ECE 320 - Homework #3

LEDs, AC to DC Converters. Due Monday, September 13th

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 Kelly Green:

- Red = 2784 mcd (71/255)
- Green = 6156 mcd (157/255)
- Blue = 2039 mcd (52/255)

Red

$$I_r = \left(\frac{2784mcd}{10{,}000mcd}\right)20mA = 5.568mA$$

$$R_r = \left(\frac{5V-2.0V}{5.568mA}\right) = 539\Omega$$

Green:

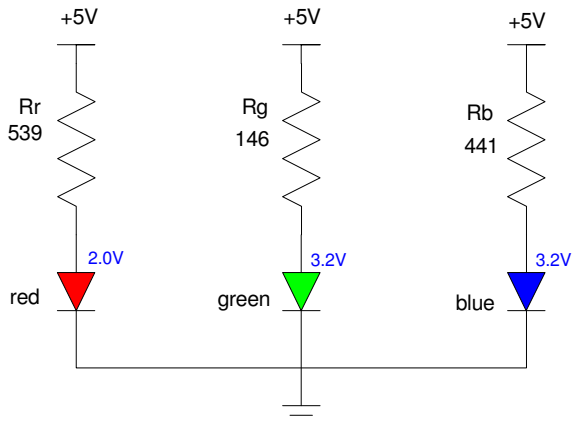
$$I_g = \left(\frac{6156mcd}{10{,}000mcd}\right)20mA = 12.312mA$$

$$R_g = \left(\frac{5V-3.2V}{12.312mA}\right) = 146\Omega$$

Blue:

$$I_r = \left(\frac{2039mcd}{10{,}000mcd}\right)20mA = 4.078mA$$

$$R_g = \left(\frac{5V-3.2V}{4.078mA}\right) = 441\Omega$$



2) Design a circuit to drive these LEDs with a 5V source producing Cobalt Blue:

- Red = 352 mcd (9/255)
- Green = 3450 mcd (88/255)
- Blue = 9254 mcd (236/255)

Red

$$I_r = \left(\frac{352mcd}{10{,}000mcd}\right)20mA = 0.704mA$$

$$R_g = \left(\frac{5V-2.0V}{0.704mA}\right) = 4261\Omega$$

Green

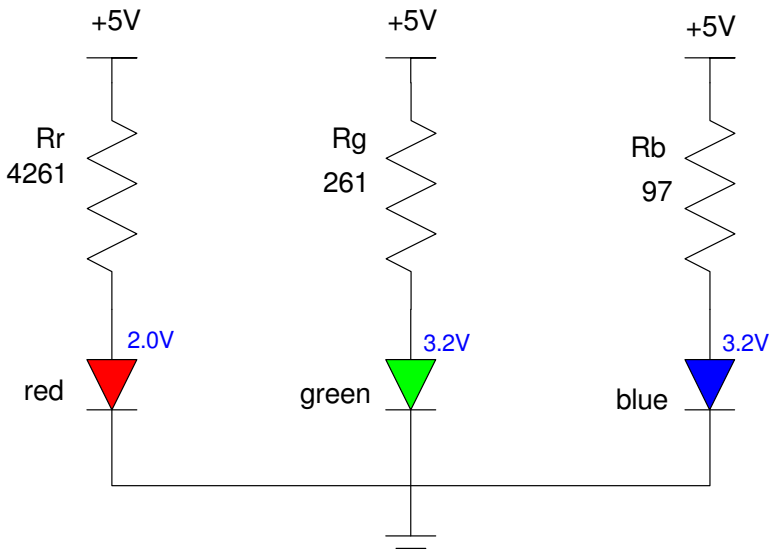
$$I_r = \left(\frac{3450mcd}{10{,}000mcd}\right)20mA = 6.900mA$$

