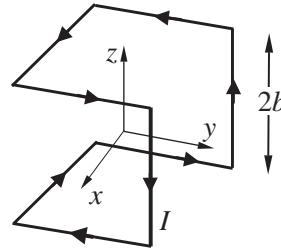


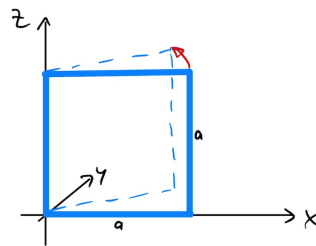
## Problems

1. **A current loop:**

A filamentary current loop traverses eight edges of a cube with side length  $2b$  as shown in the figure. The origin is placed at the center of the cube.



- (a) (30 pts) Find the magnetic dipole moment  $\vec{m}$  of this structure.
2. **Rotating square loop:** A square loop with the side of length  $a$  is uniformly charged along its length with the linear charge density  $\lambda$ . The loop is rotating around one of its sides with angular velocity  $\omega$ .



- (a) (30 pts) Find the time-averaged magnetic moment of the loop. [Hint: cmp. rotating cylinder on HW9.]
3. **Non-relativistic particle in magnetic field:** Consider the motion of a non-relativistic point particle in a static homogeneous magnetic field, ignoring radiation. Assume  $\vec{B}$  is in the  $z$  direction,  $\vec{B}(\vec{r}, t) = B_0 \hat{z}$ .
- (a) (40 pts) Starting from the Lorentz force, derive the trajectory  $\vec{r}_0(t)$  of the particle and identify the non-relativistic cyclotron frequency. What is the change of kinetic energy of the particle with time? [Hint: you could solve the differential equation using the method we used in class in the context of Larmor precession. It is also fine if you make an ansatz and determine its parameters by insertion.]