MP309

Experiment 9

Full Wave Rectification

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List of Figures

Figure 1: A rectifier is a device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers are essentially of two types – a half wave rectifier and a full wave rectifier.

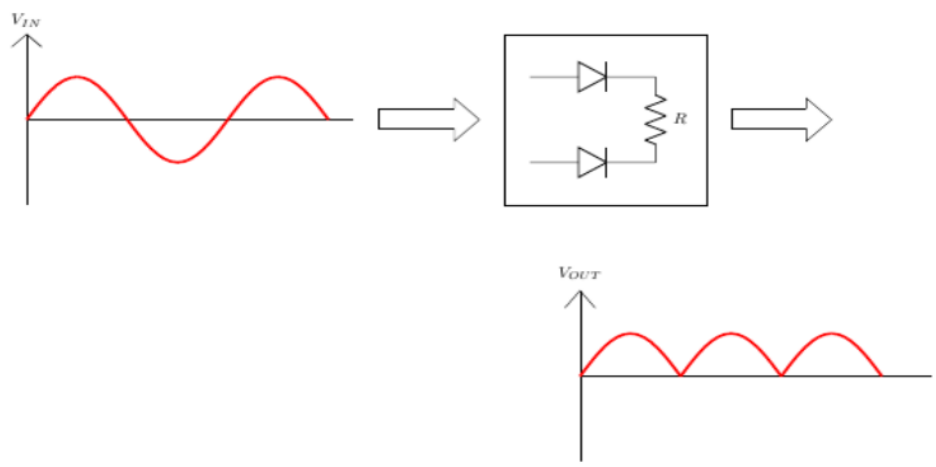


Figure 2: Full Wave Rectifier

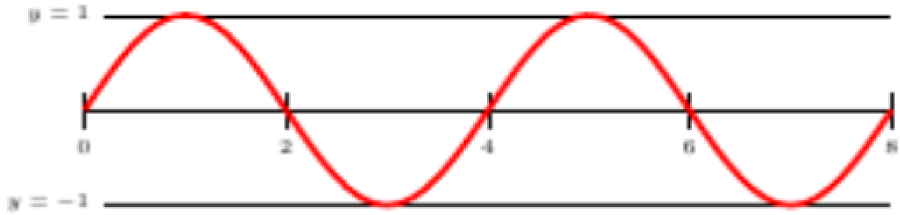


Figure:7

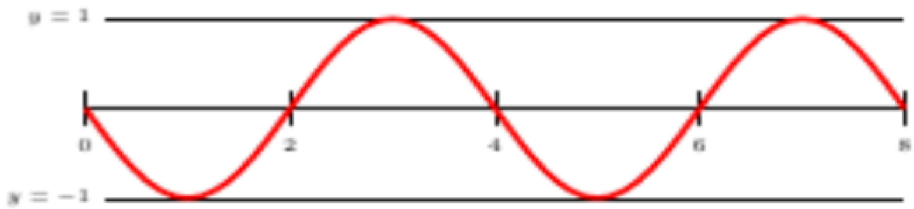


Figure:8

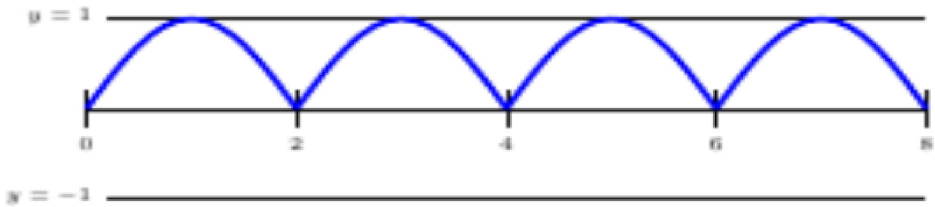


Figure 3: Full Wave Rectifier - Waveforms

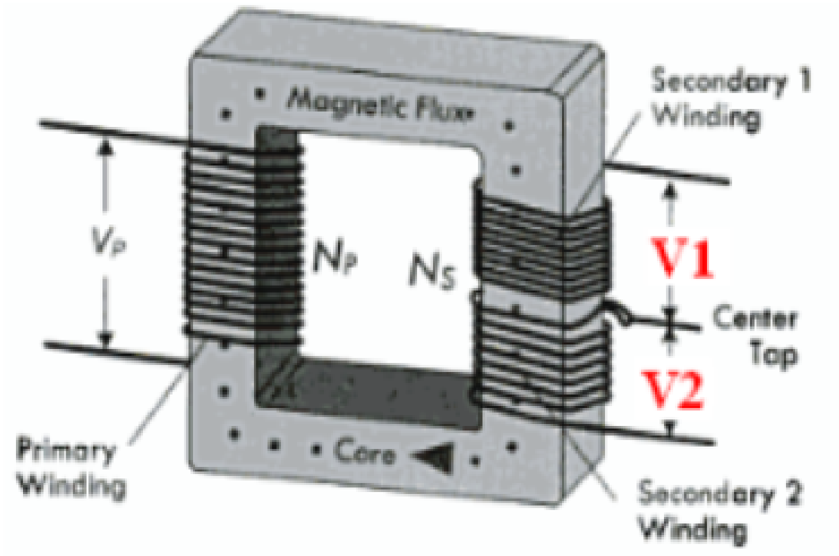


Figure 4: Full Wave Rectifier - Center Tapped Transformer

