Code: %experiment 2 WA

clc;

close all;

% Waveguide dimensions

a = 2.286

; % Length in cm in x-direction

b = a/2; % Length in cm in y-direction

f = 45\*10.^9; % Frequency of operation 45GHz

c = 3\*10.^8; % Velocity of light

% m = 1; % Mode number in X-Direction

% n = 0; % Mode number in Y-Direction

choice = input('Enter choice: 1 for TE and 2 for TM: ');

if choice == 1

m = input('Enter mode value m:');

n = input('Enter mode value n:');

elseif choice == 2

m = input('Enter mode value m:');

n = input('Enter mode value n:');

else

sprintf('Alert!!! Wrong choice!!!')

end

Amn = 1; % Particular mode Constant

% A10 = 1; % for example

% Wave propagation in Z-Direction

%\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*%

fc = c\*100/2\*sqrt((m/a).^2+(n/b).^2); % Cutoff frequency calculation in GHz

% lambda = 2\*a; %for TE10 mode

lambda = c\*100/fc; % Wavelength in cm

epsilon = 8.8540e-12; % Permittivity constant

epsilon\_r = 1; % Relative Permittivity constant

mu1 = 4\*pi\*10e-7; % Permeability constant

mu1\_r = 1; % Relative Permeability constant

omega = 2\*pi\*f; % Frequency of operation in rad/s

M = 40; % Number of points to be poltted

beta = omega\*(sqrt(mu1\*epsilon)); %Propagation constant

Bx = m\*pi/a; %Beta(x)

By = n\*pi/b; %Beta(y)

Bc = sqrt(Bx.^2+By.^2); %Beta(c), cutoff wavenumber

Bz = sqrt(beta.^2-Bc.^2);

if choice ==1

if m == 0 && n == 0

fprintf(['TE\_',num2str(m),num2str(n), ' mode doesnot exist']);

elseif fc>f

fprintf(['TE\_',num2str(m),num2str(n), ' mode cutoff frequency exceeds frequency of operation; hence mode does not porpagate\n']);

sprintf('The frequency of operation is up to: %0.5g',f)

sprintf('The cutoff frequency is: %0.5g',fc)

else

sprintf('The frequency of operation is up to: %0.5g',f)

sprintf('The cutoff frequency is: %0.5g',fc)

% Front View

z = 0;

x = linspace(0,a,M);

y = linspace(0,b,M);

[x,y] = meshgrid(x,y);

% z = linspace(0,2\*lambda,M);

%Field Expression for TEmn

% Ex = Amn\*(By/epsilon)\*cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% Ex = Amn\*(By/epsilon)\*cos(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

Ex = cos(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

% Ey = -Amn\*(Bx/epsilon)\*sin(Bx.\*x).\*cos(By.\*y).\*exp(-1i\*Bz\*z);

Ey = -sin(Bx.\*x).\*cos(By.\*y).\*exp(-1i\*Bz\*z);

Ez = 0;

% Hx = Amn\*(Bx\*Bz/(omega\*mu1\*epsilon))\*sin(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

Hx = sin(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% Hy = Amn\*(Bx\*Bz/(omega\*mu1\*epsilon))\*cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

Hy = cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% Hz = -1i\*Amn\*(Bc.^2/(omega\*mu1\*epsilon))\*cos(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

Hz = -cos(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

figure();

quiver(x,y,real(Ex),real(Ey));

title(['Plot of front view for TE\_',num2str(m),'\_',num2str(n),' E-Field']);

legend('E-Field');

xlabel('x-dimension 0 to a');

ylabel('y-dimension 0 to b=a/2');

figure();

quiver(x,y,real(Hx),real(Hy));

title(['Plot of front view for TE\_',num2str(m),'\_',num2str(n),' H-Field']);

legend('H-Field');

xlabel('x-dimension 0 to a');

ylabel('y-dimension 0 to b=a/2');

figure();

quiver(x,y,real(Ex),real(Ey));

hold on

quiver(x,y,real(Hx),real(Hy));

grid on

title(['Plot of front view for TE\_',num2str(m),'\_',num2str(n)]);

legend('E-Field','H-Field');

xlabel('x-dimension 0 to a');

ylabel('y-dimension 0 to b=a/2');

% Top View for TEmn

y = b; % Position of x-z plane

x = linspace(0,a,M);

% y = linspace(0,b,M);

z = linspace(0,lambda,M);

