MP309

Experiment 8

Half 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.

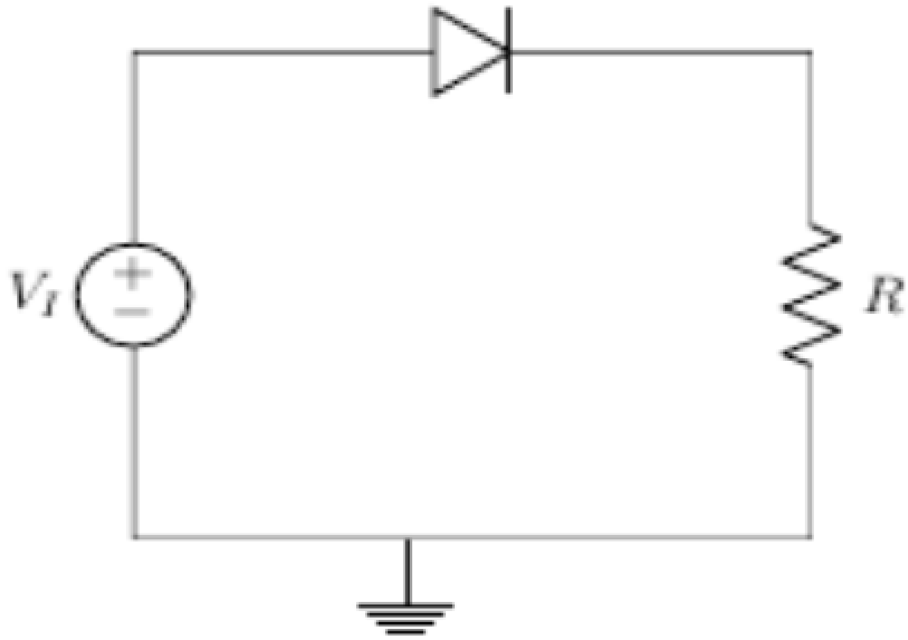


Figure 2: Half Wave Rectification Circuit Diagram

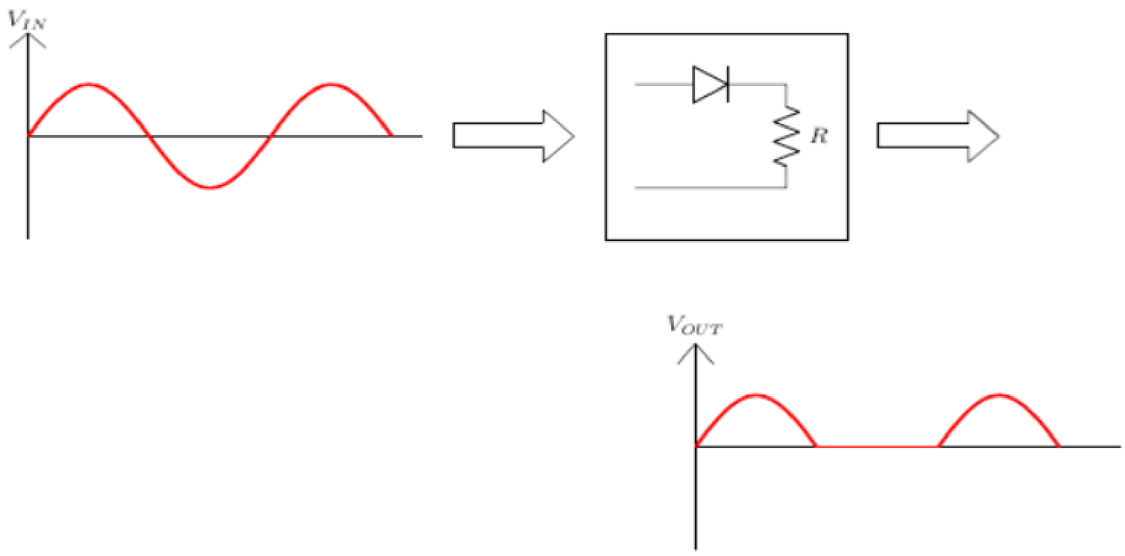


Figure 3: Half Wave Rectification

