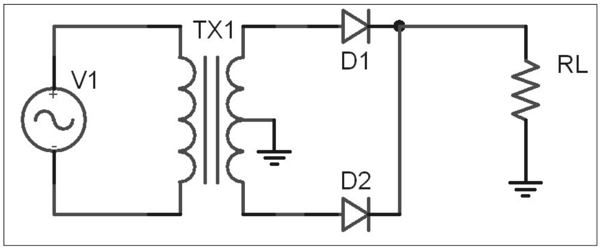
Full Wave Rectifier -- Centre Tapped Transformer

The following circuit "rectifies" both the positive half-wave and the negative half-wave.



For this circuit, you need to remember that only half of the secondary's voltage appears at the output at any given time -- the other half of the secondary can't conduct when its diode is reverse-biased.

Your instructor will likely go through this diagram, explaining why it works as it does. In essence, it's just two half-wave rectifiers linked to the same load.

The average voltage is twice what we would expect from just one half-wave per original cycle:

$$V_{ave} = \frac{2\ V_P}{\pi}$$

The RMS voltage is back to what we would expect for a sine wave -- flipping the bottom half up has effectively done the same thing as squaring all the values in the sine wave calculation before taking the square root in the RMS calculation:

$$V_{RMS} = \frac{V_P}{\sqrt{2}}$$

The frequency of the resulting signal is now double the source signal's frequency, because there are two identical half-waves one after the other during one input cycle.

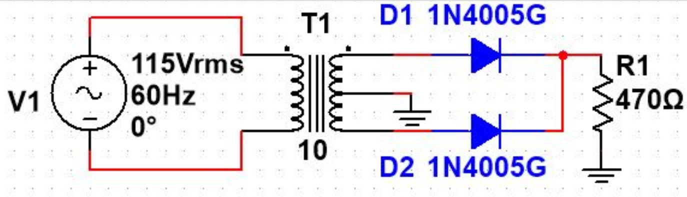
$$f_{FW} = 2\ f_{Source}$$

Question: Assume the same signal voltage, 120 V_{AC}, same transformer turns ratio, 8:1, same diode barrier potential, 0.7 V, and same resistor as before, 220 Ω.

1. What is the peak voltage at the output of the secondary of the transformer, given that the ground reference is in the middle of the secondary? 10.6 V_p
2. Using the practical diode model, what is the peak voltage across the load, referenced to ground? 9.91 V_p
3. What is the frequency of the signal across the load? 120 Hz
4. What is the period, in milliseconds, of the signal across the load? 8.33 ms
5. What is the average voltage across the load resistor? 6.31 V_{DC}
6. What is the RMS voltage across the load resistor? 7.01 V_{RMS}
7. What power will be dissipated by the load resistor? 223 mW

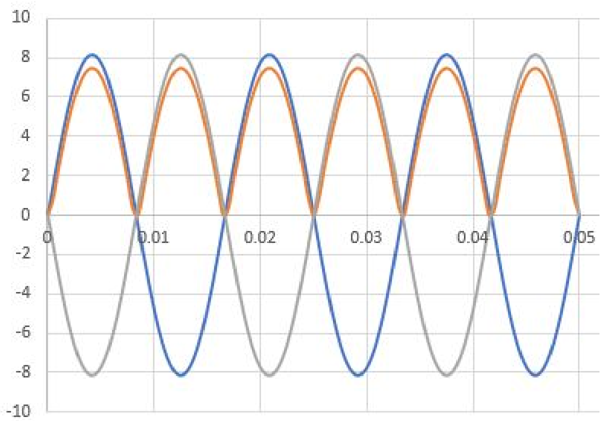
Unfortunately, because we used the same turns ratio in the transformer but split it in the middle, the resulting power is significantly lower. However, notice that the average and RMS voltages are much closer to each other, which indicates that this is closer to true DC, which is one of our goals.

Here's a worked example that carries on using the same components as in the previous worked example.



- The power source is 162.6 V_p
- The transformer output voltage, from top to bottom, is 16.3 V_p; however, with the centre-tap grounded, that means that, when the top of the transformer is positive, the bottom of the transformer will be equally negative; so the signals at the two terminals of the transformer will be two half-size sine waves, 180° out of phase; therefore, the peak voltage presented to the diodes is 8.13 V_p.
- From the orientation of the diodes, current is supplied to the load resistor when the transformer voltage is positive; both diodes act as half-wave rectifiers, but with a 180° phase shift between them, the result is a full-wave positive rectified signal with a peak voltage down one diode drop (on each half wave) from the peak voltage; therefore, the peak voltage presented to the load resistor is 8.13 V_p - 0.7 V = +7.43 V_p.
- Since the second half of the original signal is now a positive half-wave, the period of the signal is half the original, or 8.33 ms; the frequency is therefore 1/T = 120 Hz.

The resulting signal, compared to the signals at the two ends of the transformer referenced to ground, looks like this:



- The average voltage for a full-wave rectified signal can be predicted using $2V_p/\pi$ or 2*7.43 V_p/π = +4.73 V_{DC}
- The power-related voltage for a full-wave rectified signal is the same as for a sine wave, or $V_p/\sqrt{2}$ = 5.26 V_{RMS}
- The power dissipated by the resistor, based on the RMS voltage using $P=V_{RMS}^2/R$ will be 58.8 mW