科目：電磁學 A(3007)　　校系所組：交通大學電子研究所(甲組、乙A組、乙B組)
交通大學電信工程研究所（乙A組）
清華大學電子工程研究所
清華大學工程與系統科學系（丁組）

參考用

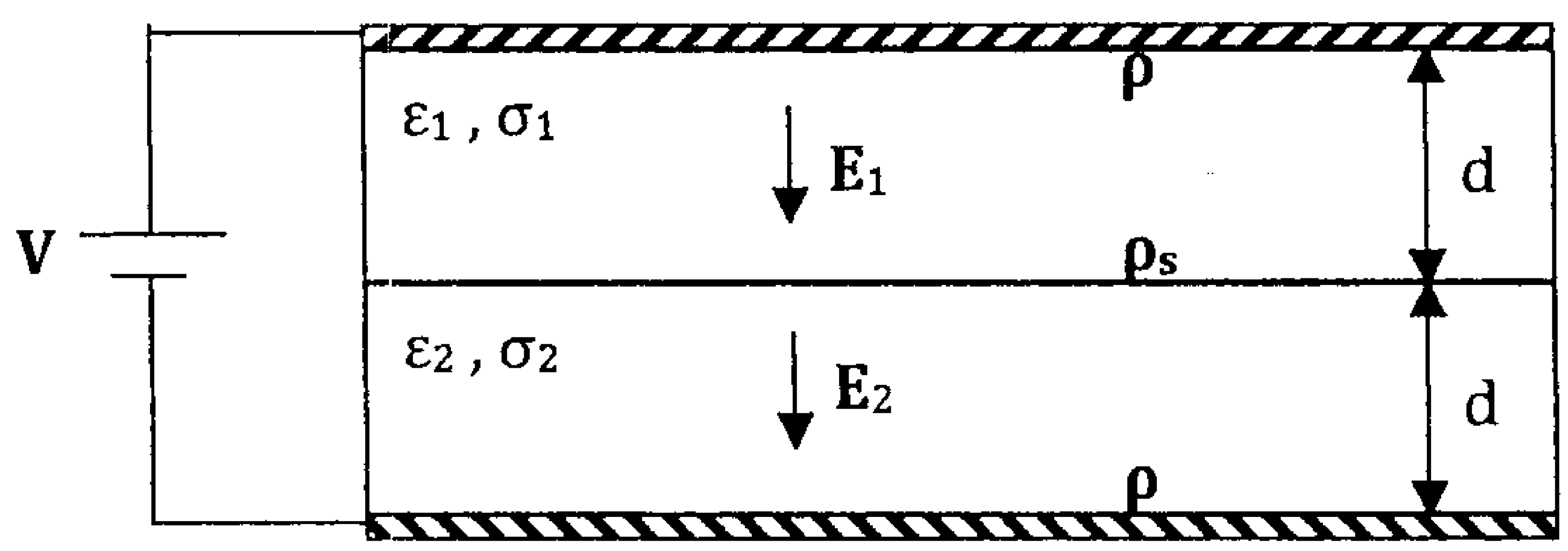
1. (15 points)

(1). Derive the "**equation of continuity**" in differential form. (5%)

(2). A voltage V is applied across a parallel-plate capacitor of area S as shown in following figure. The space between the conducting plates is filled with two different lossy dielectrics of thickness d_1 and d_2, permittivties ε_1 and ε_2, and conductivities σ_1 and σ_2, respectively.

(a) Determine the electrical field intensities (**E1 & E2**) in both dielectrics. (5%)

(b) Determine the surface charge densities ρ_1 **&** ρ_2 on the two plates, and at the interface ρ_s. **(5%)**

