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// Scilab code to plot wave impedance, phase velocity, and group velocity
// for a rectangular waveguide operating in the TM11 mode and TE11 modes.
// Given dimensions
a = 6.2e-2; // Width of the waveguide (in meters)
b = 4.2e-2; // Height of the waveguide (in meters)
c = 3e8; // Speed of light in vacuum (m/s)
epsilon0 = 8.854e-12; // Permittivity of free space (F/m)
mu0 = 4 * %pi * 1e-7; // Permeability of free space (H/m)
eta0 = sqrt(mu0 / epsilon0); // Intrinsic impedance of free space (Ohms)
// Frequency range
f_min = 5e9; // 5 GHz
f_max = 15e9; // 15 GHz
f = linspace(f_min, f_max, 1000); // Frequency range from 5 GHz to 15 GHz
// Mode indices for TM11
m = 1;
n = 1;
// Calculate cutoff frequency for TM11 mode
fc = (1 / (2 * sqrt(mu0 * epsilon0))) * sqrt((m/a)^2 + (n/b)^2);
// Calculate wave impedance, phase velocity, and group velocity
lambda0 = c ./ f; // Free-space wavelength
fc_ratio = fc ./ f;
// Calculate guide wavelength
lambda_g = lambda0 ./ sqrt(1 - fc_ratio.^2);
// Phase velocity
vp = c ./ sqrt(1 - fc_ratio.^2);
// Group velocity
vg = c .* sqrt(1 - fc_ratio.^2);
// Wave impedance for TM11 mode
Zg_TM11 = eta0 .* sqrt(1 - fc_ratio.^2);
// Wave impedance for TE11 mode
Zg_TE11 = eta0 ./ sqrt(1 - fc_ratio.^2);
// Plotting Wave Impedance vs Frequency
scf(1);
plot(f/1e9, Zg_TM11, 'b','LineWidth', 2);
plot(f/1e9, Zg_TE11, 'r','LineWidth', 2);
title('Variation of Wave Impedance with Frequency for TE11 & TM11 modes');
xlabel('Frequency (GHz)');
ylabel('Wave Impedance (Ohms)');
legend(['TM11 Mode', 'TE11 Mode'], 'location', 'upper left');
xgrid(); // Add grid lines to the plot
// Plotting Phase and Group Velocity vs Frequency
scf(2);
plot(f/1e9, vp, 'b','LineWidth', 2);

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plot(f/1e9, vg, 'r','LineWidth', 2);  
title('Variation of Phase and Group Velocity with Frequency');  
xlabel('Frequency (GHz)');  
ylabel('Velocity (m/s)');  
legend(['Phase Velocity', 'Group Velocity'], 'location', 'upper left');  
xgrid(); // Add grid lines to the plot
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