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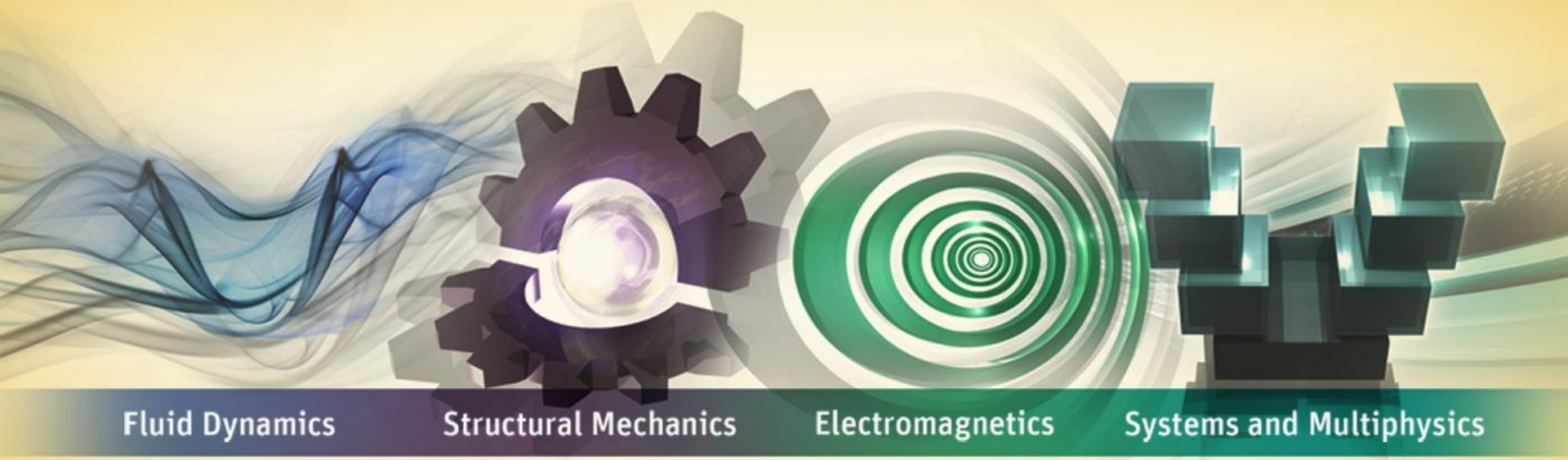
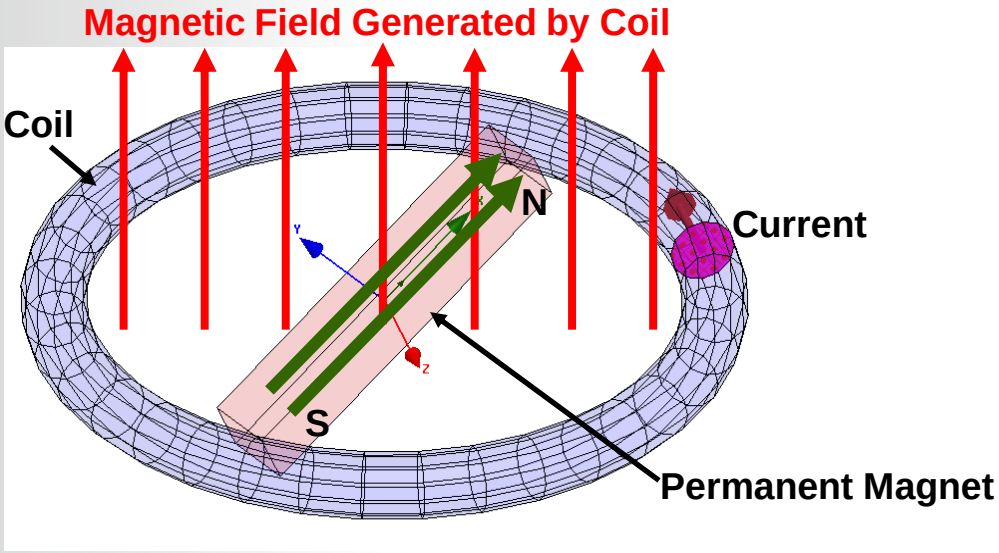
Workshop 1 :
Basic Magnetostatic Analysis



