MATLAB EXERCISE 2.19 MoM analysis of a parallel-plate capacitor in MATLAB. Write the main MATLAB program based on the method of moments to evaluate the capacitance (C) of the parallel-plate capacitor in Fig.2.9, using function `matrixACap`, developed in the previous MATLAB exercise. Assume that $a = 1$ m, $V = 1$ V ($V_1 = 1$ V and $V_2 = -1$ V), and $N = 100$ (each plate is subdivided into $N = 10 \times 10 = 100$ patches). By means of this MoM program, find C for the following d/a ratios: (i) 0.1, (ii) 0.5, (iii) 1, (iv) 2, and (v) 10. *(ME2_19.m on IR)*

SOLUTION:

The computed surface charge distribution over the upper plate is shown in Fig.S2.10.

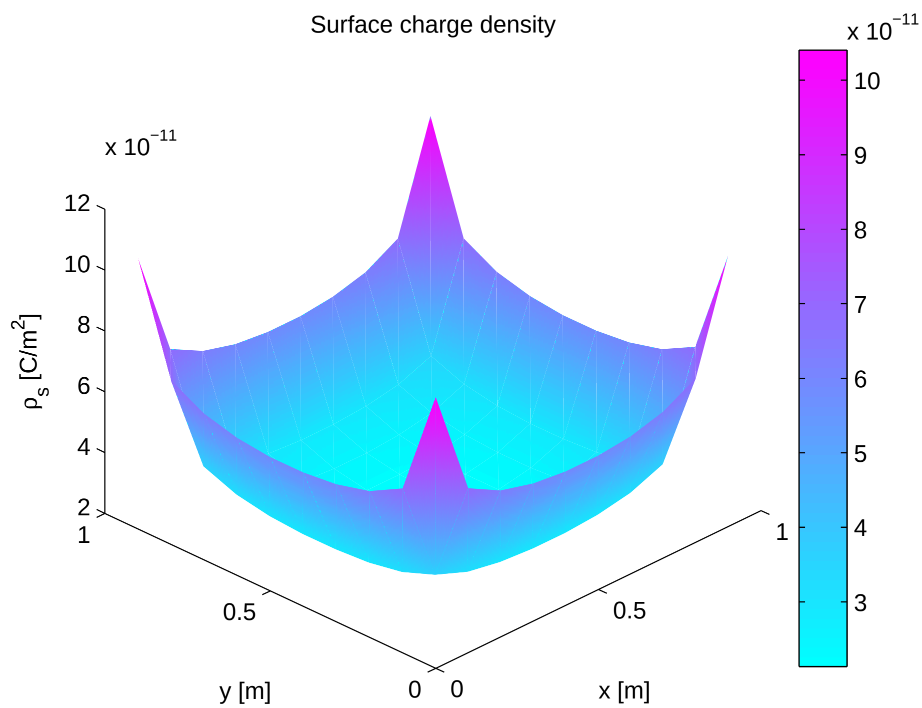

Figure S2.10 MATLAB display of the charge distribution of the upper plate of the parallel-plate capacitor in Fig.2.9 computed by a method-of-moments MATLAB code; for MATLAB Exercise 2.19.

For d/a ratios of 0.1, 0.5, 1, 2, and 10, C turns out to be 117 pF, 38.3 pF, 28.7 pF, 24 pF, and 20.6 pF, respectively. Note that the corresponding C values obtained from Eq.(2.28) (from the book), which neglects the fringing effects, are 88.5 pF, 17.7 pF, 8.85 pF, 4.43 pF, and 0.885 pF.

```
%
%   Book: MATLAB-Based Electromagnetics (Pearson Prentice Hall)
%   Author: Branislav M. Notaros
%   Instructor Resources
%   (c) 2011
%
%   This MATLAB code or any part of it may be used only for
%   educational purposes associated with the book
%
%
%


%    MoM analysis of a parallel-plate capacitor in MATLAB


% k = i) 0.1,(ii) 0.5, (iii) 1, (iv) 2, and (v) 10,


clear all;
close all;
V = 1;
N = 100;
n = sqrt(N);
a = 1;
k = [0.1 0.5 1 2 10]; % given ratio d/a
EPS0 = 8.8542*10^(-12);

[x,y,S] = localCoordinates(n,n,a,a);

C = zeros(1,length(k));
Ca = zeros(1,length(k));

for t = 1:length(k)
d = k(t)*a;
A = matrixACap(EPS0,S,x,y,d);
B = V*ones(N,1);
rhos = inv(A)*B;

for i = 1:n;
    rhos2D(i,:) = rhos((i-1)*n+1:i*n);
end;

X = 0.05:0.1:0.95;
Y = 0.05:0.1:0.95;

figure(1);
surf(X,Y,rhos2D);
title('Surface charge density');
xlabel('x [m]');
ylabel('y [m]');
zlabel('\rho_s [C/m^2]');
```

```
colorbar; colormap 'cool'; shading interp; grid off;

Qtot = totalCharge(S,rhos);
C(t) = Qtot/(2*V);

Ca(t) = EPS0*a^2/d;
end;

figure(2);
plot(k , C*10^12 ,'r','linewidth',2);
hold on;
plot(k, Ca*10^12,'b','linewidth',2);
hold off;
xlabel('ratio d/a');
ylabel('C [pF]');
legend('Numerical','Analytical');
```