Computational Electromagnetics

Hw6-Q5

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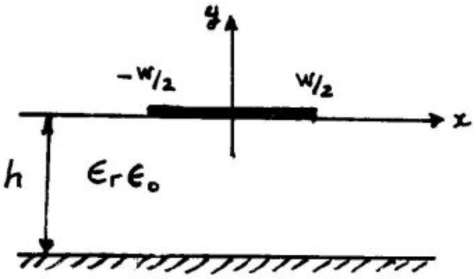
1401/09/30

```
clear; close all; clc;
```

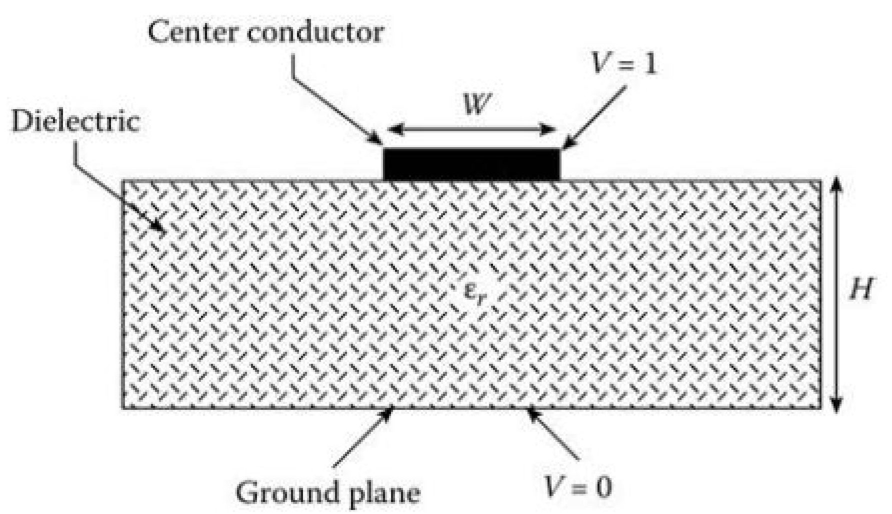


۵- مطلوبست یافتن توزیع بار بر روی خط نوار شکل داده شده با حل معادله

$$\int_{-W/2}^{W/2} \sigma(x')\, G(x,x')\, dx' = V \qquad -\frac{W}{2} < x < \frac{W}{2}$$

و محاسبه امپدانس مشخصه (Z_0) خط با پارامترهای $W=h=1\,mm$ و $\epsilon_r=9.6$. نتایج بدست آمده را با آنچه که قبلاً از طریق FD محاسبه کرده‌اید (مثال 3.24 کتاب 4th ed.) مقایسه نمائید.

مرجع: P. Silvester, "TEM properties of Microstrip..." Proc. IEE, pp 43-48, 1968




```
NN = [3  7 20 30 60 100 150 200 500 1000];
ER =9.6;

i =0 ;
Z = zeros(1,length(NN));

W  =1;
H  =1;


for N = NN
```

```
i = i +1;
[ ~ , ~ ,~ , Z(i) ] = Impedance_MoM_Calc(N,ER,W,H);

disp(N+ "    |   " + Z(i)  );
disp("----------------");
end
```

```
3   |  50.0235
----------------
7   |  58.5266
----------------
20   |  65.6422
----------------
30   |  65.9336
----------------
60   |  66.2762
----------------
100   |  66.4386
----------------
150   |  66.5295
----------------
200   |  66.5787
----------------
500   |  66.6775
----------------
1000   |  66.7158
----------------
```