ANSYS Maxwell 3D V16

About the Workshop

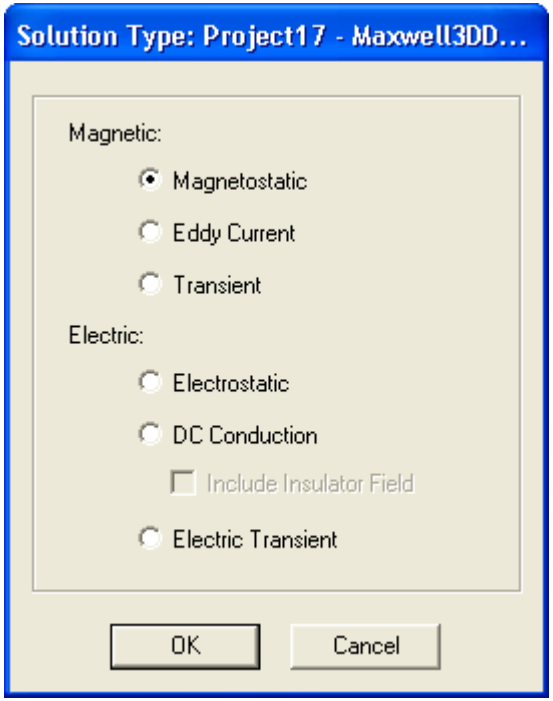
- **Torque Calculation in Magnetostatic Solver**
  - This workshop demonstrates the basic steps required to setup a Magnetostatic problem using Maxwell 16. The workshop will discuss calculation of Torque acting on a Magnetic material due to applied magnetic field
- **Problem Description**
  - As shown in the following image, the current in the coil generates a magnetic field pointing upward. The permanent magnet in the middle is magnetized along X-axis, hence there is a torque generated along Z-axis.



Problem Setup

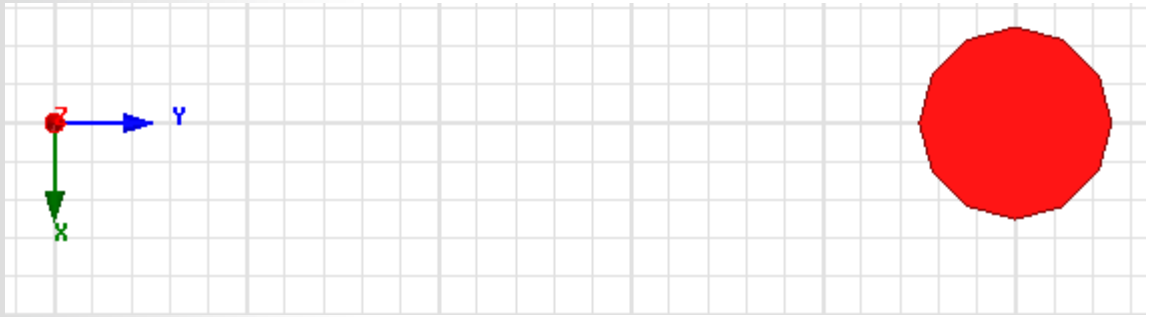
- **Create Design**
  - Select the menu item ***Project → Insert Maxwell 3D Design***, or click on the icon

- **Set Solution Type**
  - Select the menu item ***Maxwell 3D > Solution Type***
  - Solution Type Window:
    1. Choose **Magnetostatic**
    2. Click the **OK** button