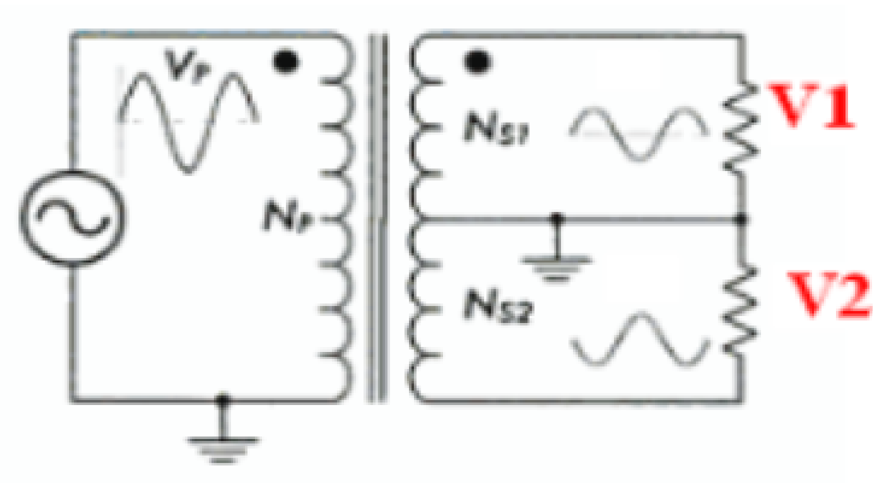


Figure 5: Full Wave Rectifier - Center Tapped Transformer Circuit

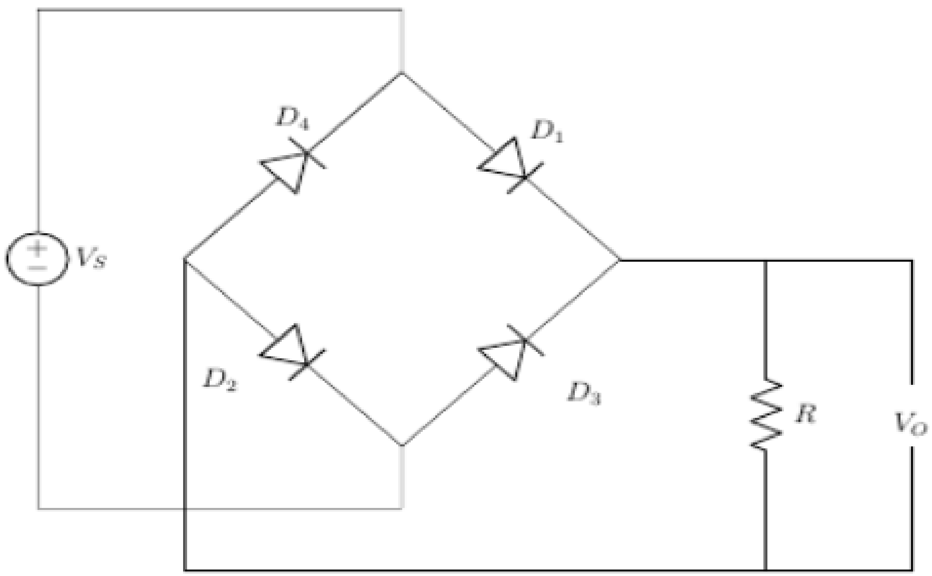


Figure 6: Bridge Rectifier Circuit

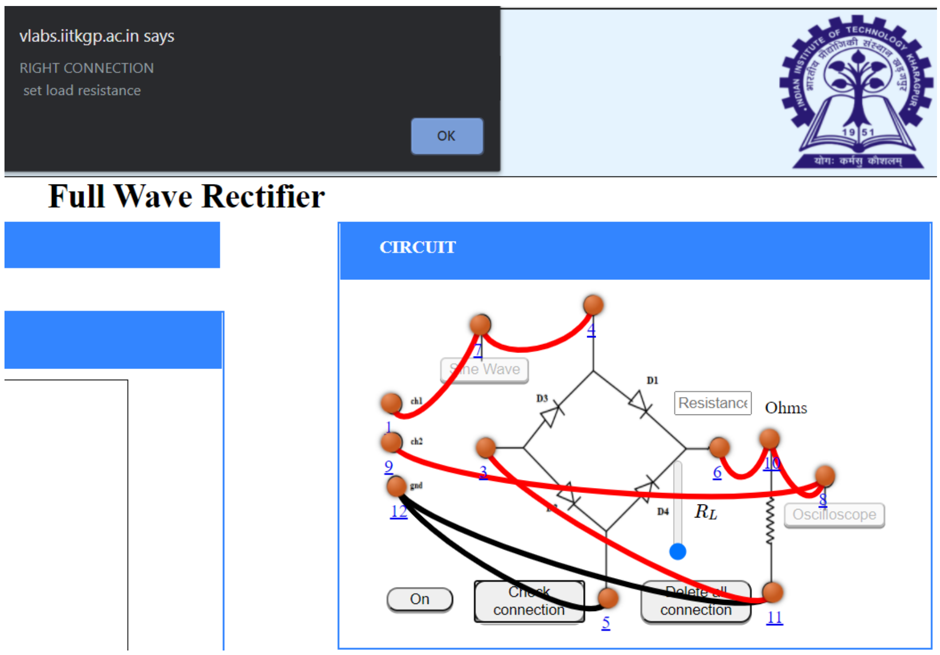


Figure 7: Connections

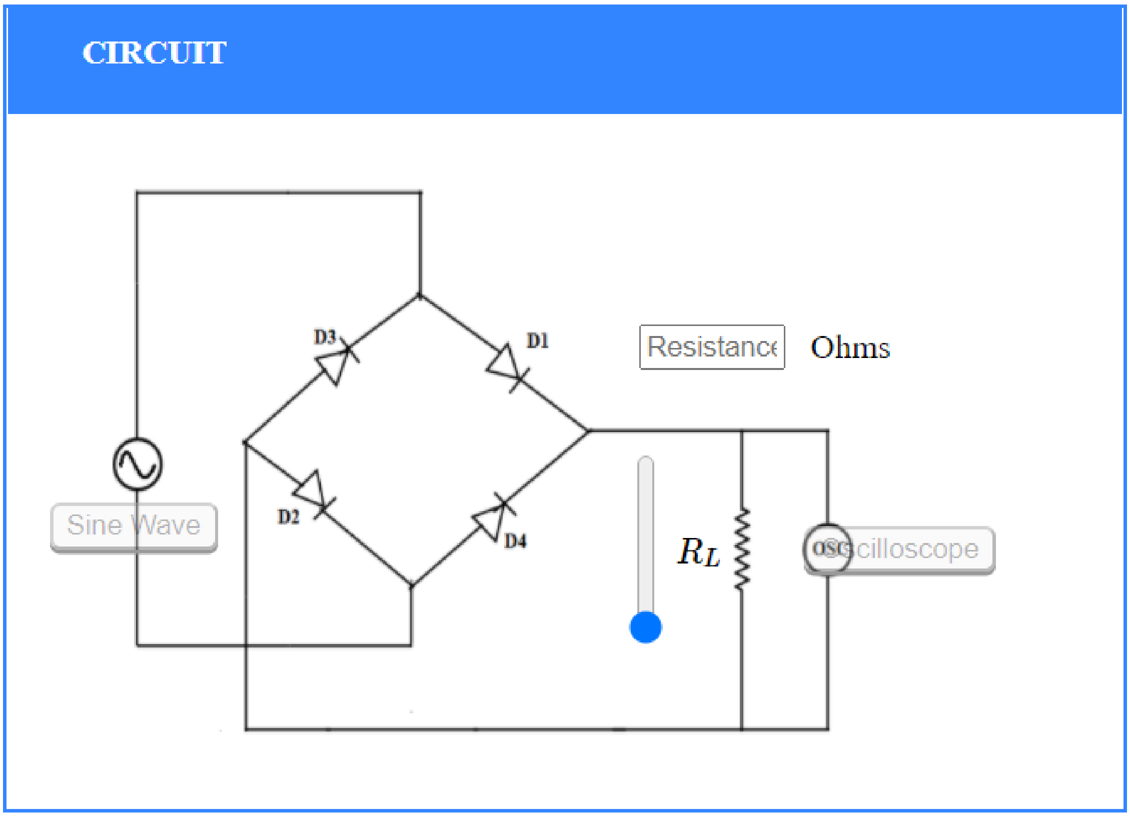


Figure 8: Circuit Used in Experiment

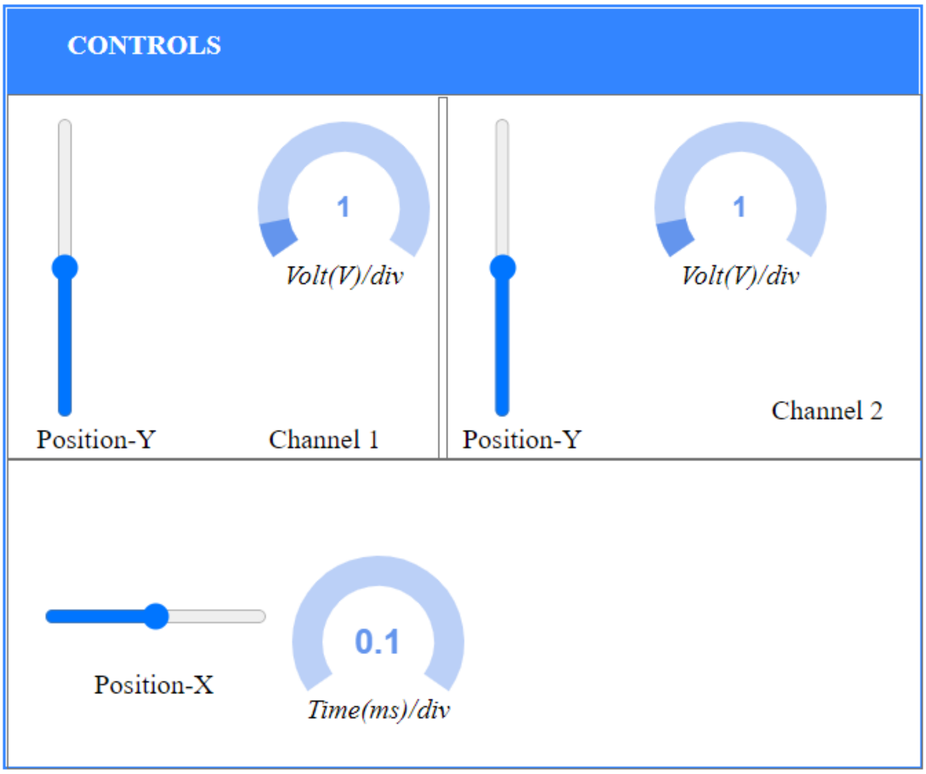


Figure 9: Controls

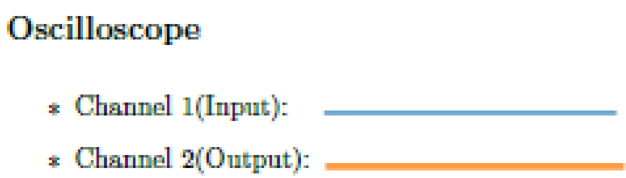


Figure 10: Oscilloscope Channel representation

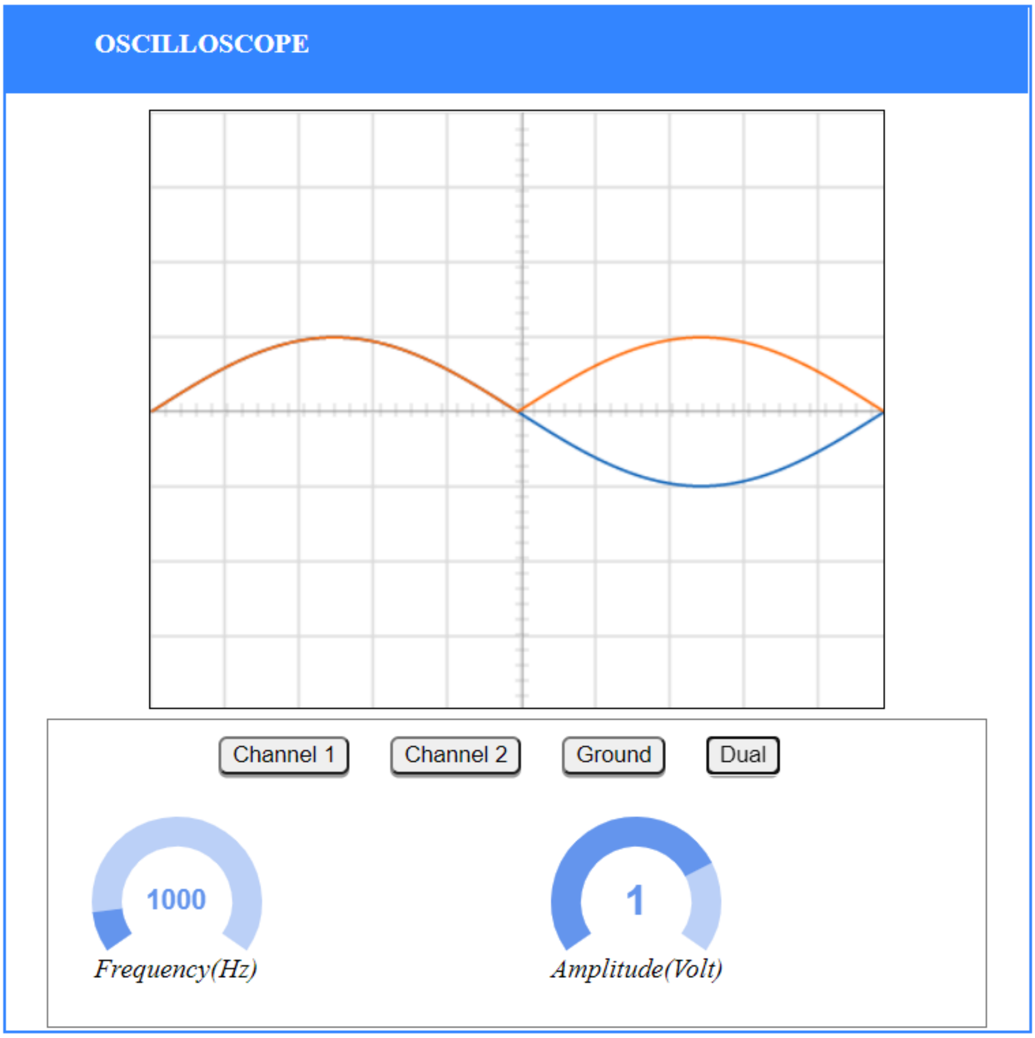


Figure 11: $Full\ Wave\ Rectifier\ for\ Frequency = 1000Hz$

$Frequency = (1/TimePeriod)$

