1. Draw all the results in your answer sheets.

   (a) (1%) Where is the point with the lowest impedance on the Smith Chart?

   (b) (1%) Where is the point with the highest impedance on the Smith Chart?

   (c) (2%) Plot the locus of the input reflection coefficient of a one-port shunt capacitor on the Smith Chart from DC to infinite frequency.

   (d) (2%) Plot the locus of the input reflection coefficient of a $\lambda/4$-long short-stub transmission line at 1 GHz on the Smith Chart from DC to 1 GHz.

   (e) (2%) Plot the locus of the input reflection coefficient of an one λ-long open-stub transmission line at 8 GHz on the Smith Chart from DC to 1 GHz.

   (f) (12%) Assume Γ_r and Γ_i are the real and imaginary parts of the voltage reflection coefficient Γ, r and x are the normalized resistance and normalized reactance of the load impedance Z_L, respectively. Determine the equations for the locus of the resistance and reactance on the Smith Chart.

2. Answer the following questions:

   (a) (2%) List the cutoff frequencies and dominant modes for the coaxial cable and parallel-plate waveguide.

   (b) (2%) List four features for the rectangular waveguide.

   (c) (2%) Which statements below are true for the antenna?

   　　1) The antenna is a reciprocal device.

   　　2) The same antenna can serve as a receiving or transmitting device.

   　　3) The antenna is a key component in any wireless system.

   　　4) The antenna size increases with the frequency.

   　　5) The antenna is a component that radiates the RF power.

   (d) (5%) A metallic, water-filled (ε_r), rectangular waveguide has the inner dimensions of a by b ($a > 2b$). If only one mode is allowed to propagate, what is the bandwidth of this waveguide?

   (e) (4%) Assume the length of the waveguide is d, and $d > a > 2b$, determine the dominant mode and frequency for the rectangular cavity resonator.

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3. (10%) An electron is moving at constant velocity in vacuum. Will it generate any electromagnetic wave that would propagate through the space? Please explain why.

4. Consider a plane wave obliquely impinging upon a plane boundary between two dielectric materials.
   (a) (5%) Please describe the definitions of perpendicular polarization and parallel polarization.
   (b) (15%) Assume that both materials are nonmagnetic. Please mathematically prove that the magnitude of the reflection coefficient for perpendicular polarization is always greater than or equal to that for parallel polarization, i.e., $|\Gamma_\perp| \geq |\Gamma_\parallel|$.

5. Assume there is a coaxial cable, with a solid inner conductor. The radii of inner and outer conductors are a and b, respectively. The constants of interest for the insulating material are ε, μ, and σ.
   (a)(10%) Determine the inductance per unit length of the line.
   (b)(10%) Determine the capacitance per unit length of the line.

6. (15%) Three positive static point charges Q_1, Q_2, and Q_3 locate at $(1, 0, 0)$, $(-2, 0, 0)$, and $(0, 0, 0)$, respectively. In addition, there is an infinite grounded plane situated in y-z plane. Find the electric potential and the electric field intensity at $(2, 0, 0)$.

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