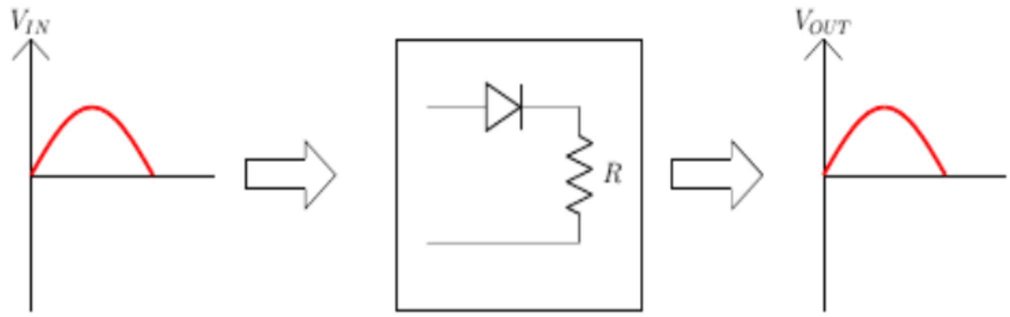


Figure 4: Positive Half Cycle

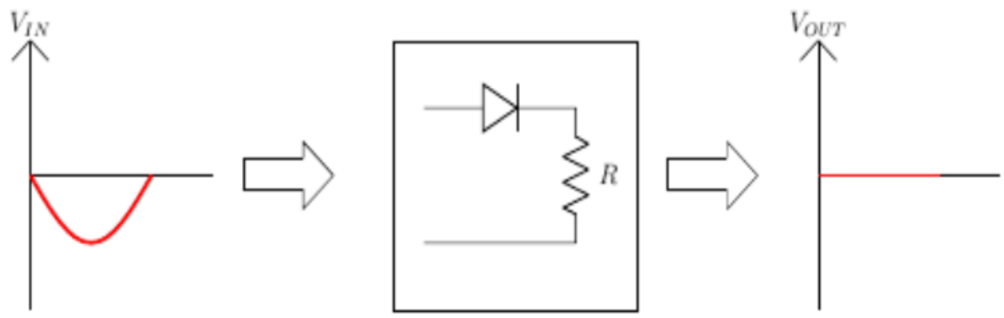


Figure 5: Negative Half Cycle

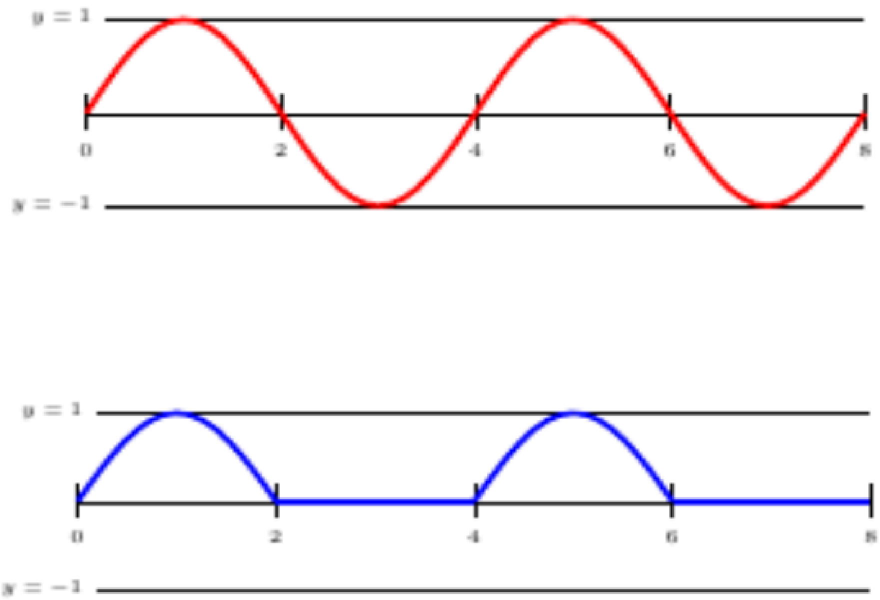


Figure 6: Half Wave Rectifiers - Waveforms

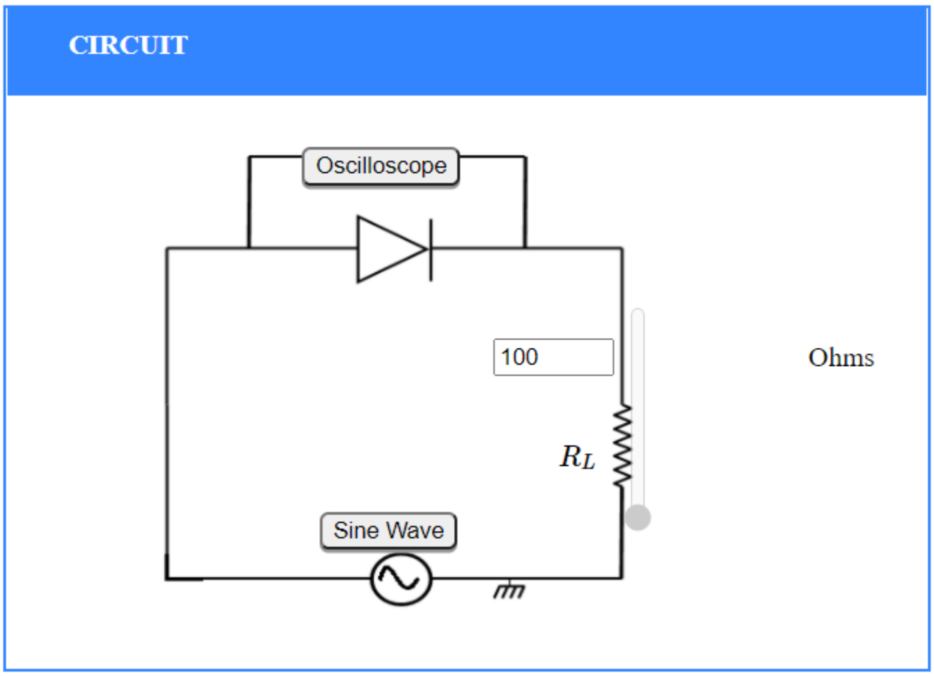


