ECE 320 - Quiz #5 - Name _____

555 Timers, Transistor Switch, Comparitors, Schmitt Triggers - February 19, 2021

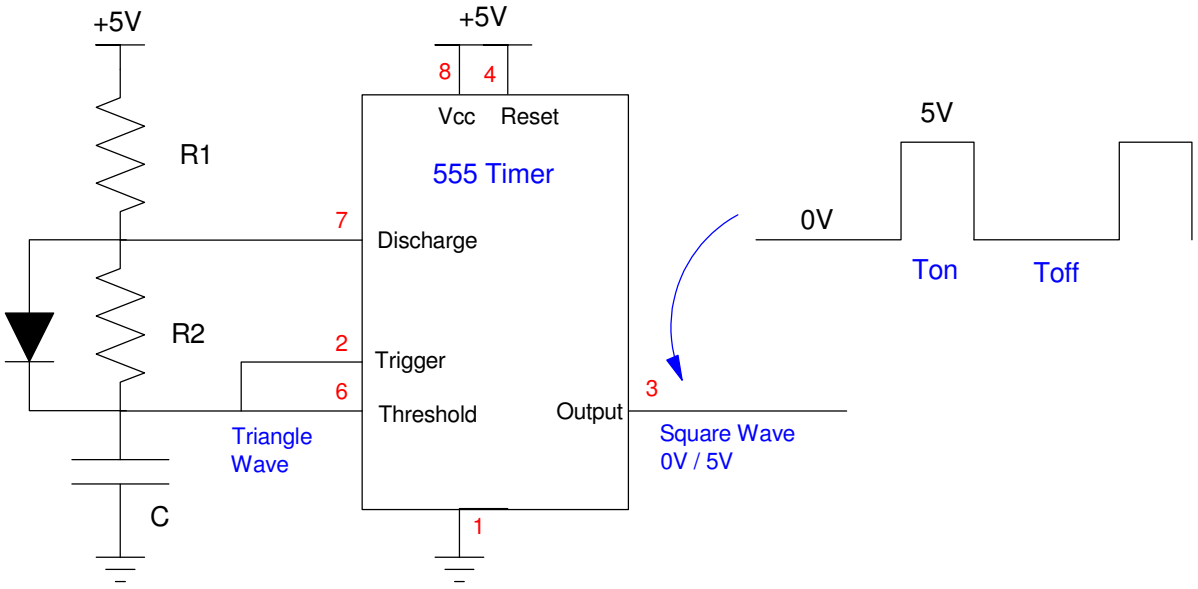
1) 555 Timers. Determine R1, R2, and C so that the 555 timer outputs a 5% duty cycle 50Hz square wave:

$$t_{on} = R_1 \cdot C \cdot \ln(2.58) = 1.0ms$$

$$t_{off} = R_2 \cdot C \cdot \ln(2) = 19.0ms$$

Let R1 be your birthday day (1000 + 100*Month + Day. May 14th would be 1514 Ohms)

R1 1000 + 100*Month + Day	R2	C
1514	**39.33k**	**697nF**



$$t_{on} = 1514\Omega \cdot C \cdot \ln(2.58) = 1.0ms$$

$$C = 697nF$$

$$t_{off} = R_2 \cdot 697nF \cdot \ln(2) = 19.0ms$$

$$R_2 = 39.33k\Omega$$

2) Transistor Switch: Design. Specify R1 and R2 so that when Vin = 5.00V,

- Ic = (1000 + 100*Birth Month + Birth Day) mA. May 14th would be 1514mA (1.514A)
- The transistor is saturated, and
- Ib < 25mA (the maximum output of a 555 timer)

Assume 6144 transistors

- | Vbe | = 0.7V
- | Vce | = 0.36V when saturated
- $\beta = 200$

Ic (mA) 1000 + 100*(Mo) + (Day)	Rc	min value of Rb	max value of Rb
1514 mA	**3.065 Ohms**	**172 Ohms**	**568 Ohms**

