Physics Department
Indian Institute of Technology Delhi
PHL110: Fields and waves
1st semester 2007-08
MINOR-I
ATTEMPT ALL QUESTIONS.

Duration: 1 hour   Max. Marks: 25

1. (a) Check Stoke's theorem for the function $\vec{F} = 6xy\hat{x} - 3y^2\hat{y}$ using the rectangular path around the region, $2 \le x \le 5$, $-1 \le y \le 1$, $z = 0$. Can this function represent an electrostatic field? Give reasons.

   (b) Obtain an expression for the electrostatic field $\vec{E}$ at a point $r (r \le R)$ in a sphere of charge density $\rho = \rho_0 \left[1 - \left(\frac{r}{R} \right)^2 \right]$ and radius R.   (5+3)

2. (a) Obtain the boundary conditions satisfied by the perpendicular component of $\vec{D}$ across a dielectric interface having free surface charge.

   (b) The electric field inside a dielectric sphere of radius R and permittivity ε placed in vacuum is given by $\vec{E}_{in} = E_0 \hat{z}$. Using boundary conditions, obtain the electric field vector just outside the sphere at $r = R$ and express in spherical polar coordinates.   (3+3)

3. In a certain region the vector potential is given by $\vec{A} = \alpha x^2 \hat{z}$. Obtain $\vec{B}$. If a square loop of side l is placed in the x-z plane with its center at the origin, obtain the flux linked with the loop.
                                                                                                                                                                           (4)

4. (a) Consider four point charges +2q, -q, -q and +q located at the four corners of a square of side d as shown in Fig.1. For what position of origin will this charge configuration have zero dipole moment?

   (b) Consider a uniformly polarized dielectric with polarization $\vec{P} = P_0 \hat{z}$ as shown in Fig.2. What are the values of $\oint \vec{E}.d\vec{a}$ and $\oint \vec{D}.d\vec{a}$ over the closed surface S which cuts through the dielectric completely enclosing the lower surface.
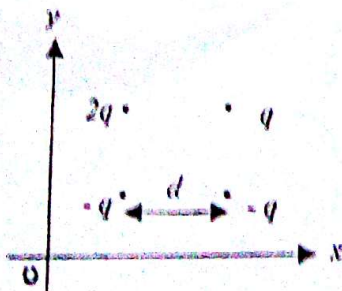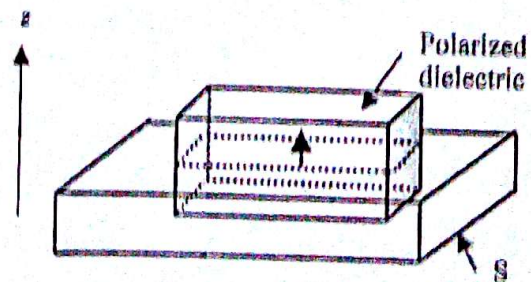   (3+4)

Fig. 1

Fig. 2