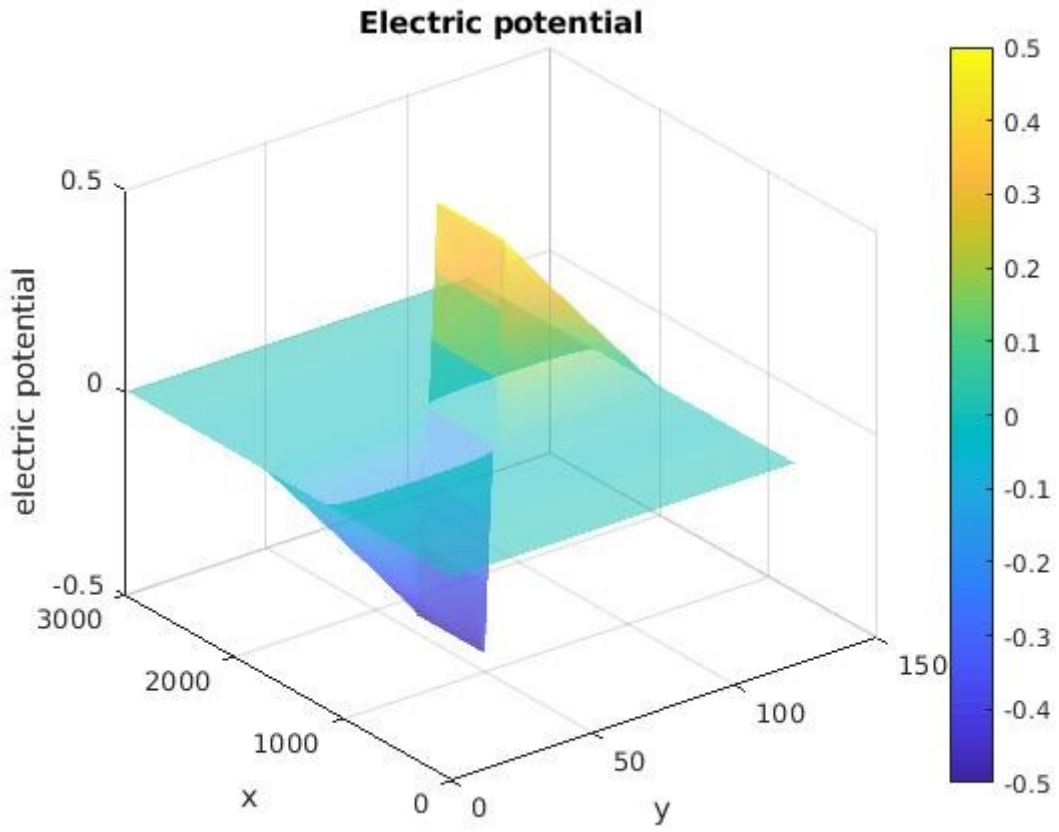
EE 735: ASSIGNMENT 1 REPORT

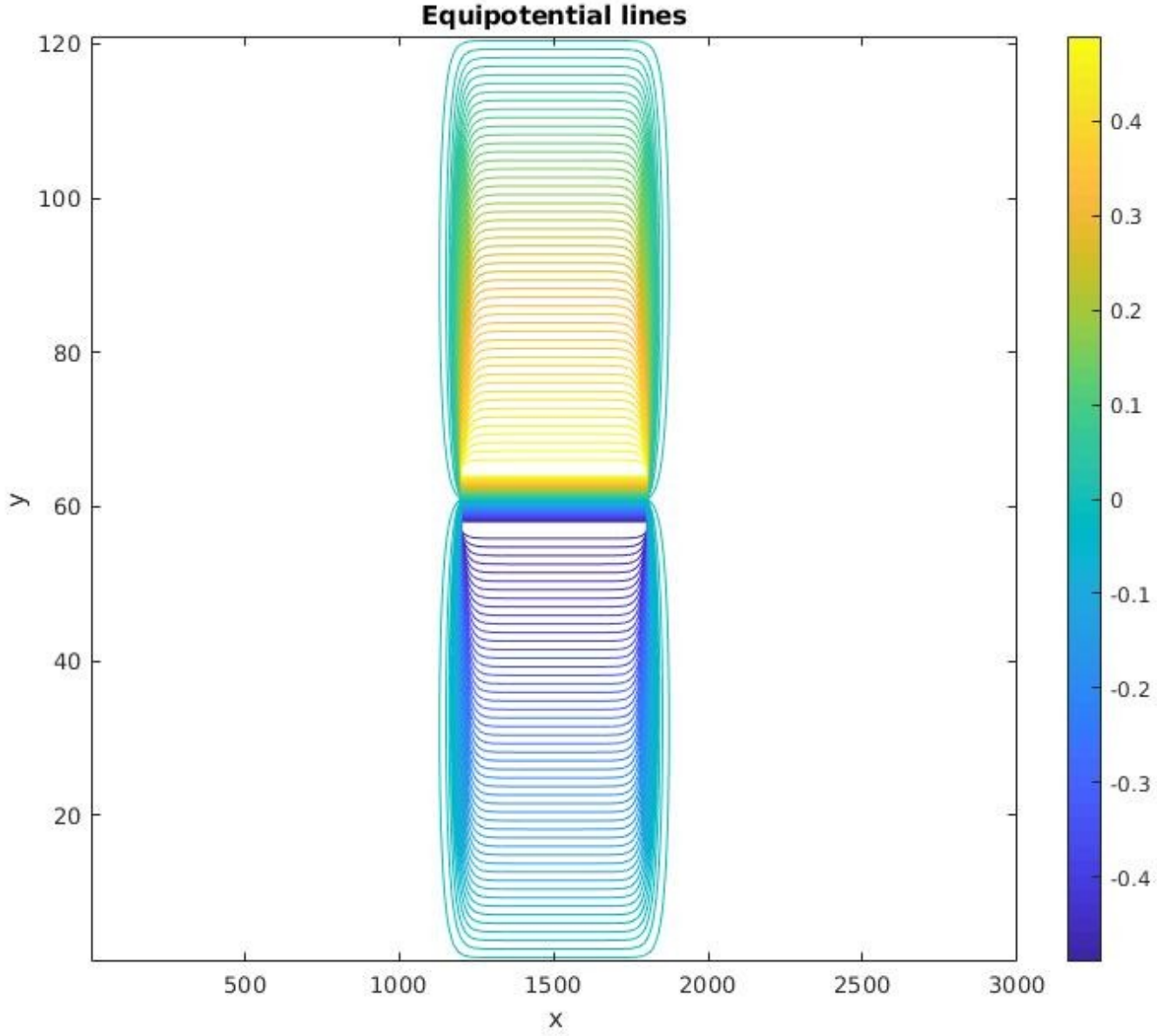
NAME: DIMPLE KOCHAR
ROLL NO.: 16D070010

Q1 a) I assumed that the dimensions of the box are **(3000 X 120) nm** (which seems large compared to plates of 600 nm length with a distance of 6 nm in between them. One plate was set at a voltage of 0.5 V and another -0.5 V. (When I used 1V,0V – equipotential lines weren't well plot due to very small potentials around grounded plate).
vnew(i,j) = (v(i-1,j)+v(i+1,j)+v(i,j-1)+v(i,j+1))/4 using this and running iterations on it till change at every potential point is less than 0.1 (set by e<0.1 condition in code) we obtain convergence of the potential. Then, taking the gradient of V to get the electric field, we calculate the total charge using Gauss Law, and thus the capacitance.

