Computational Electromagnetics

Hw6-Q2

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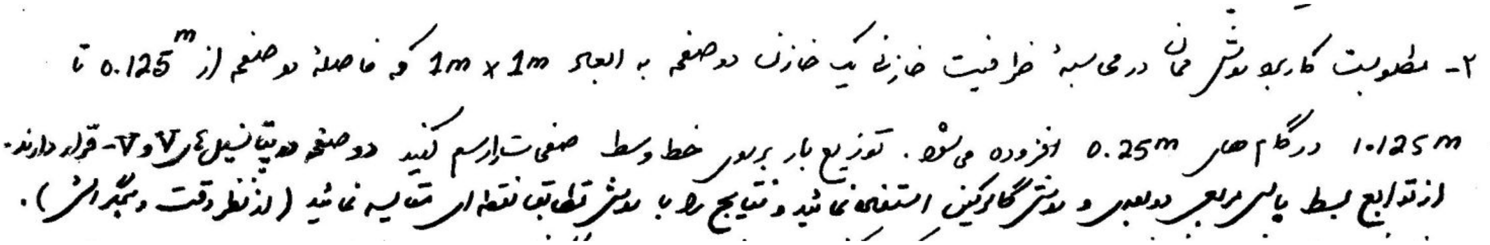
```
clear; clc; close all;
```



۲- مطلوبست کاربرد روش ممان در محاسبه ظرفیت خازنی یک خازن دوصفحه به ابعاد 1m x 1m که فاصله دو صفحه از 0.125m تا 1.125m در گام های 0.25m افزوده می‌شود. توزیع بار برروی خط وسط صفحات را رسم کنید دو صفحه در پتانسیل های V و V- قرار دارند. از توابع بسط پالس مربعی دوبعدی و روش گالرکین استفاده نمائید و نتایج را با روش تطابق نقطه‌ای مقایسه نمائید (از نظر دقت و همگرائی).

```
a = 1/2;

N = 9;

b = a/sqrt(N) ;


eps0 = 8.854*1e-12  ;  % F/m
```

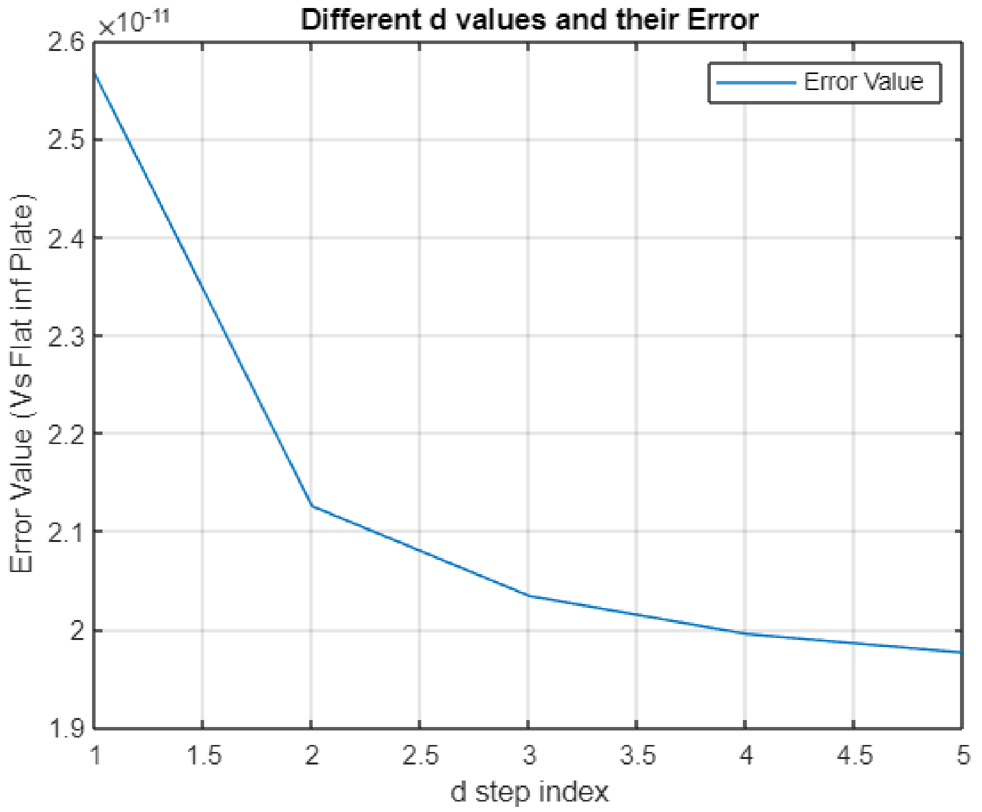
Epsilon Naught is synonymous to the permittivity of free space or absolute permittivity or electric constant, represented by the Greek alphabet ε0. The Epsilon Naught value is constant at any part of the universe.

```

delta_X = 2*b;
delta_Y = 2*b;

%syms m n
% Self Terms:
% Find_Cordx(m)  =   mod(m,sqrt(N)+1)*delta_X  ;
% Find_Cordy(m)  =   (floor(m/sqrt(N+1)+1)*1 -  1/2)*delta_Y ;