$Time\ Period = (1/frequency)$

i.e. $Time\ Period = (1/1000) = 1msec$

$Amplitude\ (Volt/div) = 1V$

$Time(ms)/div = 0.1ms$

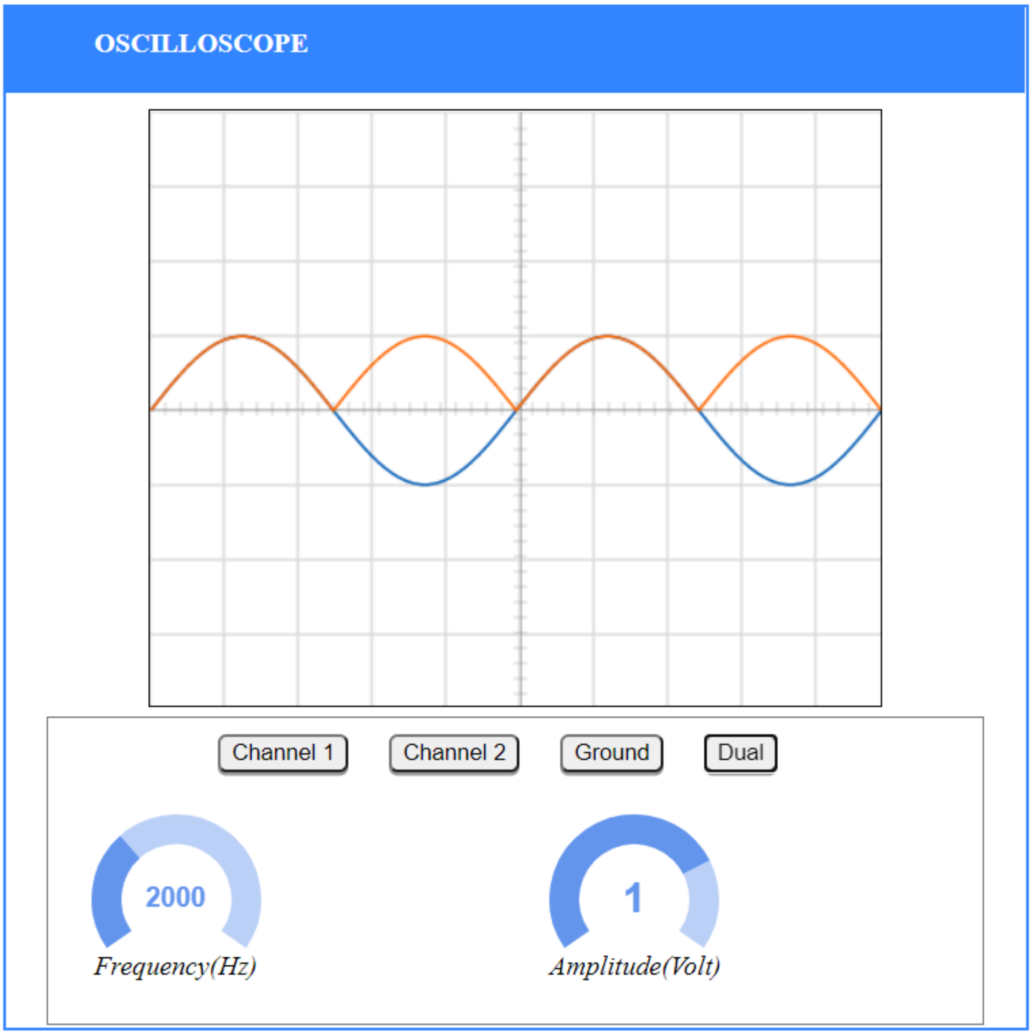


Figure 12: $Full\ Wave\ Rectifier\ for\ Frequency = 2000Hz$

$Time\ Period = (1/frequency)$

i.e. $Time\ Period = (1/2000) = 0.5msec$

$Amplitude\ (Volt/div) = 1V$

$Time(ms)/div = 0.1ms$

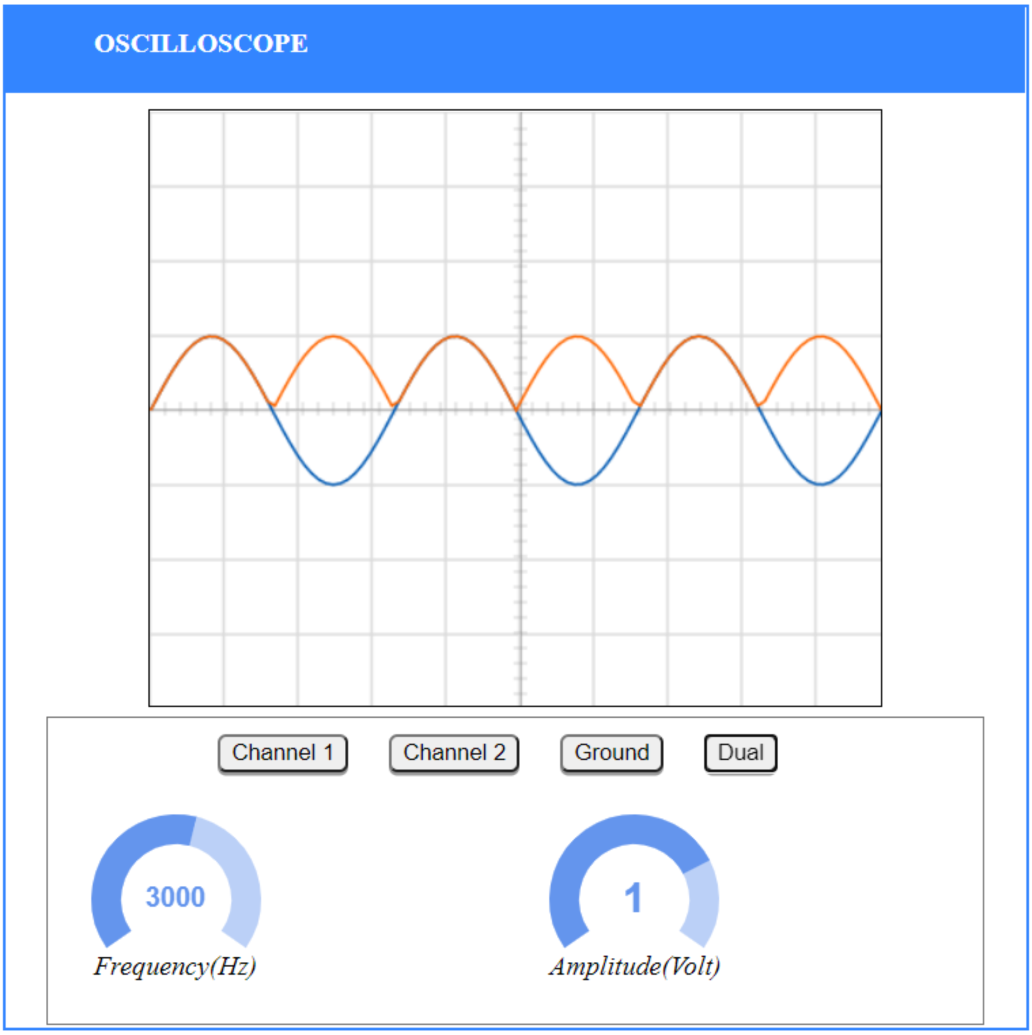


Figure 13: $Full\ Wave\ Rectifier\ for\ Frequency = 3000Hz$

$Frequency = (1/TimePeriod)$

$Time\ Period = (1/frequency)$

i.e. $Time\ Period = (1/3000) = 0.333msec$

$Amplitude\ (Volt/div) = 1V$

$Time(ms)/div = 0.1ms$