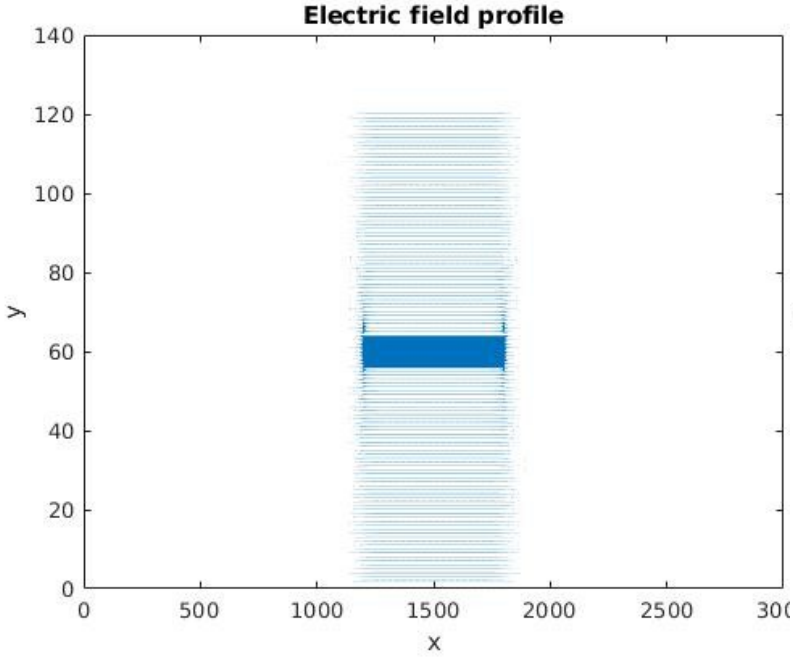
Capacitance per unit width by solving the 2D Poisson equation = **0.94424 nF**

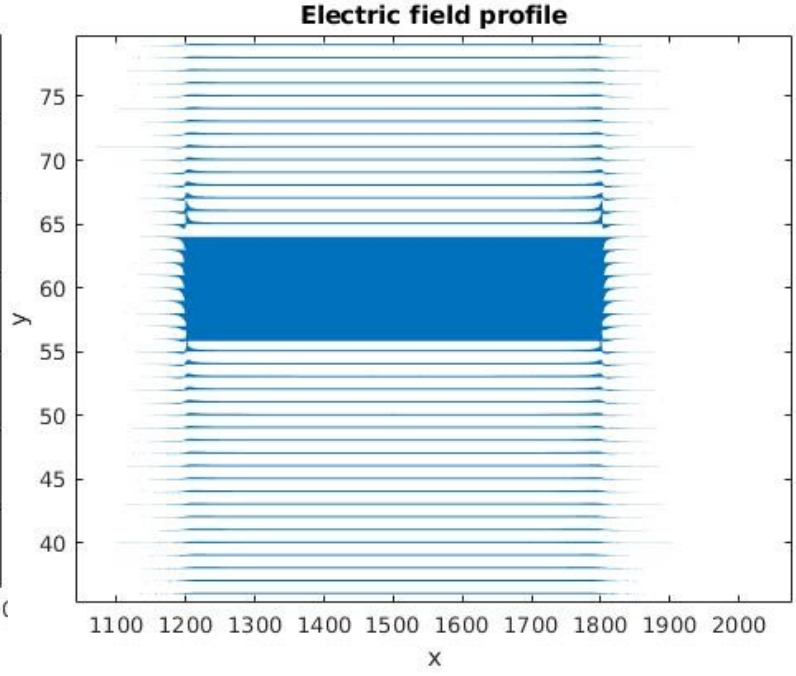
Q1 b)




Equipotential lines
120
100
80
60
40
20
y
500
1000
1500
2000
2500
3000
x
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4

Q1 c)


