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Experiment III

AIM:

Design a Full Wave Rectifier:

1. Without Capacitive Filter
2. With Capacitive Filter

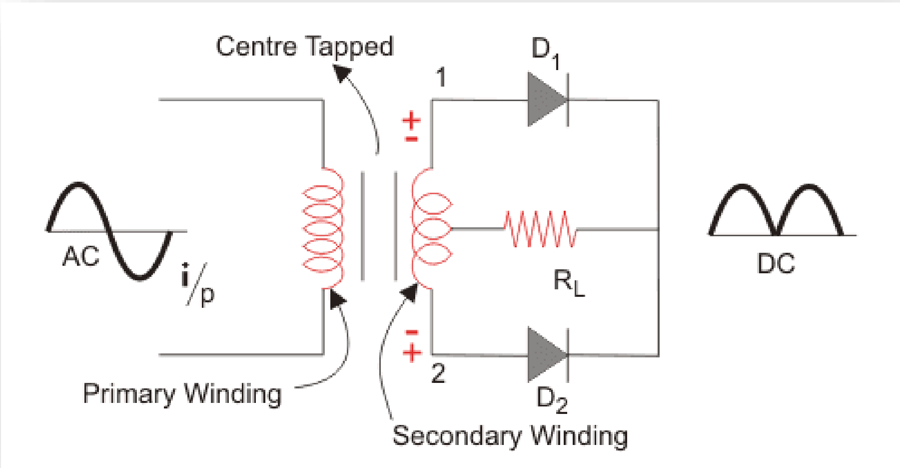
Theory:

Rectifier:

Junction diode allows current to pass only when it is forward biased. So, if an alternating voltage is applied across a diode, the current flows only in that part of the cycle, when the diode is forward biased. This property is used to rectify alternating voltages and the circuit used for this purpose is called a rectifier.

Full wave Rectifier:

In full-wave rectifier circuit, two diodes are used, one for each half of the cycle. A multiple winding transformer is used whose secondary winding is split equally into two halves with a common centre trapped connection (C). This configuration results in each diode conducting in turn when its anode terminal is positive with respect to the transformer centre point C producing an output during both half cycles, twice that for the half-wave rectifier



Working:

1. A high AC voltage is applied to the to the primary side of the step-down transformer and we will get a low voltage at the secondary winding which will be applied to the diodes.
2. During the positive half cycle of the AC voltage, the first diode will be forward biased and the current flows through the first diode.
3. During the negative half cycle of the AC voltage, the second diode will be forward biased and the current flows through the second diode.
4. The final output voltage waveform on the secondary side is the upper half of the Input AC voltage during both +ve and -ve cycles.

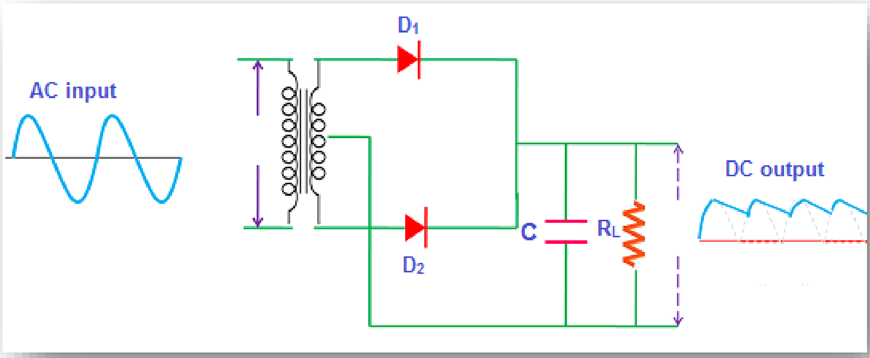
Full Wave Rectifier Capacitor Filter

Filters are components used to convert (smoothen) pulsating DC waveforms into constant DC waveforms. They achieve this by suppressing the DC ripples in the waveform.

A capacitor is widely used as filter for the Full wave Rectifier.

A capacitor does this by absorbing the excess of voltage and supplying it whenever it is required. This accounts for several charging and discharging cycles occurring in the capacitor.

Thus, this leads to clearing off the ripples by making the output waveform quite smooth.



