EE 236: Electronic Devices Lab

LAB 10

C-V Characteristics of MOS Capacitor

Jatin Kumar

(22B3922)

Part 1

The gain of the sinusuoid part was 1/10 so the expected output was a sinusuoid with amplitude 0.1 V_{p-p}. The experimental output of the circuit was a sinusuoid with amplitude around 101 mV.

Part 2

This is a high pass filter so we expect that the output amplitude will go down as we decrease the frequency. The experimental results were that the amplitude at 5 KHz was 48 mV.

Part 3

C_{DUT} was calculated using the formula

$$C_{DUT} = C_{fb} \sqrt{1 + \frac{1}{(\omega R_{fb} C_{fb})^2}} \left| \frac{V_{out\ p-p}}{V_{DUT\ p-p}} \right|$$

AC Gain is $\dfrac{V_{out\ p-p}}{V_{in\ p-p}}$. $V_{in\ p-p}$ is const and is $1V$ here.

V_{DC} (V)	V_{p-p} (mV)	$V_{out\ p-p}$ (mV)	AC Gain	C_{DUT} (F)
-5	100	876	8.76	8.80917E-10
-4.5	100	876	8.76	8.80917E-10
-4	100	868	8.68	8.72872E-10
-3.5	100	880	8.8	8.8494E-10
-3	100	876	8.76	8.80917E-10
-2.5	100	876	8.76	8.80917E-10
-2	100	872	8.72	8.76895E-10
-1.5	100	868	8.68	8.72872E-10
-1	100	864	8.64	8.6885E-10
-0.5	100	864	8.64	8.6885E-10
0	100	850	8.5	8.54771E-10
0.5	100	808	8.08	8.12535E-10
1	102	684	6.705882353	6.74352E-10
1.5	100	438	4.38	4.40459E-10
2	102	300	2.941176471	2.95769E-10
2.5	100	274	2.74	2.75538E-10
3	100	258	2.58	2.59448E-10
3.5	100	252	2.52	2.53415E-10
4	100	250	2.5	2.51403E-10
4.5	100	250	2.5	2.51403E-10
5	100	248	2.48	2.49392E-10

Table 1: Readings for Large N Plate

V_{DC} (V)	V_{p-p} (mV)	$V_{out\ p-p}$ (mV)	AC Gain	C_{DUT} (F)
-5	100	366	3.66	3.68054E-10
-4.5	100	362	3.62	3.64032E-10
-4	100	364	3.64	3.66043E-10
-3.5	100	364	3.64	3.66043E-10
-3	100	360	3.6	3.62021E-10
-2.5	100	358	3.58	3.6001E-10
-2	100	356	3.56	3.57998E-10
-1.5	100	354	3.54	3.55987E-10
-1	100	350	3.5	3.51965E-10
-0.5	100	342	3.42	3.4392E-10
0	100	332	3.32	3.33864E-10
0.5	100	292	2.92	2.93639E-10
1	102	196	1.921568627	1.93235E-10
1.5	100	104	1.04	1.04584E-10
2	102	78	0.764705882	7.68998E-11
2.5	100	70	0.7	7.03929E-11
3	100	68	0.68	6.83817E-11
3.5	100	64	0.64	6.43592E-11
4	100	66	0.66	6.63705E-11
4.5	100	66	0.66	6.63705E-11
5	100	66	0.66	6.63705E-11

Table 2: Readings for Small N Plate

V_{DC} (V)	V_{p-p} (mV)	$V_{out\ p-p}$ (mV)	AC Gain	C_{DUT} (F)
-5	100	430	4.3	4.32414E-10
-4.5	100	432	4.32	4.34425E-10
-4	100	434	4.34	4.36436E-10
-3.5	100	434	4.34	4.36436E-10
-3	100	434	4.34	4.36436E-10
-2.5	100	436	4.36	4.38447E-10
-2	100	436	4.36	4.38447E-10
-1.5	100	440	4.4	4.4247E-10
-1	100	444	4.44	4.46492E-10
-0.5	100	452	4.52	4.54537E-10
0	102	456	4.470588235	4.49568E-10
0.5	102	468	4.588235294	4.61399E-10
1	104	492	4.730769231	4.75732E-10
1.5	104	572	5.5	5.53087E-10
2	104	720	6.923076923	6.96194E-10
2.5	100	880	8.8	8.8494E-10
3	100	910	9.1	9.15108E-10
3.5	100	920	9.2	9.25164E-10
4	100	920	9.2	9.25164E-10
4.5	100	930	9.3	9.3522E-10
5	100	930	9.3	9.3522E-10