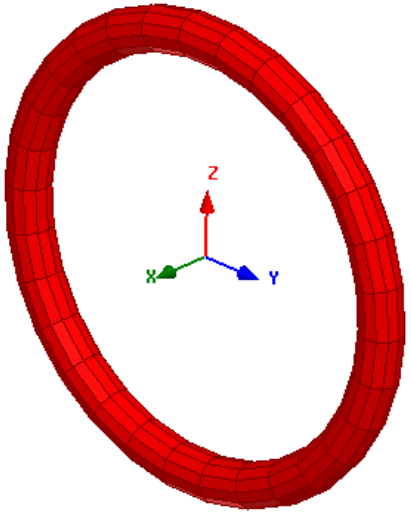
Create Coil

- **Create Profile for Sweep**
  - Select the menu item ***Draw → Regular Polygon***
    1. Using the coordinate entry fields, enter the center position
       - **X: 0, Y: 5, Z: 0**, Press the **Enter** key
    2. Using the coordinate entry fields, enter the radius
       - **dX: 0.5, dY: 0, dZ: 0**, Press the **Enter** key
    3. Number of Segments: **12**
    4. Press **OK**
  - Change the name of resulting object to **Coil**



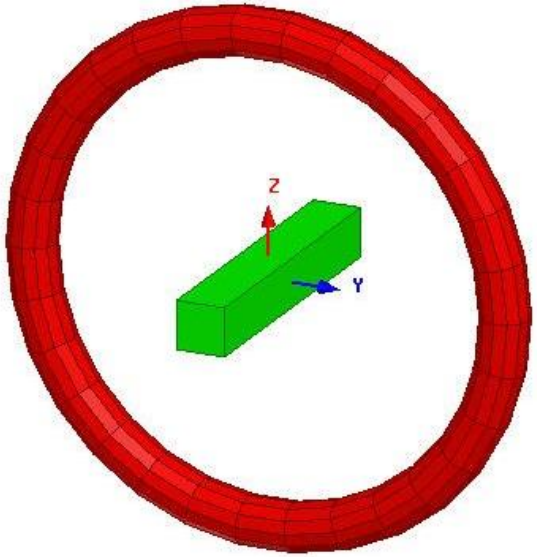
Create Coil

- **Sweep Profile**
  - Select the object **Coil** from the history tree
  - Select the menu item ***Draw → Sweep → Around Axis***
  - In Sweep Around Axis window
    1. Sweep Axis: **X**
    2. Angle of Sweep: **360 deg**
    3. Number of Segments: **30**
    4. Press **OK**
  - Change material of resulting object to **Copper**
  - Change its Color and transparency if desired



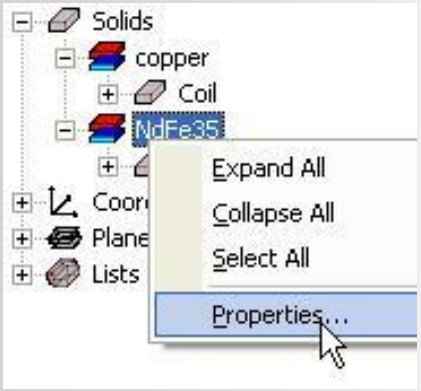
Create Magnet

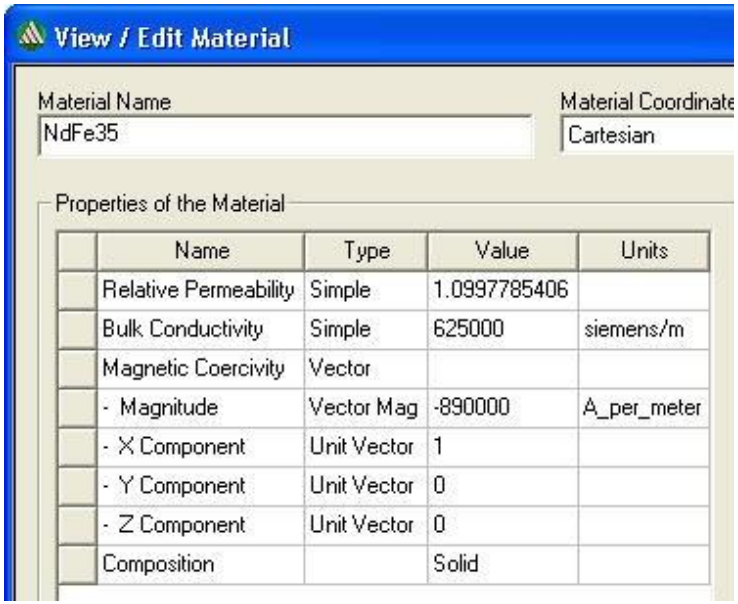
- **Create permanent Magnet**
  - Select the menu item ***Draw → Box***
    1. Using the coordinate entry fields, enter the box position
       - **X: -3, Y: -0.5, Z: -0.5**, Press the **Enter** key
    2. Using the coordinate entry fields, enter the opposite corner
       - **dX: 6, dY: 1, dZ: 1**, Press the **Enter** key
  - Change the name of the resulting object to **Magnet**
  - Change material of the object to **NdFe35**
  - Change its color and transparency if desired