Circuit Analysis:

Let input AC voltage be V_{in} with frequency v, Phase 0 degrees and RMS voltage V_{rms}

$$V_{initial} = V_{pk}\sin(2\pi vt + 0)\,V = V_{pk}\sin(2\pi vt)\,V$$

Input AC voltage for Diode after passing through the Transformer,

$$V_{+} = \frac{n_s}{n_p} V_{initial}\sqrt{2}\sin(2\pi vt)\,V\ (for + ve\ cycle)$$

$$V_{-} = -\frac{n_s}{n_p} V_{initial}\sqrt{2}\sin(2\pi vt)\,V\ (for - ve\ cycle)$$

Output DC Voltage (without Capacitive filter),

$$\begin{aligned} V_{out} &= V_{+} \quad ,when\ \sin(2\pi vt) > 0 \\ &= V_{-} \quad ,when\ \sin(2\pi vt) \le 0 \end{aligned}$$

Ripple Factor:

Ripple is the residual periodic variation of the DC voltage within a power supply which has been derived from an alternating current (AC) source.

$$r_{without\ filter} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} = 0.482\ (approx)$$

$$r_{with\ filter} = \frac{1}{4\sqrt{3}vRC}$$

Here we get the less value of ripple factor in compared to Half Wave Rectifier as we know that here we get values from 2 waves as a result we can see that flattening occurs rapidly in comparison with the Half Wave Rectifier.

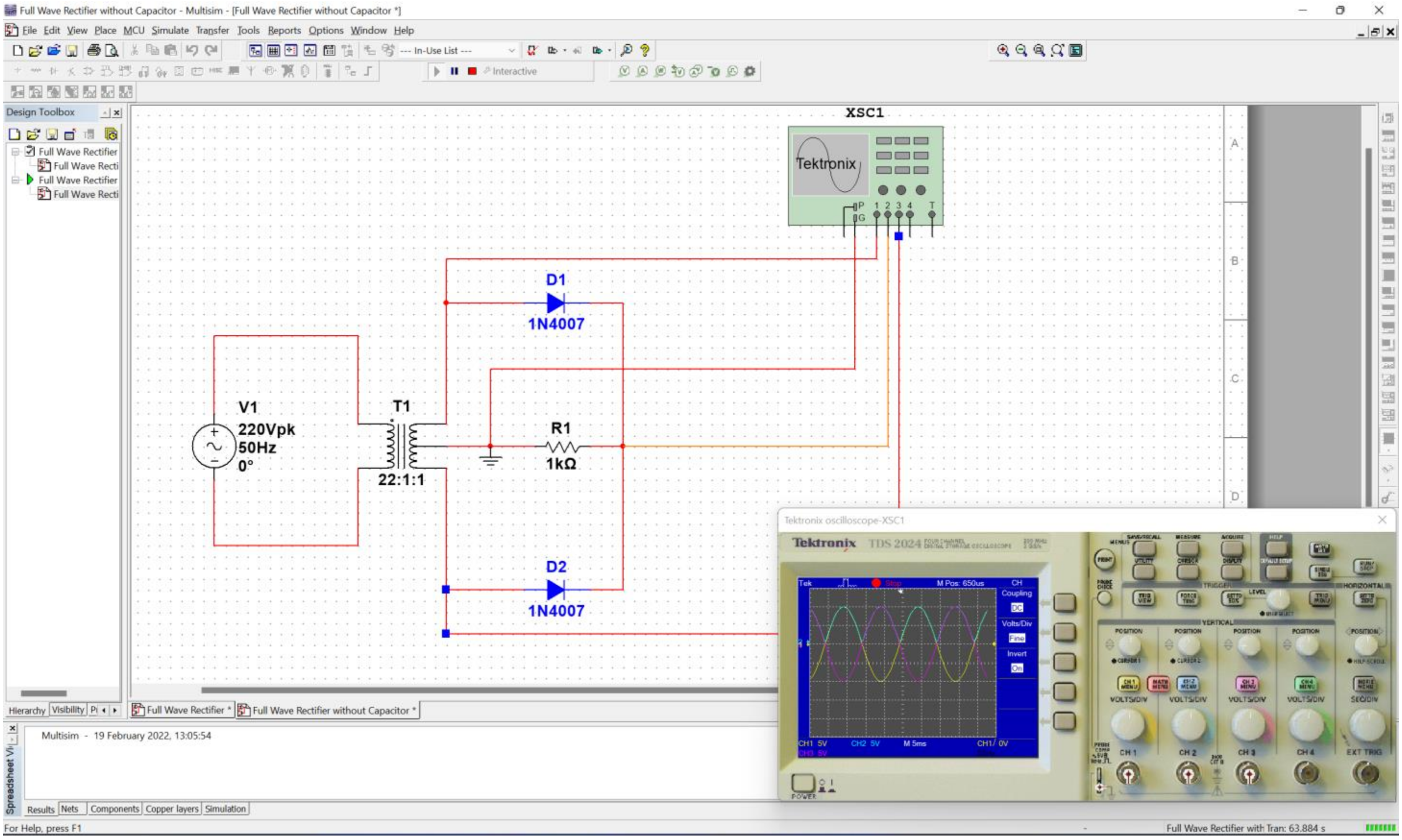
Hence, we get the lower value of Ripple factor here (which is approximately half).

