

## Symmetries & Idealizations Homework 1

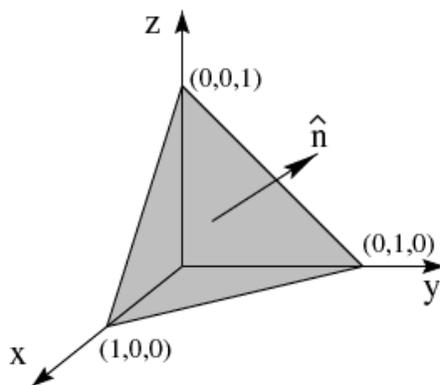
### PRACTICE:

The following conceptual problems can be used to test your understanding as you prepare for the final exam:

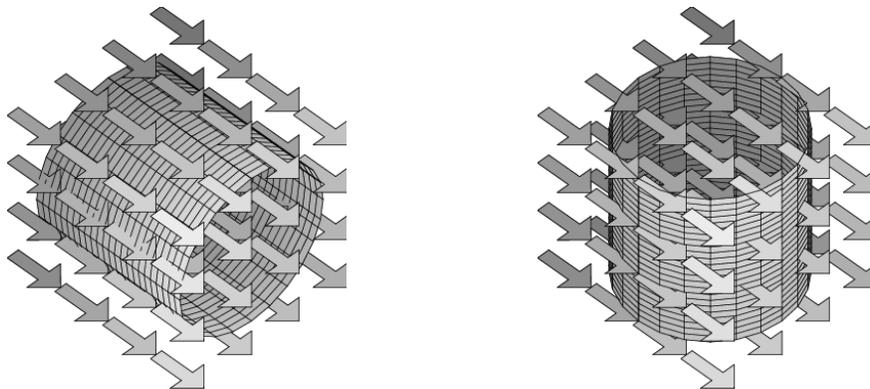
1. A “ribbon” (width  $a$ ) of surface current flows with surface current density  $\vec{K}$ . Right next to it is a second identical ribbon of current.



- (a) Viewed collectively, what is the new total surface current density?
  - (b) Viewed collectively, what is the new total current?
2. You have a charge distribution composed of two point charges: one with charge  $+3q$  located at  $x = -d$  and the other with charge  $-q$  located at  $x = +d$ .
    - (a) Sketch the charge distribution.
    - (b) Write an expression for the *volume* charge density  $\rho(\vec{r})$  everywhere in space.
  3. Use the cross product to find the components of the unit vector  $\hat{n}$  perpendicular to the plane shown in the figure below, i.e. the plane joining the points  $\{(1, 0, 0), (0, 1, 0), (0, 0, 1)\}$ .



4. A charge  $q$  sits at the corner of a cube. Find the flux of  $\vec{E}$  through each side of the cube. **Do not do a long calculation (either by hand or by computer)!**
5. What do you think will be the flux through the cylindrical surface that is placed as shown in the constant vector field in the figure on the left? What if the cylinder is placed upright, as shown in the figure on the right? Explain.



6. A current  $I$  flows down a wire of radius  $a$ .

- (a) If it is uniformly distributed over the surface, give a formula for the surface current density  $\vec{K}$ .
- (b) If it is distributed in such a way that the volume current density,  $|\vec{J}|$ , is inversely proportional to the distance from the axis, give a formula for  $\vec{J}$ .