ECE 320 - Quiz #5 - Name _____

555 Timers, Transistor Switch, Comparitors, Schmitt Triggers - Spring 2022

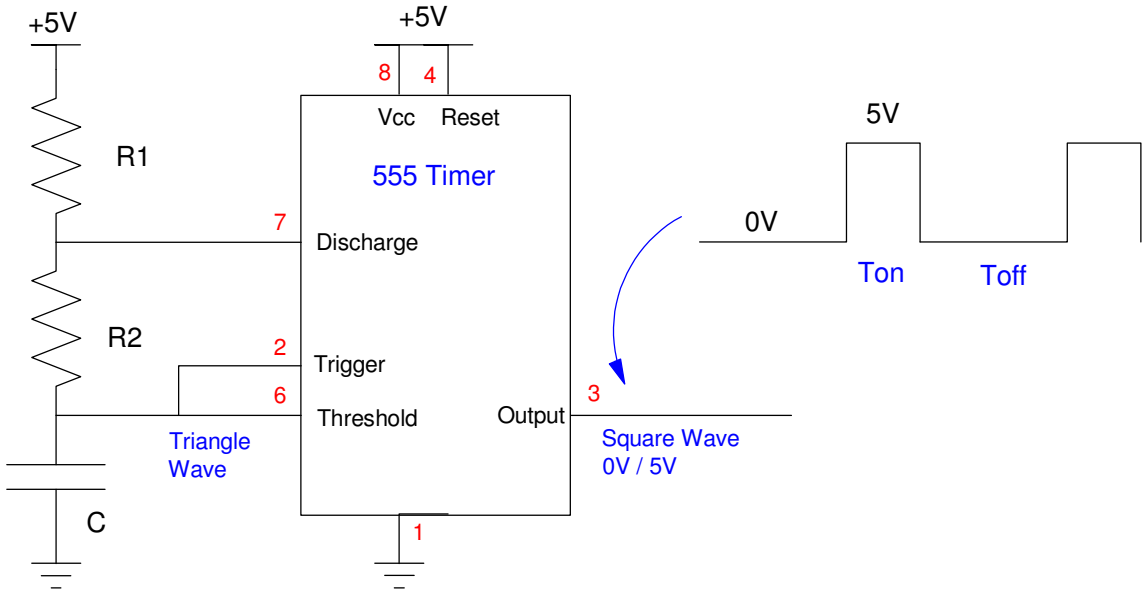
1) 555 Timers. Determine R1, R2, and C so that the 555 timer outputs a 60% duty cycle 220Hz square wave:

$$t_{on} = (R_1 + R_2) \cdot C \cdot \ln(2) = 2.727ms$$

$$t_{off} = R_2 \cdot C \cdot \ln(2) = 1.818ms$$

Let R1 be your birthday day (900 + 100*Month + Day)

R1 900 + 100*Month + Day	R2	C
1414	**2828**	**927nF**



$$\frac{(R_1+R_2)\cdot C\cdot \ln(2)}{R_2\cdot C\cdot \ln(2)} = \frac{2.727ms}{1.818ms}$$

$$\frac{R_1+R_2}{R_2} = \frac{2.727ms}{1.818ms}$$

$$R_2 = \left(\frac{1.818ms}{2.727ms - 1.818ms}\right) R_1 = 2R_1 = 2828\Omega$$

$$R_2 \cdot C \cdot \ln(2) = 1.818ms$$

$$C = 927nF$$

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

- Ic = (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
- $\beta = 60$

Ic (mA) 100*(Mo) + (Day)	Rc	min value of Rb	max value of Rb
514 mA	**9.34 Ohms**	**172 Ohms**	**501.9 Ohms**