Figure 14: $Full\ Wave\ Rectifier\ for\ Frequency = 4000Hz$

$Frequency = (1/TimePeriod)$

$Time\ Period = (1/frequency)$

i.e. $Time\ Period = (1/4000) = 0.25msec$

$Amplitude\ (Volt/div) = 1V$

$Time(ms)/div = 0.1ms$

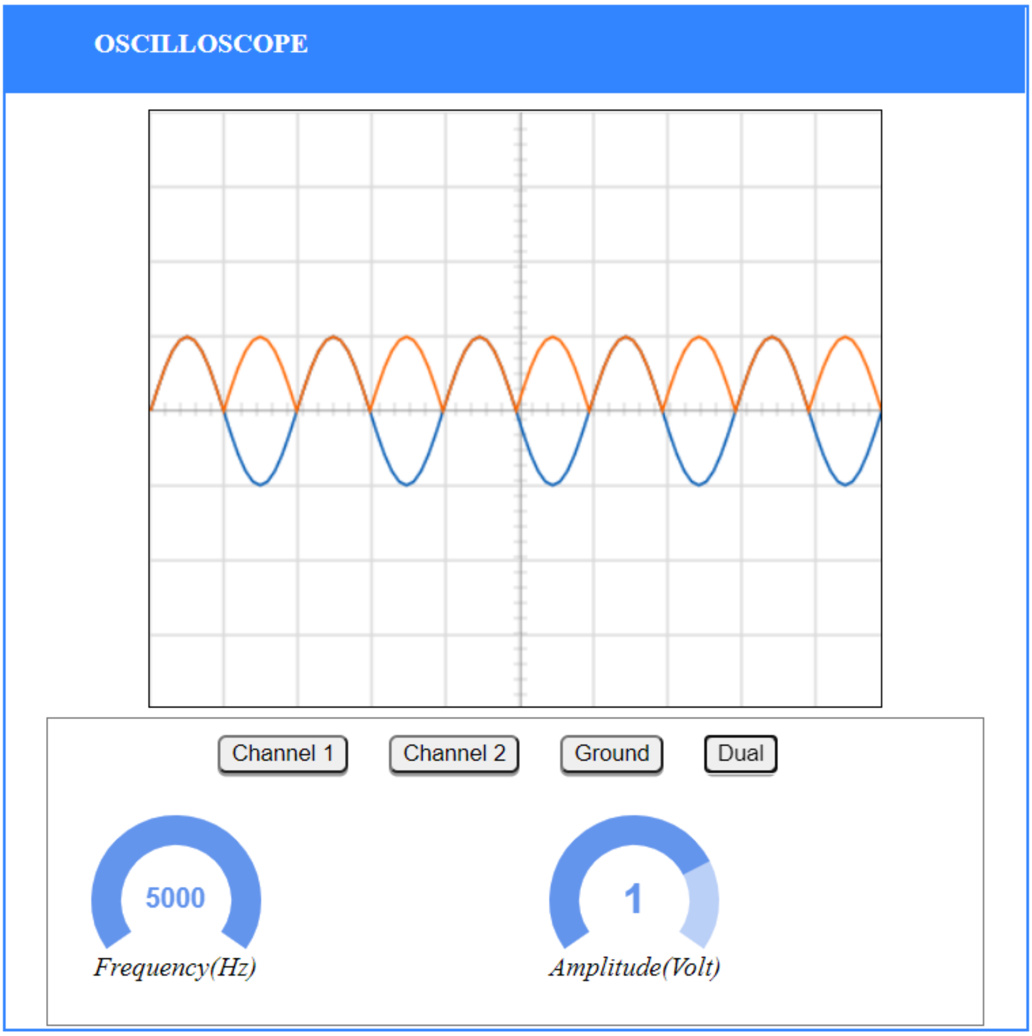


Figure 15: $Full\ Wave\ Rectifier\ for\ Frequency = 5000Hz$

$Frequency = (1/TimePeriod)$

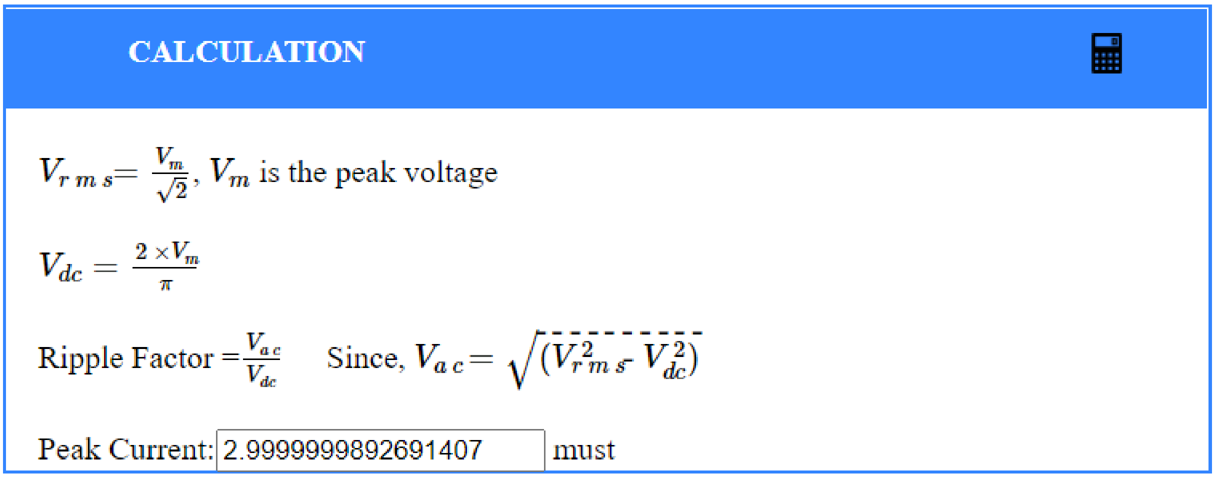
$Time\ Period = (1/frequency)$

i.e. $Time\ Period = (1/5000) = 0.2msec$

$Amplitude\ (Volt/div) = 1V$

$Time(ms)/div = 0.1ms$

Figure 16: Calculation for $R_L = 100\Omega$



