PRACTICE:

1. Below are cross-sections for several vector fields (assume each cross-section is the same).

(a) If the above sketches represent an electric field,
   i. Which violate one of Maxwell’s Equations within the region shown?
   ii. For those that do not violate Maxwell’s equations, what charge distribution would be needed to generate this field and where would it be located?

Solution:
The Maxwell Equations that pertain to electric fields are:

\[ \nabla \cdot \vec{E} = \frac{\rho}{\varepsilon_0} \]
\[ \nabla \times \vec{E} = 0 \]

In both (II) and (III), the curl of the field is non-zero (can you see this?). Therefore, they cannot be electric fields. In (I), a charge distribution that could create this field would be a positively charged plate below the region indicated.

(b) If the above sketches represent a magnetic field,
   i. Which violate one of Maxwell’s Equations within the region shown?
   ii. For those that do not violate Maxwell’s equations, what charge distribution would be needed to generate this field and where would it be located?

Solution:
The Maxwell Equations that pertain to electric fields are:

\[ \nabla \cdot \vec{B} = 0 \]
\[ \nabla \times \vec{B} = \mu_0 \vec{J} \]
In both (I) and (III), the divergence of the field is non-zero (can you see this?). Therefore, they cannot be magnetic fields. In (II), the current distribution that would create this field would be a plane of current below the region indicated that is flowing out of the page.