MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.630 Electromagnetics
Quiz No. 2 Time: 3:00pm-5:00pm

Problem 1 (8%)

Close one end of a charged transmission line at $t = 0$ with $V(z) = 1$ as shown in Fig. 1. Determine $V(z)$ at times $t = 0$, $\frac{\ell}{2v}$, $\frac{\ell}{v}$, $\frac{3\ell}{2v}$.

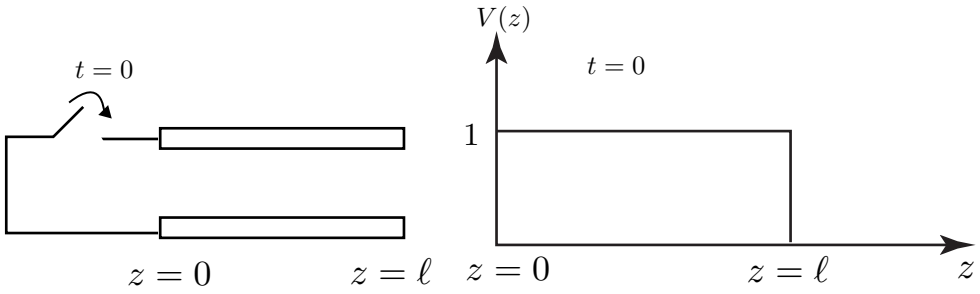

Fig.1

Problem 2 (6%)

Find the radiation pattern for the six-dipoles array as shown in Fig. 2. What are the unit pattern, group pattern, and resultant pattern?

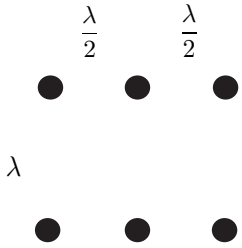

Fig.2

Problem 3 (10%)

Consider the periodic structure shown in Fig. 3. Find μ_{eff}. When is $\mu_{eff} < 0$?

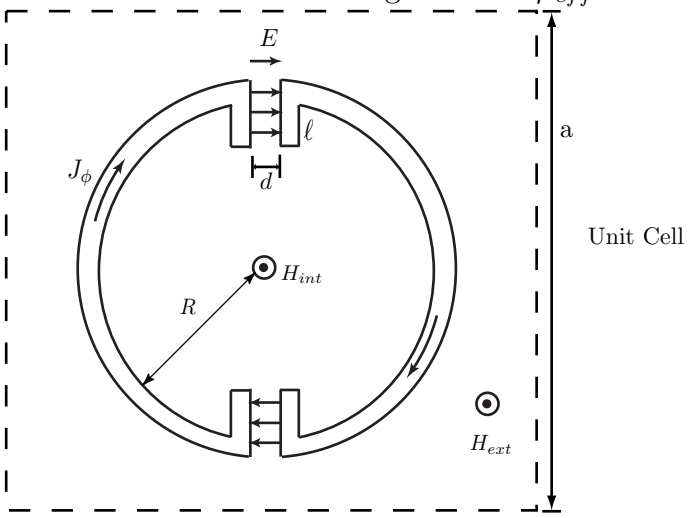

Fig.3

Problem 4 (20%)

The result of a measurement of the voltage standing wave pattern on a transmission line with characteristic impedance $Z_o = 100\Omega$ is shown in Fig. 4.
(a) What is the wavelength λ.
(b) Calculate the VSWR.
(c) Calculate the reflection coefficient Γ_L.
(d) Determine the load impedance Z_L.

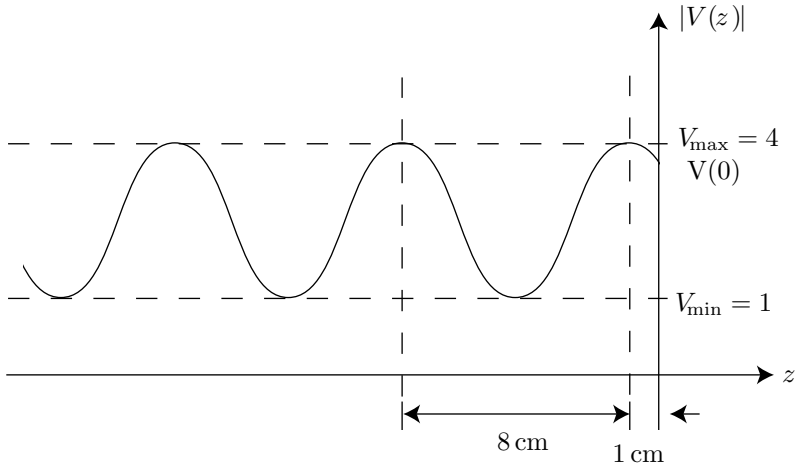

Fig.4

Problem 5 (30%)

