1. (10%) Does $\mathbf{A} \times \mathbf{B} = \mathbf{A} \times \mathbf{C}$ imply $\mathbf{B} = \mathbf{C}$? Explain.

2. (10%) Write the symbol, value, and unit, respectively, of the three universal constants in the electromagnetics, and what are their relations?

3. (10%) Can a static magnetic field exist in the interior of a perfect conductor? Explain. Can a time-varying magnetic field? Explain.

4. (10%) Determine the force on the conducting plates of a charged parallel-plate capacitor. The plates have an area S and are separated in air by a distance x.

5. (10%) An air coaxial transmission line has a solid inner conductor of radius a and a very thin outer conductor of inner radius b. Assume that a current I flows in the inner conductor and returns via the outer conductor. Determine the magnetic flux density a) inside the inner conductor and b) between the inner and outer conductors.

6. (10%) There is a continuing discussion on radiation hazards to human health. The U. S. standard for personal safety in a microwave environment is that the power density be less than 10 mW/cm². A cell-phone boost-station radiates energy at a rate of 50 kW. Calculate the corresponding standard in terms of electric and magnetic field intensities, respectively, and determine weather the residents living in a house which is located 10 meters away from the boost-station receive over exposure or not.

7. (10%) Plot the magnitude and phase of the reflection coefficient as a function of the angle of incidence for external reflection of the TE polarized wave. Hint: $\Gamma_\perp = \dfrac{E_{r0}}{E_{i0}} = \dfrac{n_i \cos\theta_i - n_t \cos\theta_t}{n_i \cos\theta_i + n_t \cos\theta_t}$, where n_i and n_t are the refractive index for dielectric 1 and dielectric 2, respectively, and $n_i < n_t$.

8. (10%) The **E**-field of a uniform plane wave propagating in a dielectric medium is given by

$$\mathbf{E}(t,z) = \mathbf{a}_x 2\cos\left(10^8 t - z/\sqrt{3}\right) + \mathbf{a}_y \sin\left(10^8 t - z/\sqrt{3}\right) \ (\text{V/m}).$$

a) Determine the frequency and wavelength of the wave.

b) What is the dielectric constant of the medium?

c) Describe the polarization of the wave.

d) Find the corresponding **H**-field.

9. (10%) Compare transmission lines and ordinary electric networks. What is the essential difference between a transmission line and an ordinary electric network?

10. (10%) A waveguide is formed by two parallel copper sheets, $\sigma_c = 6.0 \times 10^7$ (S/m), operated by a 5 cm thick lossy dielectric, $\varepsilon_r = 2.5$, $\mu_r = 1$, $\sigma = 10^{-10}$ (S/m). With an operating frequency of 20 GHz, find β, u_p, u_g, and λ for the TEM mode.