所別：電機工程學系碩士班 電波組(一般生)　科目：電磁學　共 3 頁 第 1 頁
本科考試禁用計算器　　　　　　　　　　　　　　　　*請在試卷答案卷（卡）內作答

參考用

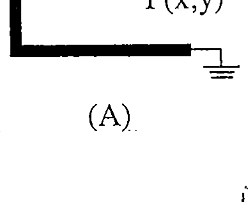
1. A microwave signal generator with $V_g = 1\angle 0°$ (V) and internal resistance 50 (Ω) is connected to a lossless 50-Ω air transmission line that is 2-λ long and terminated in a 30 + j40 (Ω) load. Find (a) (4%)voltage reflection coefficient at the load, (b) (4%)the voltage standing-wave ratio on the line, and (c) (4%)the average power delivered to the load. (d) (8%)Based on the single-stub method for matching the load to the 50-Ω line, and determine the position and length of the short-circuited stub using the Smith chart. (please provide two possible solutions, and also draw all the results in your answer sheets)

2. (a) (2%)Can the TEM waves exist in a semicircular waveguide? Why? (b) (2%)What is meant by the dominant mode of a waveguide? (c) (2%)What are cavity resonators? What are their most desirable properties? (d) (2%)Which design parameter limits the maximum time-average power through the rectangular waveguide at the dominant mode? (e) (7%)A air-filled rectangular waveguide has cross section of sides a (x-direction) and b (y-direction) ($a > b$). Assuming the electromagnetic waves propagate in the +z-direction, and the appropriate time-harmonic solution for $H_z^0(x, y)$ is

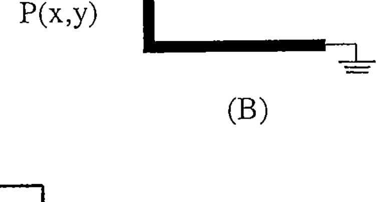
$$H_z^0(x, y) = H_0 \cos\left(\frac{m\pi}{a}x\right)\cos\left(\frac{n\pi}{b}y\right),$$

where m and n are integers for the possible mode. Find the instantaneous surface currents on the guide walls for the dominant mode

3. There are two grounded perpendicular conducting half-planes in the Figures shown below:
   (a). (14%) As in Fig. (A), there is a positive static point charge Q at (1, 2). Please determine the electric field intensity at arbitrary point P(x,y) in the first quadrant by using the method of images.
   (b). (8%) Explain how the method of images works based on the uniqueness theorem.
   (c). (8%) In Fig. (B), there is a positive static point charge Q at (-1, 2). Can you still use the method of images to determine the electric field intensity at arbitrary point P(x,y) in the second, third, and fourth quadrants? State your reasons.



(A)



(B)

注意：背面有試題

參考用

4.

(a) (3%) Write down the differential form of the equation of continuity.

(b) (4%) Write down the Lorenz gauge condition for potentials.

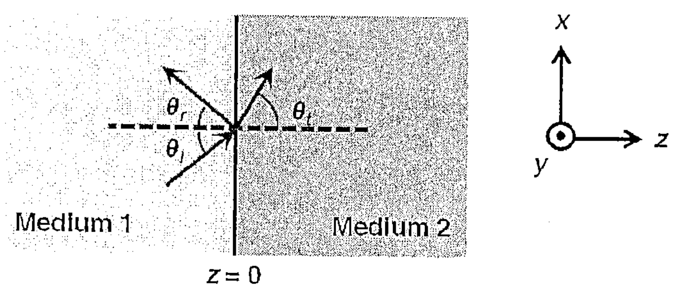
(c) (7%) Using Maxwell's equations and the Lorenz condition, derive the nonhomogeneous wave equations for vector magnetic potential $\vec{\mathbf{A}}$ and scalar electric potential V, namely,

$$\nabla^2\vec{\mathbf{A}} - \mu\varepsilon\frac{\partial^2}{\partial t^2}\vec{\mathbf{A}} = -\mu\vec{\mathbf{J}}, \text{ and}$$

$$\nabla^2 V - \mu\varepsilon\frac{\partial^2}{\partial t^2}V = -\frac{\rho}{\varepsilon}.$$

(d) (6%) Derive the equation of continuity by using the nonhomogeneous wave equations and the Lorenz condition. This, in a way, proves that the Lorenz condition is consistent with the equation of continuity.

5. Consider a plane wave obliquely impinging upon a boundary between two different materials as illustrated in the figure below. Both materials are lossless. The relative permittivities of medium 1 and medium 2 are 3 and 7, respectively. The relative permeabilities of medium 1 and medium 2 are 9 and 1, respectively.



The E field of the incident wave is as follows.

$$\vec{\mathbf{E}}_i(x,z,t) = 36\,\vec{\mathbf{a}}_y \cos\left(\omega t - \beta_1\left(\frac{1}{2}x + \frac{\sqrt{3}}{2}z\right)\right) \quad \text{(V/m)},$$

where $\vec{\mathbf{a}}_x$ and $\vec{\mathbf{a}}_z$ are unit vectors pointing in x and z directions, respectively, and β_1 is the phase constant of medium 1.

(a) (3%) Calculate the intrinsic impedance of medium 1. Express it in Ω and round the number to the nearest integer.

(b) (5%) Calculate the time-average power density of the incident wave.

(c) (3%) Calculate the Brewster angle for perpendicular polarization. Express it in degree.

(d) (4%) Find the time-average power density of the reflected wave.

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參考用

The Smith Chart