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**CapacitorStatics** function: (User Accessed Function)

**Description:**

This program was developed for ECE 1259: Electromagnetics at The University of Pittsburgh. This function calculates the capacitance, conductance, leakage current, and breakdown voltage of a capacitor with a specified shape, material, and geometry. It calls one of three nested functions (**parallel**, **cylinder**, or **spherical**) based on the shape input to perform the calculations for that capacitor geometry. Additionally, this program will allow us to track the magnitude and phase at different levels via Bode Plot.

**Requirements:**

This function reads data in from the “Dielectric\_Table.xlsx” file. The user must ensure that the “Dielectric\_Table.xlsx” file is stored in the same folder as the “CapacitorStatics.m” file. The user should also ensure that the columns of the “Dielectric\_Table.xlsx” file are listed as Name, Epsilon\_r, Ebr, and Sigma, respectively. Explanations of these column headers are below.

* Name: The dielectric material name of the capacitor.
* Epsilon\_r: The relative permittivity of the capacitor’s dielectric material
* Ebr: The breakdown electric field strength of the capacitor’s dielectric material
* Sigma: The conductivity of the capacitor’s dielectric material

**Inputs:**

* **shape**: A string that specifies the shape of the capacitor. It can be **"P"** for parallel-plate capacitor, **"C"** for cylindrical capacitor, or **"S"** for spherical capacitor.
* **material**: A string that specifies the material of the capacitor.
* **distance**: The distance between the plates of the parallel-plate capacitor or the distance between the center of the cylindrical/spherical capacitor and its outer surface. Units: meters
* **voltage**: The voltage across the capacitor. Units: Volts
* **length**: The length of the parallel-plate capacitor or the height of the cylindrical/spherical capacitor. Units: meters
* **width**: The width of the parallel-plate capacitor or the outer radius of the cylindrical/spherical capacitor. Units: meters
* **height**: The height of the cylindrical capacitor. Units: meters
* **inner\_radius**: The inner radius of the cylindrical/spherical capacitor. Units: meters
* **outer\_radius**: The outer radius of the cylindrical/spherical capacitor. Units: meters

**Outputs:**

* **C**: The capacitance of the capacitor. Units: Ferads
* **G**: The conductance of the capacitor. Units: Siemans
* **I**: The leakage current of the capacitor. Units: Amps
* **V**: The breakdown voltage of the capacitor. Units: Volts

**Functions:**

* **parallel:** calculates the capacitance, conductance, leakage current, and breakdown voltage of a parallel plate capacitor.
* **cylinder:** calculates the capacitance, conductance, leakage current, and breakdown voltage of a cylindrical capacitor.
* **spherical:** calculates the capacitance, conductance, leakage current, and breakdown voltage of a spherical capacitor.
* **leakage\_current:** calculates the leakage current of a capacitor based on its conductance and applied voltage.
* **breakdown\_voltage:** calculates the breakdown voltage of a capacitor based on the electric field strength and the distance between the plates.

**parallel** function:

**Description:**

This function is called based on the string input **shape** from the **CapacitorStatics** function. It performs the calculations of the capacitance, conductance, leakage current, and breakdown voltage for a parallel-plate capacitor. The inputs are called from the original inputs of the **CapacitorStatics** function. The **outputs** are sent to be the **outputs** of the **CapactitorStatics** function. The user should never need to physically call this function.

* Inputs:
  + **info**: A table containing the dielectric constant, the breakdown electric field strength, and the conductivity of the specified capacitor material.
  + **voltage**: The voltage across the capacitor. Units: Volts
  + **length**: The length of the parallel-plate capacitor. Units: meters
  + **width**: The width of the parallel-plate capacitor. Units: meters
  + **distance**: The distance between the plates of the parallel-plate capacitor. Units: meters
* Outputs:
  + **C**: The capacitance of the parallel-plate capacitor. Units: Ferads
  + **G**: The conductance of the parallel-plate capacitor. Units: Siemans
  + **I**: The leakage current of the parallel-plate capacitor. Units: Amps
  + **V**: The breakdown voltage of the parallel-plate capacitor. Units: Volts

**cylinder** function:

**Description:**

This function is called based on the string input **shape** from the **CapacitorStatics** function. It performs the calculations of the capacitance, conductance, leakage current, and breakdown voltage for a cylindrical capacitor. The inputs are called from the original inputs of the **CapacitorStatics** function. The **outputs** are sent to be the **outputs** of the **CapactitorStatics** function. The user should never need to physically call this function

* Inputs:
  + **info**: A table containing the dielectric constant, the breakdown electric field strength, and the conductivity of the specified capacitor material.
  + **voltage**: The voltage across the capacitor. Units: Volts
  + **height**: The height of the cylindrical capacitor. Units: meters
  + **outer\_radius**: The outer radius of the cylindrical capacitor. Units: meters
  + **inner\_radius**: The inner radius of the cylindrical capacitor. Units: meters
* Outputs:
  + **C**: The capacitance of the cylindrical capacitor. Units: Ferads
  + **G**: The conductance of the cylindrical capacitor. Units: Siemans
  + **I**: The leakage current of the cylindrical capacitor. Units: Amps
  + **V**: The breakdown voltage of the cylindrical capacitor. Units: Volts

**spherical** function:

**Description:**

This function is called based on the string input **shape** from the **CapacitorStatics** function. It performs the calculations of the capacitance, conductance, leakage current, and breakdown voltage for a spherical capacitor. The **inputs** are called from the original **inputs** of the **CapacitorStatics** function. The **outputs** are sent to be the **outputs** of the **CapactitorStatics** function. The user should never need to physically call this function.

* Inputs:
  + **info**: A table containing the dielectric constant, the breakdown electric field strength, and the conductivity of the specified capacitor material.
  + **voltage**: The voltage across the capacitor. Units: Volts
  + **inner\_radius**: The inner radius of the spherical capacitor. Units: meters
  + **outer\_radius**: The outer radius of the spherical capacitor. Units: meters
* Outputs:
  + **C**: The capacitance of the spherical capacitor. Units: Ferads
  + **G**: The conductance of the spherical capacitor. Units: Siemans
  + **I**: The leakage current of the spherical capacitor. Units: Amps
  + **V**: The breakdown voltage of the spherical capacitor. Units: Volts

**leakage\_current** function:

**Description:**

This function is called from the member functions **parallel, cylinder,** and **spherical** within the **CapacitorStatics** function. It performs calculations of the leakage current and sends the **output** to the corresponding member function to return to the **CapacitorStatics** function.

* Inputs:
  + **G**: The conductance of the capacitor. Units: Siemans
  + **V**: The voltage of the capacitor. Units: Volts
* Outputs:
  + **I**: The leakage current of the capacitor

**Breakdown\_voltage** function:

**Description:**

This function is called from the member functions **parallel, cylinder,** and **spherical** within the **CapacitorStatics** function. It performs calculations of the breakdown voltage and sends the **output** to the corresponding member function to return to the **CapacitorStatics** function.

* Inputs:
  + **d**: The distance between the plates of the parallel-plate capacitor or the distance between the center of the cylindrical/spherical capacitor and its outer surface. Units: meters
  + **Ebr**: The breakdown field strength of the material of the capacitor. This input is read from the required file. Units: Vm-1
* Output:
  + **Vbr**: The breakdown voltage of the capacitor. Units Volts

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