1) $Peak\ Current,\ I_m = 2.99mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 2.99/3.14 = 1.904mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt{(}2) = 2.99/1.41 = 2.114mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (2.114A)^2 \times 100\Omega \times 10^{-6}$

i.e. $P_{ac} = 446.89 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(1.904A)^2 \times 100\Omega \times 10^{-6}$

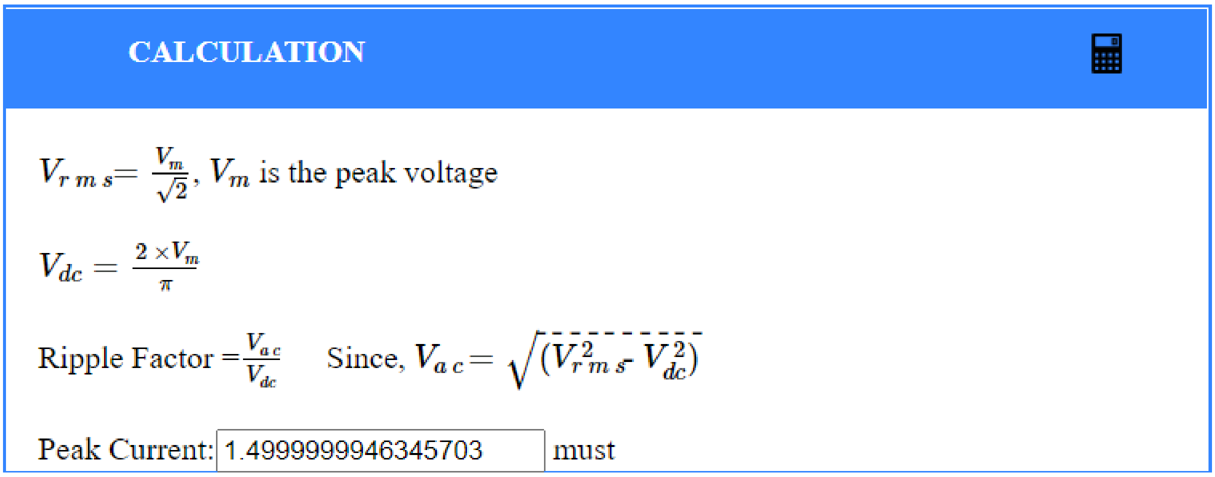
i.e. $P_{dc} = 362.5 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = P_{(}362.5 \times 10^{-6})/(446.89 \times 10^{-6}) \times 100 = 81.1\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((2.114 \times 10^{-3})/(1.904 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.48$