Electric field profile
140
120
100
80
60
40
20
0
y
0
500
1000
1500
2000
2500
x

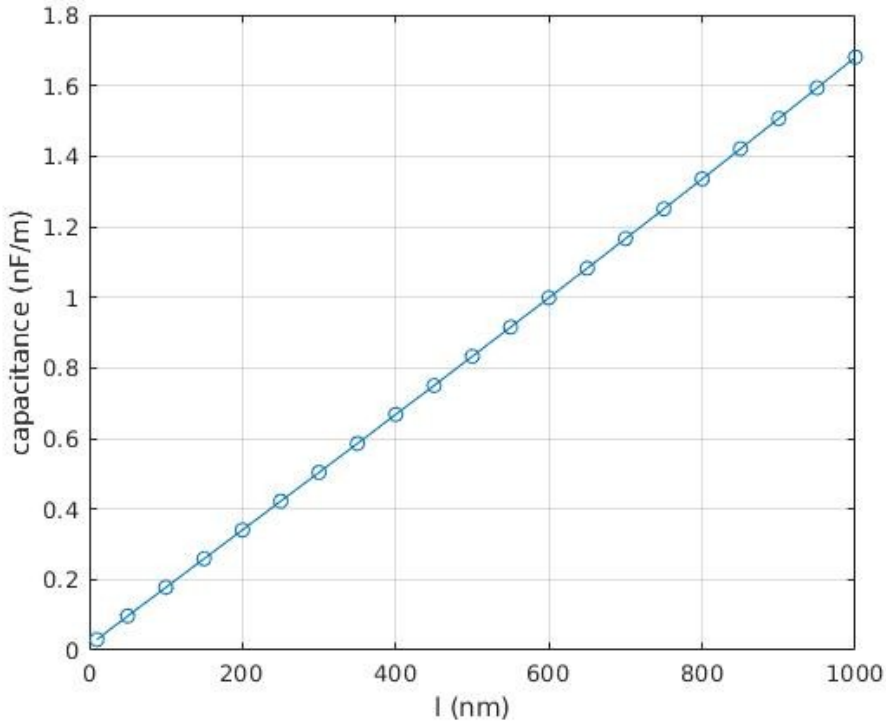

Electric field profile
75
70
65
60
55
50
45
40
y
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
x

Q1 d) Simulated capacitance = **0.94424 nF**

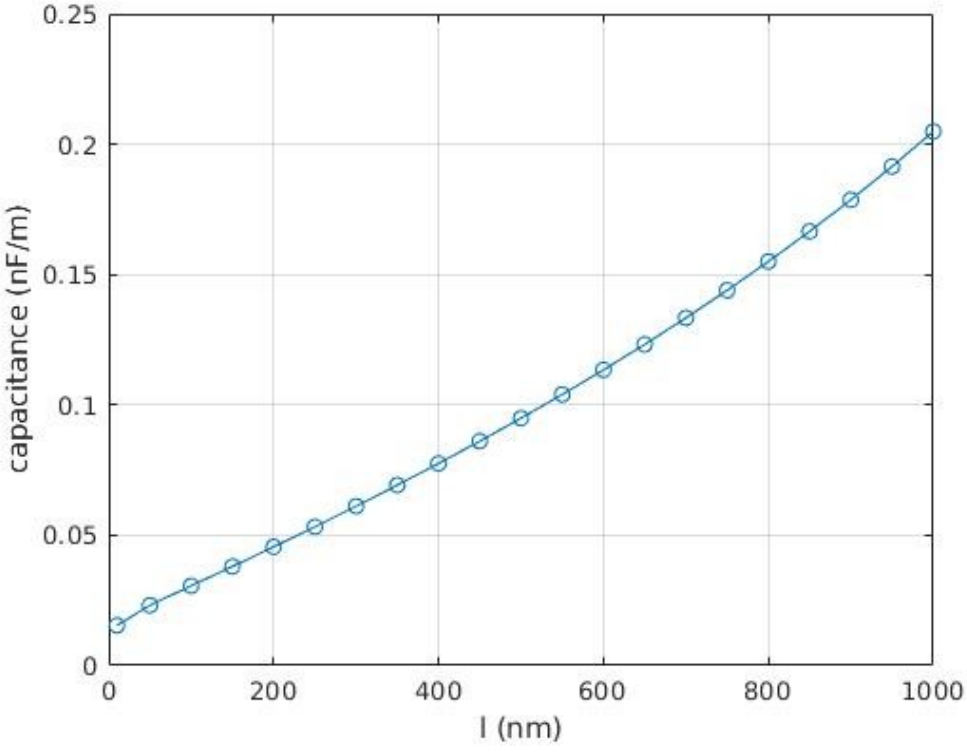
Theoretical capacitance = **0.88540 nF**

Simulated capacitance is larger that theoretical due to fring effect. A voltage difference applied between the plates results in an electric field between them. This electric field exists not just directly between the plates, but extends some distance away, causing a fringing field. Fringe effect occurs when the electric field extends the area of the overlap.

