ECE 320 - Quiz #5 - Name _____

555 Timers, Transistor Switch, Comparitors, Schmitt Triggers - Spring 2023

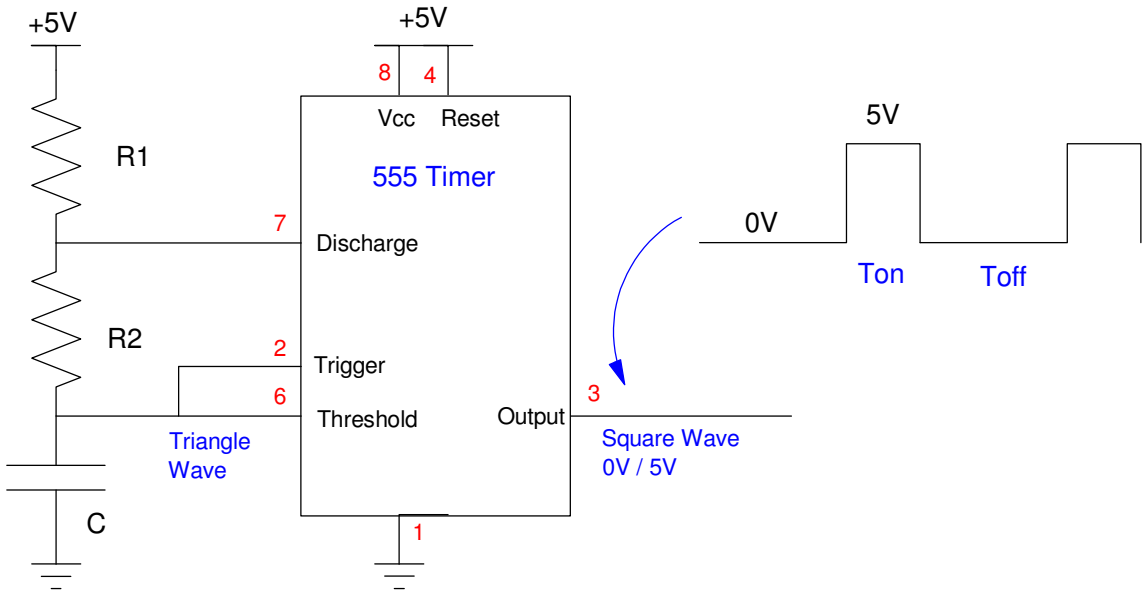
1) 555 Timers. Determine R1, R2, and C so that the 555 timer outputs a 20% duty cycle 220Hz square wave:

$$t_{on} = (R_1 + R_2) \cdot C \cdot \ln(2) = 2.000ms$$

$$t_{off} = R_2 \cdot C \cdot \ln(2) = 8.000ms$$

Let R1 be your birthday day (800 + 100*Month + Day)

R1 800 + 100*Month + Day	R2	C 800 + 100*Month + Day (uF)
-6.5876 Ohms or not possible with this circuit	**8.7835**	**1314 uF**



$$R_2 \cdot C \cdot \ln(2) = 8.000ms$$

$$R_2 = 8.7835\Omega$$

$$(R_1 + R_2) \cdot C \cdot \ln(2) = 2.000ms$$

$$R_1 + R_2 = 2.1959\Omega$$

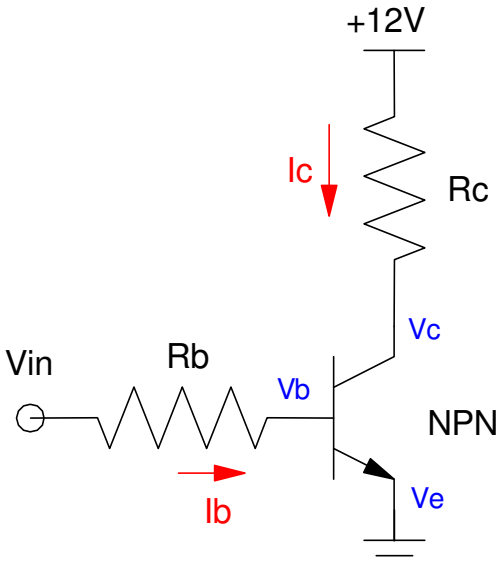
2) Transistor Switch: Design. Specify R1 and R2 so that when Vin = 5.00V,

- Ic = (800 + 100*Birth Month + Birth Day) mA.
- The transistor is saturated, and
- Ib < 25mA (the maximum output of a 555 timer)

Assume 6144 transistors

- | Vbe | = 0.7V
- | Vce | = 0.2V when saturated
- $\beta = 200$

Ic (mA) 800 + 100*(Mo) + (Day)	Rc	min value of Rb	max value of Rb
1314 mA	**8.9802 Ohms**	**172 Ohms**	**654.49 Ohms**



$$R_c = \left(\frac{12V - 0.2V}{1314mA}\right) = 8.9802\Omega$$

$$\min(I_b) = \left(\frac{I_c}{\beta}\right) = \left(\frac{1314mA}{200}\right) = 6.57mA$$

$$R_b = \left(\frac{5V - 0.7V}{6.57mA}\right) = 654.49\Omega$$

$$\max(I_b) = 25mA$$

$$R_b = \left(\frac{5V - 0.7V}{25mA}\right) = 172\Omega$$

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

- | Vbe | = 0.7V
- | Vce | = 0.2V when saturated
- $\beta = 200$

Let Rb be 800 + 100(Birth Month) + Birth Day. Find the currents and voltages.

