ECE 320 - Homework #3

LEDs, AC to DC Converters. Due Monday, September 14th

Please make the subject "ECE 320 HW#3" if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)

LEDs

The specifications for a Piranah RGB LED are

Color	Vf @ 20mA	mcd @ 20mA
red	2.0V	10,000
green	3.2V	10,000
blue	3.2V	10,000

1) Design a circuit to drive these LEDs with a 5V source to produce lavender:

- Red = 9020 mcd (230/255)
- Green = 6353 mcd (162/255)
- Blue = 8706 mcd (222/255)

$$I_r = \left(\frac{9{,}020mcd}{10{,}000mcd}\right)20mA = 18.040mA$$

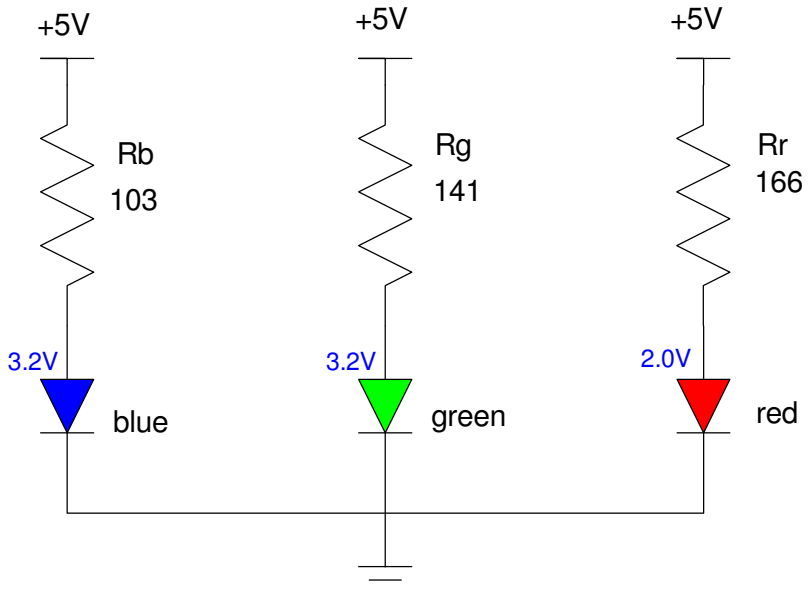
$$R_r = \left(\frac{5V-2.0V}{18.040mA}\right) = 166\Omega$$

$$I_g = \left(\frac{6{,}353mcd}{10{,}000mcd}\right)20mA = 12.706mA$$

$$R_g = \left(\frac{5V-3.2V}{12.706mA}\right) = 141\Omega$$

$$I_b = \left(\frac{8706mcd}{10{,}000mcd}\right)20mA = 17.412mA$$

$$R_b = \left(\frac{10V-3.2V}{17.412mA}\right) = 103\Omega$$



2) Design a circuit to drive these LEDs with a 5V source producing teal blue:

- Red = 1412 mcd (36/255)
- Green = 5176 mcd (132/255)
- Blue = 5373 mcd (137/255)

$$I_r = \left(\frac{1412mcd}{10{,}000mcd}\right)20mA = 2.824mA$$

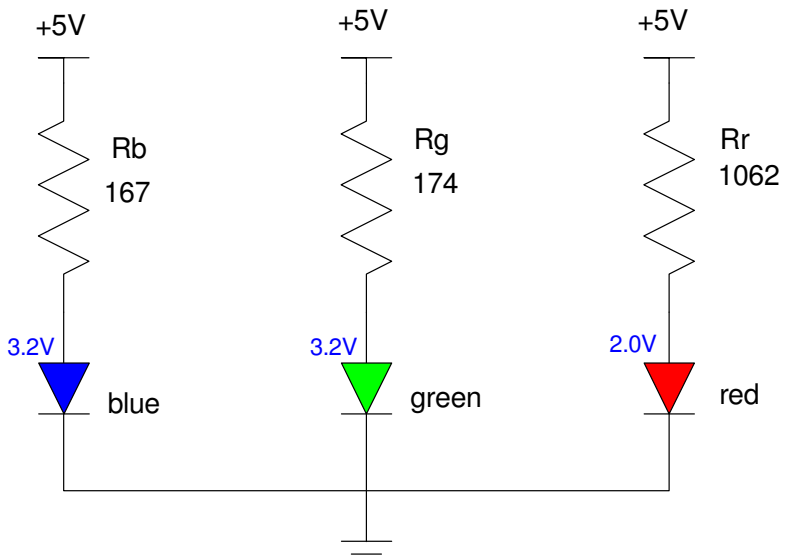
$$R_r = \left(\frac{5V-2.0V}{2.824mA}\right) = 1062\Omega$$

