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### Question 3

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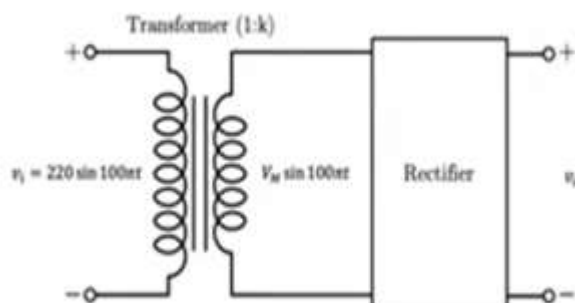
A voltage waveform  $v_i = 8\sin(2000\pi t)V$  is input to a full-wave rectifier. A resistance of  $R = 50k\ \Omega$  is connected at the load. [Assume that the diodes used in the circuit have a forward drop of  $0.8V$ ].

- (a) Draw the circuit of the full wave rectifier. Label the input and output voltages properly. [1]
- (b) Draw the waveforms of the input and output voltages. What are the peak values of input and output? Show them in the graph. [1+1]
- (c) Find the average voltage measured at the output. [1]

Now a  $10\ \mu F$  capacitor is connected in parallel with the load.

- (d) Find the frequency of the input signal and the frequency of the ripple. [0.5+0.5]
  - (e) Find the peak-to-peak ripple of the output voltage. [1.5]
  - (f) Find the DC value of the output voltage. [1.5]
  - (g) If we want to reduce the ripple to 1% of the input peak voltage what value of capacitor should we use? [2]
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Suppose you are using the following reference circuit to design a charger for your phone.



Here the input  $v_i$  is connected to the wall outlet with maximum voltage of  $220\text{ V}$  and a frequency  $f_i$  of  $50\text{ Hz}$  (hence  $\omega_i = 2\pi f = 100\pi$ ). The function of the transformer is to reduce the voltage  $v_i$  by a factor of  $k$  while keeping the signal shape intact. This means that the output of the transformer (hence the input of the rectifier) will still be a sinusoid with frequency  $f_i = 50\text{ Hz}$  but with amplitude

$$V_M = \frac{220}{k}.$$

The output of the rectifier is connected to the phone to be charged. The output voltage,  $v_o$ , must have the following criteria:

- Average or DC voltage,  $V_{DC} = V_{AV} = 6\text{ V}$
- Maximum output peak to peak ripple voltage,  $v_{r(p-p)} = 0.2\text{ V}$
- Output ripple frequency,  $f_r = 100\text{ Hz}$

**Question:**

- Which type of rectifier should you use (half wave or full wave)? Why? [1]
- Design the rectifier (i.e. find the value of  $k$  of the transformer and  $R$  and  $C$  for the rectifier). [2 + 1 + 1]