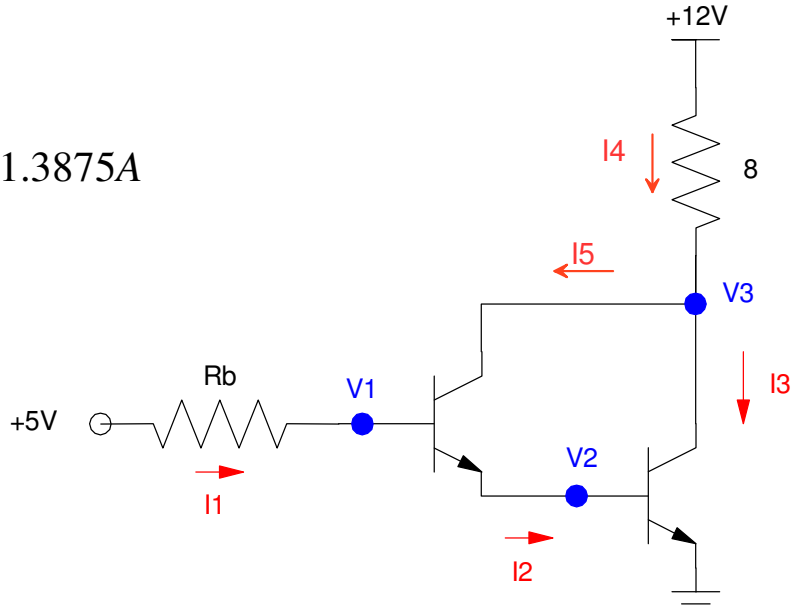
Rb 800 + 100*Mo + Day	I1	I2	I3
1314 Ohms	**2.7397mA**	**6.9166mA**	**1.3833A**
	V1	V2	V3
	1.4V	**0.7V**	**0.9V**

$$I_1 = \left(\frac{5V - 1.4}{1314\Omega}\right) = 2.7397mA$$

$$I_3 + I_5 = I_4 = \left(\frac{12V - 0.9V}{8\Omega}\right) = 1.3875A$$

$$I_2 = I_1 + I_5$$

$$I_3 = 200 I_2$$



Solving

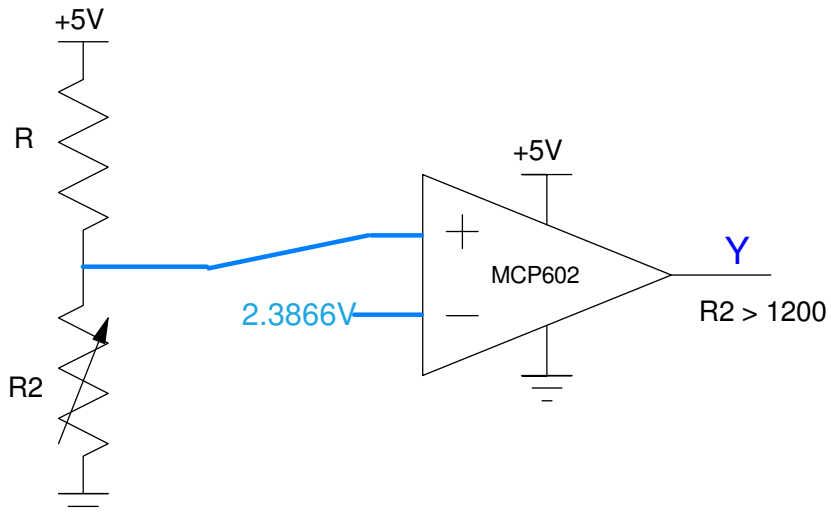
$$I_2 = 6.9166mA$$

$$I_3 = 1.3833A$$

4) Comparitor: Design a circuit which output

- 5V when R2 > 1200 Ohms
- 0V when R2 < 1200 Ohms

where R is 800 + 100*(Birth Month) + (Birth Day).