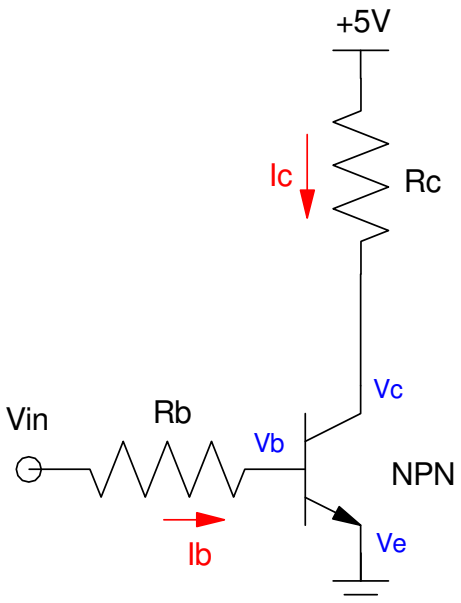
$$R_c = \left(\frac{5V - 0.36V}{1514mA}\right) = 3.065\Omega$$

$$\beta I_b > I_c = 1514mA$$

$$25mA > I_b > \frac{1514mA}{200} = 7.57mA$$

$$\left(\frac{5V - 0.7V}{25mA}\right) < R_b < \left(\frac{5V - 0.7V}{7.57mA}\right)$$

$$172\Omega < R_b < 568\Omega$$



3) Darlington Pair (analysis). Assume two 6144 NPN transistors are connected as a Darlington pair.

- | Vbe | = 0.7V
- | Vce | = 0.36V when saturated
- $\beta = 200$

Let Rb be 1000 + 100(Birth Month) + Birth Day. (May 14 = 1514 Ohms). Find the currents and voltages.

Rb 1000 + 100*Mo + Day	I1	I2	I3
1514 Ohms	**2.378mA**	**5.574mA**	**1.115A**
	V1	V2	V3
	1.4V	**0.7V**	**1.06V**

Transistor T1 is saturated

Transistor T2 is active (I3 = 200 I2)

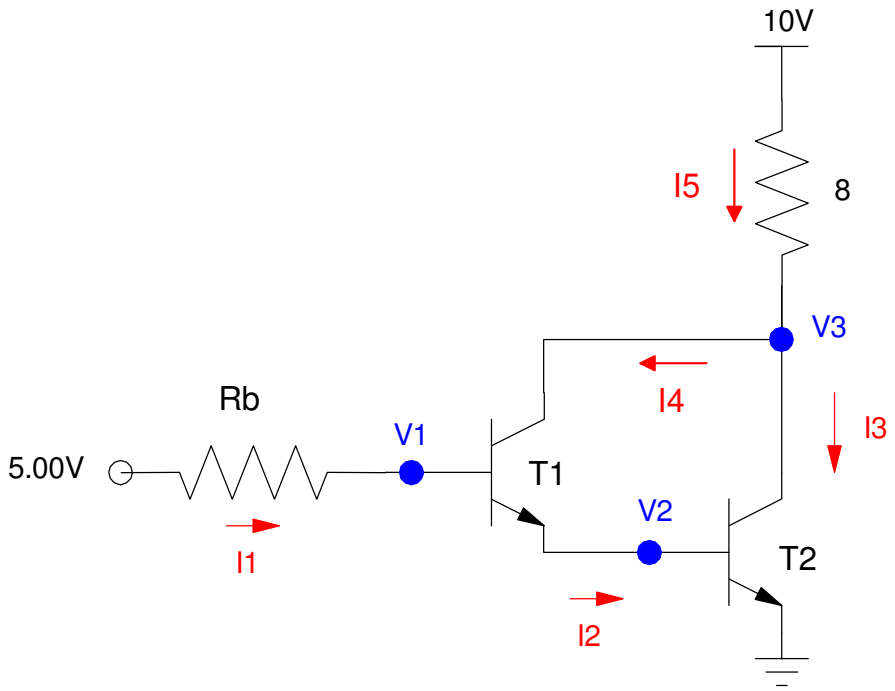
$$I_1 = \left(\frac{5-1.4}{1514}\right) = 2.378mA$$

