※ 請於答案卷上非選擇題作答區標明題號作答。計算題請詳列過程。 $\varepsilon_0 = 10^{-9}/(36\pi)$ F/m, $\mu_0 = 4\pi\times10^{-7}$ H/m

1. The velocity of light in free space is 3×10^8 m/s. Consider an electromagnetic wave which propagates from Medium 1 to Medium 2, as shown in the Fig. P1. The frequency of the wave is 3×10^{14} Hz in Medium 1. Both Medium 1 and Medium 2 have a permeability which is equal to that in free space (μ_0). Medium 1 has a refractive index $n_1 = 1.5$, and Medium 2 has a refractive index $n_2 = 2$.
   (a) **(3%)** What is the frequency of the wave in Medium 2?
   (b) **(3%)** What is the phase velocity of the wave in Medium 1?
   (c) **(3%)** What is the phase velocity of the wave in Medium 2?
   (d) **(3%)** What is the wavelength of the wave in Medium 1?
   (e) **(3%)** What is the wavelength of the wave in Medium 2?
   (f) **(3%)** Assuming normal incidence upon the interface, what is reflection coefficient Γ?

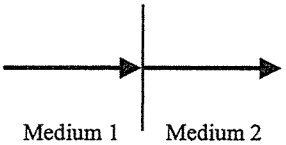

Fig. P1

2. *Mechanical Force of Electric Origin*
   (a) **(5%)** Consider a capacitor consisting of two conducting plates in free space, separated by a distance x. The top plate has an area of A_1, and the bottom plate has an area of A_2. A_2 is larger than A_1, as shown in the Fig. P2a. If a voltage V is applied across the capacitor, what is the mechanical force $\mathbf{F}_e$ of electric origin exerted on the top plate? What is the direction of the force? (Please ignore fringing of the electric field.)

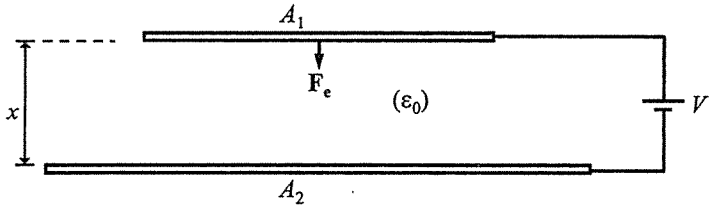

Fig. P2a

   (b) **(10%)** Fig. P2b shows a magnetic-field electromechanical device in which the magnetic core is free to slide inside a long air-core solenoidal coil. The solenoid has length l, radius a, and number of turns per meter N, and carries a current I. The magnetic core has length $b < l$, radius a, and permeability $\mu >> \mu_0$, and extends a distance x into the solenoid. Find the mechanical force $\mathbf{F}_e$ of electric origin on the core for $0 < x < b$ and $b < x < l$, respectively. What is the direction of the force? (Please neglect fringing of the field.)

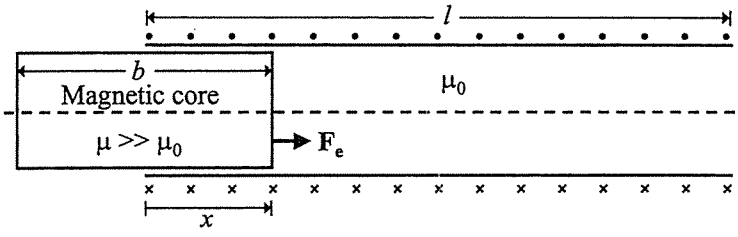

Fig. P2b

3. In the system shown in Fig. P3(a), the switch S is closed at $t=0$. The line voltage variations with time at positions

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$z=0$ and $z=l$ for the first 5 μs are observed to be as shown in Fig. P3(b) and (c), respectively. Please find the values of V_0, R_g, R_L, and T.**(16%)**

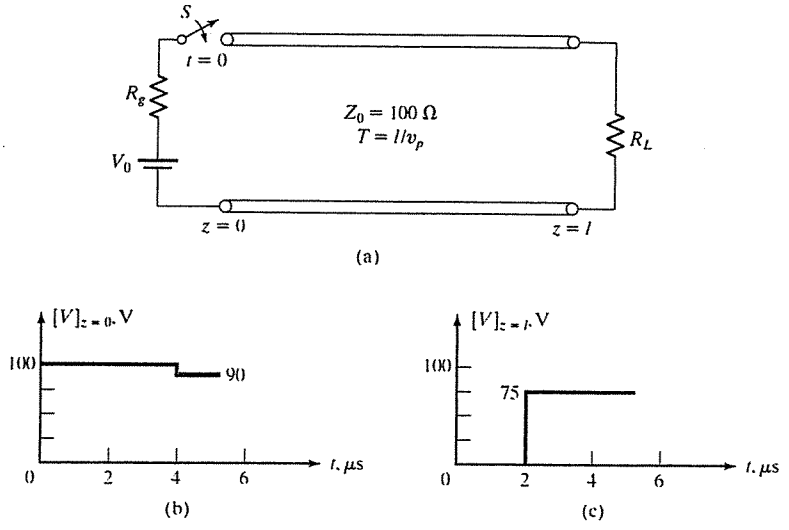

Fig. P3

4. **(12%)** In Fig. P4, a (+) wave carrying power P_0 is incident on the junction a-a' from line 1. Please find
   (a) The power reflected into line 1.
   (b) The power transmitted into line 2.
   (c) The power transmitted into line 3.

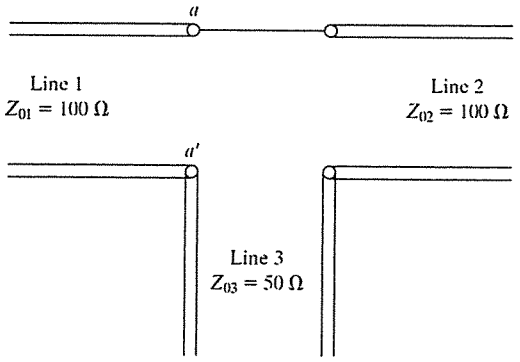

Fig. P4

5. **(6%)** Continued from Problem 1, a quarter-wave dielectric coating is usually employed to eliminate the reflection of uniform plane wave, please find
   (a) The thickness of the dielectric coating.
   (b) The permittivity of the dielectric coating.

6. We want to transmit satellite signals of 300 Watt power using an antenna with a gain of 35 dB at 10.7 GHz over a distance of 7,500 km. What is the power received by another antenna with a gain of 30 dB? **(8 %)**

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7. We have joined two rectangular waveguides together end-to-end with identical dimensions, where a = 2b. If one waveguide is filled with air, and the other one is filled with a lossless dielectric characterized by ϵ_R.
   (a) We want to ensure that single-mode operation can be simultaneously existed in *both* waveguides at some frequency. What is the maximum allowable value of ϵ_R? **(8 %)**
   (b) Following (a), what is the frequency range? Express your answer in terms of ϵ_R, dimension, or other known constants as needed. **(6 %)**

8. An optical fiber is 10 km long with an attenuation of 0.2 dB/km and a diameter of 50 μm. Assume the fiber has $n_1 = 1.54$, $n_2 = 1.53$, and the dispersion coefficient is 18 ps/km-nm at wavelength of 1.55 μm.
   (a) What is the maximum angle at which rays will enter the fiber and be trapped? **(3 %)**
   (b) What is the percentage of input power received? **(3 %)**
   (c) A Gaussian pulse envelope of half-width 5 ps propagates in this fiber at $\lambda = 1.55$ μm. What is the half-width pulse envelope after 10 km? **(5 %)**

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