```

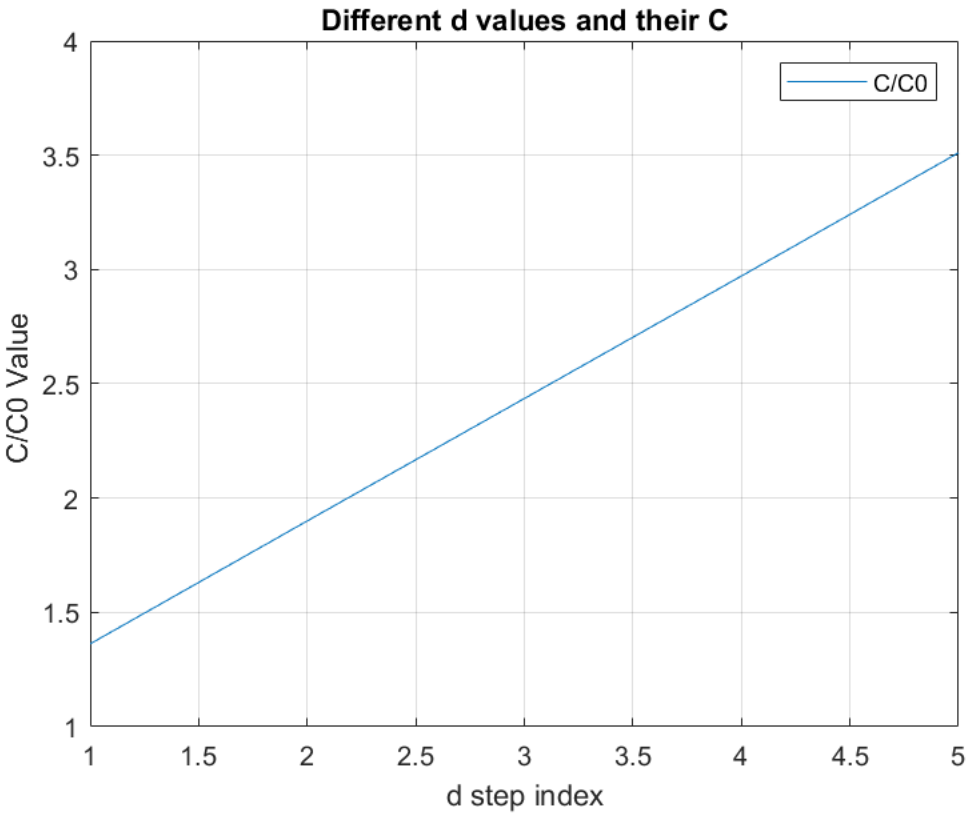
```

N = 9;

D       = 0.125: 0.25 : 1.125 ;
Sweep_N = [ 9 , 16 , 25 , 36 , 49 , 64  , 81 , 100];

C       = zeros( length(D) , length(Sweep_N));
C_plate = zeros( length(D),1);
```

```
A  = (2*a)^2;

Alpha_t =cell(1,length(D)) ;

for i=1:length(D)
    for j=1:length(Sweep_N)

        [C(i,j) , Alpha_t{i}] = Find_C(D(i) , Sweep_N(j),a );

    end
    C_plate(i,1) =  eps0*A/D(i);

end
```

```
% Compare:
rep_C_Plate = repmat(C_plate , 1,length(Sweep_N));
Error  =   sqrt ( abs( rep_C_Plate  - C  ).^2  )  ;

figure(1)
plot(1:length(D) , Error(:,end))
grid on
legend("Error Value")
title("Different d values and their Error")
xlabel("d step index")
ylabel("Error Value (Vs Flat inf Plate)")
```