Figure 17: Calculation for $R_L = 200\Omega$



1) $Peak\ Current,\ I_m = 1.499mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 1.499/3.14 = 0.954mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt{(2)} = 1.499/1.414 = 1.06mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (1.06A)^2 \times 200\Omega \times 10^{-6}$

i.e. $P_{ac} = 224.72 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.954A)^2 \times 200\Omega \times 10^{-6}$

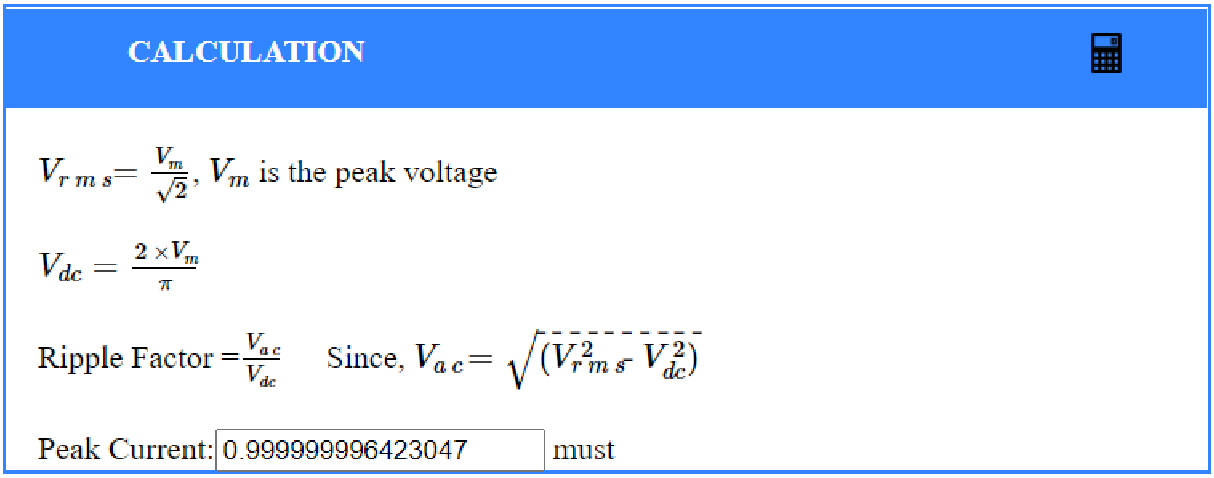
i.e. $P_{dc} = 182.02 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = (182.02 \times 10^{-6})/(224.72 \times 10^{-6}) \times 100 = 81\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((1.06 \times 10^{-3})/(0.954 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.48$

Figure 18: Calculation for $R_L = 300\Omega$



1) $Peak\ Current,\ I_m = 0.999mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.999/3.14 = 0.636mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt(2) = 0.999/1.414 = 0.706mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.706A)^2 \times 300\Omega \times 10^{-6}$

i.e. $P_{ac} = 149.53 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.636A)^2 \times 300\Omega \times 10^{-6}$

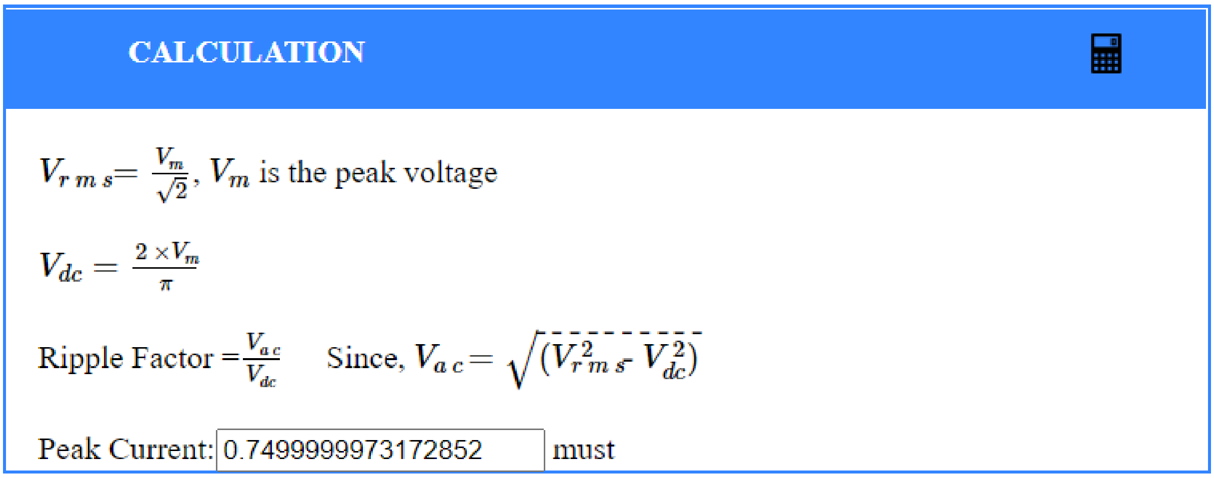
i.e. $P_{dc} = 121.35 \times 10^{-6}W$

6) $Efficiency{=}P_{dc}/P_{ac} \times 100{=}121.35 \times 10^{-6}/149.53 \times 10^{-6} \times 100 =81.15\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.706 \times 10^{-3})/(0.636 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.48$

Figure 19: Calculation for $R_L = 400\Omega$



1) $Peak\ Current,\ I_m = 0.7499mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.7499/3.14 = 0.477mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt{(2)} = 0.7499/1.414 = 0.530mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.530A)^2 \times 400\Omega \times 10^{-6}$

i.e. $P_{ac} = 112.5 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L$ =$(0.477A)^2 \times 400 \times 10^{-6}$

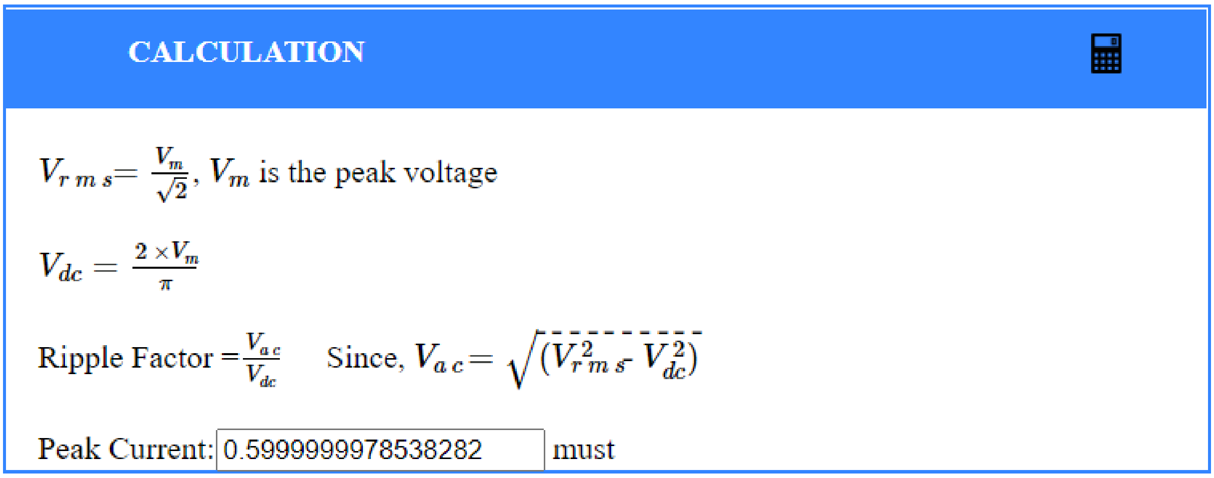
i.e. $P_{dc} = 91.01 \times 10^{-6}W$

6) $Efficiency$=$P_{dc}/P_{ac} \times 100$=$91.01 \times 10^{-6}/112.5 \times 10^{-6} \times 100$ =81%