Observations:

Full Wave Rectifier (without Capacitive filter):

Without Capacitive filter we get Positive portion of the input AC waves as the output DC wave because of the forward junction of both of the diodes one by one.

When the input voltage is negative then output voltage gets the same value input voltage because here D2 works in place of D1 for the output voltage.



Here we get the Blue wave as the output wave from the Yellow input wave from D1 and Pink input wave from D2.

Here the equations are as follows,

Input AC Voltage (Yellow Wave),

$$V_{initial} = 220\sin(100\pi t)\,V$$

$$V_+ = \frac{1}{22}220\sin(100\pi t)\,V = 10\sin(100\pi t)\,V$$

$$V_- = -\frac{1}{22}220\sin(100\pi t)\,V = -10\sin(100\pi t)\,V$$

Output DC Voltage (Blue Wave),

$$V_{out} = 10\sin(100\pi t) \quad , when\ \ \sin(100\pi t) > 0$$

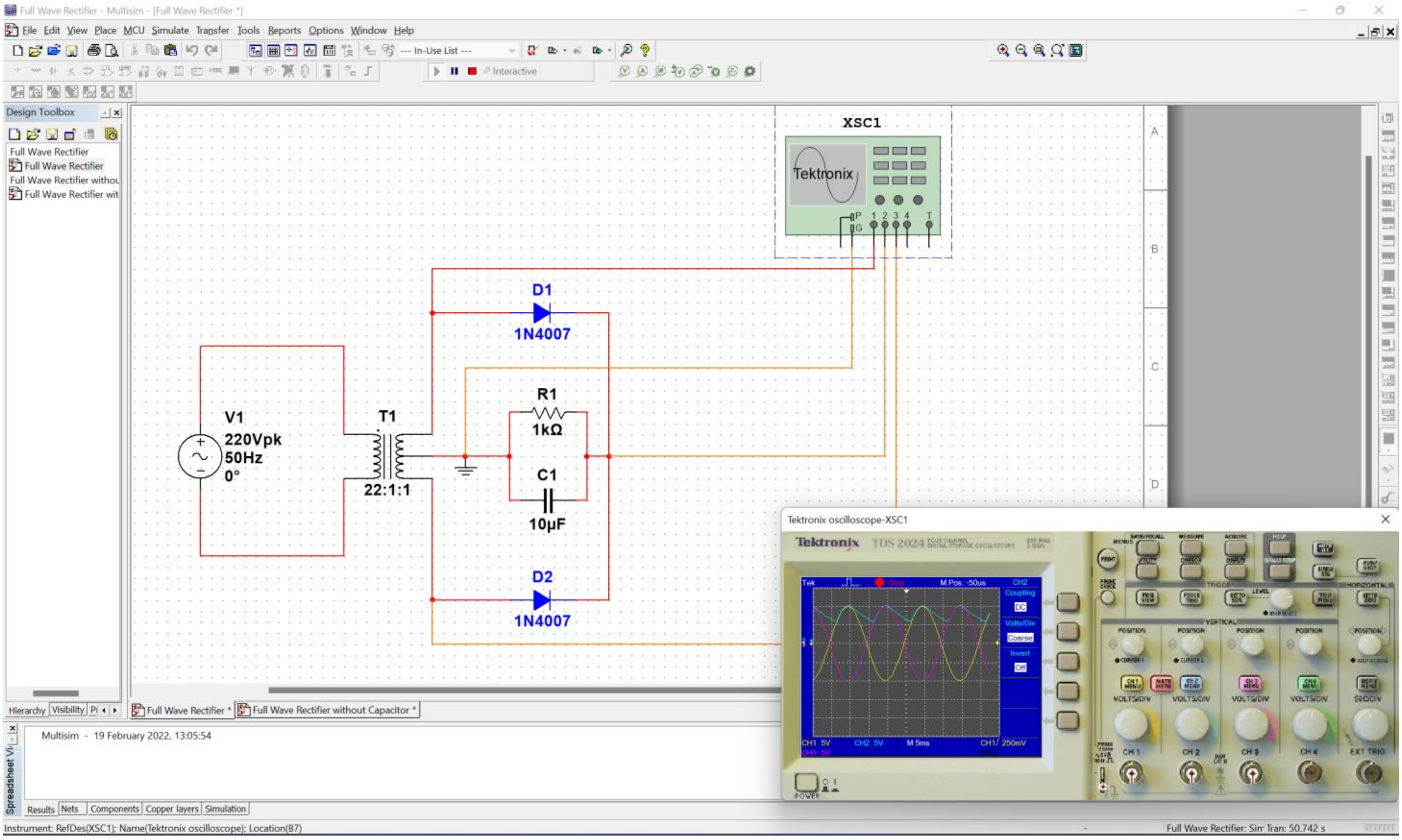
$$\quad = -10\sin(100\pi t) \quad , when\ \ \sin(100\pi t) \le 0$$

