國立中央大學 110 學年度碩士班考試入學試題

所別： 光電類　　共2頁 第1頁

科目： 電磁學

本科考試可使用計算器，廠牌、功能不拘　　＊請在答案卷(卡)內作答

※計算題需計算過程，無計算過程者不予計分

Part A

1. (a) Describe how the electric permittivity and magnetic permeability are defined? (5pts).
   (b) And by what experiments can one measure them? (5pts).

2. Electret filters are key components in medical face masks that exhibit enhanced ability to capture airborne particulate matters (PM). Normally, electret filters are made by corona-charging or the so-called melt-blown technology to load charges onto nonwoven fabrics. Suppose here, a high energy electron beam with current I=0.5μA is used to bombard the polypropylene fabric (with relative permittivity ε_r=2.5) over an area A= 5×5 cm^2 for 1 sec. Assume that the all the electrons are uniformly trapped in a very thin layer.
   (a) Describe the operational principle of such a filter for PM2.5 (i.e., a particulate matter of diameter of 2.5 μm). (5pts)
   (b) What is the energy of a PM2.5 a distance h=1cm (h<<A) above the mask. (hint: you may treat the particle as an electric dipole with a dipole moment **p**). (5pts)
   (c) What is the force exerted on the PM2.5 by the mask. (5pts).
   (d) Is the design appropriate and reasonable? If not, give your reasons and solutions? (Hint: you may compare the obtained force with the gravity the particle "feels".) (5pts).

3. A long straight conducting wire has a circular cross-section of radius R and carries a current I. Inside the conductor, there is a cylindrical hole of radius a whose axis is parallel to the axis of the conducting wire and is located at a distance b from it. Calculated the magnetic field inside the hole. (15 pts).

Part B

4. (15%) The intrinsic impedance of an unknown material at 200 MHz is found to be approximately

$$\eta_c \approx 25.3e^{j41^\circ} \ (\Omega).$$

   Assuming that the material is nonmagnetic,
   (a) (5%) determine the relative dielectric constant ϵ_r',
   (b) (5%) find out its (effective) conductivity at this frequency, and
   (c) (5%) obtain the loss tangent of this material. What's the physical meaning of the loss tangent?

5. (27%) A uniform plane wave in a nonmagnetic *simple* medium 1 (μ_0, ϵ_1) is incident upon a nonmagnetic *simple* medium 2 (μ_0, ϵ_2) of half-space as shown in Fig. 1, where μ_0 and ϵ denote the free-space permeability and the absolute permittivity, respectively. According to the experimental data there is no reflection at some incident angle. Assume a time dependence of $e^{j\omega t}$, answer the following questions:
   (a) (5%) What do we mean by a *simple* medium?
   (b) (3%) Given the free-space wavelength λ_0, write down the incident wave vector $\mathbf{k}_i$.

注意:背面有試題

(c) (5%) If the incident magnetic field of constant amplitude H_{i0} points in the y-direction, determine the phasor form of the incident electric field $\mathbf{E}_i$.

(d) (9%) Assume the direction of the $\mathbf{H}$ field does not change upon reflection and transmission at the interface and the magnetic field amplitudes of the reflected and transmitted waves are denoted by H_{r0} and H_{t0}, respectively. Obtain the relation that the tangential components of the electric fields in media 1 and 2 must satisfy at $x = 0$.

(e) (5%) Explain how the phase matching condition is obtained based on the result from (d).

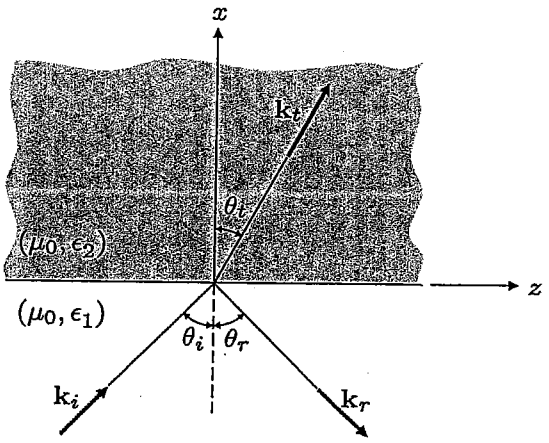

Fig. 1

6. (13%) A load of $Z_L = 32 + j60\ \Omega$ is to be matched to a main line of characteristic impedance $Z_0 = 50\ \Omega$ using a circuit shown in Fig. 2.

(a) (8%) Determine the characteristic impedance of Z_{0Q} of this quarter-wave segment.

(b) (5%) Find out the shortest short-circuited stub length l_s required to match the load at interface BB'.

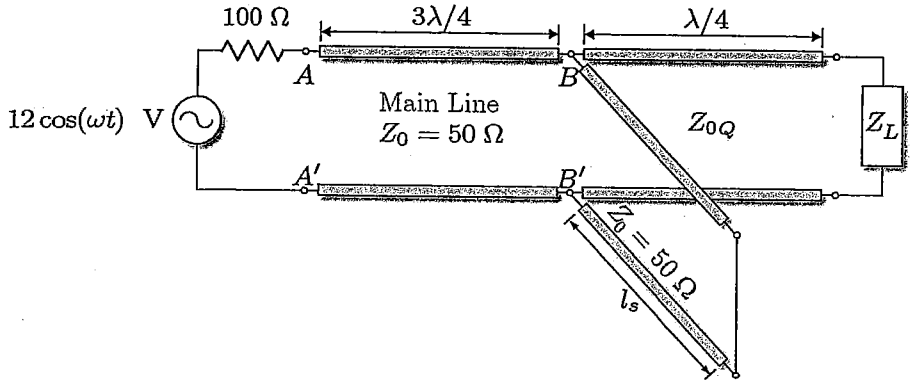

Fig. 2

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