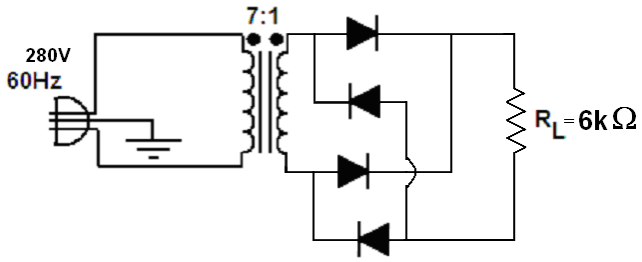
Electronics

Bridge rectifiers

Problem 1.- Using the second approximation for the diodes in the following circuit, calculate the DC output voltage (V_{DC}) and the power dissipated in the load resistor (P_{RL}).



Solution: We recognize the circuit as a full wave rectifier in the popular configuration where the circuit forms a bridge and the current always goes through two diodes.

The secondary voltage of the transformer is $V_s = \frac{280V}{7} = 40V$

The maximum voltage of the secondary will be:

$$V_{\max} = 40 \times \sqrt{2} = 56.56V$$

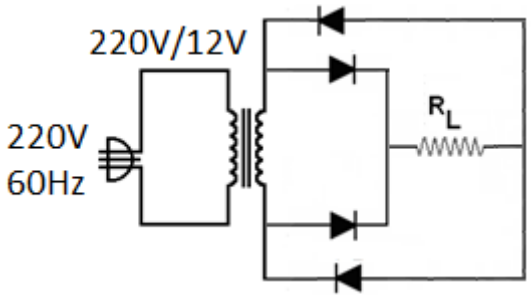
To get the DC voltage we subtract 1.4V (due to the drop in the two diodes) and multiply by 2/π, which we deduced previously (see notes in the full rectifier item).

$$V_{DC} = \frac{2(V_{\max} - 1.4V)}{\pi} = \frac{2(56.56V - 1.4V)}{3.1416} = \mathbf{35.1\ V}$$

To calculate the power we can use the equation V^2/R, but the voltage has to be the rms value:

$$V_{rms} = \frac{V_{\max} - 1.4V}{\sqrt{2}} = \frac{56.56V - 1.4V}{1.4142} = 39.0V \rightarrow P = \frac{V_{rms}^2}{R} = \frac{(39V)^2}{6000\Omega} = \mathbf{254\ mW}$$

Problem 2.- For a test instrument used in quality control in industry it is necessary to feed a resistive load with DC and it is not important the harmonic content, so we will select a bridge rectifier without filter for this application.



The load resistance has a value of R_L=0.125Ω and the transformer has a nominal relation of 220V/12V, however consider possible fluctuations of +/- 8%.
Specify for the diodes:

a) Maximum average current.

b) Peak maximum current.

c) Peak inverse voltage.

d) Power average.

Solution: To calculate the maximum values we will consider the 8% fluctuation. Then the peak voltage at the transformer output will be:

$$V_{\max} = 12\sqrt{2} \times 1.08 = 18.3V$$

a) In each diode the current will pass only during half a cycle, so the average can be calculated with this equation.

$$I_{DC-diode} = \frac{V_{\max} - 2 \times 0.7}{\pi R} = \frac{18.3 - 2 \times 0.7}{\pi (0.125)} = 43.1A$$

b) The peak current will occur when the voltage is maximum.

$$I_{peak-diode} = \frac{18.3 - 2 \times 0.7}{0.125} = 135A$$

c) Notice that the maximum voltage in a diode occurs when it is not conducting. In that case, the peak voltage of the transformer appears in reverse on the diode (minus the drop in the other diode). Then the peak reverse voltage is:

$$V_{peak-reverse} = 18.3 - 0.7 = 17.6V$$

d) To calculate the power in the diode we multiply its voltage when it conducts (which is 0.7V) times the DC current. When in the reverse condition the current is so low that that power can be ignored. In the condition of 8% fluctuation we have an average power of:

$$P_{diode} = 0.7 \times 43.1 = 30.2W$$