$$R_g = \left(\frac{5V-3.2V}{6.900mA}\right) = 261\Omega$$

Blue

$$I_r = \left(\frac{9254mcd}{10{,}000mcd}\right)20mA = 18.508mA$$

$$R_g = \left(\frac{5V-3.2V}{18.508mA}\right) = 97\Omega$$



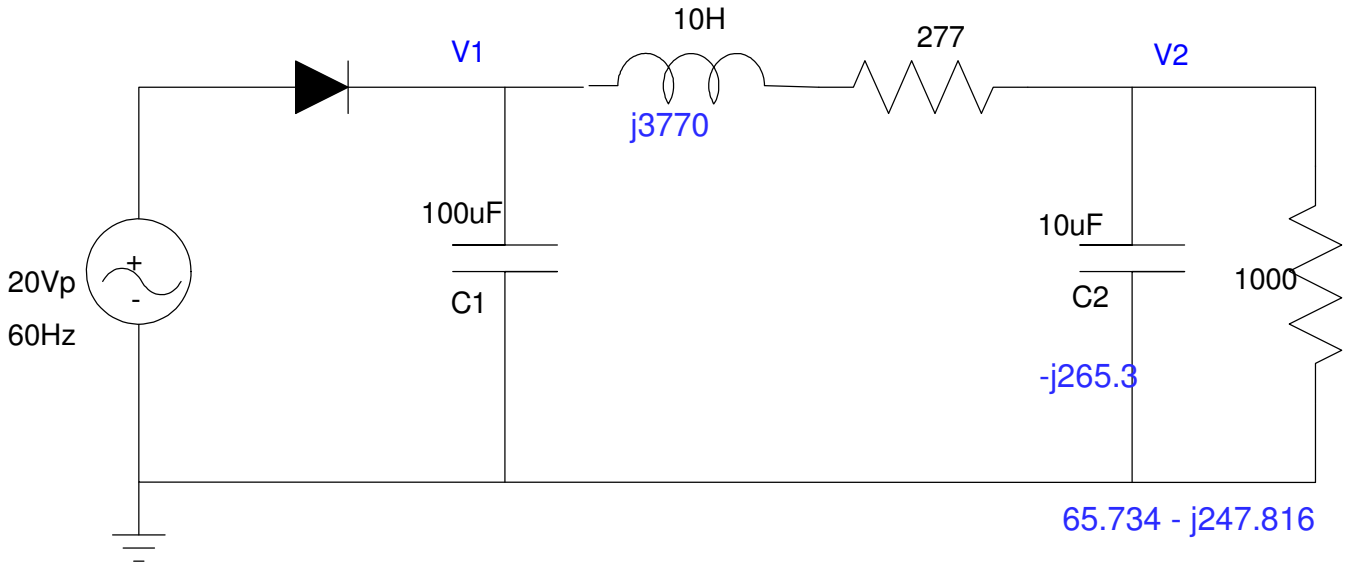
Other colors can be obtained from

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

AC to DC Converters

For the circuit below:

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



max(V1) = 20V - 0.7V = 19.3V

$$I \approx \left(\frac{19.3V}{1000\Omega+277\Omega}\right) = 15.11mA \qquad \textit{worst case}$$

For V1

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

$$15.11mA = 100\mu F\left(\frac{dV}{1/60s}\right)$$

$$dV = 2.519V \qquad \textit{V1pp (AC)}$$

$$V_1(AC) = 2.519V_{pp}$$

$$V_1(DC) = 19.3V - \tfrac{1}{2}(2.519V_{pp}) = 18.04V$$

For V2

$$V_2(DC) = \left(\frac{1000}{1000+277}\right)18.04V = 14.13V$$

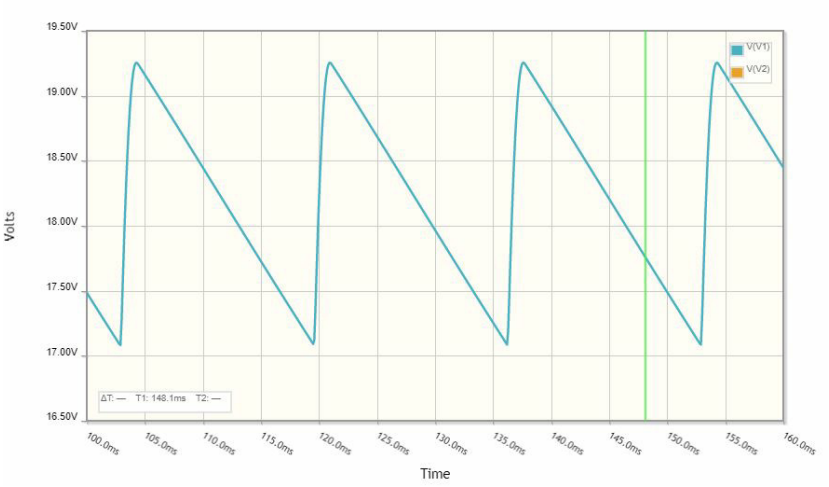
$$V_2(AC) = \left(\frac{(65.734-j247.816)}{(65.734-j247.816)+(277+j3770)}\right)2.519V_{pp}$$