Q2 a) Simulated Capacitance:



Q2 b) Parasitic Capacitance:



Data (in F):

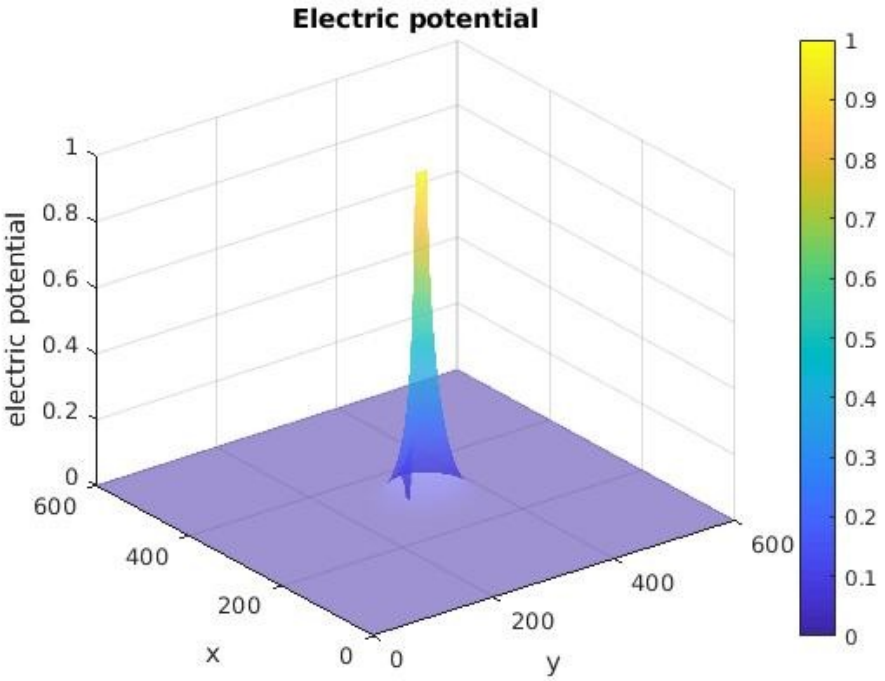
l(nm)	Capacitance simulated	Capacitance Theoretical	Parasitic Capacitance	Percentage parasitic
10	3.01493407759743e-11	1.47566666666667e-11	1.53926741093077e-11	51.0547617730133
50	9.69449556912931e-11	7.37833333333334e-11	2.31616223579597e-11	23.8915188446880
100	1.78180468877079e-10	1.47566666666667e-10	3.06138022104121e-11	17.1813456342017
150	2.59366649701720e-10	2.21350000000000e-10	3.80166497017197e-11	14.6574934539348
200	3.40690808724457e-10	2.95133333333333e-10	4.55574753911234e-11	13.3720881880231
250	4.22178299498264e-10	3.68916666666667e-10	5.32616328315976e-11	12.6159096511820
300	5.03852959600053e-10	4.42700000000000e-10	6.11529596000532e-11	12.1370646802581
350	5.85720083441026e-10	5.16483333333333e-10	6.92367501076928e-11	11.8207915461830
400	6.67816033433613e-10	5.90266666666667e-10	7.75493667669458e-11	11.6123846814850
450	7.50142433058219e-10	6.64050000000000e-10	8.60924330582189e-11	11.4768115046142
500	8.32731982973245e-10	7.37833333333333e-10	9.48986496399119e-11	11.3960615876766
550	9.15629439818694e-10	8.11616666666667e-10	1.04012773152028e-10	11.3597017121493
600	9.98828998084219e-10	8.85400000000000e-10	1.13428998084219e-10	11.3561979379633
650	1.08237816958032e-09	9.59183333333334e-10	1.23194836246990e-10	11.3818663115459
700	1.16634139037888e-09	1.03296666666667e-09	1.33374723712209e-10	11.4353074333479
750	1.25070289596137e-09	1.10675000000000e-09	1.43952895961371e-10	11.5097595461086
800	1.33553155999994e-09	1.18053333333333e-09	1.54998226666610e-10	11.6057329762103
850	1.42087597495023e-09	1.25431666666667e-09	1.66559308283563e-10	11.7222974573412
900	1.50679095178992e-09	1.32810000000000e-09	1.78690951789915e-10	11.8590406703497
950	1.59333874731522e-09	1.40188333333333e-09	1.91455413981887e-10	12.0159893371381
1000	1.68059063850362e-09	1.47566666666667e-09	2.04923971836956e-10	12.1935685670258