[x,z] = meshgrid(x,z); % Create Mesh grid in x-z

% Field Expression for TEmn

% Ex = Amn\*(By/epsilon)\*cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

Ex = cos(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

Ey = -sin(Bx.\*x).\*cos(By.\*y).\*exp(-1i\*Bz\*z);

% Ez = 0;

Ez = zeros(size(real(Ey)));

Hx = sin(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-1j\*Bz\*z);

% Hx = A10\*(Bz/(omega\*mu1\*epsilon))\*pi/a.\*sin(pi.\*x./a).\*exp(-j\*Bz\*z);

Hy = cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-1j\*Bz\*z);

Hz = -cos(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-1j\*Bz\*z);

figure();

quiver(z,x,real(Ez),real(Ex));

title(['Plot of Top view for TE\_',num2str(m),'\_',num2str(n),' E-Field']);

legend('E-Field');

ylabel('x-dimension 0 to a');

xlabel('z-direction');

figure();

quiver(z,x,real(Hz),real(Hx));

title(['Plot of Top view for TE\_',num2str(m),'\_',num2str(n),' H-Field']);

legend('H-Field');

ylabel('x-dimension 0 to a');

xlabel('z-direction');

figure();

quiver(z,x,real(Ez),real(Ex));

hold on

quiver(z,x,real(Hz),real(Hx));

grid on

title(['Plot of TOP view of E-H for TE\_',num2str(m),'\_',num2str(n)]);

legend('E-Field','H-Field');

ylabel('x-dimension 0 to a');

xlabel('z-direction');

% Side View for TEmn

x = a/2;

% x = linspace(0,a,M);

y = linspace(0,b,M);

z = linspace(0,2\*lambda,M);

[y,z] = meshgrid(y,z);

% Field Expressions for TEmn

Ex = cos(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

Ey = -sin(Bx.\*x).\*cos(By.\*y).\*exp(-1i\*Bz\*z);

Ez = 0;

Ez = zeros(size(real(Ey)));

Hx = sin(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

Hy = cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

Hz = -cos(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

figure();

quiver(z,y,real(Ez),real(Ey));

title(['Plot of Side view for TE\_',num2str(m),'\_',num2str(n),' E-Field']);

legend('E-Field');

ylabel('y-dimension 0 to b');

xlabel('z-direction');

figure();

quiver(z,y,real(Hz),real(Hy));

title(['Plot of Side view for TE\_',num2str(m),'\_',num2str(n),' H-Field']);

legend('E-Field');

ylabel('y-dimension 0 to b');

xlabel('z-direction');

figure();

quiver(z,y,real(Ez),real(Ey));

hold on

quiver(z,y,real(Hz),real(Hy));

grid on

title(['Plot of Side view of E-H for TE\_',num2str(m),'\_',num2str(n)]);

legend('E-Field','H-Field');

ylabel('y-dimension 0 to b');

xlabel('z-direction');

end

elseif choice == 2

if m == 0 || n == 0

fprintf(['TM\_',num2str(m),num2str(n), ' mode doesnot exist']);

elseif fc>f

fprintf(['TM\_',num2str(m),num2str(n), ' mode cutoff frequency exceeds frequency of operation; hence mode does not porpagate\n']);

sprintf('The frequency of operation is up to: %0.5g',f)

sprintf('The cutoff frequency is: %0.5g',fc)

else

sprintf('The frequency of operation is up to: %0.5g',f)

sprintf('The cutoff frequency is: %0.5g',fc)

% Field Pattern plot for Rectangular wave guide for TMmn mode

%TM\_mn mode field expressions

% Front View

x = linspace(0,a,M);

y = linspace(0,b,M);

% z = linspace(0,2\*lambda,M);

z = 0;

[x,y] = meshgrid(x,y);

% % % Field Expressions for TMmn

% % Ex = -cos(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

% % Ey = -sin(Bx.\*x).\*cos(By.\*y).\*exp(-1i\*Bz\*z);

% % Ez = -sin(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

% %

% % Hx = sin(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% % Hy = cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% % % Hz = 0;

% % Hz = zeros(size(real(Hy)));

%tmequation();

%Plot of TMmn E-Field view

figure();

quiver(x,y,real(Ex),real(Ey));

title(['Plot of front view for TM\_',num2str(m),'\_',num2str(n),' E-Field']);

legend('E-Field');

xlabel('x-dimension 0 to a');

ylabel('y-dimension 0 to b=a/2');