$$I_g = \left(\frac{5176mcd}{10{,}000mcd}\right)20mA = 10.352mA$$

$$R_g = \left(\frac{5V-3.2V}{10.352mA}\right) = 174\Omega$$

$$I_b = \left(\frac{5373mcd}{10{,}000mcd}\right)20mA = 10.746mA$$

$$R_b = \left(\frac{10V-3.2V}{10.746mA}\right) = 167\Omega$$

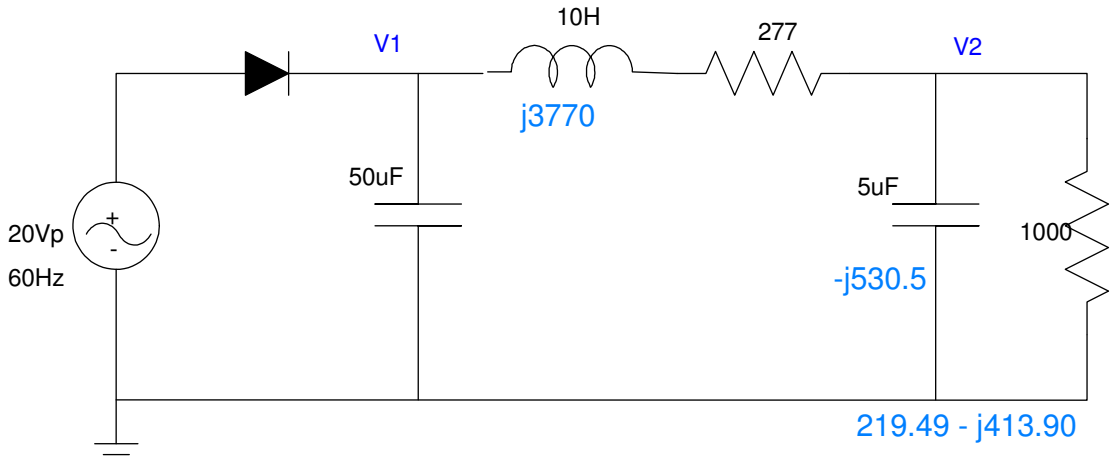


Other colors can be obtained from

https://www.rapidtables.com/web/color/color-wheel.html

AC to DC Converters

3) Determine the votlages at V1 and V2 (DC and AC)



V1: Peak voltage = 19.3V

$$I \approx \left(\frac{19.3V}{1277\Omega}\right) = 15.11mA$$

$$I = C\,\frac{dV}{dt}$$

$$15.11mA = 50\mu F\,\frac{dV_1}{1/60s}$$

$$dV_1 = 5.038V_{pp}$$ *this is the AC signal for V1*

$$V_1(DC) \approx \max(V_1) - \tfrac{1}{2}V_{1pp}$$

$$V_1(DC) \approx 19.3V - \tfrac{1}{2}\,5.038V_{pp} = 16.78V$$ *the DC signal for V1*