TABLE I

CHARACTERISTIC IMPEDANCES OF MICROSTRIP TRANSMISSION LINES

W/H	$\epsilon_{r2}=6.0$		$\epsilon_{r2}=9.5$		$\epsilon_{r2}=16.0$		$\epsilon_{r2}=28.0$	
	Z_0*	Z_0†	Z_0*	Z_0†	Z_0*	Z_0†	Z_0*	Z_0†
0.1	135.455	134.352	110.172	110.058	85.9659	87.762	65.5298	68.819
0.2	113.272	112.255	91.809	91.776	71.6954	73.015	54.6138	57.110
0.4	91.172	89.909	73.702	73.290	57.4999	58.110	43.7391	45.281
0.7	73.613	71.995	59.379	58.502	46.2344	46.217	35.1153	35.872
1.0	62.713	60.970	50.501	49.431	39.2512	38.948	29.7629	30.144
2.0	43.149	41.510	34.592	33.493	26.7555	26.248	20.2086	20.197
4.0	27.301	26.027	21.763	20.906	16.7210	16.300	12.5529	12.474
10.0	13.341	12.485	10.568	9.981	8.0385	7.8079	5.9746	5.892

* Characteristic impedance obtained by method of moment.
† Characteristic impedance obtained by conformal mapping.

What we achieved here, is about 66.57 [ohm] ! --> Comparing to FD method, it took less time and the accuracy is considerable!

Computational Electromagnetics

Hw3

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1401/08/18

Q-3.24:

3.24 Modify the program in Figure 3.21 or write your own program to cal
for the microstrip line shown in Figure 3.54. Take $a = 2.02$, $b = 7.0$, $h =$
$t = 0.01$, $\epsilon_1 = \epsilon_0$, $\epsilon_2 = 9.6\epsilon_0$.

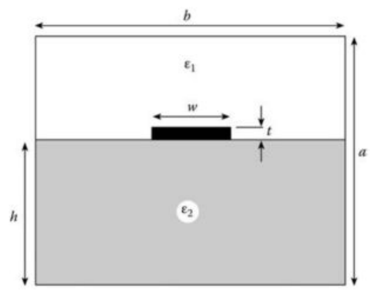

FIGURE 3.54
For Problem 3.24.

we can use symmetry in this problem and consider the right half of this geometry -->

Step 1:

H =	0.1	0.1	0.01	0.01	0.01	0.01	0.001	0.001
NT =	1000	5000	1000	5000	10000	30000	10000	30000
Z0 =	56.15	56.1581	145.6462	64.5268	56.9608	53.2661	5523000	1678

values obtained in FD method, shows tendacy to 65 [ohm] in high number of iterations!

** Both Values are almost the same and are reasonable **

```
function  [G ]  =  impedance_MoM_TEM_strips(N,ER,AIR , W,H)


%     vo = 3.0e08; % SPEED of LIGHT in free space  % Given

%     ER = 9.6; % Given

     Eo = 8.8541878176e-12; % F/m % Given
%
%     H = 1.0; % Given
%     W = 1;
```

```
    G = zeros(N,N);
    C = G;

    if(AIR == 0)
     k = (ER-1)/(ER+1);
    else
        k=1;
    end

    Delta = W/N;

    for i=1:N
        for j=1:N
            SUM = 0;
            C(i,j) = Delta/H * abs(2*(i-1) - 2*(j-1) -1 ) ;
            for n = 1: 100
                SUM = SUM + k^(2*(n-1))*log( (   C(i,j)^2 + (4*n-2)^2  ) / ( C(i,j)^2 + (4*n-4)
                            k^(2*n-1)*log(   (   C(i,j)^2 + (4*n-2)^2  ) / ( C(i,j)^2 + (4*n)^2
            end

            G(i,j) = 1/(4*pi*Eo) * SUM   ;

        end
    end
end

function [G , Capo , Cap , Zo] = Impedance_MoM_Calc(N,ER,W,H)

     AIR = 0;
     vo = 3.0e08; % SPEED of LIGHT in free space  % Given


     G = impedance_MoM_TEM_strips(N,ER,AIR , W,H);
     Alpha = inv(G)*ones(N,1);

     Cap = sum(Alpha,'all') ;  % F/m

     AIR =1;
     G_Air_Filled = impedance_MoM_TEM_strips(N,ER,AIR , W,H);
     Alpha_AIR_FIlled = inv(G_Air_Filled)*ones(N,1);
     Capo = sum(Alpha_AIR_FIlled,'all') ;  % F/m

     Zo =  1/ (vo * sqrt(Capo*Cap)   ) ;




end
```