Electromagnetics I First Examination (2001.11.7)

1. Let P and P' be the points with spherical coordinates $(1,\theta,\phi)$ and $(1,\theta',\phi')$, respectively. Let O be the origin of the coordinate system. Find the angle γ between the two vectors $\overline{OP}$ and $\overline{OP'}$. (12%)
2. In Cartesian coordinate system, let S be the plane through the points (1,0,0), (0,2,0), (0,0,3). Find the unit normal vector to the plane S. (12%)
3. Show that $\overline{A}\times(\overline{B}\times\overline{C}) = (\overline{A}\cdot\overline{C})\overline{B} - (\overline{A}\cdot\overline{B})\overline{C}$. (13%)
4. Two point charges $+Q$ and $-Q$ are located at $(0,0,d/2)$ and $(0,0,-d/2)$, respectively. Such an arrangement is known as the electric dipole. Find the electric field intensity $\overline{E}(\overline{r})$ at the point $\overline{r}$, due to the electric dipole, such that the spacing d is much smaller than the distance $r = |\overline{r}|$ from the origin. (13%)
5. Determine the electric field intensity of an infinitely long straight line charge of a uniform density $\rho_l(C/m)$ in air. (12%)
6. Find the magnetic flux density at a point $(0,0,z)$ on the axis of a circular loop of radius b that carries a direct current I. (12%)
7. The electrostatic deflection system of a cathode-ray tube is depicted in Fig.1. The electrons, with initial velocity $\overline{v}_0 = \hat{z}v_0$, enter at $z=0$ into a region of deflection plates where a uniform electric field $\overline{E} = -\hat{y}E_d$ is maintained over a width w. By ignoring gravitational effects, find the vertical deflection d of the electrons on the fluorescent screen at $z=L$. (13%)
8. Infinite plane sheets of uniform surface charge densities $\rho_s(\pm d) = \mp\rho_{so}(C/m^2)$ occupy the planes $z=\pm d$. The region $-b<z<b$ is a dielectric of permittivity $4\varepsilon_0$. Find the values of $\overline{P}$, $\overline{E}$, and $\overline{D}$ in the regions $|z|<b$ and $b<|z|<d$. (13%)

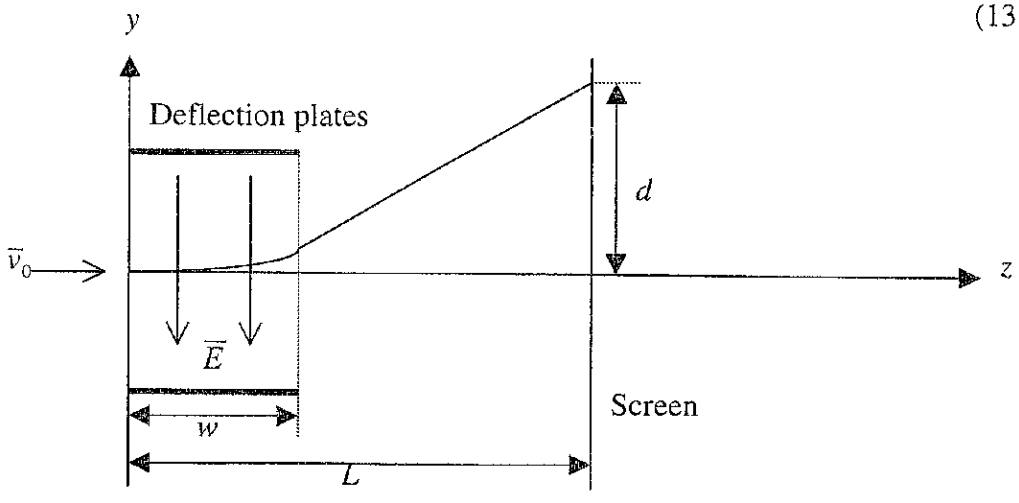

Fig.1