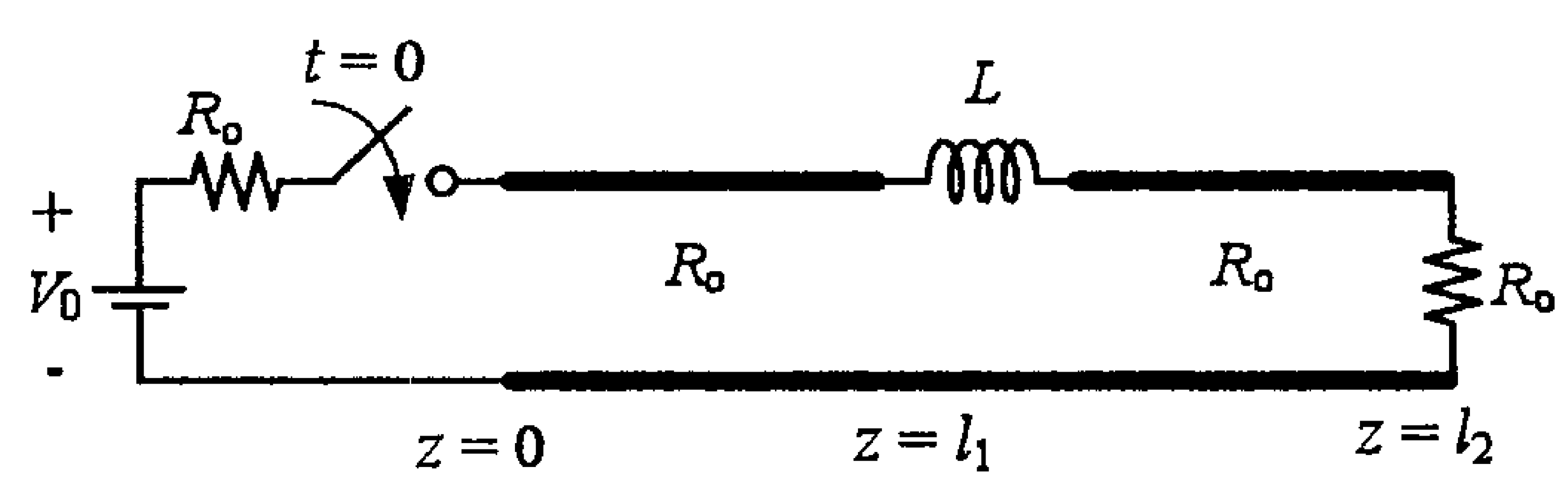


2. (15 points)

For a 50 Ohm transmission line terminated with a lossless ideal capacitor which has an impedance of -j50 Ohm at 20GHz, please make a simple drawing of the Smith chart first and then indicate the DC-20GHz trajectory (i.e. contour) of the reflection coefficient at the terminal. And what will happen to the DC-20GHz trajectory if a 10 Ohm resistor is in series with this capacitor to make it lossy now; please make a drawing of the revised trajectory on the same Smith chart too.

3. (15 points)

A dc voltage V_o is applied to a lossless and air-dielectric transmission line with a characteristic resistance R_o as follows. The line is terminated into a resistive load of R_o at $z = l_2$, while a lumped inductor L of zero length is placed at $z = l_1$. At $t = 0$, the line is connected to the dc voltage. Plot the voltage observed at $z = 0$ for all $t \geq 0$. (Mark the voltage magnitude and time in the plot.)



注意：背面有試題

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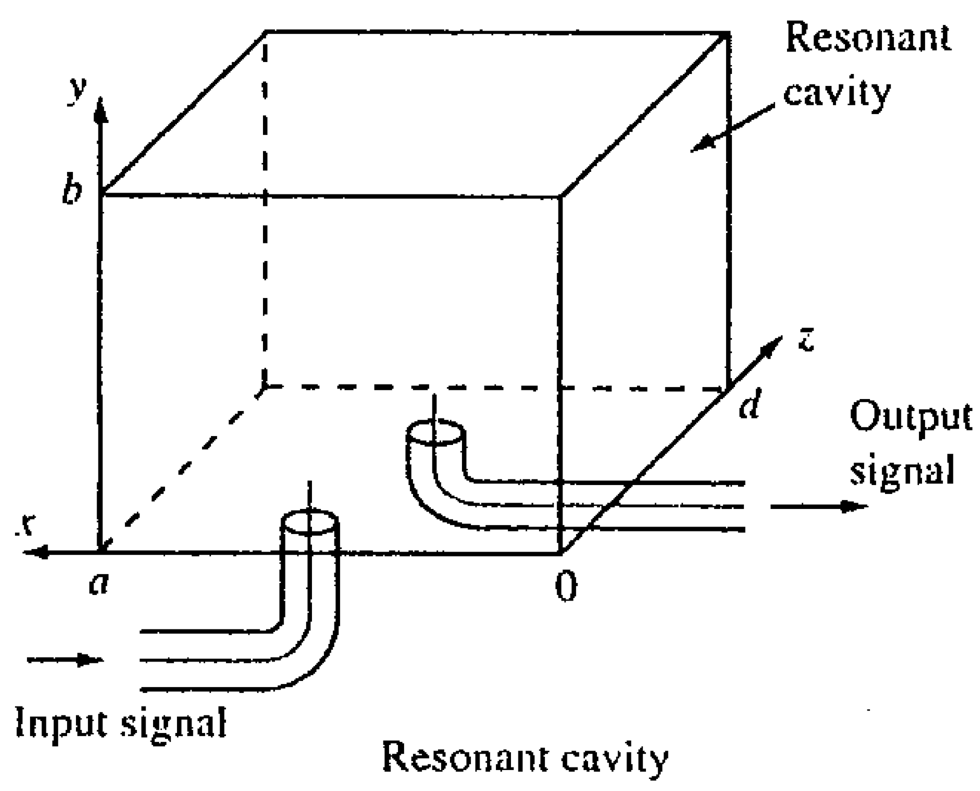
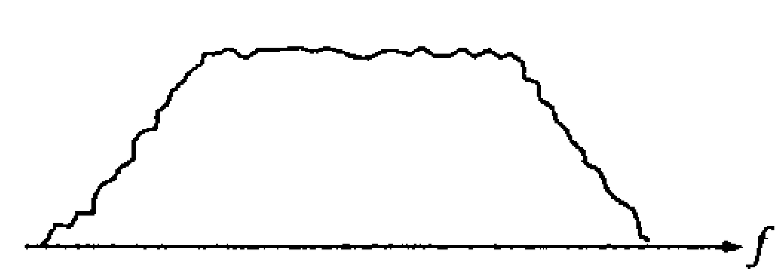
4. (13 points)
Let us consider some physical insights and engineering applications of electromagnetic waves.
(1). As you learned before, TEM waves are allowed in lossless coaxial cables which were widely used in transmission line systems. Please theoretically prove (or illustrate it by using intuitive plots) that TEM waves aren't allowed in rectangular metallic waveguides. (3%)
(2). We can deliver water and natural gas from a utility company to consumers by using a metallic pine of arbitrary cross section. Can we use metallic waveguides of an arbitrary cross section to guide microwaves from a receiving antenna to a signal processing office? Please clearly write down your explanations. (3%)
(3). A resonant metallic cavity and an input spectrum are shown below. Please plot the corresponding output spectrum and explain your result. (3%)



