Problem 1 (20%)

Semi-infinite conducting planes at $\varphi=0$ and $\varphi=\varphi_0$ are separated by an infinitesimal insulating gap as shown below. Given the applied voltages $V(\varphi=0)=0$ and $V(\varphi=\varphi_0)=V_o$, calculate (a) potential distribution V and (b) electric field distribution $\bar{E}$ in the region between the planes.

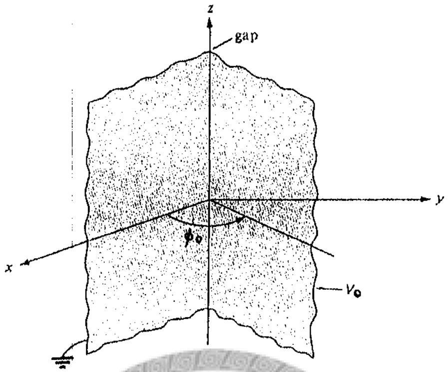

Figure of Problem 1.

Problem 2 (30%)

There is a lossy transmission line system with source (V_g, Z_g) connected to a transmission-line of length l, attenuation constant α, and characteristic impedance Z_0, terminated by a load Z_R, as shown below. Find (a) the reflection coefficient at the load end Γ(d=0); (b) the reflection coefficient at the input end Γ(d=l); (c) the input impedance at the input end Z_i(d=l); (d) the time-average power flow at the input end <P(d=l)>; (e) the time-average power delivered to the load <P(d=0)>; and (f) the time-average power dissipated in the transmission line. (Hint: the time-average power <P>=Re(VI^*)/2. You may need to derive the general <P(d)> and note that $I_m(Z_0)$ is negligible for the low loss transmission line.)

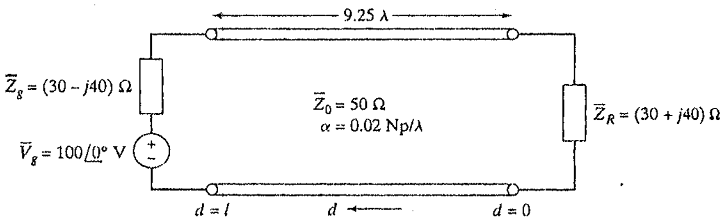

Figure of Problem 2.

Problem 3 (20%)

A cross section of Taipei MRT power line with near-by telephone line is shown below. Both the power line and telephone line are two-wire lines. The amplitude of current I_m with frequency f is through the overhead power line (the one above the ground). Its magnetic field will then influence the telephone line. (a) Find the mutual inductance per unit length of the telephone line caused by this overhead line. (b) What is the induced voltage in a section of the telephone line of length s.

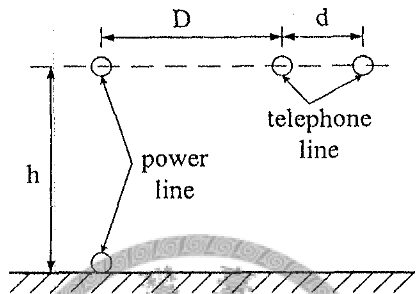

Figure of Problem 3.

Problem 4 (30%)

A microwave communication structure is shown below.

(a) The dimension of waveguide A is a=1cm, b=1.5cm (a is the waveguide dimension in x-direction, and b is the dimension in y direction). It is operated in TE_{10} mode as a transmitting antenna. Calculate its cutoff frequency. (b) A 15GHz source is connected to the waveguide A. Can this signal radiate from the open end of waveguide A to the free space? Why? (c) An observation point O is at the mid-point between waveguide A and waveguide B. This point is in the far field of waveguide A, i.e., d>>operating wavelength. Write down the expressions of electric field $\bar{E}$ and magnetic field $\bar{H}$ at point O. Define the symbols you used. (d) What is the polarization observed at point O? (e) An open ended waveguide B with dimension a=1cm, b=2cm is used as the receiving antenna. Can waveguide B receive the signal? Why? (Note: Waveguide B and waveguide A are different in dimensions.) (f) Assume the signal detected in (e) is 0dBm, and waveguide B is now rotated by 90°. What is the power level detected? Why? (g) If waveguide B is further rotated by 45°, what is the power level detected? Why?

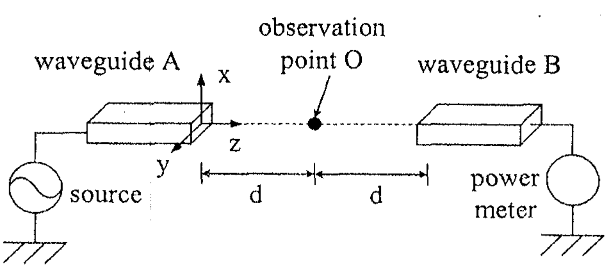

Figure of Problem 4.