$$|V_2(AC)| = 0.183V_{pp}$$

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

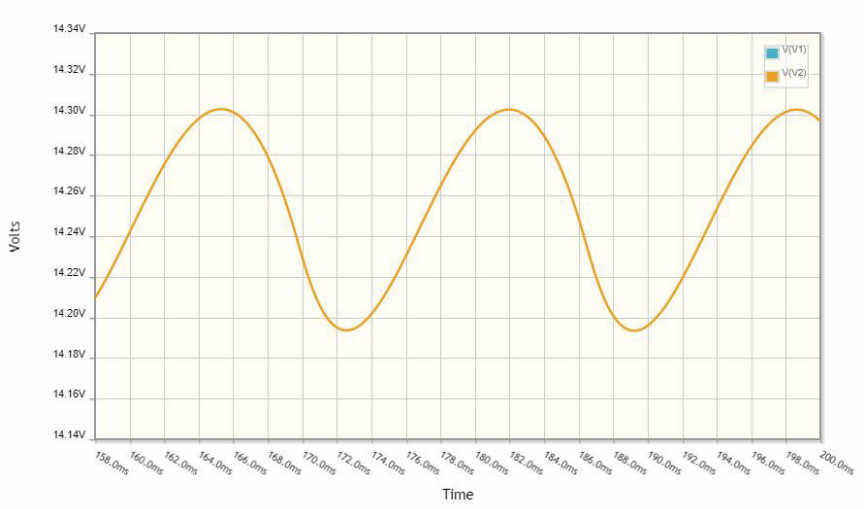
V1:

- max = 19.25V
- min = 17.09V
- V1(DC) = (max+min)/2 = 18.17V
- V1(AC) = max - min = 2.160vpp



V2:

- max = 14.30V
- min = 14.19V
- V2(DC) = (max+min)/2 = 14.245V
- V2(AC) = max - min = 0.11Vpp



	V1		V2	
	DC	AC	DC	AC
Calculated	18.04 V	2.519 Vpp	14.13 V	0.183 Vpp
CircuitLab	18.17 V	2.160 Vpp	14.245 V	0.11 Vpp

7) Determine C1 and C2 so that AC voltages are: V1 = 2Vpp and V2 = 250mVpp.

V1:

max(V1) = 19.3V

min(V1) = 17.3V *2Vpp*

V1(DC) = 18.3V *(max + min) / 2*

V1(AC) = 2Vpp *given*

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

C1:

$$I = C_1 \frac{dV}{dt}$$

$$14.33mA = C_1\left(\frac{2V}{1/60s}\right)$$

$$C_1 = 119.4\mu A$$

C2:

If C2 = 0, then V2(AC) is

$$V_2(AC) = \left(\frac{(1000)}{(1000)+(277+j3770)}\right)(2V_{pp}) = 502.5mV_{pp}$$

To reduce V2(AC) to 250mVpp, the impedance of the capacitor needs to be about 1/2 of 1000 Ohms

$$|Z_c| = \left|\frac{1}{j\omega C}\right| = \left(\frac{250mV_{pp}}{502.5mV_{pp}}\right)1000\Omega$$

$$\frac{1}{\omega C} = 497.6\Omega$$

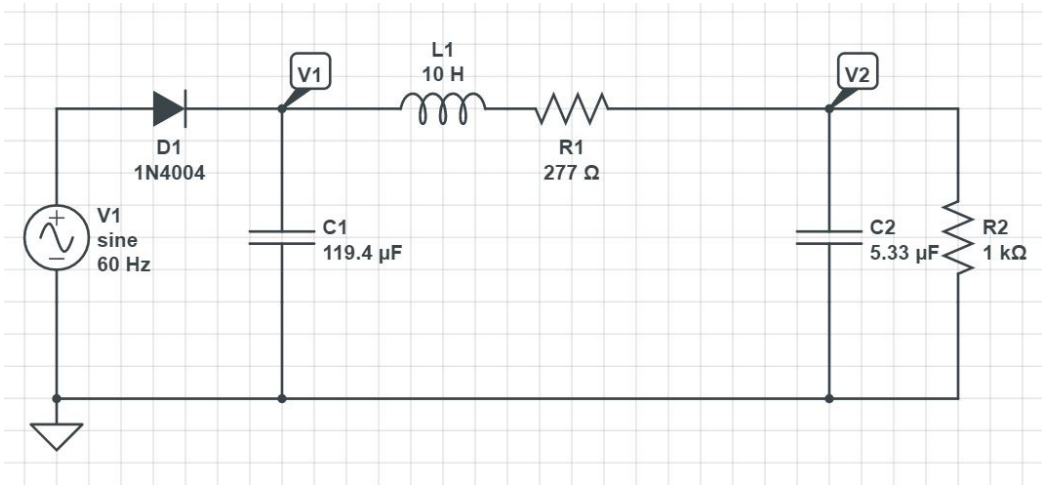
$$C_2 = 5.33\mu F$$

So

C1 = 119.4uF

C2 = 5.33uF

8) Build this circuit in CircuitLab (or similar program) and verify your calculations for problem #8



Running a transient simulation results in

- max(V1) = 19.25V
- min(V1) = 17.41V
- V1(DC) = mean(max, min) = 18.33V (vs. 18.30 calculated)
- V1(AC) = max - min = 1.840Vpp (vs. 2.00V calculated)

For V2

- max(V2) = 14.45V
- min(V2) = 14.28V
- V2(DC) = mean(max, min) = 14.365V
- V2(AC) = max - min = 170mVpp (vs. 250mVpp calculated)