Consider a $\frac{\lambda}{4}$ long transmission line, with characteristic impedance $50\,\Omega$, as shown in Fig. 5. One end is connected to a voltage source $V_g = 100\sin\omega t$, which has a source impedance $Z_g = 50\Omega$, while the other end connected to a load impedance $Z_L = j50\Omega$.
(a) Write out the complex expression for $V(z)$, $I(z)$.
(b) Solve the instantaneous power and time-averaged power dissipated in Z_L.
(c) Find Z_A, which is the input impedance at $z = -\lambda/4$.

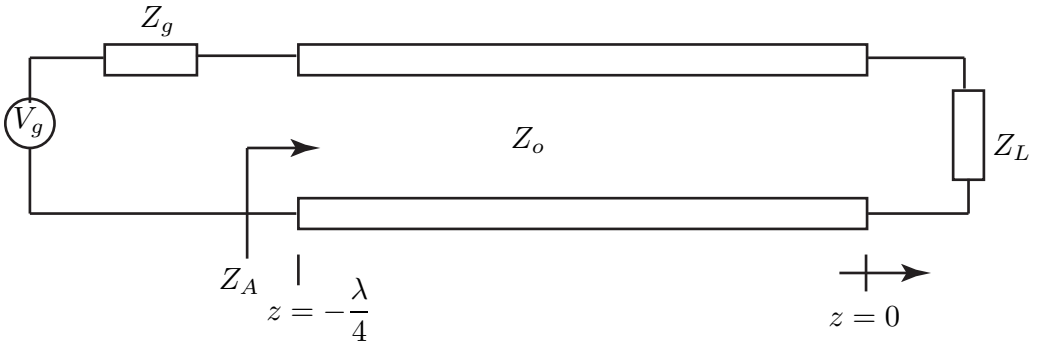

Fig.5

Problem 6 (26%)

Cosider a perfectly conducting parallel-plate waveguide with the plates seperated by d. The guided TM waves propagate in the $\hat{z}$ direction. The operating frequency is 10 GHz.

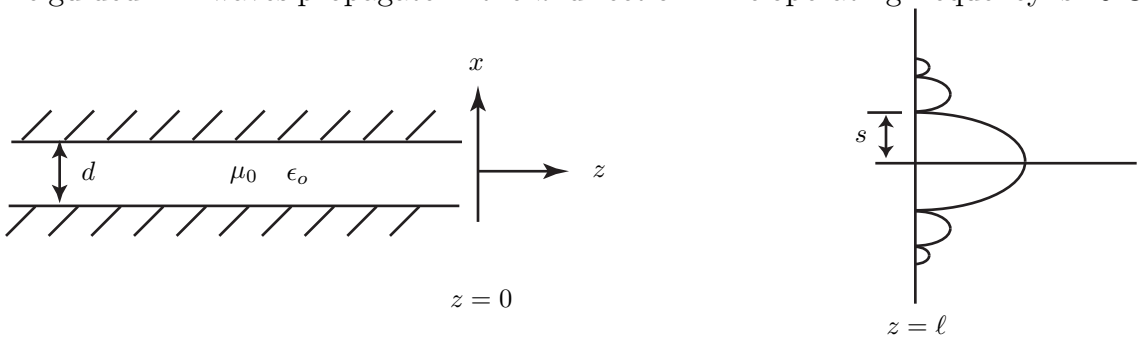

Fig.6

(a) What's the relationship between d and the highest TM mode which can be guided in this waveguide?

(b) If d is reduced to ensure that only one TM mode exists in this waveguide, write down the condition for d.

(c) Under the condition where only one TM mode is propagating in this waveguide, the diffraction pattern is shown on a screen at $z = \ell$ $(\ell >> d)$. The first null on the screen is at $x = s$. Write out s in terms of d and ℓ.