Check Magnetization Direction

- **Check Properties of Material**
  - Right click on **NdFe35** from the history tree and select **Properties**
  - In Select Definition window, select **View/Edit Materials**
    - In View/Edit material window
      1. Ensure X Component is set to **1**
      2. Ensure Y and Z Component is set to **0**





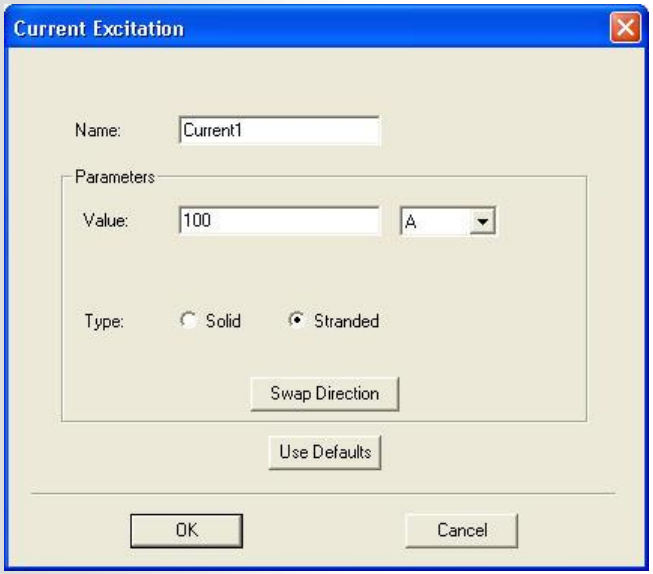
Note: It is important to check the direction in which the material is magnetized. By default Maxwell assigns magnetization direction of object as X axis of their orientation co-ordinate system. Users can either modify the direction or create a coordinate system in required direction to alter the direction of magnetization

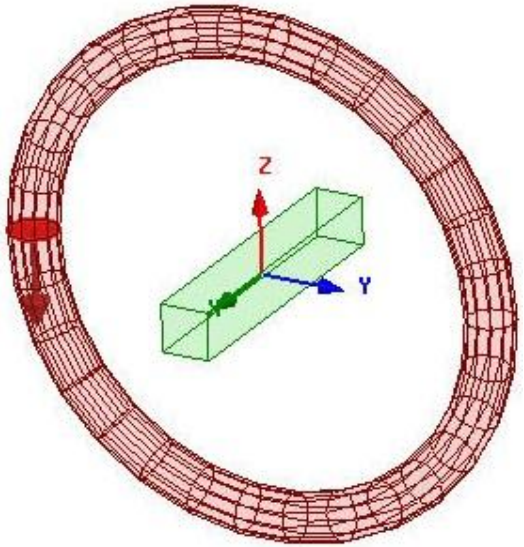
Create Coil Terminal

- **Create Coil terminal**
  - Select the object **Coil** from the history tree
  - Select the menu item ***Modeler → Surface → Section***
    1. Section Plane: **XY**
    2. Press **OK**
  - Change the name of the resulting sheet to **Terminal**
- **Separate Sheets**
  - Select the sheet **Terminal** from the history tree
  - Select the menu item ***Modeler → Boolean → Separate Bodies***
- **Delete Extra Sheet**
  - Select the sheet **Terminal_Separate1** from the history tree
  - Select the menu item ***Edit → Delete***