%Plot of TMmn H-Field view

figure();

quiver(x,y,real(Hx),real(Hy));

title(['Plot of front view for TM\_',num2str(m),'\_',num2str(n),' H-Field']);

legend('H-Field');

xlabel('x-dimension 0 to a');

ylabel('y-dimension 0 to b=a/2');

%Plot of TMmn E-Field and H-Field view

figure();

quiver(x,y,real(Ex),real(Ey));

hold on

quiver(x,y,real(Hx),real(Hy));

grid on

title(['Plot of front view for TM\_',num2str(m),'\_',num2str(n)]);

legend('E-Field','H-Field');

xlabel('x-dimension 0 to a');

ylabel('y-dimension 0 to b=a/2');

% Top View

y = b; %Position of view

x = linspace(0,a,M);

% y = linspace(0,b,M);

z = linspace(0,lambda,M);

[x,z] = meshgrid(x,z);

% % %Field expression for TMmn

% % Ex = -cos(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

% % Ey = -sin(Bx.\*x).\*cos(By.\*y).\*exp(-1i\*Bz\*z);

% % Ez = -sin(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

% %

% % Hx = sin(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% % Hy = cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% % % Hz = 0;

% % Hz = zeros(size(real(Hy)));

%tmequation();

figure();

quiver(z,x,real(Ez),real(Ex));

title(['Plot of Top view for TM\_',num2str(m),'\_',num2str(n),' E-Field']);

legend('E-Field');

ylabel('x-dimension 0 to a');

xlabel('z-direction');

figure();

quiver(z,x,real(Hz),real(Hx));

title(['Plot of Top view for TM\_',num2str(m),'\_',num2str(n),' H-Field']);

legend('H-Field');

ylabel('x-dimension 0 to a');

xlabel('z-direction');

figure();

quiver(z,x,real(Ez),real(Ex));

hold on

quiver(z,x,real(Hz),real(Hx));

grid on

title(['Plot of TOP view of E-H for TM\_',num2str(m),'\_',num2str(n)]);

legend('E-Field','H-Field');

ylabel('x-dimension 0 to a');

xlabel('z-direction');

% Side View

x = a/2;

% x = linspace(0,a,M);

y = linspace(0,b,M);

z = linspace(0,2\*lambda,M);

[y,z] = meshgrid(y,z);

% % %Field Expression for TMmn

% % Ex = -cos(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

% % Ey = -sin(Bx.\*x).\*cos(By.\*y).\*exp(-1i\*Bz\*z);

% % Ez = -sin(Bx.\*x).\*sin(By.\*y).\*exp(-1i\*Bz\*z);

% %

% % Hx = sin(m\*pi.\*x./a).\*cos(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% % Hy = cos(m\*pi.\*x./a).\*sin(n\*pi.\*y./b).\*exp(-j\*Bz\*z);

% % % Hz = 0;

% % Hz = zeros(size(real(Hy)));

%tmequation();

figure();

quiver(z,y,real(Ez),real(Ey));

title(['Plot of Side view for TM\_',num2str(m),'\_',num2str(n),' E-Field']);

legend('E-Field');

ylabel('y-dimension 0 to b');

xlabel('z-direction');

figure();

% quiver(y,z,real(Hy),real(Hz));

quiver(z,y,real(Hz),real(Hy));

title(['Plot of Side view for TM\_',num2str(m),'\_',num2str(n),' H-Field']);

legend('E-Field');

ylabel('y-dimension 0 to b');

xlabel('z-direction');

figure();

quiver(z,y,real(Ez),real(Ey));

hold on

quiver(z,y,real(Hz),real(Hy));

grid on

title(['Plot of Side view of E-H for TM\_',num2str(m),'\_',num2str(n)]);

legend('E-Field','H-Field');

ylabel('y-dimension 0 to b');

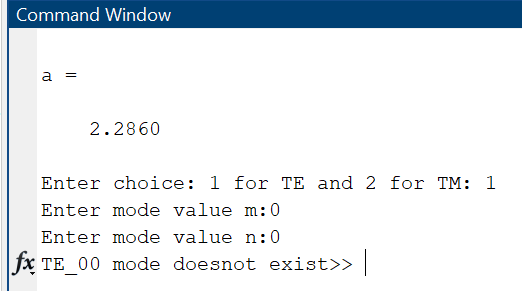
xlabel('z-direction');

end

else

sprintf('Alert!!! Something went wrong, try again!!!');

end



TMM