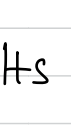
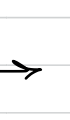
- Homework 1 solution:

- Problem 1:

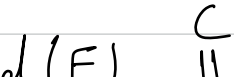
The touchpad is consist of resistors and buttons. The goal of using a resistive touchpad is to get the location from the voltage measurements. Hence, the voltage divider and buttons are sensors that can detect touch. The arduino and the code running in arduino that converts voltage info to location is the processing element.

- Problem 2:

Voltage: voltage is the pressure from an electrical circuit's power source that pushes charged electrons or the current through a conduction loop. → unit: volts (V) 

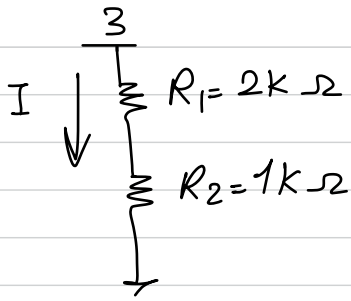
- current: Current is the rate at which electrons flow past a point in a complete electrical circuit → unit: Amp (A) 

- Resistance: Resistance is a measure of the opposition to the flow of the current in an electrical circuit. → unit: ohm (Ω) 

- Capacitance: Capacitance is the capacity of a material or a device to store electric charges → unit: Farad (F) 

- Inductance: Inductance is the tendency of an electrical conductor to oppose a change in the electric current flowing through it → unit: henry (H) : 

Problem 3:



KVL: $3 = R_1 I + R_2 I = (R_1 + R_2) I \Rightarrow$

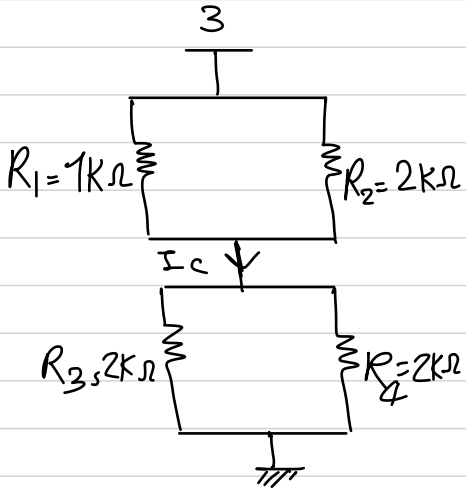
$3^{V} = 3^{K\Omega} I \Rightarrow I = 1mA$

Since R_1 and R_2 are in series: $I_{R_1} = I_{R_2} = I = 1mA$

$V_{R_1} = R_1 I_{R_1} = 2^{K\Omega} \times 1^{mA} = 2V$

$V_{R_2} = R_2 I_{R_2} = 1^{K\Omega} \times 1^{mA} = 1V$

Problem 4:



$R_1 \parallel R_2 \Rightarrow R_{12} = \frac{2 \times 1}{2+1} = \frac{2}{3} K\Omega$

$R_3 \parallel R_4 \Rightarrow R_{34} = \frac{2 \times 2}{2+2} = 1 K\Omega$

KVL: $3 = R_{12} I_{12} + R_{34} I_{34} \Rightarrow$

R_{12} & R_{34} are in series so: $I_{12} = I_{34} = I_C$

$$3 = \frac{2}{3} I_C + 1 I_C = \frac{5}{3} I_C \Rightarrow I_C = \frac{9^{mA}}{5} = 1.8\,mA$$

$$V_{12} = R_{12} I_{12} = \frac{2^{K\Omega}}{3} \times \frac{9^{mA}}{5} = \frac{6}{5} = 1.2^{V}$$

$$V_{34} = R_{34} I_{34} = 1^{K\Omega} \times \frac{9^{mA}}{5} = \frac{9}{5} = 1.8^{V}$$

since R_1 & R_2 are in parallel: $V_{R_1} = V_{R_2} = V_{12} = 1.2V$

since R_3 & R_4 are in parallel: $V_{R_3} = V_{R_4} = V_{34} = 1.8V$

$$I_{R_1} = \frac{V_{R1}}{R_1} = \frac{1.2^V}{1^{K\Omega}} = 1.2mA$$

$$I_{R_2} = \frac{V_{R2}}{R_2} = \frac{1.2^V}{2^{K\Omega}} = 0.6mA$$

$$I_{R_3} = \frac{V_{R3}}{R_3} = \frac{1.8^V}{2^{K\Omega}} = 0.9mA$$

$$I_{R_4} = \frac{V_{R4}}{R_4} = \frac{1.8^V}{2^{K\Omega}} = 0.9mA$$

- Problem 5:

a)

