1. A linear electrostatic quadrupole is along the a-axis with the center at x=0 and the charge separation distance a/2. (a)Find the electric field and potential at a distant point P(R,θ,ϕ). (b)Derive the equations for the equipotential surfaces and streamlines. (c)Draw a family of equipotential and streamlines.(10%)

2. The vector magnetic potential $\mathbf{A}=3x^2y^3\mathbf{a}_x-x^3y^2\mathbf{a}_y$. (a)Find the $\oint \mathbf{A} \cdot d\mathbf{l}$ around the triangular contour shown in Figure 1. (b)Evaluate $\int \nabla \times \mathbf{A} \cdot d\mathbf{s}$ over the triangular area. (c)Determine the magnetic flux density **B**.(10%)

3. A lossy transmission line with the characteristic impedance Z_0 is terminated in an arbitrary load impedance Z_L. (a)Express the standing-wave ratio S on the line in terms of Z_0 and Z_L. (b)Find in terms of S and Z_0 the impedance looking toward the load at the location of a voltage maximum. (c)Find the impedance looking toward the load at a location of a voltage minimum.(15%)

4. Assuming that the radiation electric field intensity of antenna system is $\mathbf{E}=E_\theta\mathbf{a}_\theta + E_\phi\mathbf{a}_\phi$, find the expression for the average outward power flow per unit area.(10%)

5. A Doppler flow meter is used to determine the speed of a moving metal surface in a tube by measuring the frequency shift of the wave reflected from the surface. (a)Assuming that the signal is a time-harmonic uniform plane wave of a frequency f incident normally on the surface, find the relation between the frequency shift Δf and the speed u of the metal surface. (b)Determine u if Δf = 2.5kHz with f = 5GHz.(15%)

6. Determine the mutual inductance between a very long, straight wire and a conducting rectangular loop as shown in Figure 2.(15%)

7. Design the magnetic field sensor using the concept of electromagnetism. Describe your underlying principle.(15%)

8. Derive the equation of continuity based on the conservation of charge and describe its relationship to the Kirchhoff's current law.(10%)

Figure 1

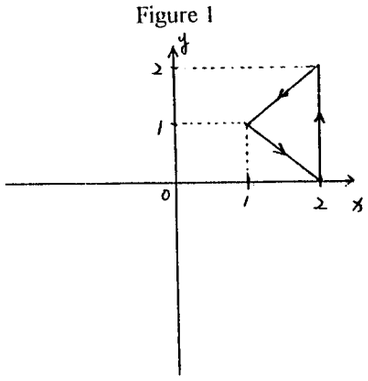

Figure 2