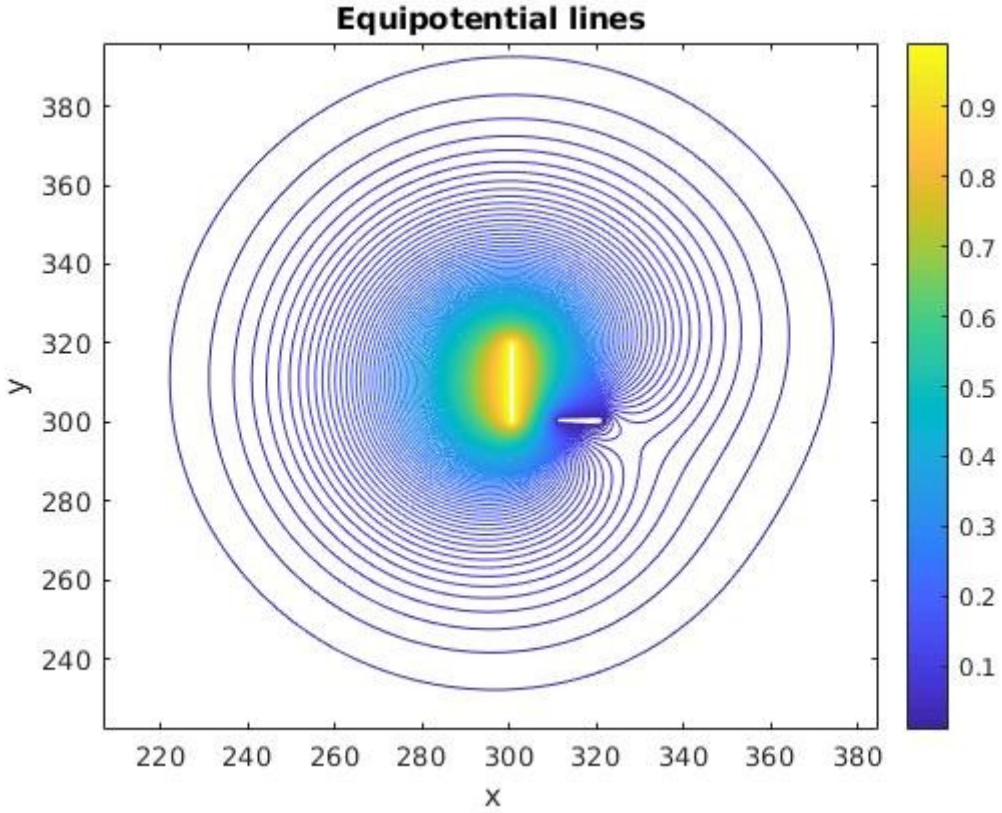
Nature of plot: We can see that the slope of the parasitic capacitance plot is less than that of the simulated capacitance plot. This implies that difference between the simulated and theoretical capacitance decreases as the length of the plates increases. (Which I also checked by calculating the percentage as seen in the above data). This is because as the length of the plate decreases, fringing effect is more dominant and hence adds to the net capacitance. On doubling the length, the simulated capacitance is less than double the previous, as fringe effects do not double.

