MT360_UR7_2_2_2 Coaxial Transmission-Line Model

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Description

A coaxial line with inner and outer conductor diameters of 0.5 cm and 1 cm, respectively , is filled with and insulating material with $\epsilon_r = 4.5$ and $\sigma = 10^{-3}$ S/m. The Conductors are made of copper.

Exercise

1. Calculate the line parameters at 1 GHz.
2. Calculate R' as a function of frequency with f being $f = 1e^6 : 1e^6 : 20e^9$ Hz.
3. Plot R' as a function of frequency.

Questions

1. What effect does frequency of the signal have on the perceived resistance of the wire?

Useful Information

Below are the parameters for the coaxial transmission-line

```
a = outer radius of inner conductor, m
b = inner radius of outer conductor, m
```

$$R' = \frac{R_s}{2\pi}\left(\frac{1}{a} + \frac{1}{b}\right)$$

$$L' = \frac{\mu}{2\pi} \ln(b/a)$$

$$G' = \frac{2\pi\sigma}{\ln(b/a)}$$

$$C' = \frac{2\pi\epsilon}{\ln(b/a)}$$

$$R_s = \sqrt{\pi f \mu_c / \sigma_c}$$

*Note that μ, ϵ, and σ pertain to the insulating material between the conductors, and μ_c and σ_c pertain to the conductors.

Provided Code

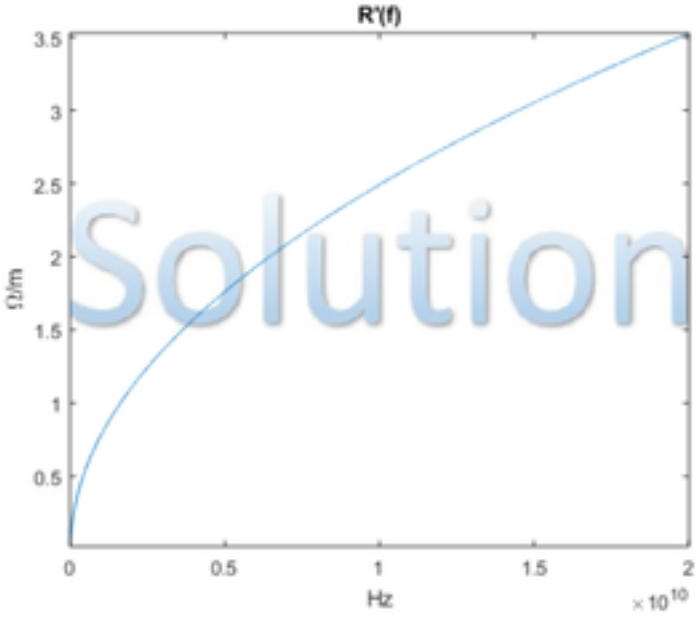
```
param
a = 0.25e-2;       % Outer radius of inner conductor, m
b = 0.5e-2;         % Inner radius of outer conductor, m

% Insulator Parameters
epsilon_r = 4.5;  % Relative permittivity of insulator
epsilon =...      % Permittivity of insulator, F/m
  epsilon_r*P.Eo;
sigma = 1e-3;     % Conductivity of insulator, S/m
mu = P.Uo;        % Permeability of insulator, H/m

% Conductor Parameters
sigma_c = 5.8e7;  % Conductivity of conductor, S/m
mu_r_c = 1;       % Relative permeability of conductor
mu_c = P.Uo;      % Permeability of conductor, H/m

% 1)
f = 1e9;                      % Operating frequency, Hz
Rs = %INSERT CODE HERE
R =  %INSERT CODE HERE        % Resistance, Ohms/m
L =  %INSERT CODE HERE        % Inductance, H/m
G =  %INSERT CODE HERE        % Conductance, S/m
C =  %INSERT CODE HERE        % Capacitance, F/m

% 2)
f = 1e6:1e6:20e9;             % Range of frequencies, Hz
Rs = %INSERT CODE HERE        %
R = %INSERT CODE HERE         % Resistance, Ohms/m

% 3)
figure(1),clf;
plot(f,R);
xlabel('Hz');
ylabel('Ohms');
```

```
title('R(f)');
```

Solution

```
R' = 0.78784 Ohms/m
L' = 1.3863e-07 H/m
G' = 0.0090647 S/m
C' = 3.61e-10 F/m
```

```
R' as a function of frequency (Hz)
```



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