Table 3: Readings for Large P Plate

| V_{DC} (V)	V_{p-p} (mV)	$V_{out\ p-p}$ (mV)	AC Gain	C_{DUT} (F)
-5	100	106	1.06	1.06595E-10
-4.5	100	104	1.04	1.04584E-10
-4	100	106	1.06	1.06595E-10
-3.5	100	104	1.04	1.04584E-10
-3	100	104	1.04	1.04584E-10
-2.5	100	104	1.04	1.04584E-10
-2	100	104	1.04	1.04584E-10
-1.5	100	106	1.06	1.06595E-10
-1	100	108	1.08	1.08606E-10
-0.5	100	108	1.08	1.08606E-10
0	102	114	1.117647059	1.12392E-10
0.5	100	118	1.18	1.18662E-10
1	104	142	1.365384615	1.37305E-10
1.5	100	218	2.18	2.19224E-10
2	102	294	2.882352941	2.89853E-10
2.5	100	352	3.52	3.53976E-10
3	100	360	3.6	3.62021E-10
3.5	100	374	3.74	3.76099E-10
4	100	384	3.84	3.86155E-10
4.5	100	390	3.9	3.92189E-10
5	100	396	3.96	3.98223E-10

Table 4: Readings for Small P Plate
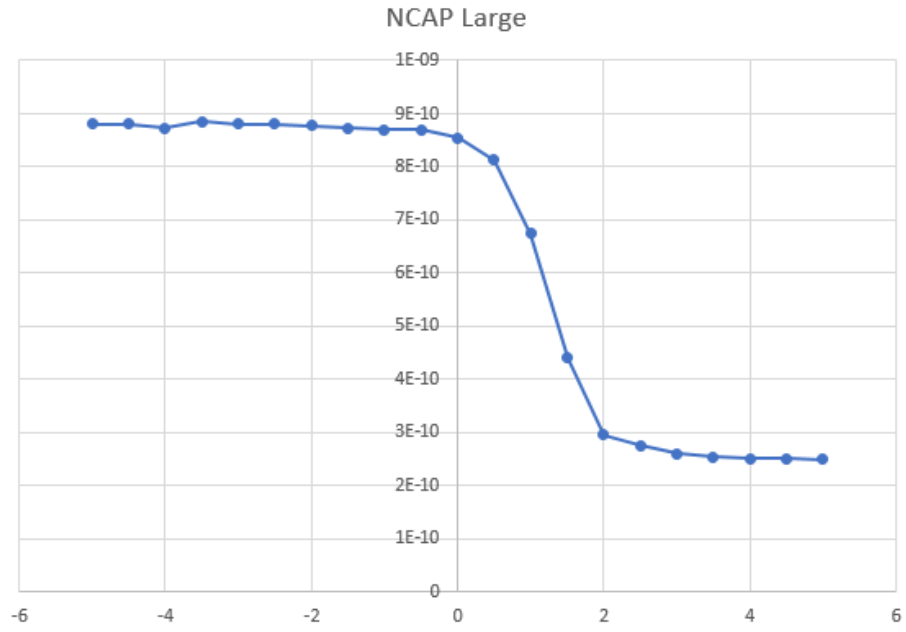
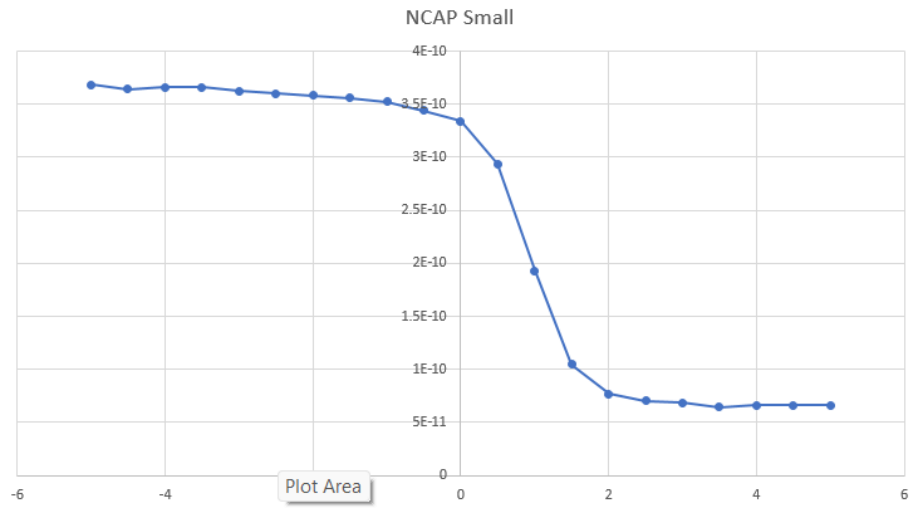Figure 1: C_{DUT} vs V_{DC} for Big N Plate