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.530 \times 10^{-3})/(0.477 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor$ =0.48

Figure 20: Calculation for $R_L = 500\Omega$



1) $Peak\ Current,\ I_m = 0.599mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.599/3.14 = 0.381mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt{(2)} = 0.599/1.414 = 0.423mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.423A)^2 \times 500\Omega \times 10^{-6}$

i.e. $P_{ac} = 89.46 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L = (0.381A)^2 \times 500\Omega \times 10^{-6}$

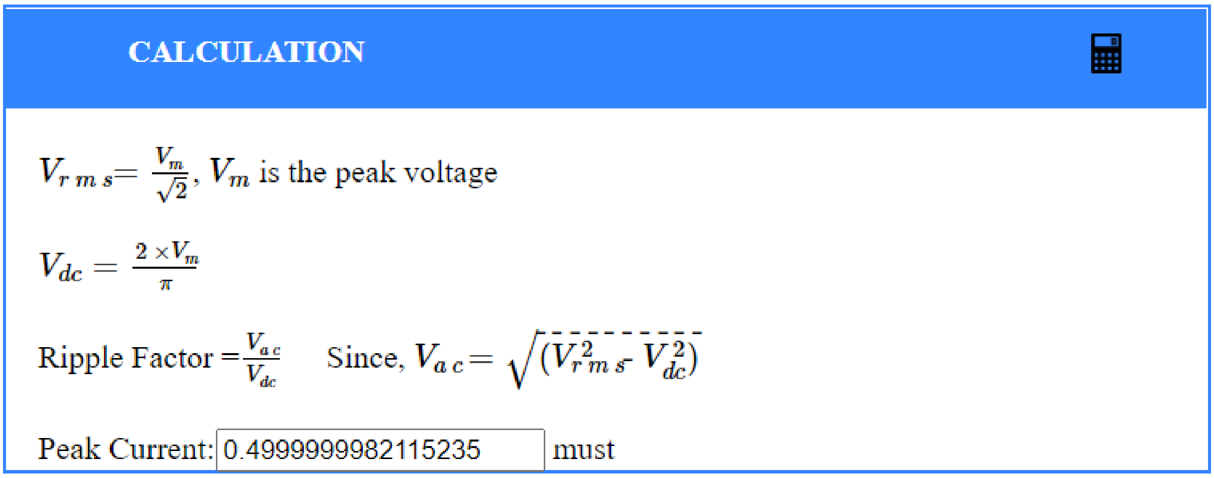
i.e. $P_{dc} = 72.58 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = 72.58 \times 10^{-6}/89.46 \times 10^{-6} \times 100 = 81.1\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.423 \times 10^{-3})/(0.381 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.48$

Figure 21: Calculation for $R_L = 600\Omega$



1) $Peak\ Current,\ I_m = 0.499mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.499/3.14 = 0.317mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt(2) = 0.499/1.414 = 0.353mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.353A)^2 \times 600\Omega \times 10^{-6}$

i.e. $P_{ac} = 74.76 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.317A)^2 \times 600\Omega \times 10^{-6}$

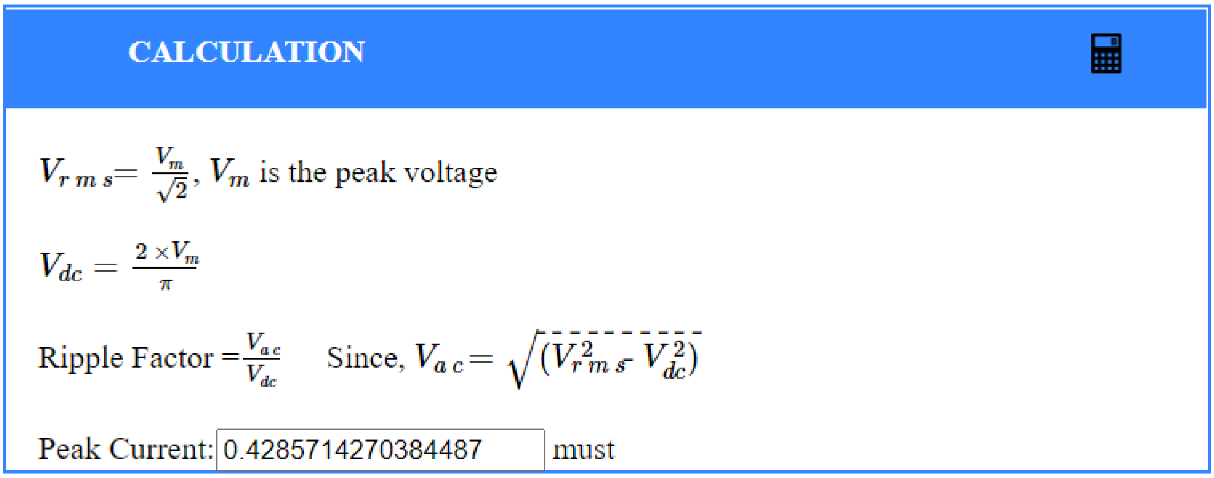
i.e. $P_{dc} = 60.29 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = 60.29 \times 10^{-6}/74.76 \times 10^{-6} \times 100 = 80.64\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.353 \times 10^{-3})/(0.317 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.48$

Figure 22: Calculation for $R_L = 700\Omega$



1) $Peak\ Current,\ I_m = 0.428mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.428/3.14 = 0.272mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt(2) = 0.428/1.414 = 0.302mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.302A)^2 \times 700\Omega \times 10^{-6}$

i.e. $P_{ac} = 63.84 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L = (0.272A)^2 \times 700\Omega \times 10^{-6}$