V2: DC

$$V_2(DC) = \left(\frac{1000}{1000+277}\right)16.78V$$

$$V_2(DC) = 13.14V$$

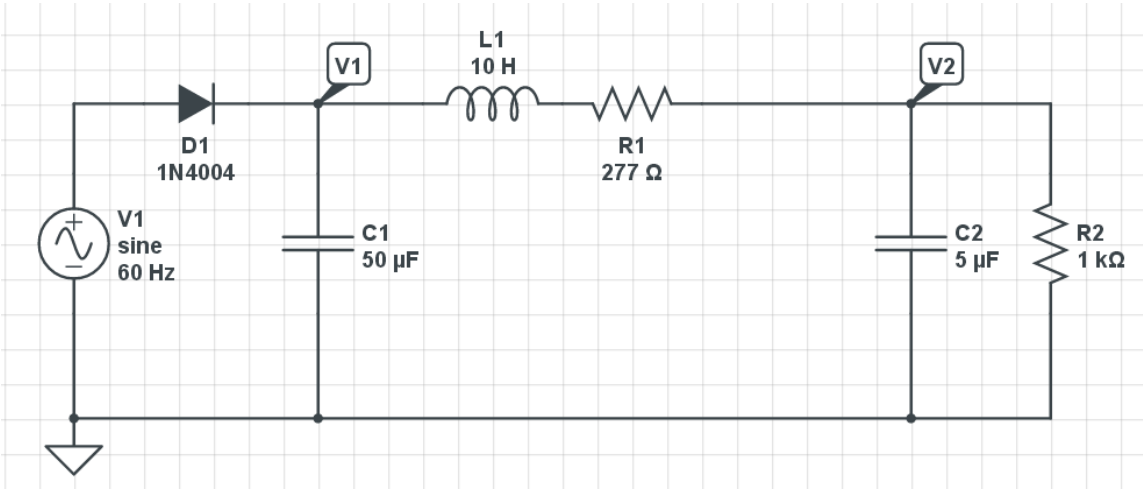
V2: AC

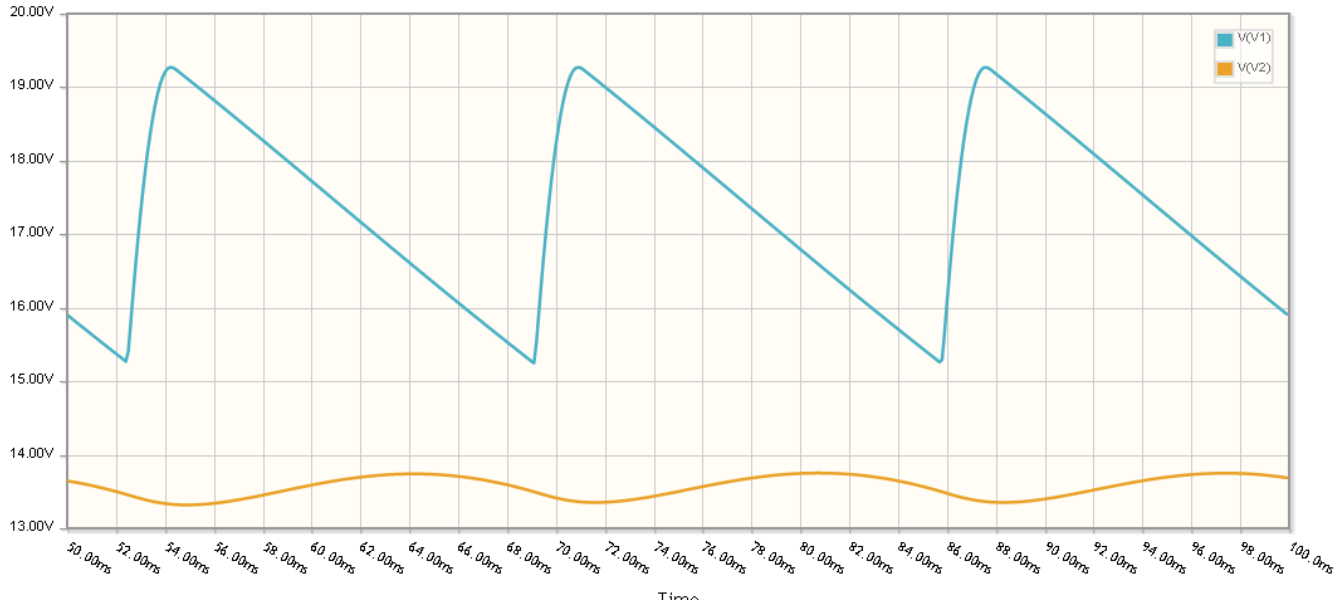
$$V_2(AC) = \left(\frac{(219.49-j413.90)}{(219.49-j413.90)+(277+j3770)}\right)5.038V_{pp}$$

$$V_2(AC) = 0.696V_{pp}$$ *take the magnitude*

phase is the delay (don't care about that)

4) Build the circuit in CircuitLab (or similar program) and verify your calculations for problem #3





	V1		V2	
	DC	AC	DC	AC
Calculated	16.78 V	5.038 Vpp	13.14 V	696 mVpp
Simulated	17.27 V	3.97 Vpp	13.53 V	420 mVpp

5) Determine C1 and C2 so that AC voltages are: V1 = 2Vpp and V2 = 300mVpp.