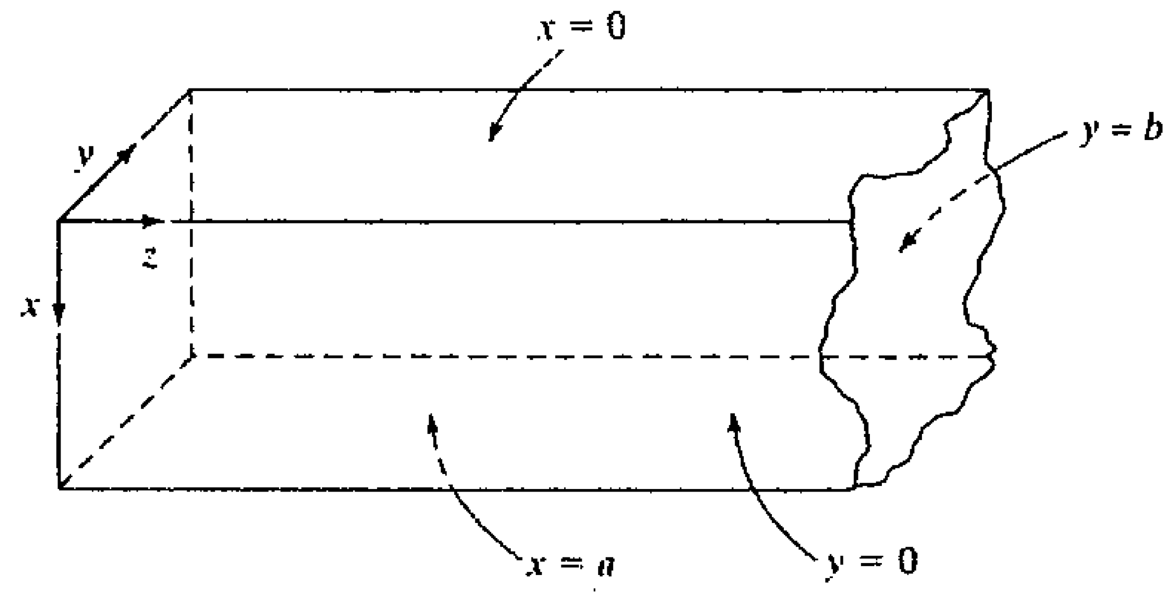
Resonant cavity



Input spectrum

(4). Let us neglect possible absorption within rectangular metallic waveguides. A propagating electromagnetic wave shows decay along the waveguiding direction if its frequency is smaller than the cut-off frequency. Please give the physical insight why the magnitude of the wave shows decay or attenuation. (4%) **No credit will be given if you use any equation or mathematical expression here.**

5. (12 points)
Let us consider a hollow rectangular metallic waveguide which has an a×b cross section and the waveguiding direction is the z-direction.
(1). Please derive the functional form of E_z. (5%)
(2). Without resorting to the E_z-H_z formula, we can derive the functional forms of E_x, E_y, H_x *and* H_y. Please determine the functional form of H_y without using the E_z-H_z formula. **You get zero credit if you use the E_z-H_z formula.** (7%)



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參考用

6. (15 points)
A voltage source $V_0 \sin(\omega t)$ is connected between two concentric conducting spheres of radii a and b (where $b > a$) respectively. The region between them is an insulating material with relative permittivity of ε_r. Find the total displacement current through the dielectric in terms of V_0, ωt, a, b, and ε_r.

7. (15 points)
Consider the right isosceles triangular prism upon which an incident wave of light is impingent, as shown in the figure below. Assuming $\varepsilon_r = 4$ for glass,
(1) state the reason for total internal reflection at the two non-hypotenuse surfaces (7%), and
(2) calculate the percentage of the incident light power reflected back by the prism. (8%)