Math 223 - Section 010
Vector Fields Lab

In this lab, you will use the applet at http://www.falstad.com/vector3d/ to develop some intuition about vector fields in space. Some general comments about the applet:

- The "Particles (Vel.)" and "Streamlines" display modes (in the second drop-down menu from the top) are typically the most useful.
- In the "Field Vectors" display mode, the magnitude of each vectors is indicated by its color, rather than by the length of the arrow.
- Many of the predefined fields in the "Field selection" menu have been scaled by constant factors. You can scale the vector fields you enter either by multiplying by a scalar in each formula or by adjusting the "Field Strength" slider.
- Click the "Reset" button to start more particles flying around the field.
- To enter a field, choose "user-defined field" from the "Field selection" drop-down menu. Three boxes will appear underneath the menus. The first box represents the $\vec{i}$ component of the field, the second box represents the $\vec{j}$ component, and the third box represents the $\vec{k}$ component.
- If your vector field is not defined at some points–e.g., on the xy-plane–the applet may show you something strange at those points.

1. Find formulas for the following vector fields from the first drop-down menu under "Field selection."

   a. One direction

   b. Linear radial

   c. Constant radial

   d. Linear to xy-plane

   e. Constant to xy plane

f. Linear rotational

g. Constant rotational

h. Helical

2. Give a formula for a vector field that causes a particle at any point in space to rise straight up (in the direction of the vector $\vec{k}$) at increasing speed.

3. Give a formula for a vector field that causes a particle at any point in space to move in the direction of the vector $\vec{i} + \vec{j} + \vec{k}$ at increasing speed.

4. Find a vector field that causes particles to spiral up toward the xy-plane from below and spiral down toward the xy-plane from above. Design your field so that particles spiral in the same direction above and below the xy-plane.

5. Find a vector field that causes particles to spiral upward in such a way that

   a. particles below the xy-plane spiral counterclockwise, and particles above the xy-plane spiral clockwise (when viewed from above).

   b. any particle that starts below the xy-plane never ranges above the xy-plane.

6. (Bonus) Give a formula for a vector field that causes particles to revolve about the line $z = y$, $x = 0$.