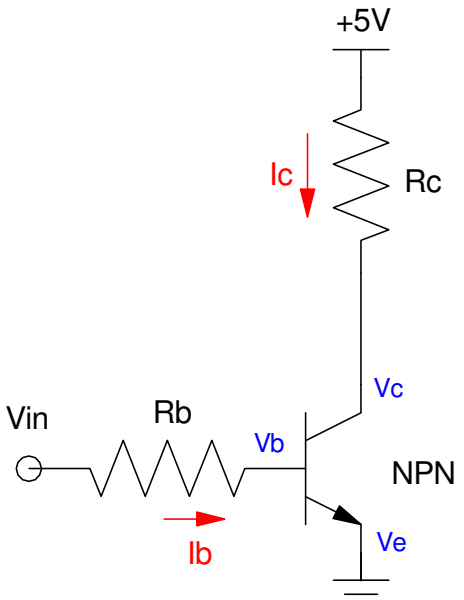
$$R_c = \left(\frac{5V - 0.2V}{514mA}\right) = 9.34\Omega$$

$$\left(\frac{I_c}{\beta}\right) < I_b < 25mA$$

$$\left(\frac{514mA}{60}\right) = 8.57mA < I_b < 25mA$$

$$\left(\frac{5V - 0.7V}{8.57mA}\right) < R_b < \left(\frac{5V - 0.7V}{25mA}\right)$$

$$501.9\Omega < R_b < 172\Omega$$



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

- | Vbe | = 0.7V
- | Vce | = 0.2V when saturated
- $\beta = 60$

Let Rb be 900 + 100(Birth Month) + Birth Day. Find the currents and voltages.

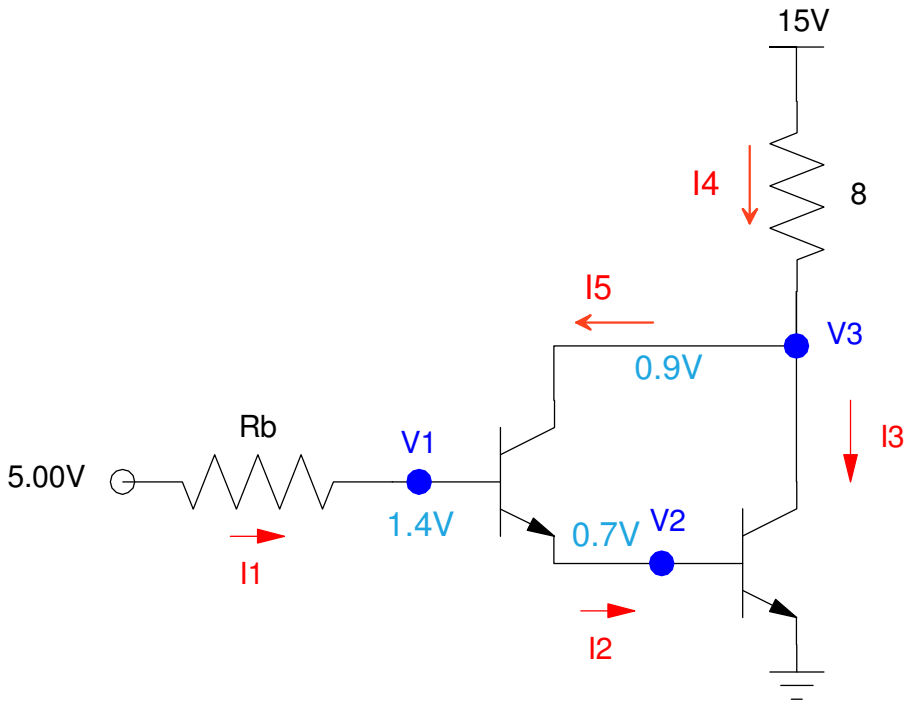
Rb 900 + 100*Mo + Day	I1	I2	I3
1414	**2.546mA** (5 - V1) / Rb	**28.94mA**	**1736mA** 60 * I2
	V1	V2	V3
	1.4V	**0.7V**	**0.9V**

