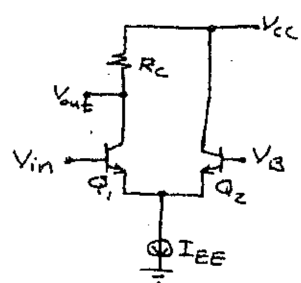


Fig. q4

5. Consider the circuit shown in Fig. q5. Derive the expression for $V_{out}(t)$ if $V_{out}(t = 0) = V_{DD}$. (20 points)

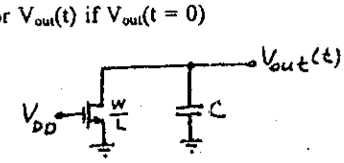


Fig. q5

6. For a typical CMOS inverter shown in Fig. q6, if the input has relatively fast transitions, the output exhibits small "overshoots" and "undershoots'. Explain where these "shoots" come from and how their amplitude varies as C_L increases from zero. (20 points)

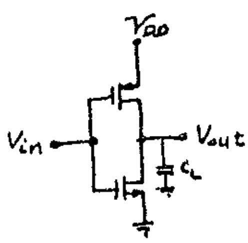
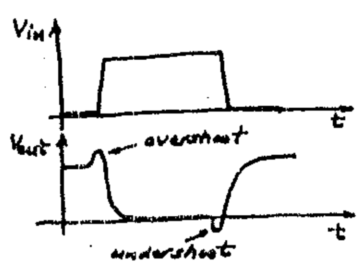


Fig. q6



Modern Physics

1. An electron is confined to a 1-D infinite potential well of width a=0.5 nm.

(a) Calculate the energies of the ground state and the first two excited states. (15%)

(b) Also calculate the probability that the electron will be found in the region $0<x<0.25$ nm for the ground state and for the first excited state. (10%)

(c) Calculate the expectation values of x and x^2 for the ground and first excited states. (10%)

(d) Calculate the uncertainly product $\Delta x \Delta p_x$ for the ground and the first excited state. (10%)

(e) If the electron is now confined to a 2-D square potential well of width a=0.5 nm, what would be the energies of the ground state and the first two excited states ? (10%)

2. Explain the following terms. (5% each)

(a) Hall Effect (b) Fermi Level (c) Zeeman Effect (d) Pauli Exclusion Principle (e) Bose-Einstein Condensation (f) Stimulated Emission (g) Quantum Tunneling.

3. The ionization energy of the hydrogen atom in the ground state is 13.6 eV. What are the ionization energies of He^+ and Li^{+2} atoms in their corresponding ground states ? (10%)