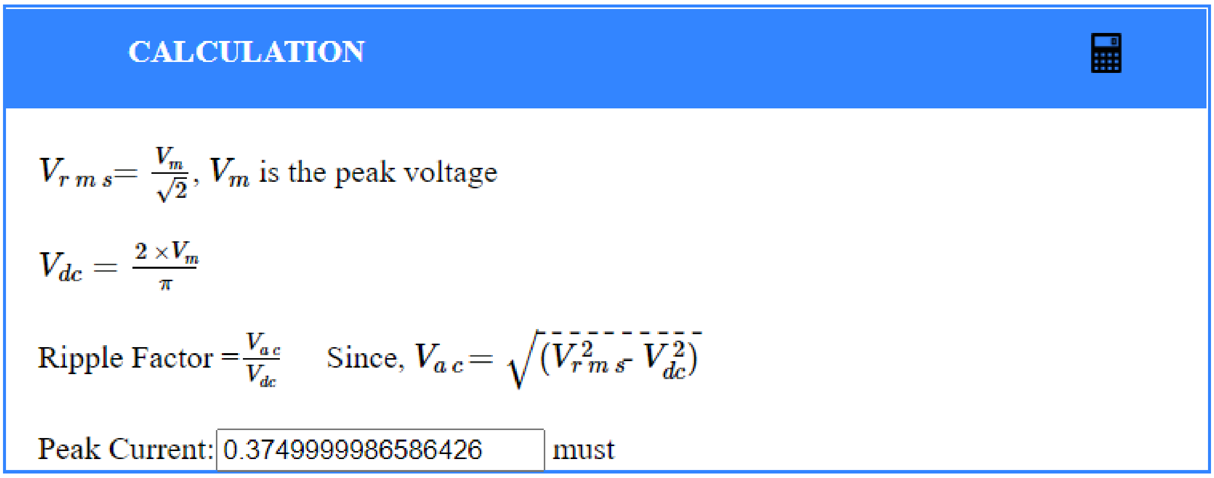
i.e. $P_{dc} = 51.78 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = 51.78 \times 10^{-6}/63.84 \times 10^{-6} \times 100 = 81.1\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.302 \times 10^{-3})/(0.272 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.48$

Figure 23: Calculation for $R_L = 800\Omega$



1) $Peak\ Current,\ I_m = 0.375mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.375/3.14 = 0.238mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt{(2)} = 0.35/1.414 = 0.265mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.265A)^2 \times 800\Omega \times 10^{-6}$

i.e. $P_{ac} = 56.18 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.238A)^2 \times 800\Omega \times 10^{-6}$

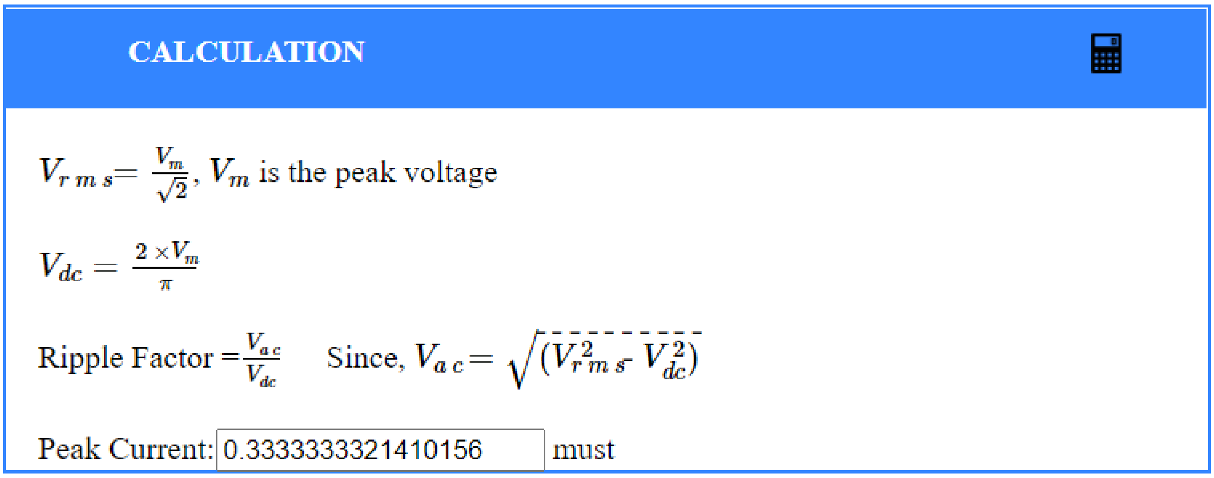
i.e. $P_{dc} = 45.31 \times 10^{-6}W$

6) $Efficiency{=}P_{dc}/P_{ac} \times 100{=}45.31 \times 10^{-6}/56.18 \times 10^{-6} \times 100 = 80.65\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.265 \times 10^{-3})/(0.238 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.48$

Figure 24: Calculation for $R_L = 900\Omega$



1) $Peak\ Current,\ I_m = 0.333mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.333/3.14 = 0.212mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt{(2)} = 0.333/1.414 = 0.235mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.235A)^2 \times 900\Omega \times 10^{-6}$

i.e. $P_{ac} = 49.70 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.212A)^2 \times 900\Omega \times 10^{-6}$

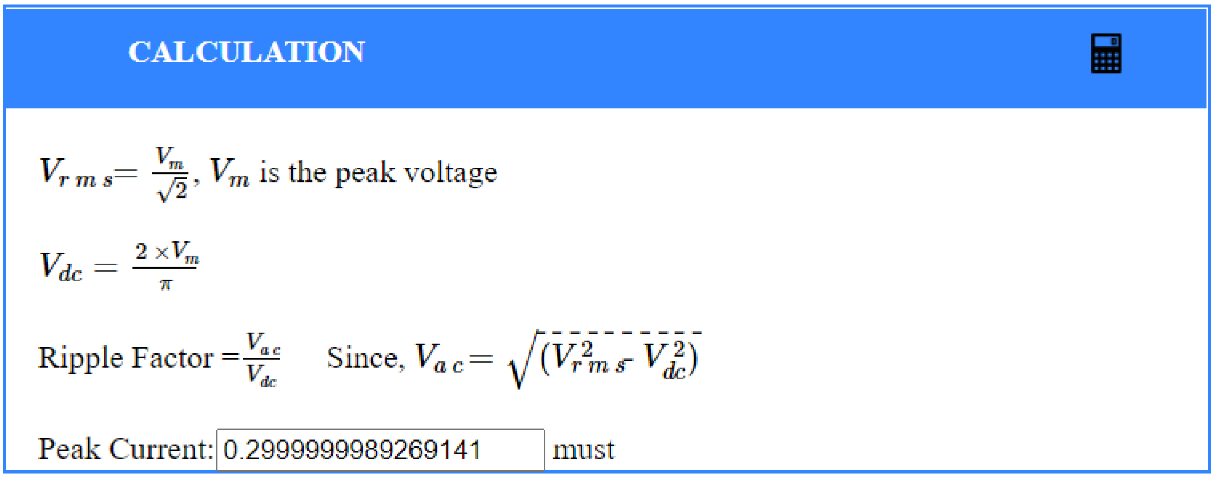
i.e. $P_{dc} = 40.45 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = 40.45 \times 10^{-6}/49.70 \times 10^{-6} \times 100 = 81.3\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.235 \times 10^{-3})/(0.212 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.477$

Figure 25: Calculation for $R_L = 1000\Omega$



1) $Peak\ Current,\ I_m = 0.299mA$

2) $Average\ DC\ Current,\ I_{av} = 2 \times I_m/\pi = 2 \times 0.299/3.14 = 0.190mA$

3) $RMS\ Current,\ I_{rms} = I_m/\sqrt{(2)} = 0.299/1.414 = 0.211mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.211A)^2 \times 1000\Omega \times 10^{-6}$

i.e. $P_{ac} = 44.52 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.190)^2 \times 1000\Omega \times 10^{-6}$

i.e. $P_{dc} = 36.1 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = 36.1 \times 10^{-6}/44.52 \times 10^{-6} \times 100 = 81.05\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.211 \times 10^{-3})/(0.190 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 0.46$