Figure 2: C_{DUT} vs V_{DC} for Small N Plate
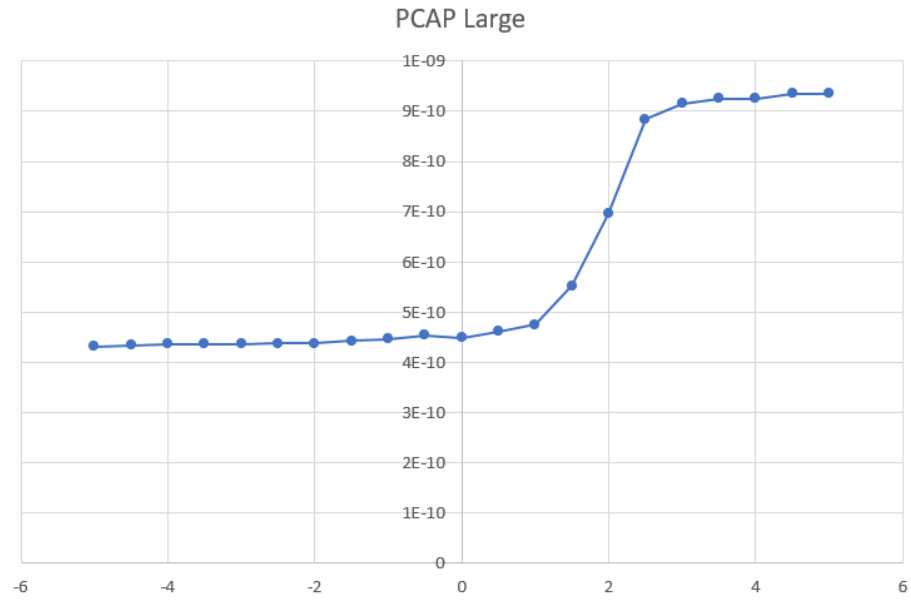
6

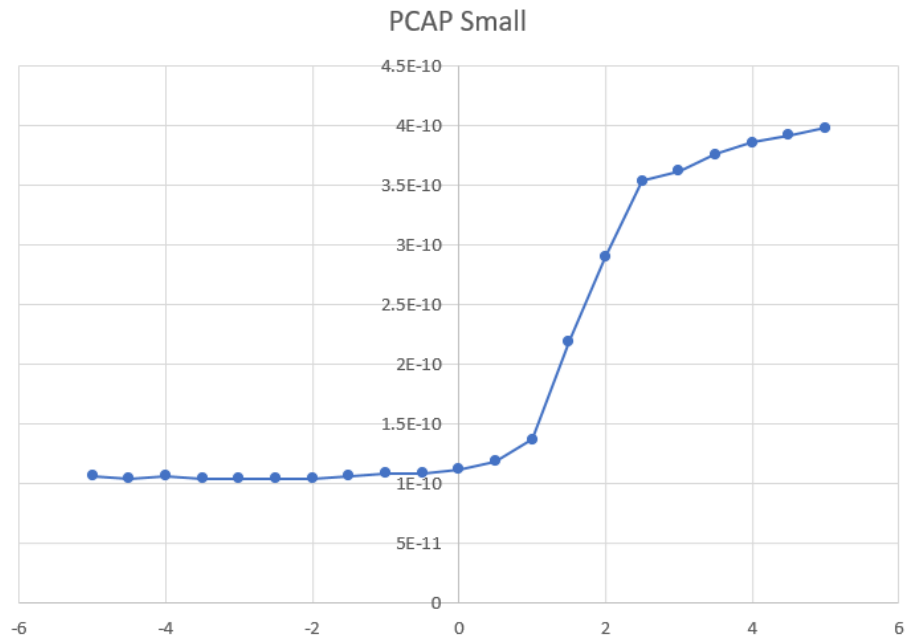Figure 3: C_{DUT} vs V_{DC} for Big P Plate

Figure 4: C_{DUT} vs V_{DC} for Small P Plate

Results

Table 5: Summary of Calculated Values for MOSCAPs

Parameter	Big N Plate	Small N Plate	Big P Plate	Small P Plate
C_{ox} (F)	4.09×10^{-10}	4.42×10^{-10}	2.74×10^{-10}	3.94×10^{-10}
t_{ox} (m)	2.65×10^{-07}	3.12×10^{-07}	9.89×10^{-08}	8.76×10^{-08}
C_{min} (F)	2.07×10^{-10}	2.31×10^{-10}	6.61×10^{-11}	9.23×10^{-11}
C_{debye} (F)	1.32×10^{-10}	1.29×10^{-10}	1.57×10^{-10}	1.34×10^{-10}
L_{debye} (m)	2.46×10^{-06}	3.21×10^{-06}	5.18×10^{-07}	7.73×10^{-07}
N (m^{-3})	2.78×10^{18}	1.63×10^{18}	6.27×10^{19}	2.82×10^{19}