1. (1) To transform the Cartesian coordinates into cylindrical coordinates, please find the transformation vector from Cartesian unit vector to cylindrical unit vector. **(10%)** (2) For spherical coordinates, write down the differential displacement vector and differential volume scalar. **(10%)**

2. Describe the divergence theorem by the flux of a vector. Draw the picture to show positive divergence, negative divergence, and zero divergence by the flux of a vector field at point P. **(20%)**

3. Given an electric flux density vector $\mathbf{D}=z^2\rho\cos^2\phi\ \mathbf{a}_z$ C/m^2, calculate the charge density at $(2, \pi/3, 4)$, and the total charge enclosed by the cylinder of radius 2 m with $-1 \leq z \leq 1$ m. **(20%)**

4. A parallel-plate capacitor with circular plate of 4 cm diameter and plate separation of 5 cm has a voltage $60\sin10^2t$ V applied to its plates. Calculate the displacement current assuming the permittivity ε of the material between plates, $\varepsilon =5\varepsilon_0$, where $\varepsilon_0=10^{-9}/36\pi$. Recall that displacement current is got from electric flux density and note that the unit of each symbol must be correct to get the right answer. The final answer also needs the correct unit. **(20%)**

5. A 20-cm-long lossless transmission line with $Z_o=50+j10\ \Omega$ operating at 400MHz is terminated with a load. Assumed wave propagation speed at the transmission line $u=0.5$ c (optical wave speed in the air). Calculate (1) reflection coefficient **(5%)**, (2) standing wave ratio **(5%)**, (3) input impedance **(10%)**.