$$I_5 = I_3 + I_4 = \left(\frac{10V-1.06V}{8\Omega}\right) = 1.118A$$

$$I_2 = I_1 + I_4$$

$$I_3 = 200I_2$$

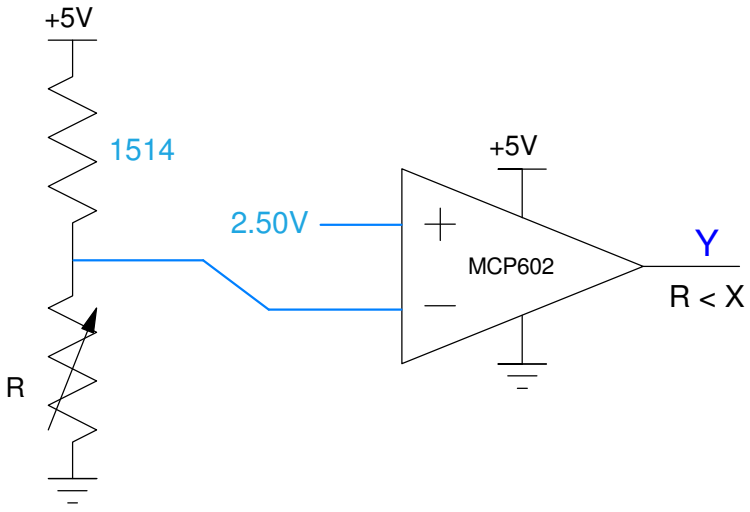
Four equations and four unknowns



4) Comparitor: Design a circuit which output

- 0V when R > X Ohms
- 5V when R < X Ohms

where X is 1000 + 10*(Birth Month) + (Birth Day).



5) Schmitt Trigger: Design a circuit which output

- 5V when R < X Ohms
- 0V when R > X + 200 Ohms
- No change for X < R < X + 200 Ohms

Let X be 1000 + 10(Birth Month) + (Birth Date).

X = 1514 Ohms

R = 1514 Ohms

- V1 = 2.500V
- Y = 5V

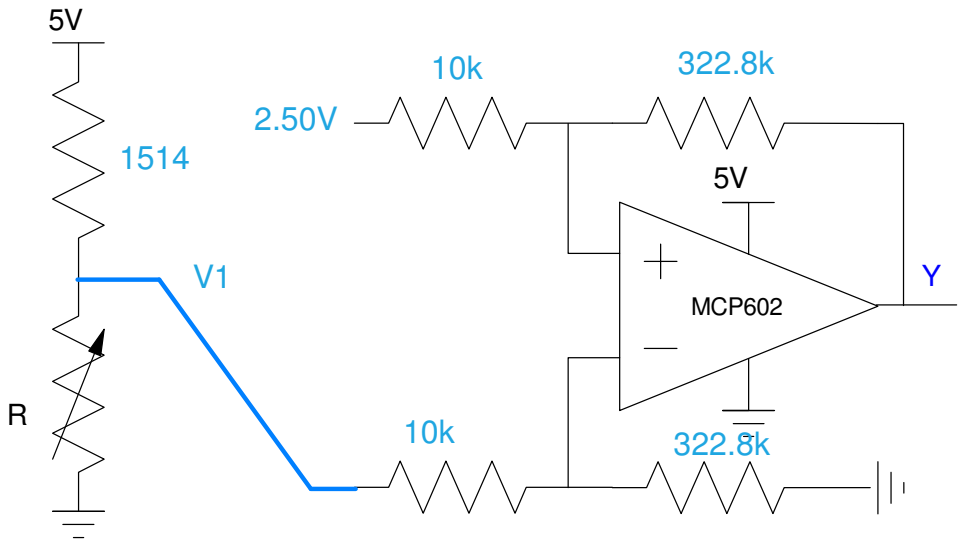
R = 1714 Ohms

- V1 = 2.655V
- Y = 0V

Connect to the minus input (Y goes down when V1 goes up)

Make the offset 2.500V (Y goes high when V1 is 2.500V)

Make the gain $\left(\frac{5V-0V}{2.655V-2.500V}\right) = 32.38$



6) Schmitt Trigger: Analysis. Determine the voltages and resistance where the following Schmitt trigger turns on and off. Assume Rx is 1000 + 100*(Birth Month) + (Birth Day). May 14th gives Rx = 1514 Ohms.

Rx 1000 + 100*Mo + Day	On (V2 = +5V)		Off (V2 = 0V)	
1514	V1	R	V1	R
	3.50V	**3533**	**1.833V**	**876**

$$gain = 3.00 = \left(\frac{5V-0V}{V_{on}-V_{off}}\right)$$

$$V_{off} = 3.50V - \left(\frac{5V}{3}\right) = 1.833V$$ February 20, 2021

$$R_{on} = \left(\frac{3.5V}{5.0V-3.5V}\right)1514 = 3533\Omega$$

$$R_{off} = \left(\frac{1.833V}{5V-1.833V}\right)1514 = 876\Omega$$