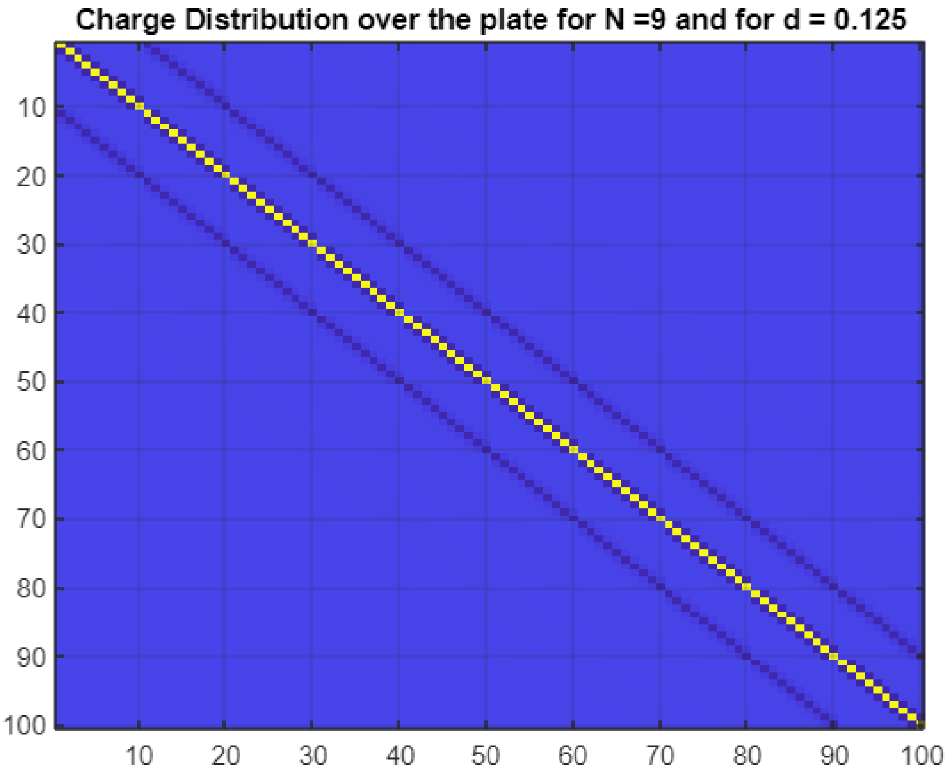
```
figure(2)
plot(1:length(D) , C(:,end)./C_plate)
grid on
legend("C/C0")
title("Different d values and their C")
xlabel("d step index")
ylabel("C/C0 Value ")
```



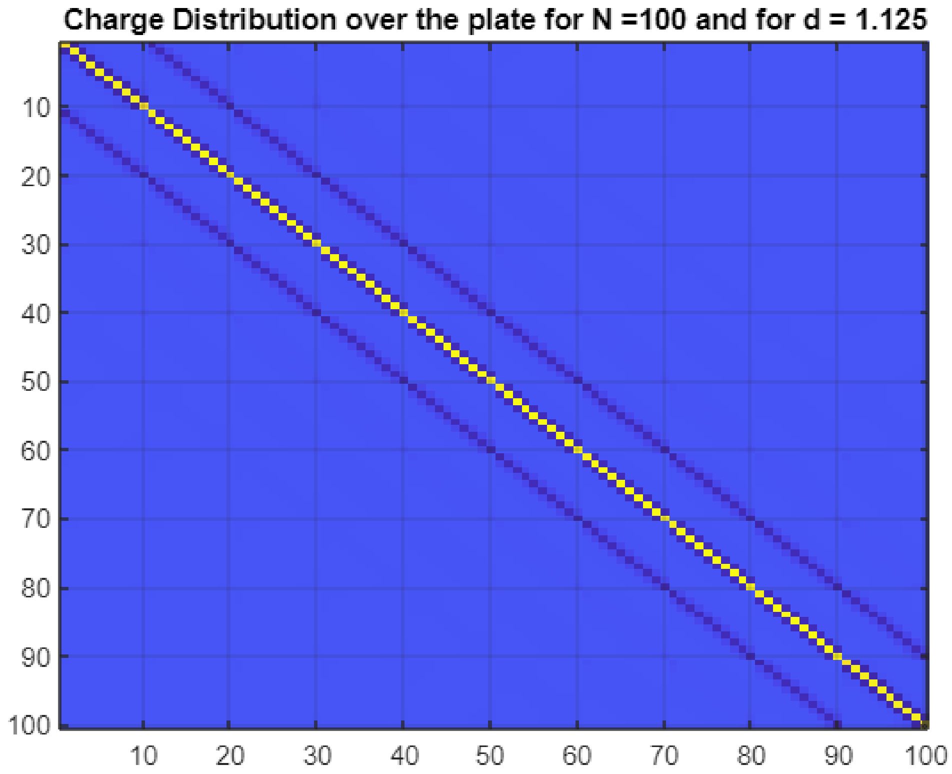
It is obvious and crystal clear that with increase in d (gap between 2 plates, the C/C0 value has became larger meaning **increase** in **fringing effect**)!!!!