Ripple Factor,

$$r_{without\ filter} = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} = 0.482\ (approx)$$

Full Wave Rectifier (with Capacitive filter):
With capacitive filter we can get some ripples and we can manage ripples value using value of Capacitor i.e. either we increase or decrease them.
Capacitor do it using charging and discharging.

Case I (Capacitor = 10 micro farad):



Here we get ripples as Blue wave from the Yellow input wave from D1 and Pink input wave from D2.
Here the equations are as follows,

Input AC Voltage (Yellow Wave),

$$V_{initial} = 220\sin(100\pi t)\,V$$

$$V_{+} = \frac{1}{22}220\sin(100\pi t)\,V = 10\sin(100\pi t)\,V$$

$$V_{-} = -\frac{1}{22}220\sin(100\pi t)\,V = -10\sin(100\pi t)\,V$$

$$R = 1000\ ohm$$

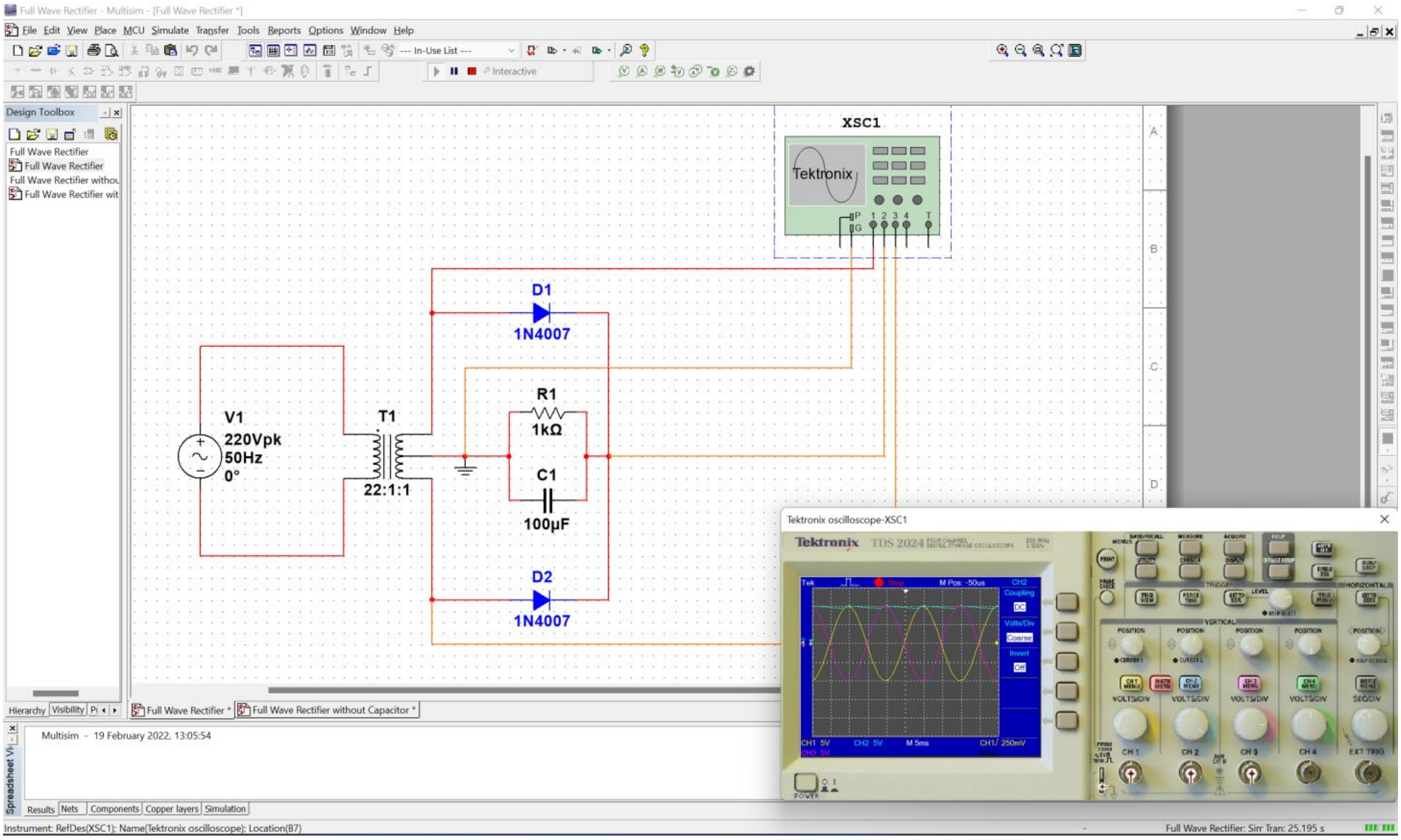
$$C = 10\ X\ 10^{-6}\ f$$

$$v = 50\ Hz$$

Ripple Factor,

$$r_{with\ filter} = \frac{1}{4\sqrt{3}vRC} = \frac{10^{6}}{4\sqrt{3}\ X\ 50\ X\ 10^{3}\ X\ 10} = 0.2885$$

Case II (Capacitor = 100 micro farad):



Here we get ripples as Blue wave (less bumps than previous case) from Yellow input wave from D1 and Pink input wave from D2.

