Problem 14)

a) $\vec{\nabla}\cdot\vec{D}=\rho_{free} \Rightarrow \vec{D}_\perp(\vec{r}_0,t)$ is continuous, that is, $\vec{D}_\perp(\vec{r}_0^{\,-},t)=\vec{D}_\perp(\vec{r}_0^{\,+},t)$ unless there is surface charge density $\sigma_{free}(\vec{r}_0,t)$ at the surface, in which case $D_\perp(\vec{r}_0^{\,+},t)-D_\perp(\vec{r}_0^{\,-},t)=\sigma_{free}(\vec{r}_0,t)$

b) $\vec{\nabla}\times\vec{H}=\vec{J}_{free}+\frac{\partial\vec{D}}{\partial t} \Rightarrow \vec{H}_\parallel(\vec{r}_0,t)$ is continuous, that is, $\vec{H}_\parallel(\vec{r}_0^{\,-},t)=\vec{H}_\parallel(\vec{r}_0^{\,+},t)$

unless there is surface current density $\vec{J}_s(\vec{r}_0,t)$ at the surface, in which case $\vec{H}_\parallel(\vec{r}_0^{\,+},t)-\vec{H}_\parallel(\vec{r}_0^{\,-},t)$ is equal in magnitude and perpendicular in direction to $\vec{J}_s(\vec{r}_0,t)$. Note that $\vec{J}_s$ in general could have contributions from <u>both</u> $\vec{J}_{free}$ and $\vec{J}_{bound}=\partial\vec{P}(\vec{r}_0,t)/\partial t$.

c) $\vec{\nabla}\times\vec{E}=-\partial\vec{B}/\partial t \Rightarrow \vec{E}_\parallel(\vec{r}_0,t)$ is continuous, that is, $\vec{E}_\parallel(\vec{r}_0^{\,-},t)=\vec{E}_\parallel(\vec{r}_0^{\,+},t)$ unless there is <u>surface</u> current density of <u>magnetic monopoles</u>, $\partial\vec{M}/\partial t$ at the surface, in which case $\vec{E}_\parallel(\vec{r}_0^{\,+},t)-\vec{E}_\parallel(\vec{r}_0^{\,-},t)$ is equal in magnitude and perpendicular in direction to the <u>surface magnetic current density</u> associated with $\partial\vec{M}(\vec{r}_0,t)/\partial t$.

d) $\vec{\nabla}\cdot\vec{B}=0 \Rightarrow \vec{B}_\perp(\vec{r}_0,t)$ is continuous, that is, $\vec{B}_\perp(\vec{r}_0^{\,-},t)=\vec{B}_\perp(\vec{r}_0^{\,+},t)$.