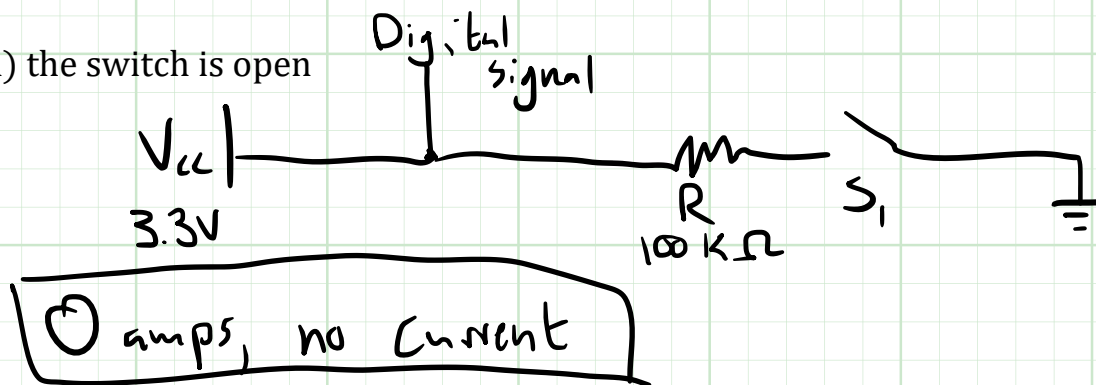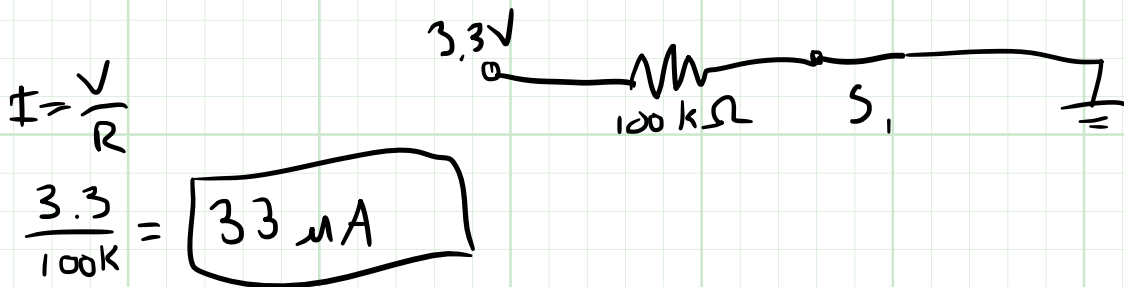1a) A 100kΩ resistor is used in conjunction with a switch to produce a digital signal. If V_{CC} is 3.3V, how much current that flows through the resistor when

(a) the switch is open

Digital Signal

V_{cc} 3.3V

R 100 KΩ S_1

$\boxed{0 \text{ amps, no Current}}$

b) The switch is closed

3.3V

100 kΩ S_1

$I = \dfrac{V}{R}$

$\dfrac{3.3}{100k} = \boxed{33 \mu A}$

2) A switch is used to drive a digital signal, but the maximum current through the switch is limited to 1 μA. Assuming V_{CC} is 3.3V, what is the minimum size of resistor that should be used?

$V = IR \qquad 3.3 = 1E{-}6 \cdot R \qquad R = \dfrac{3.3}{1E{-}6}$

$\boxed{R = 3.3 \, M\Omega}$

3) If a phototransistor is connected as in Figure 3-5, what is the voltage level (high or low) if light is striking the phototransistor? (Assume the light is the correct wavelength.)

V_{CC}

R1

To Digital Circuit

Q1

Voltage level is $\boxed{\text{low}}$
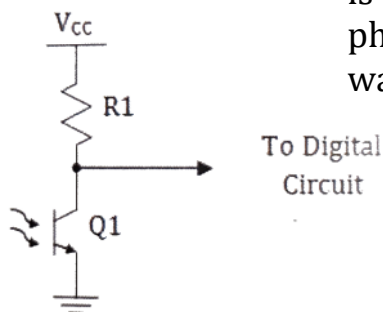
4b) A load cell is a device that generates a voltage proportional to the force that is applied to it. Suppose the load cell produces a 2V output when the force is 10,000N. If the load cell is connected to a 12-bit ADC with a voltage reference of 3V, what is the ADC output when the force is 8000N? From part A, the voltage is 1.6V at 8000N.
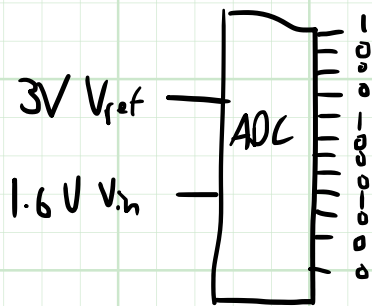
$$D = \left\lfloor \left(\frac{V_{in}}{V_{ref}}\right) 2^N \right\rfloor$$

$$= \left\lfloor \frac{1.6}{3} \cdot 2^{12} \right\rfloor = 2184$$

$$= 0b\ 1000\ 1000\ 1000$$

5) An oxygen sensor generates an analog voltage of 13mV per percent O_2 (i.e. the voltage would be 1.3V in a pure oxygen environment). At what voltage should the negative input of a comparator be set so that its digital output goes low when the percentage of oxygen drops below 15%?

$$15 \cdot 13\text{mV} = \boxed{195\ \text{mV}}$$

6) An LED is driven from a digital signal as shown in Figure 3-8. If $V_f = 1.8V$, $I = 10\text{mA}$, and $V_{CC} = 5.0V$, what resistor value should be used? Assume the digital signal is 0.3V when it is low.

Vcc

R1

From Digital Circuit   D1
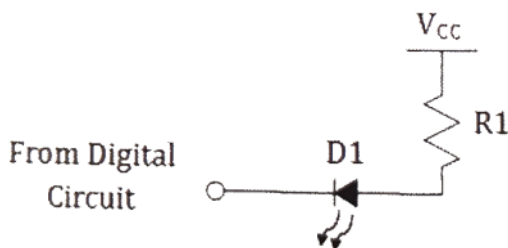
$$\frac{V_{CC} - V_f - 0.3}{R_1} = I$$

$$\frac{5.0 - 1.8 - 0.3}{R_1} = 10\ \text{mA}$$

$$\frac{2.9}{10\ \text{mA}} = R_1$$

$$\boxed{R_1 = 290\ \Omega}$$

$$(R_1 = 240 \, \Omega)$$

9)   Go online. Find and list a manufacturer and part number for each of the following devices:

b)   An opto-isolator   Toshiba   TLP2745

c)   A comparator   ST Microelectronics   LM393DT