

元智大學 103 學年度研究所 碩士班 招生試題卷

系(所)別： 通訊工程學系碩
士班

組別： 微波組

科目： 電磁學

用紙第 / 頁共 2 頁

● 不可使用電子計算機

1. A plane boundary exists at $y=0$ which separates the space into two media. The dielectric constant in medium 1 ($y < 0$) is $\epsilon_r = 9$. Medium 2 ($y > 0$) is filled with perfect conductor with $\sigma = \infty$. A time-harmonic plane wave with electric field linearly polarized in x-direction of the frequency $f = \frac{1}{2\pi}$ GHz is incident from the region $y < 0$ and propagating toward the boundary $y=0$. Given the magnitude of the incident wave to be 1 (V/m) and assuming source-free case: 50%
 - 1) Find the characteristic impedance and the characteristic phase velocity of the plane wave in the media $y < 0$. (5%)
 - 2) Write down the expression for the wave vector $\underline{k}^{(i)}$ of the incident wave in medium 1. (5%)
 - 3) Write down the phasor representation of the incident wave (E-field and H-field). (10%)
 - 4) Write down the phasor representation of the reflected wave (E-field and H-field), assuming the magnitude of the reflected E-field is E_r . (10%)
 - 5) Determine the reflection coefficient at $y = 0$ by matching the proper boundary conditions. (10%)
 - 6) Using cosine reference, write the total electric field including the incident and reflected waves in time instantaneous expression. (10%)

2. Write down the following 26%
 - a) The fundamental postulates for magnetostatics. (6%)
 - b) The mathematical expression (in its integral form) for Gauss's Law. (6%)
 - c) The Maxwell's equations. (8%)
 - d) The mathematical expression for Ampere's Law. (6%)

3. Choose the correct answer: (15%, 3% each)
 - 1) An infinite straight line that lies on the z-axis carrying a current I in the z-direction. For an observation point located at a distance r from the line, which of the followings are true?
 - (a) The magnetic vector potential \underline{A} due to the straight line is inversely proportional to r^5 ;
 - (b) The magnetic flux density \underline{B} due to the straight line is inversely proportional to r ;
 - (c) The magnetic flux density \underline{B} due to the straight line is zero at any points on the x-y plane;
 - (d) The magnetic flux density \underline{B} due to the straight line is in the z-direction at any points on the x-y plane.

 - 2) In rectangular coordinate system, two point charges $+Q$, and $-Q$ locate at $(0,0,d/2)$ and $(0,0,-d/2)$ on z-axis, respectively. Such a set of two charges can be treated as the electric dipole. For an observation point located at a distance r from the origin ($r \gg d$), which of the followings are true?
 - (a) The electric field intensity \underline{E} due to the system of charges is inversely proportional to r^3
 - (b) The scalar electric potential V due to the system of charges is inversely proportional to r ;
 - (c) The potential is zero everywhere in the x-y plane ;
 - (d) The total work required to hold the two charges in place is zero.

 - 3) A lossless transmission line of 50Ω characteristic impedance is terminated with a load impedance of $Z_L = 50\Omega$. The SWR of the transmission line is:
 - (a) 0; (b) 1; (c) 5/3; (d) 1.5.

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- 4) A 50Ω transmission line shows a SWR of 2. One of the voltage maxima along the line is a half-wavelength away from the load. The load impedance is:
(a) 100Ω ; (b) 150Ω ; (c) 75Ω ; (d) 50Ω .
- 5) What is the phase velocity of a plane wave propagating in a uniform dielectric medium of dielectric constant 4? (c is the speed of light)
(a) c ; (b) $2c$; (c) $0.5c$; (d) $4c$.
4. Given the coordinates of three points in space as $A(x=2, y=-1, z=2)$, $B(\rho=\sqrt{2}, \phi=45^\circ, z=3)$, and $C(r=5\sqrt{2}, \theta=45^\circ, \phi=53^\circ)$, find (use $\cos 53^\circ = 0.6$ for all the calculations) 9%
- a) the angle spanned by \underline{AB} and \underline{AC} (3%)
b) the component of \underline{BC} in the direction of \underline{CA} (3%)
c) the unit vector of $(\underline{BC} - \underline{AC})$ (3%)

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