Plot the Q over the middle Line of the Plates:

```
delta_Sn = (2*b)^2;


Q_T = sum( Alpha_t{1} , 'all' ) * delta_Sn; % Total Q

Charge_Distribution = Alpha_t{1};

figure(4)
imagesc(Charge_Distribution)
title("Charge Distribution over the plate for N =" + num2str(Sweep_N(1))+ " and for d = "+num2s
grid on
```


Charge Distribution over the plate for N =9 and for d = 0.125

```
Charge_Distribution_end = Alpha_t{end};

figure(5)
imagesc(Charge_Distribution_end)
title("Charge Distribution over the plate for N =" + num2str(Sweep_N(end))+ " and for d = "+num
grid on
```



```
function   X_pos = Find_Cordx(m , N )

    if(m > sqrt(N) )
        Rem =  m - sqrt(N);
        X_pos = Find_Cordx(Rem , N);
    else
        X_pos  = ( m - 1/2);
    end
end

function   Y_pos = Find_Cordy(m , N )

     Y_pos =floor(m/sqrt(N+1)+1)*1 -  1/2;
end

function  R  = R_finder(m,n,delta_X,delta_Y,N)

R =              abs(  delta_X*Find_Cordx(m , N ) - delta_X*Find_Cordx(n , N ) )^2  + ...
                 abs(  delta_Y*Find_Cordy(m , N ) - delta_Y*Find_Cordy(n , N ) )^2  ;
end

function lmn =  lmn_tt(m, n , delta_Sn , delta_X ,  delta_Y , N )
    eps0 = 8.854*1e-12  ;  % F/m

    if(m==n)
```

```
        lmn = (sqrt(delta_Sn)/eps0)*0.2806;
    else
        lmn =  delta_Sn/(4*pi*eps0*sqrt( R_finder(m,n,delta_X,delta_Y,N))  ) ;
    end

end



function lmn =  lmn_tb(m, n , delta_Sn , delta_X ,  delta_Y , N , d)
    eps0 = 8.854*1e-12  ;  % F/m
    aeq  = sqrt(delta_Sn/pi)  ;

    if(m==n)
        lmn =  1/(2*eps0) * (sqrt(aeq^2+d^2) - d ) ;
    else
        lmn =  delta_Sn/(4*pi*eps0*  sqrt(R_finder(m,n,delta_X,delta_Y,N)+d^2)  ) ;
    end

end



function [C , Alpha_t] = Find_C(d, N,a )

    Lmn_tt = zeros(N,N);

    Lmn_tb = zeros(N,N);
    V =1;
    b = a / sqrt(N);
    delta_Sn  =  (2*b)^2 ;
    % eps0 = 8.854*1e-12  ;  % F/m
    delta_X = 2*b;
    delta_Y = 2*b;

    for i=1:N
        for j=1:N
            Lmn_tt(i,j)  = lmn_tt(i, j , delta_Sn , delta_X ,  delta_Y , N );
            Lmn_tb(i,j)  = lmn_tb(i, j , delta_Sn , delta_X ,  delta_Y , N , d);
        end
    end

    Alpha_t = inv(  Lmn_tt - Lmn_tb  ) * V;

    C = 1/(2*V) * sum(Alpha_t,'all')*delta_Sn;

end
```