Experiment No. 4- Performance characterization of Rectangular waveguide for TE and ™ modes.

Code-

```
//Scilab code to plot wave impedance, phase velocity , and group velocity
//Variation of wave impedance w.r.t. frequency for TM11 and TE11 modes
//Variation of Phase and Group velocity w.r.t. frequency
//Given dimensions
a=6e-2;
b=4e-2;
c=3e8;
epsilon0=8.854e-12;//Epsilon value
mu0=4*%pi*1e-7;//muev value
eta0=sqrt(mu0/epsilon0);//Eta value
disp(eta0);

//Frequency range
f_min=5e9;//minimum frequency 5Ghz
f_max=15e9;//maximum frequency 15Ghz
f=linspace(f_min,f_max,1000);//Defining frequency range

//mode indices
m=1;
n=1;

//Calculating cutoff frequency
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
Zg_TM11=eta0.*sqrt(1-fc_ratio.^2);
//Wave impedance for TE11
Zg_TE11=eta0./sqrt(1-fc_ratio.^2);

//plotting wave impedance w.r.t. frequency for TM11 and TE11 mode
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');
legend(['TM11 Mode','TE11 Mode'],'location','upper left');
xgrid();//Add grid lines to the plot

//Plotting Phase and Group velocity w.r.t. frequency
scf(2);
plot(f/1e9,vp,'b','LineWidth',2);
plot(f/1e9,vg,'r','LineWidth',2);
title('Variation of phase velocity 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
```

Output-

Variation of wave impedance with frequency for TE11 & TM11 modes

Variation of phase velocity and group velocity with frequency