Figure 7: Half Wave Rectifier Circuit

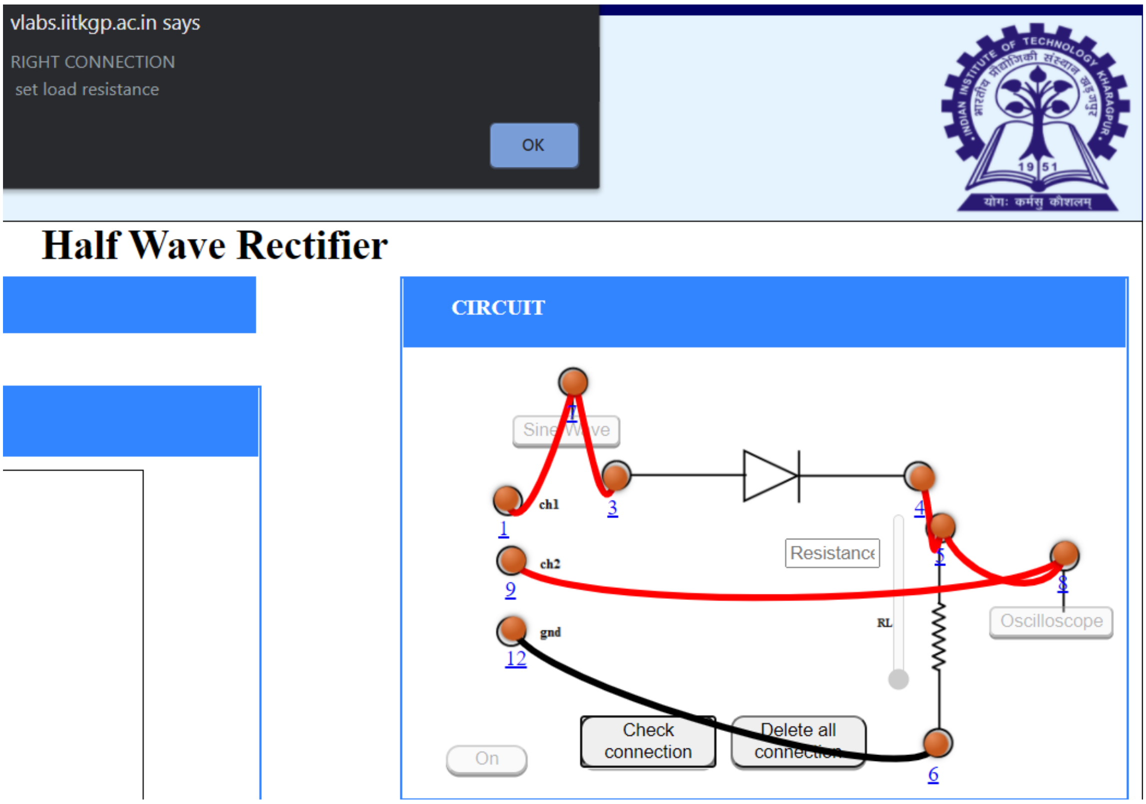


Figure 8: Circuit Connections

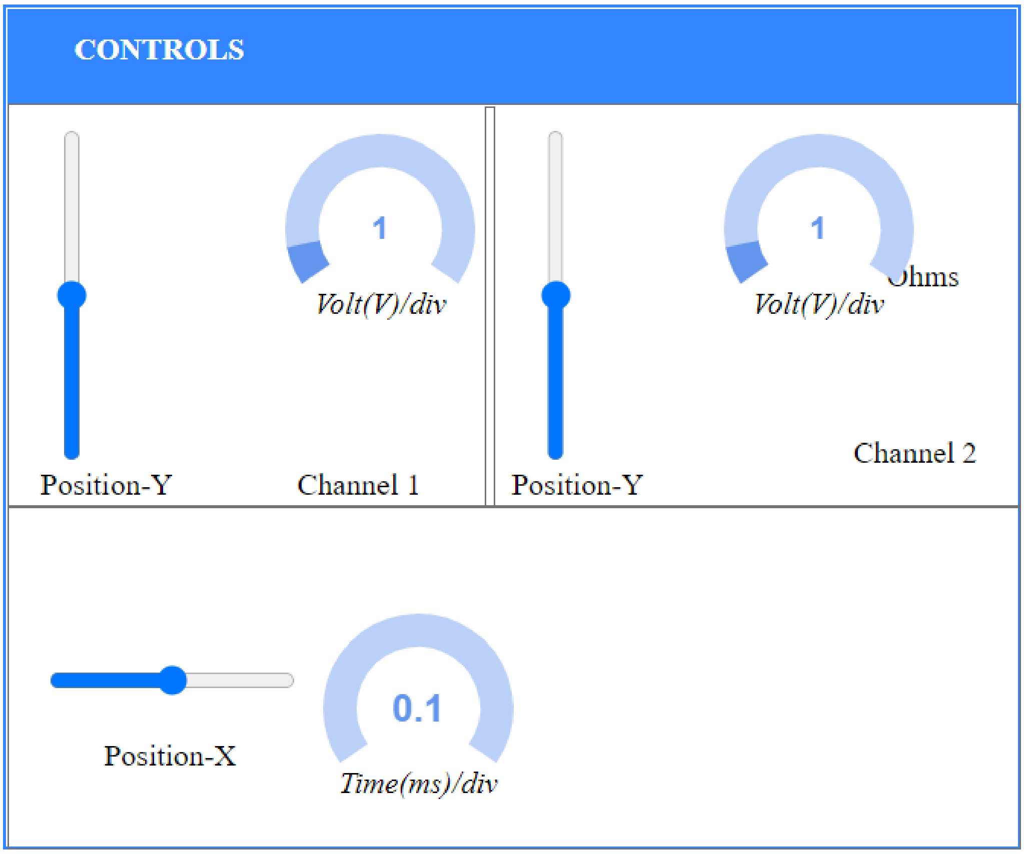


Figure 9: Controls

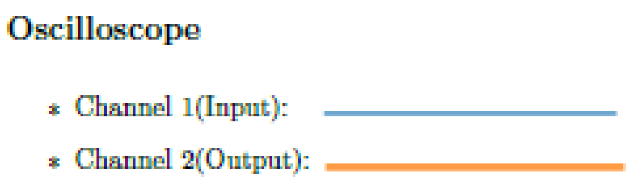


Figure 10: Oscilloscope Channel representation

