ELE 4142 HW9 Name________________

1) Consider a 5 in x 5 in, 4 wire resistive touch screen, given the following measurements, locate the touch point: 10pts

Assume: resistivity = 1K ohm / inch

Drive voltage = 7V at top and right

Y measurement = 2.77V

X measurement = 1.43V

Define the origin at the lower left corner

(2.77V/7V) x 5 in = 1.98 inches from bottom

(1.43V/ 7V) x 5 in = 1.02 inches from left

(1.02, 1.98) in

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2) Consider a projective capacitance touch screen (4 wide by 3 high) using the mutual capacitance approach. Determine the expected measured voltage for each column with a) row 1 selected and b) with row 2 selected 30pts

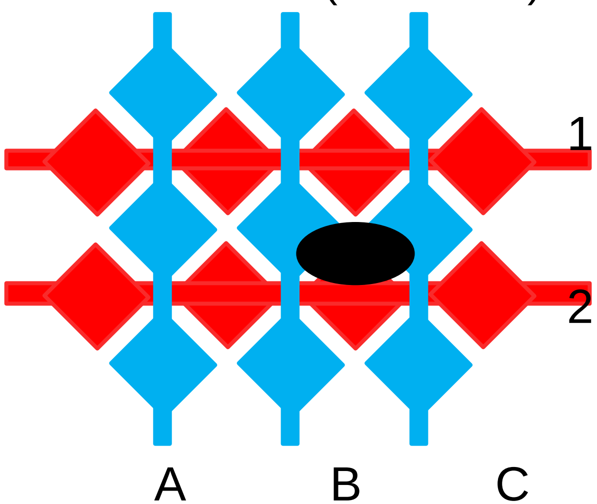
Assume: total row/column to ground capacitance = 100fF/row or column

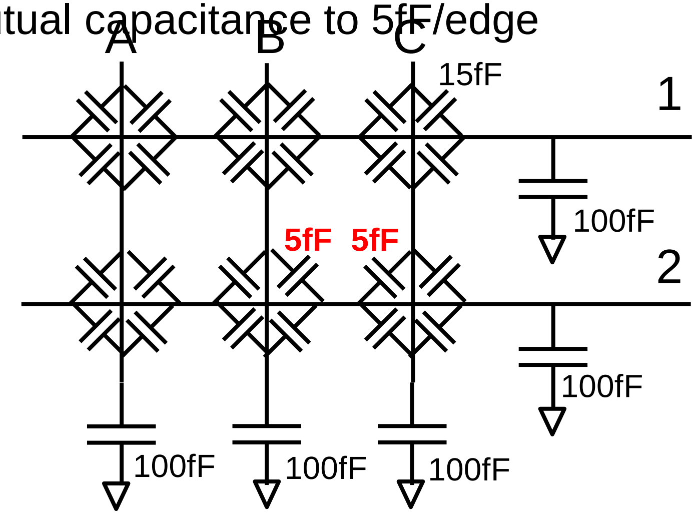
mutual capacitance between R/C sensors = 15fF / edge

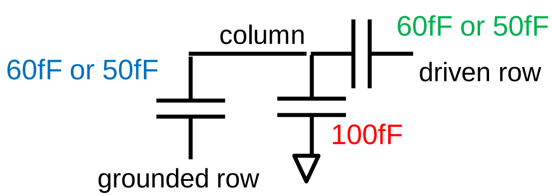
Active row = 3v

All idle rows grounded

Touch (black oval) – reduces the mutual capacitance to 5fF/edge







(1,A) V_A=3v(60fF/(60fF + 100fF + 60fF)) = 818mv

(1,B) V_A=3v(60fF/(60fF + 100fF + 50fF)) = 857mv

(1,C) V_A=3v(60fF/(60fF + 100fF + 50fF)) = 857mv

(2,A) V_A=3v(60fF/(60fF + 100fF + 60fF)) = 818mv

(2,B) V_A=3v(50fF/(50fF + 100fF + 60fF)) = 714mv

(2,C) V_A=3v(50fF/(50fF + 100fF + 60fF)) = 714mv

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3) Using the 4T APS shown in class, what value would you expect on the output of the source follower:

20pts

Assume: unity gain on the source follower, Vgs=0.55v

C sense amp = 0.5pF

Diode Area = 6um x 6um

Idark = 10pA/cm^2

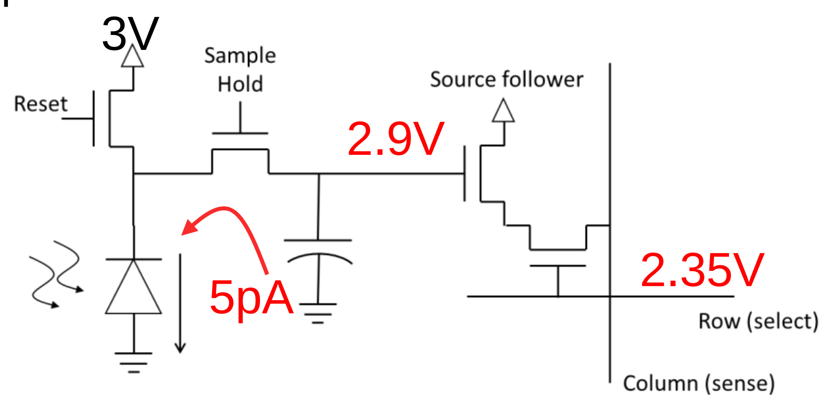
I generated = 5pA

Reset voltage = 3V

electronic shutter open for 10ms after reset removed

ignore all parasitic elements

ideal sampling switch and output switch



Diode area = 36x10-8 cm2

Dark current = 360E-20 A

i=Cdv/dt

5pA = .5pF *dv / 10ms → dv =100mV

Vout = 3V – 0.10V – 0.55V = 2.35V

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4) Part of what is transmitted in a satellites GPS packet is the time at which the packet is transmitted(according to the satellite) and the satellite's position in 3-space. The receiver then compares it's time to the decoded transmit time to determine the transit time for the signal. Assuming the satellite times are correct, calculate the receiver location(x,y,z) and the receiver time error t_{error} , given: 40pts

Use C = 186,282mi/sec

sat1:	t_{t1} = 2:2:20.15,	x= 1000mi, y= 2000mi, z= 11000mi
sat2:	t_{t2} = 2:2:20.16,	x= 2000mi, y= 1500mi, z= 11010mi
sat3:	t_{t3} = 2:2:20.155,	x= -2000mi, y= -1250mi, z= 11005mi
sat4:	t_{t4} = 2:2:20.165,	x= -2200mi, y= 1040mi, z= 11007mi

Receiver:

t_{r1} =2:2:20.207784552

t_{r2} =2:2:20.218089877

t_{r3} =2:2:20.213994840

t_{r4} =2:2:20.223684855

4 equations and 4 unknowns

d = Ct

$$\sqrt{(x1-x)^2+(y1-y)^2+(z1-z)^2} = C(t_{rcvr} - t_{sat} + t_{rcvr\ error})$$

```matlab
%%%%%%%%%%%%%%%%%%%%%%
%
% Program to solve for receiver location using
% GPS
%
%%%%%%%%%%%%%%%%%%%%%%

%%%%%%%%%%%%%%%%%%%%%
% Satellite transmit values
%%%%%%%%%%%%%%%%%%%%%%
tt1=.15;
x1=1000;
y1=2000;
z1=11000;

tt2=.16;
x2=2000;
y2=1500;
z2=11010;

tt3=.155;
x3=-2000;
y3=-1250;
z3=11005;

tt4=.165;
x4=-2200;
y4=1040;
z4=11007;

%%%%%%%%%%%%%%%%%%%%
% Receiver measured values
%%%%%%%%%%%%%%%%%%%%
tr1=0.207784552;
tr2=0.218089877;
tr3=0.213994840;
tr4=0.223684855;
```

```matlab
%%%%%%%%%%%%%%%%%%
% Setup system of equations
%%%%%%%%%%%%%%%%%
syms x y z terr
eqn1 = ((x1-x)^2+(y1-y)^2 +(z1-z)^2)-(186282*(tr1-tt1+terr))^2==0
eqn2 = ((x2-x)^2+(y2-y)^2 +(z2-z)^2)-(186282*(tr2-tt2+terr))^2==0
eqn3 = ((x3-x)^2+(y3-y)^2 +(z3-z)^2)-(186282*(tr3-tt3+terr))^2==0
eqn4 = ((x4-x)^2+(y4-y)^2 +(z4-z)^2)-(186282*(tr4-tt4+terr))^2==0

%%%%%%%%%%%%%%%%%
% Call solver
%%%%%%%%%%%%%%%%%
rcvr = solve([eqn1, eqn2, eqn3, eqn4],[x,y,z, terr]);

%%%%%%%%%%%%%%%%
% Output equations
%%%%%%%%%%%%%%%%
rcvr.x
rcvr.y
rcvr.z
rcvr.terr

%%%%%%%%%%%%%%%
% Output values
%%%%%%%%%%%%%%
vpa(rcvr.x)
vpa(rcvr.y)
vpa(rcvr.z)
vpa(rcvr.terr)
```

in space →

```
ans =
 222.22649143739765695864601987301
 300.00023419370684722829844490138
```
← x

```
ans =
 305.33999967990596960034954700501
 400.00095297556884352308277733472
```
← y

```
ans =
 19101.938486355377470779882349547
 0.98268873749517379925299882598228
```
← z

```
ans =
 -0.013154709572390134353369620660265
 0.0020000910796254151690146253679188
```
← t_{err}