Solutions

University of New Mexico
Department of Electrical and Computer Engineering

ECE 321L – Electronics I (Fall 2019) Homework #4

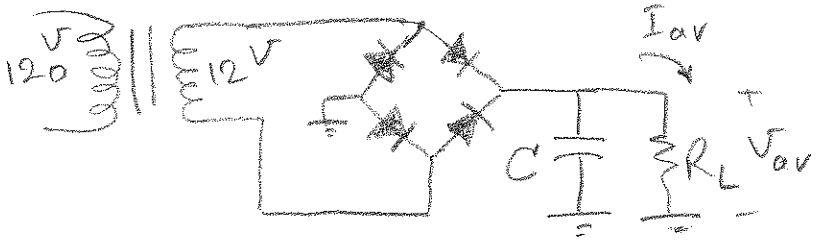
Due in class: Wednesday September 18, 2019

1. A full wave rectifier using a diode bridge and a 120V/12V transformer is designed to deliver power to a 10Ω load. Assume all diodes have Von=0.7V and negligible off current.

a. What is the ripple voltage, if the capacitance of the filter is 2500μF?

b. Considering the ripple calculated in part a, what is the average DC voltage of the output (hint: it will be approximately Vp-Vr/2)?

c. Considering the average DC voltage of the output found in part b, determine the average current and power in the load resistor.



3 main equations:

$$\begin{cases} I_{av} = \dfrac{V_{av}}{R_L} \\ V_{av} \approx V_p - \dfrac{V_r}{2} \\ V_r \approx \dfrac{I_{av}}{2fC} \end{cases}$$

$$V_p = 12\sqrt{2} - 2 \times 0.7 = 15.57^{V}$$

$$\begin{cases} I_{av} = \dfrac{V_{av}}{10} \\ V_{av} = 15.57 - \dfrac{V_r}{2} \\ V_r = \dfrac{I_{av}}{2 \times 60 \times 2500^{\mu F}} \end{cases}$$

Solving 3 equations → 3 unknowns

$$\begin{cases} V_r = 4.45^{V} \leftarrow a \\ V_{av} = 13.34^{V} \leftarrow b \\ I_{av} = 1.334^{A} \leftarrow c \end{cases}$$

average Power $P = I_{av} \cdot V_{av} = 1.334^{A} \times 13.34^{V}$

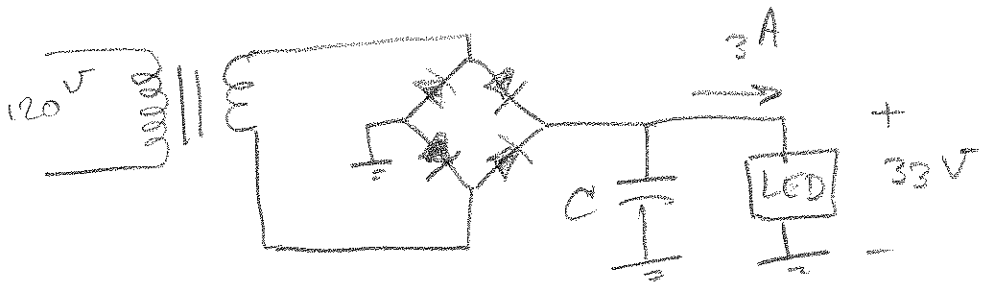
$$\rightarrow P = 17.8^{W}$$

2. Design a full wave rectifier for a regulator that delivers 100W electrical power to a white off-the-shelf LED (http://www.semileds.com/system/files/C4246-100-1010-CE.pdf). Per datasheet, the LED requires 33V and draws 3A current. You are required to limit the ripple voltage to less than 20% of average DC voltage of the output. Assume all diodes have Von=0.7V and negligible off current.

a. Draw the circuit diagram.

b. Determine the voltage of transformer and capacitance of the filter.

a)



b) $V_r = (20\%) * 33^V = 6.6^V$

$V_{av} = V_p - \frac{V_r}{2} \rightarrow V_p = V_{av} + \frac{V_r}{2} = 33^V + \frac{6.6^V}{2} = 36.3^V$

$\rightarrow V_{rms} = \frac{36.3^V + 2 \times 0.7^V}{\sqrt{2}} = 26.66^V$ — Voltage of transformer (rms)

$V_r = \frac{I_{av}}{2fC} \rightarrow 6.6^V = \frac{3^A}{2 * 60 * C}$

$\rightarrow C = 3,788^{MF}$