Q3 a) I assumed that the dimensions of the box are **(600 X 600) nm** (which seems large compared to plates nearly 20 X 20 nm in dimensions together. One plate was set at a voltage of 1 V and another 0 V
vnew(i,j) = (v(i-1,j)+v(i+1,j)+v(i,j-1)+v(i,j+1))/4 using this and running iterations on it till change at every potential point is less than 0.1 (set by e<0.1 condition in code) we obtain convergence of the potential. Then, taking the gradient of V to get the electric field, we calculate the total charge using Gauss Law, and thus the capacitance.

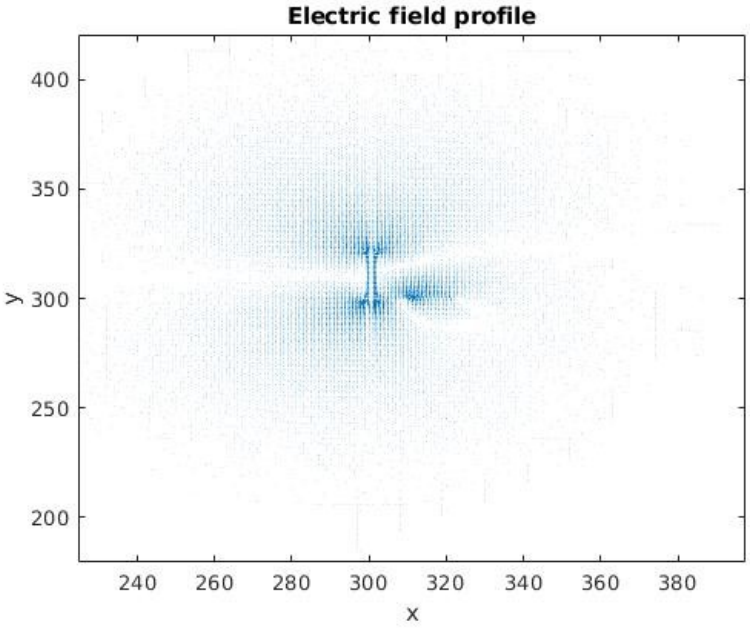
Capacitance per unit width by solving the 2D Poisson equation = **28.948 pF**

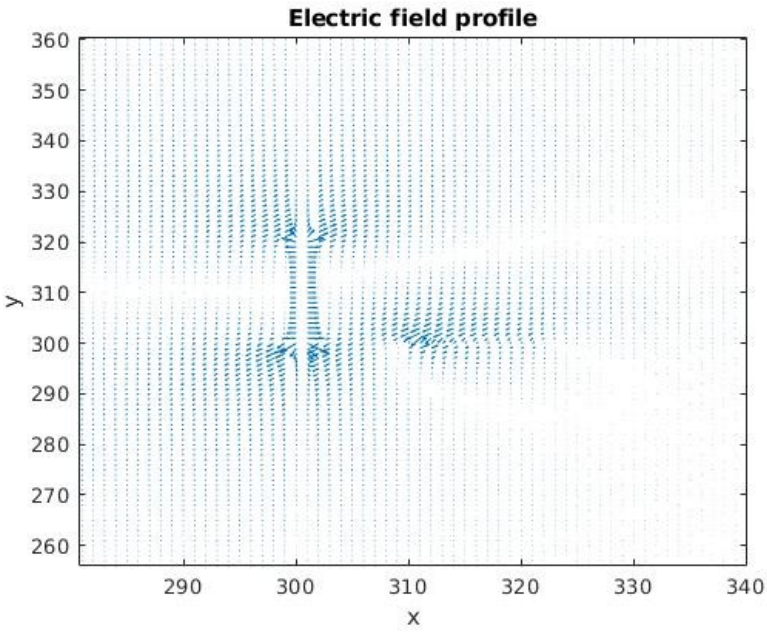
Q3 b)


Electric potential
electric potential
1
0.8
0.6
0.4
0.2
0
600
400
200
0
x
0
200
400
600
y
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


Equipotential lines
y
380
360
340
320
300
280
260
240
220
240
260
280
300
320
340
360
380
x
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

Q3 c)





Q3 d) Emax = **0.2293 V/m.** It is maximum at the lower end of the vertical plate, the side which is closer to the horizontal plate.