Here the equations are as follows,

Input AC Voltage (Yellow Wave),

$$V_{initial} = 220\sin(100\pi t)\,V$$

$$V_{+} = \frac{1}{22}220\sin(100\pi t)\,V = 10\sin(100\pi t)\,V$$

$$V_{-} = -\frac{1}{22}220\sin(100\pi t)\,V = -10\sin(100\pi t)\,V$$

$$R = 1000\ ohm$$

$$C = 100\ X\ 10^{-6}\ f$$

$$v = 50\ Hz$$

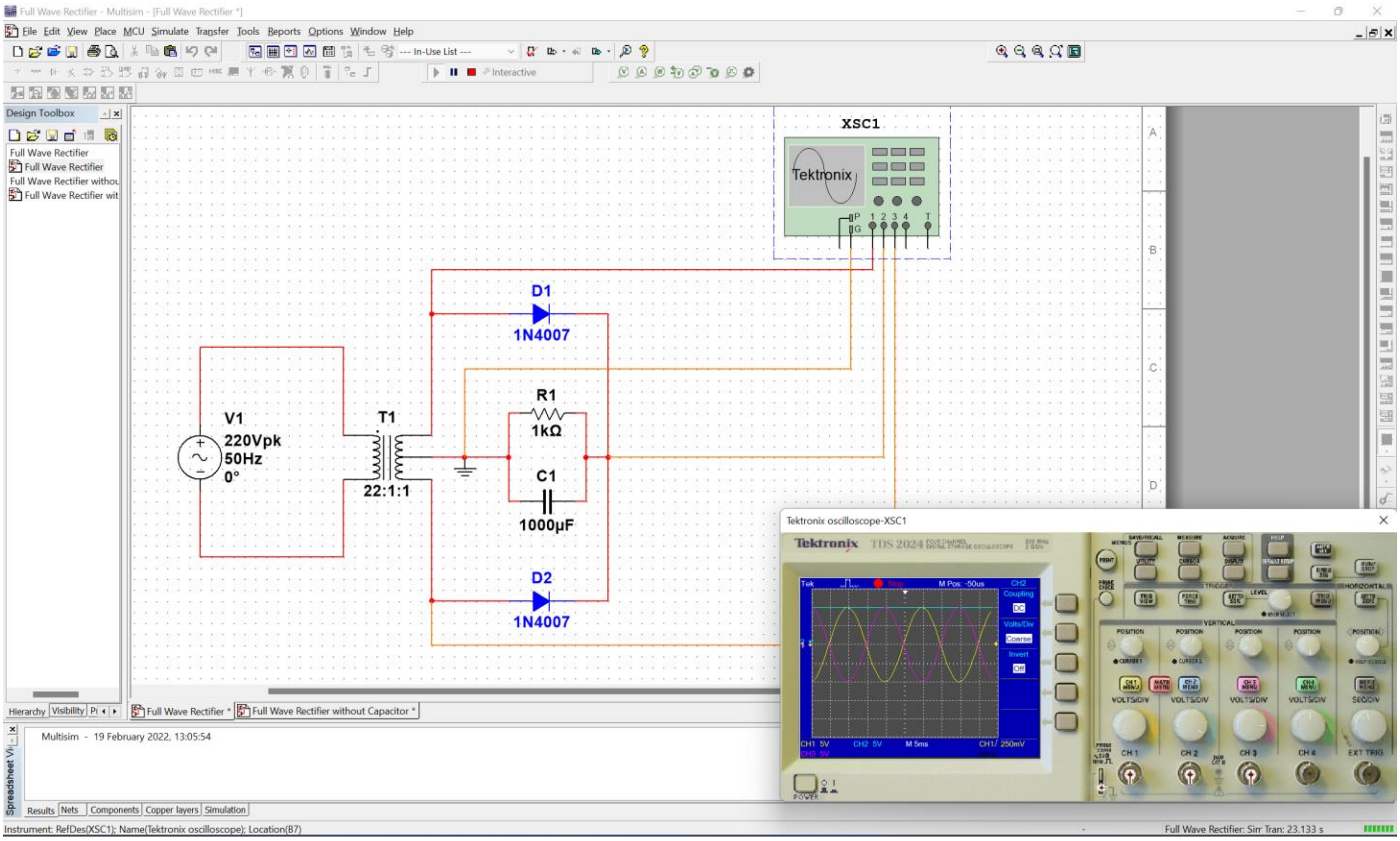
Ripple Factor,

$$r_{with\ filter} = \frac{1}{4\sqrt{3}vRC} = \frac{10^{6}}{4\sqrt{3}\ X\ 50\ X\ 10^{3}\ X\ 100} = 0.02885$$

As here Ripple factor is less than the case I,

It means and shows that here we get less bumps in the output wave that is less ripples as compared to the previous case.

Case III (Capacitor = 1k micro farad):



Here we get ripples as Blue wave (negligible) from the Yellow input wave from D1 and Pink input wave from D2.

Here the equations are as follows,

Input AC Voltage (Yellow Wave),

$$V_{initial} = 220\sin(100\pi t)\,V$$

$$V_{+} = \frac{1}{22}220\sin(100\pi t)\,V = 10\sin(100\pi t)\,V$$

$$V_{-} = -\frac{1}{22}220\sin(100\pi t)\,V = -10\sin(100\pi t)\,V$$

$$R = 1000\ ohm$$

$$C = 1k\ X\ 10^{-6}\ f$$

$$v = 50\ Hz$$

Ripple Factor,

$$r_{with\ filter} = \frac{1}{4\sqrt{3}vRC} = \frac{10^6}{4\sqrt{3}\ X\ 50\ X\ 10^3\ X\ 10^3} = 0.00288$$

Here we can see that output wave is nearly a straight line.

because here Ripple factor is less than the case I and case II,

It means and shows that here we get less bumps in the output wave that is less ripples as compared to the previous cases.