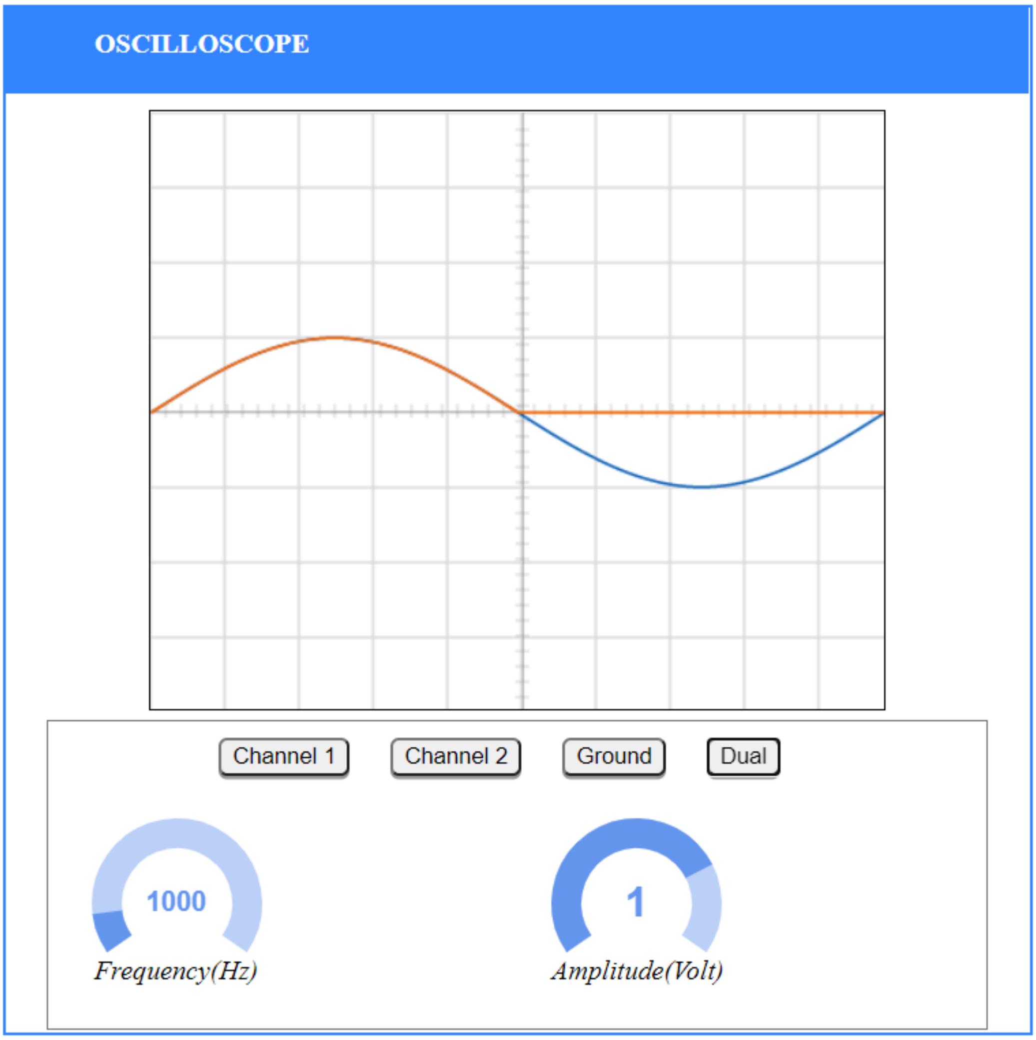


Figure 11: $Half\ Wave\ Rectifier\ for\ Frequency = 1000Hz$

$Frequency = (1/TimePeriod)$

$Time\ Period = (1/frequency)$

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

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

