

```
% PlanarMetamaterials, Oct 26 2012
% Not the best code, but it works :)
```

```
mu = 4*pi*(10^-7);
epsz = 8.854*(10^-12);
```

```
DeltaX = 0.15*(10^-2);
DeltaY = 0.5*(10^-2);
DeltaT = sqrt(mu*epsz)/sqrt((1/(DeltaX^2))+(1/(DeltaY^2)));
Nx = 201;
Ny = 21;
Nt = 500;
f = 30*(10^9);
```

```
epsr = zeros(Nx*2,Ny*2);
Ez = zeros(Nx*2,Ny*2,Nt*2);
Hx = zeros(Nx*2,Ny*2,Nt*2);
Hy = zeros(Nx*2,Ny*2,Nt*2);
E = zeros(Nx);
```

```
X = 1:1:Nx;
T = 1:1:Nt;
```

```
x = 0;
y = 0;
t = 0;
```

```
i = 0;
j = 0;
n = 0;
v = 1/sqrt(mu*epsz);
```

```
W = 0.1*(10^-9);
To = 0.3*(10^-9);
```

```
SourceX = ((6*(10^-2))/DeltaX)*2 - 1;
```

```
%Solve
```

```
for t=1:Nt;
```

```
    n = (2*t) - 1;
```

```
    %Compute Ez(n+1) inside domain
```

```
    for x=2:(Nx-1);
```

```
        for y=2:(Ny-1);
```

```
            i = (2*x) - 1;
```

```
            j = (2*y) - 1;
```

```
            epsr(i,j) = 1;
```

```
            Ez(i,j,n+2) = Ez(i,j,n) + (1/(epsz*epsr(i,j)))*((DeltaT/DeltaX)*(Hy(i+1,j,n+1) - Hy(i-1,j,n+1)) - (DeltaT/DeltaY)*(Hx(i,j+1,n+1) - Hx(i,j-1,n+1)));
```

```
            Ez(SourceX,j,n+2) = sin(2*pi*f*(((n+2)*DeltaT) - (SourceX/v)))*exp(-((((n+2)*DeltaT)-To)/(W/2))^2); %Apply Source
```

```
        end
```

```
        E(x) = Ez(i,((5*(10^-2))/DeltaY)*2 - 1,n+2); %Update drawing variable
```

```
    end
```

```
    %Apply ABCs for Ez on domain boundaries if n > 2
```

```

v = 1/sqrt(mu*epsz*1);
Term1X = (v*DeltaT - DeltaX)/(v*DeltaT + DeltaX);
Term1Y = (v*DeltaT - DeltaY)/(v*DeltaT + DeltaY);
Term2X = (2*DeltaX)/((v*DeltaT) + DeltaX);
Term2Y = (2*DeltaY)/((v*DeltaT) + DeltaY);
Term3X = (((v*DeltaT)^2)*DeltaX)/(2*(v*DeltaT + DeltaX)*(DeltaY^2));
Term3Y = (((v*DeltaT)^2)*DeltaY)/(2*(v*DeltaT + DeltaY)*(DeltaX^2));
if n > 2
    %Left Bound
    x = 1;
    i = (2*x) - 1;
    for y=2:(Ny - 1);
        j = (2*y) - 1;
        epsr(i,j) = 1;
        v = 1/sqrt(mu*epsz*epsr(i,j));
        Ez(i,j,n+2) = -Ez(i+2,j,n-2) + Term1X*(Ez(i,j,n-2)+Ez(i+2,j,n+2)) + Term2X*(Ez(i,j,n)+Ez(i
+2,j,n)) + Term3X*(Ez(i,j+2,n)-2*Ez(i,j,n)+Ez(i,j-2,n)+Ez(i+2,j+2,n)-2*Ez(i+2,j,n)+Ez(i+2,j-2,n));
    end
    %Right Bound
    x = Nx;
    i = (2*x) - 1;
    for y=2:(Ny - 1);
        j = (2*y) - 1;
        epsr(i,j) = 1;
        v = 1/sqrt(mu*epsz*epsr(i,j));
        Ez(i,j,n+2) = -Ez(i-2,j,n-2) + Term1X*(Ez(i,j,n-2)+Ez(i-2,j,n+2)) + Term2X*(Ez(i,j,n)+Ez(i-2,j,n))
+ Term3X*(Ez(i,j+2,n)-2*Ez(i,j,n)+Ez(i,j-2,n)+Ez(i-2,j+2,n)-2*Ez(i-2,j,n)+Ez(i-2,j-2,n));
    end
    %Bottom Bound
    %Leave at 0, i.e. do nothing
    %Top Bound
    %Leave at 0, i.e. do nothing
    %Average over values for corners
    Ez(1,1,n+2) = (Ez(3,1,n+2) + Ez(1,3,n+2))/2;
    Ez((Nx*2) - 1,1,n+2) = (Ez((Nx*2) - 3,1,n+2) + Ez((Nx*2) - 1,3,n+2))/2;
    Ez(1,(Ny*2) - 1,n+2) = (Ez(1,(Ny*2) - 3,n+2) + Ez(3,(Ny*2) - 1,n+2))/2;
    Ez((Nx*2) - 1,(Ny*2) - 1,n+2) = (Ez((Nx*2) - 1,(Ny*2) - 3,n+2) + Ez((Nx*2) - 3,(Ny*2) - 1,n+2))/2;
    %Compute Hx and Hy inside domain
    for x=1:(Nx - 1);
        for y=1:(Ny - 1);
            i = (2*x) - 1;
            j = (2*y) - 1;
            Hx(i,j+1,n+3) = Hx(i,j+1,n+1) - (1/mu)*(DeltaT/DeltaY)*(Ez(i,j+2,n+2) - Ez(i,j,n+2));
            Hy(i+1,j,n+3) = Hy(i+1,j,n+1) + (1/mu)*(DeltaT/DeltaX)*(Ez(i+2,j,n+2) - Ez(i,j,n+2));
        end
    end
    end
    %For animation purposes
    plot(X,E)
    axis([0 Nx -1 1])
    pause(0.1);
end

%Update variable for drawing

```

```
for x=1:Nx;
    for y=1:Ny;
        E(x) = Ez((x*2) - 1,((5*(10^-2))/DeltaY)*2 - 1,50);
    end
end

plot(X,E)
axis([0 Nx -1 1])
```