Problems $1-4$ will be discussed in the tutorial.

1. The magnetic vector potential due to a surface current distribution $\mathbf{K}(\mathbf{r}')$ at any point $\mathbf{r}$ is given by,
$$\mathbf{A}(\mathbf{r}) = \frac{\mu_0}{4\pi}\int \frac{\mathbf{K}(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}\,da'$$
Now consider a thin spherical shell of radius R with center at the origin, carrying a surface charge density σ and rotating with angular velocity $\omega\hat{z}$. Find the vector potential everywhere using the above expression.

2. (a) Find the magnetic vector potential everywhere for an infinite sheet with a uniform surface current $K\hat{x}$ using the relation $\oint \mathbf{A}\cdot\mathbf{dl} = \Phi$.
   (b) Find the vector potential everywhere for a long conducting wire of radius R carrying uniform current I along its axis using electrostatic analogy.

3. The magnetic dipole moment of a volume current distribution, as discussed in the lecture, is given by,
$$\mathbf{m} = \frac{1}{2}\int \mathbf{r}'\times\mathbf{J}(\mathbf{r}')\,d\tau'$$
Using the above expression find the magnetic dipole moment of a spherical shell of radius R, carrying a surface charge density σ and rotating with angular velocity $\omega\hat{z}$.

4. Consider a sphere of radius R, having frozen-in uniform magnetization M pointing towards the north pole. Find the 'auxiliary H' field inside the sphere using electrostatic analogy. Find the 'B' field inside the sphere.

5. Estimate the magnetic field $\mathbf{B}$ for the following objects having frozen-in uniform magnetization by using bound current densities (and the boundary conditions, wherever applicable).
   (a) Disc of radius R, thickness t magnetization M is parallel to the axis of the disk. Find the field at a point on the axis just inside and just outside.
   (b) An infinitely long cylinder carries a uniform magnetization M parallel to its axis. Find the magnetic field inside and outside the cylinder.

6. Using the expression in problem 3, find the magnetic dipole moment of a solid sphere carrying uniform volume charge density ρ and rotating with angular velocity $\omega\hat{z}$.

7. A solid sphere is uniformly magnetized along the $\hat{z}$ direction (magnetization $\vec{M} = M\hat{z}$).
   (a) Find all the bound currents and using them, find the magnetic field $\vec{B}$ inside the sphere.
   (b) Find the field at the north pole, outside the sphere.
   (c) Find the magnetic field $\mathbf{B}$ just outside the sphere at the equator using appropriate boundary conditions.

(d) Neatly sketch the magnetic field lines **B** everywhere (inside and outside the sphere).

8. A finite solid cylinder of radius R, length $L \gg R$ has a frozen-in constant magnetization M parallel to the axis.
   (a) Calculate the bound volume current and bound surface currents everywhere.
   (b) Write down the boundary conditions for the parallel and normal components of **B** and **H** fields at the flat surfaces (top and bottom) and curved surface of the cylinder.
   (c) Sketch the **B** field lines everywhere, keeping in mind the boundary conditions.