Assign Excitation

- **Assign Excitation**
  - Select the sheet **Terminal** from the history tree
  - Select the menu item ***Maxwell 3D → Excitations → Assign → Current***
  - In Current Excitation window,
    1. Name: **Current1**
    2. Value: **100 A**
    3. Type: **Stranded**
    4. Press **OK**

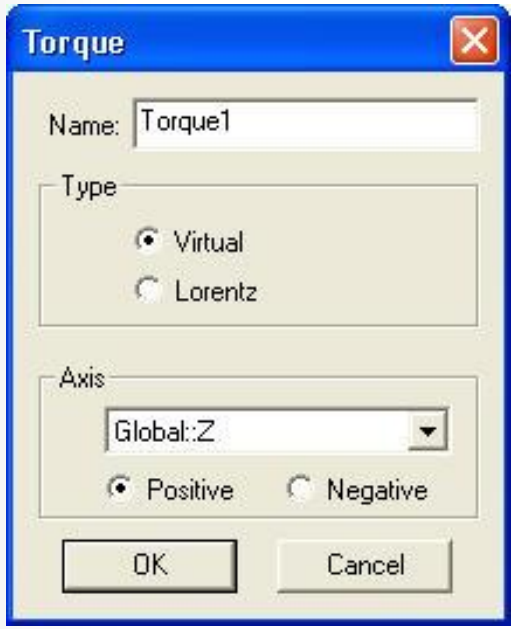




Note: The current value assigned for static solvers is in Ampere-Turns. Users should multiply the current value by number of turns in winding and specify resulting value in Current Excitation window.

Assign Torque Parameter

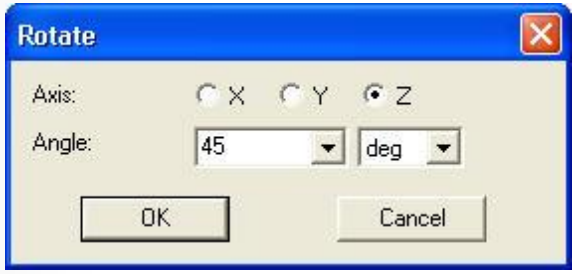
- **Assign Torque Calculation**
  - Select the object **Magnet** from the history tree
  - Select the menu item ***Maxwell 3D → Parameters → Assign → Torque***
  - In Torque window,
    1. Name: **Torque1**
    2. Type: **Virtual**
    3. Axis: **Global::Z**
    4. Positive: ☑ **Checked**
    5. Press **OK**



Note: if the Virtual option is selected for Torque, the system uses virtual work principles to compute the torque on an object.

Finalize Geometry

- **Rotate Coil**
  - Press **Ctrl** and select the object **Coil** and **Terminal** from the history tree
  - Select the menu item ***Edit → Arrange → Rotate***
  - In Rotate window,
    1. Axis: **Z**
    2. Angle: **45 deg**
    3. Press **OK**



Note: Coil rotation done after Terminal creation in order to use global planes for sectioning

- **Create Simulation Region**
  - Select the menu item ***Draw → Region***
  - In Region window,
    1. Padding all directions similarly: ☑ **Checked**
    2. Padding Type: **Percentage Offset**
       - Value: **100**
    3. Press **OK**

Analyze

- **Create an analysis setup:**
  - Select the menu item ***Maxwell 3D → Analysis Setup → Add Solution Setup***
  - Solution Setup Window:
    1. Click the **OK** to accept default settings
- **Start the solution process:**
  - Select the menu item ***Maxwell 3D → Analyze All***
- **View the Solution Results:**
  - Select the menu item ***Maxwell 3D → Results → Solution Data***
    1. To view Torque values
       - Select the **Torque** tab