$$I_1 = \left(\frac{5V - 1.4V}{1414\Omega}\right) = 2.546mA$$

$$I_4 = \left(\frac{15V - 0.9V}{8\Omega}\right) = 1763mA = I_3 + I_5$$

$$I_3 = 60 I_2$$

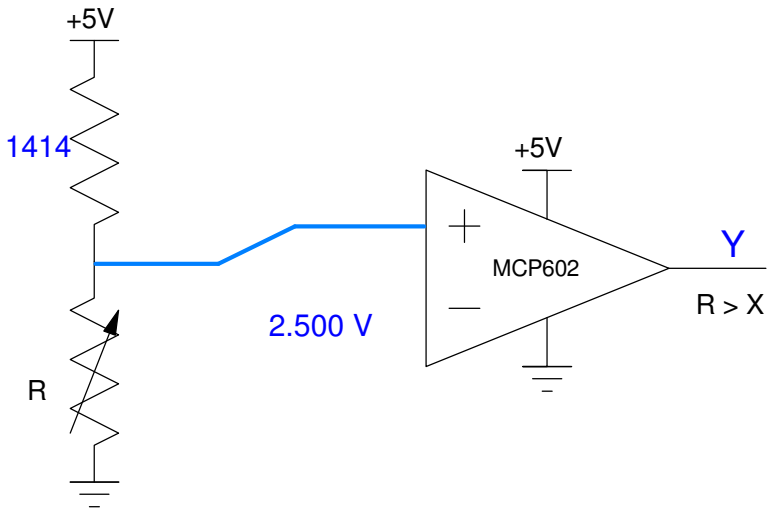
$$I_2 = I_5 + I_1$$



4) Comparitor: Design a circuit which output

- 0V when R < 1414 Ohms
- 5V when R > 1414 Ohms

where X is 900 + 100*(Birth Month) + (Birth Day).



5) Schmitt Trigger: Design a circuit which output

- 0V when R < 1414 Ohms
- 5V when R > 1914 Ohms
- No change for 1414 < R < 1914 Ohms

Let X be 900 + 100(Birth Month) + (Birth Date).

At 1414 Ohms

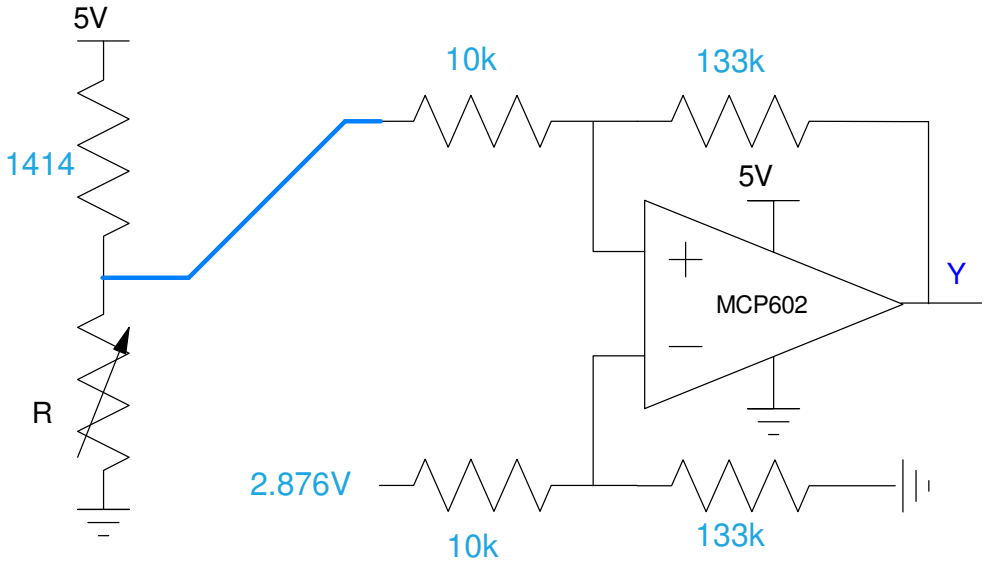
$$X = 2.500V$$

At 1914 Ohms

$$X = 2.876V$$

Gain

$$gain = \left(\frac{5V-0V}{2.876V-2.500V}\right) = 13.31$$



6) Schmitt Trigger: Analysis. Determine the voltages and resistance where the following Schmitt trigger turns on and off. Assume Rx is 900 + 10*(Birth Month) + (Birth Day).

Rx 900 + 100*Mo + Day	On (V2 = +5V)		Off (V2 = 0V)	
1414	V1	R	V1	R
	3.00V	**2121 Ohms**	**1.89V**	**859 Ohms**

Output goes high at 3.00V (offset voltage)

Gain = 4.50 (ratio of resistors)

$$gain = \left(\frac{5V-0V}{3.33V-V_{off}}\right)$$

$$V_{off} = 1.89V$$