$$V_1(DC) = 19.3V - \tfrac{1}{2}\,2V_{pp} = 18.3V$$

$$I = \left(\frac{18.3V}{1277\Omega}\right) = 14.33mA$$

$$I = C\,\frac{dV}{dt}$$

$$14.33mA = C_1\,\frac{2V}{1/60s}$$

$$C_1 = 119.4\mu F$$

$$15.11mA$$

Assume C2 = 0

$$V_2(AC) = \left(\frac{1000}{1000+(277+j3770)}\right)2V_{pp}$$

$$V_2(AC) = 529mV_{pp}$$

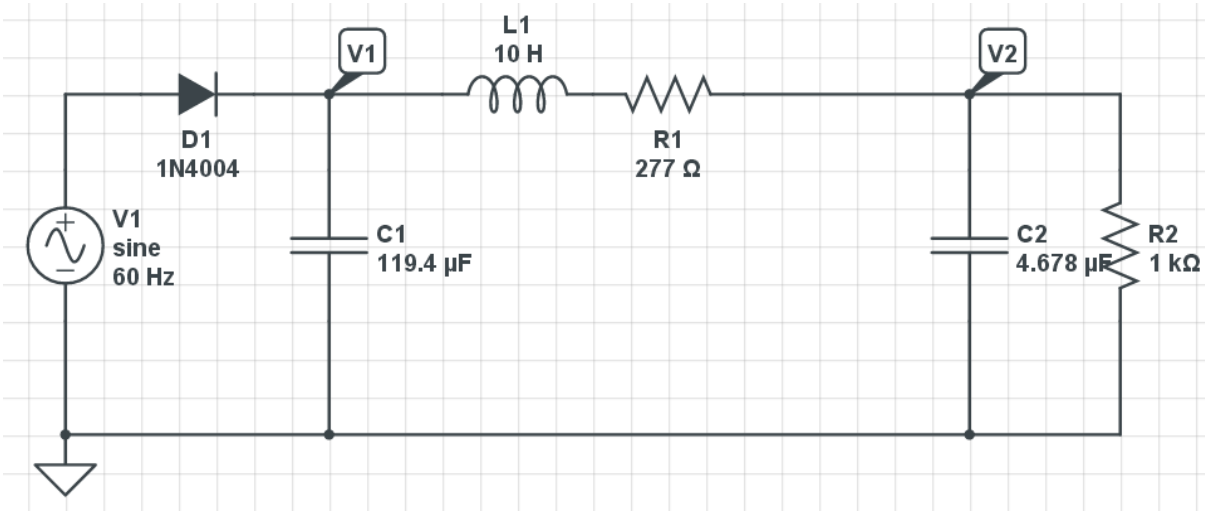
To reduce the ripple to 300mVpp, the 1000 Ohms at the load needs to be reduced

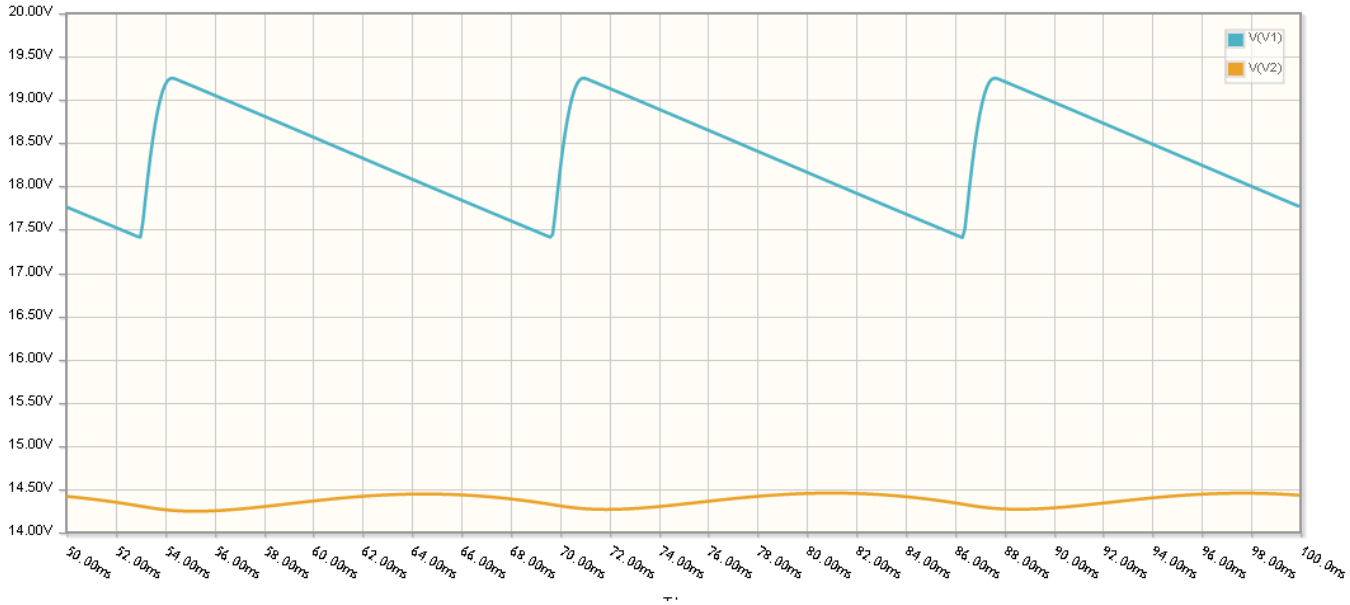
$$\left|\frac{1}{j\omega C}\right| = |-jX| = \left(\frac{300mV_{pp}}{529mV_{pp}}\right)1000\Omega = 567\Omega$$

$$\left|\frac{1}{j\omega C}\right| = 567\Omega$$

$$C_2 = 4.678\mu F$$

6) Build this circuit in CircuitLab (or similar program) and verify your calculations for problem #5





	V1		V2	
	DC	AC	DC	AC
Calculated	18.30 V	2.000 Vpp	14.33 V	300 mVpp
Simulated	18.33 V	1.840 Vpp	14.34 V	190 mVpp