$I_1 = 0.011A$

$I_2 = 0.0055A$

$I_3 = 0.011A$

$I_4 = 0.0055A$

$I_5 = 0.0055A$

$I_6 = 0.0055A$

$I_7 = 0.0055A$

$I_8 = 0.0055A$

$I_9 = 0.0055A$

$I_{10} = 0.011A$

$I_{11} = 0.0055A$

$I_{12} = 0.011A$

$I_{total} = 0.022A$

$S_1 = 3.3V$

$S_2 = 2.2V$

$S_3 = 1.65V$

$S_4 = 2.2V$

$S_5 = 1.65V$

$S_6 = 1.1V$

$S_7 = 1.65V$

$S_8 = 1.1V$

$S_9 = 0$

b)

$I_1 = 0.014$

$I_2 = 0.008$

$I_3 = 0.016$

$I_4 = 0.006$

$I_5 = 0.008$

$I_6 = 0.008$

$I_7 = 0.008$

$I_8 = 0.008$

$I_9 = 0.006$

$I_{10} = 0.016$

$I_{11} = 0.008$

$I_{12} = 0.014$

$I_{total} = 0.03$

$S_1 = 3.3V$

$S_2 = 1.94V$

$S_3 = 1.185V$

$S_4 = 2.496V$

$S_5 = 1.650V$

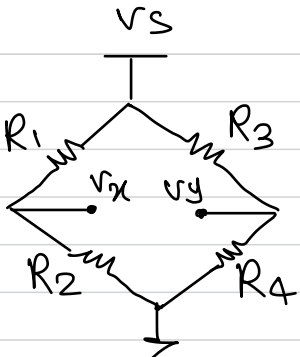
$S_6 = 0.804V$

$S_7 = 2.115$

$S_8 = 1.354$

$S_9 = 0$

• Problem 6:



$$V_x = V_{R_2} \Rightarrow V_{R_2} = V_S \times \frac{R_2}{R_1+R_2} = V_x$$

$$V_y = V_{R_4} \Rightarrow V_{R_4} = V_S \times \frac{R_4}{R_3+R_4} = V_y$$

$$V_x - V_y = \left(\frac{R_2}{R_1+R_2} - \frac{R_4}{R_3+R_4}\right) V_S = \frac{R_2(R_3+R_4) - R_4(R_1+R_2)}{(R_1+R_2)(R_3+R_4)}$$

• Problem 7:

$$R = \rho \frac{L}{A} \Rightarrow \rho = \frac{R.A}{L} = \frac{0.54\times10^{-3}\,(\Omega) \times \pi \times (1\times10^{-3})^2\,(m^2)}{10\times10^{-2}\,(m)} = 1.7\times10^{-8}\ \Omega m$$

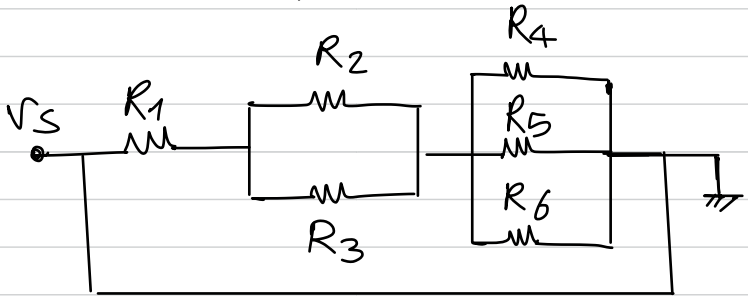
(C) is the correct answer

• Problem 8:

$$R = \rho\frac{L}{A} \Rightarrow R' = \rho\frac{2L}{\pi(2r)^2} = \rho\frac{L}{\pi r^2}\times\frac{2}{4} = \frac{1}{2}\rho\frac{L}{A}$$

(C) is the correct answer

• Problem 9:



simplifying the circuit

$V_S = 0 \overset{SO}{\Rightarrow} V_{R_1} = V_{R_2} = V_{R_3}$

$= V_{R_4} = V_{R_5} = V_{R_6}$