R = 1314 Ohms

$$V = \left(\frac{1200}{1200+1314}\right)5V = 2.3866V$$

For R2 = large (1M Ohm)

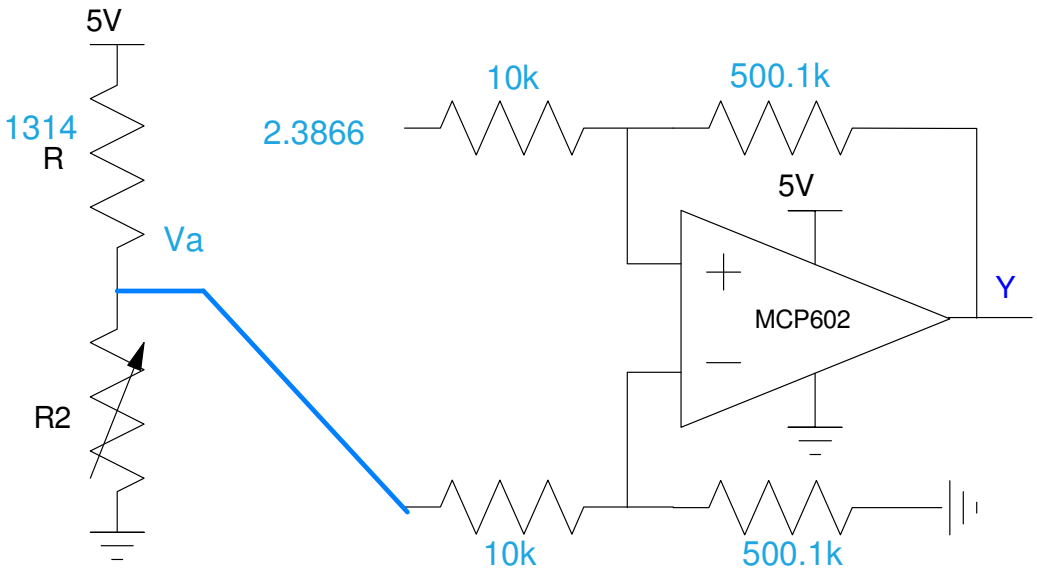
- V goes to 5V
- Y = 5V

Connect to the plus input

5) Schmitt Trigger: Design a circuit which output

- 5V when R < 1200 Ohms
- 0V when R > 1300 Ohms
- No change for 1200 < R < 1300 Ohms

Let R be 800 + 100(Birth Month) + (Birth Date).



R = 1314 Ohms

R2 = 1200 Ohms (Y = 5V)

$$V_a = \left(\frac{1200}{1200+1314}\right)5V = 2.3866V$$

R2 = 1300 Ohms (Y = 0V)

$$V_a = \left(\frac{1300}{1300+1314}\right)5V = 2.4866V$$

V(on) < V(off)

connect to the minus input

V(on) = 2.3866V

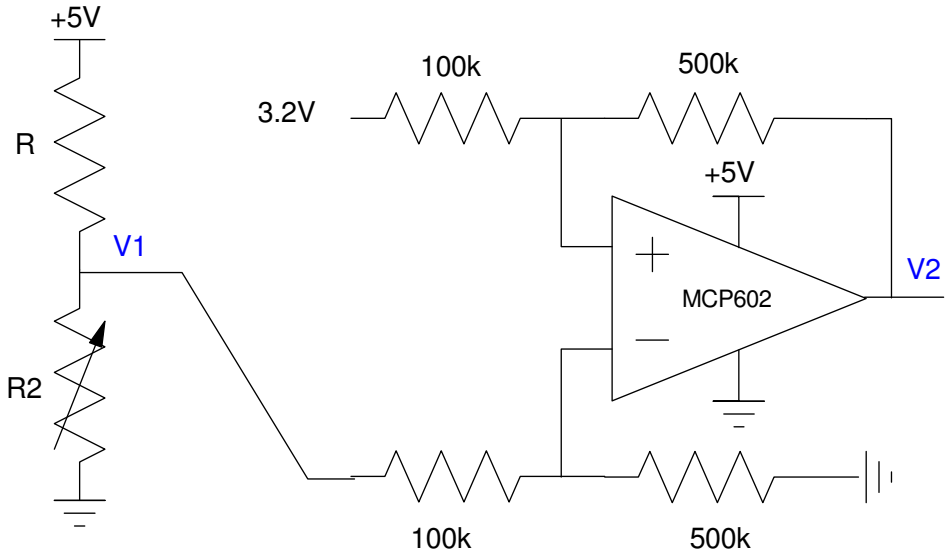
offset = 2.4866V

Gain:

$$gain = \left(\frac{5V-0V}{2.4866V-2.3866V}\right) = 50.01$$

6) Schmitt Trigger: Analysis. Determine the voltages and resistance where the following Schmitt trigger turns on and off. Assume Rx is 800 + 10*(Birth Month) + (Birth Day).

R 800 + 100*Mo + Day	On (V2 = +5V)		Off (V2 = 0V)	
1314	V1	R2	V1	R2
	3.2V	**2336 Ohms**	**4.2V**	**6898 Ohms**



V(on) = 3.2V

Offset is the on-voltage

$$3.2V = \left(\frac{R_2}{R_2+1314}\right)5V$$

$$R_2 = 2336.0\Omega$$

V(off) = 4.2V

V(on) < V(off) when connected to the minus input

$$gain = 5 = \left(\frac{5V-0V}{V(off)-3.2V}\right)$$

$$4.2V = \left(\frac{R_2}{R_2+1314}\right)5V$$

$$R_2 = 6898.5\Omega$$