$Time(ms)/div = 0.1ms$

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

$Time\ Period = (1/frequency)$

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

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

$Time(ms)/div = 0.1ms$

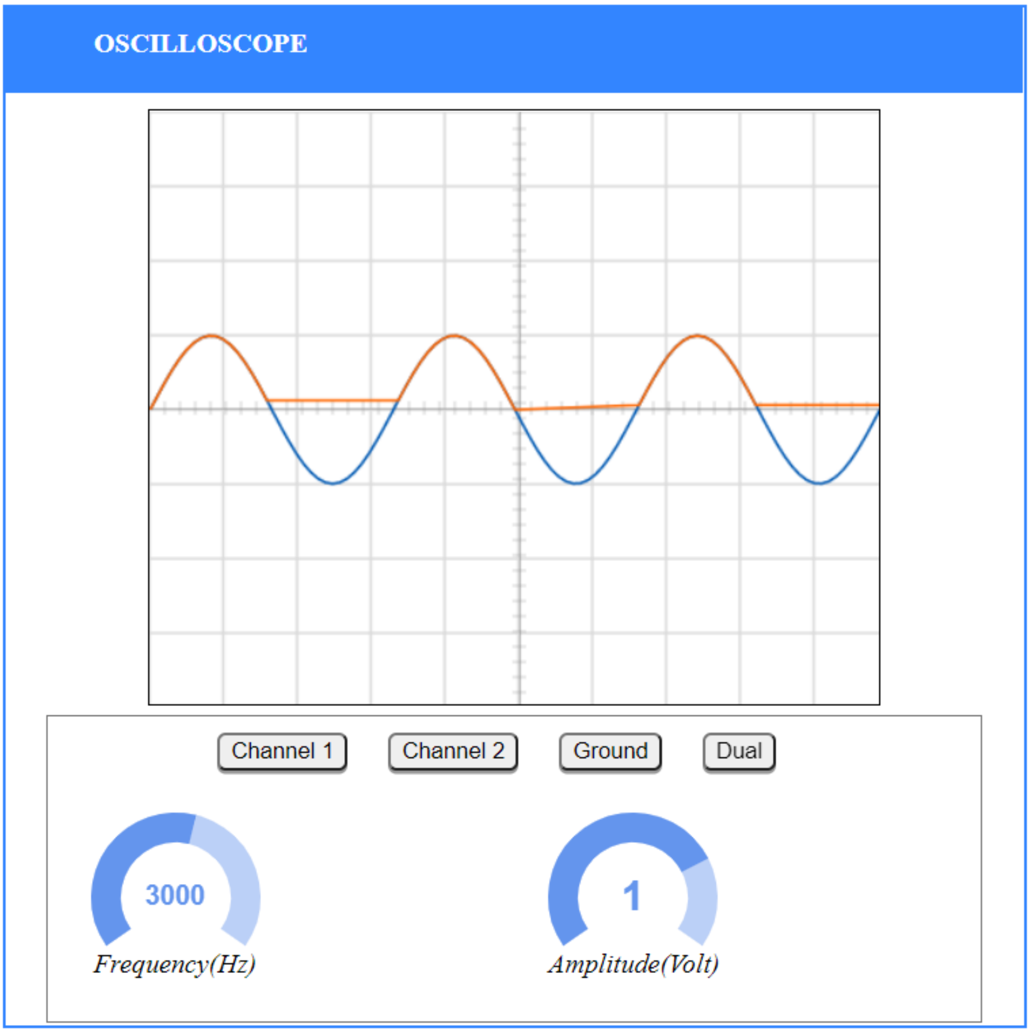


Figure 13: $Half\ Wave\ Rectifier\ for\ Frequency = 3000Hz$

$Frequency = (1/TimePeriod)$

$Time\ Period = (1/frequency)$

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

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

$Time(ms)/div = 0.1ms$

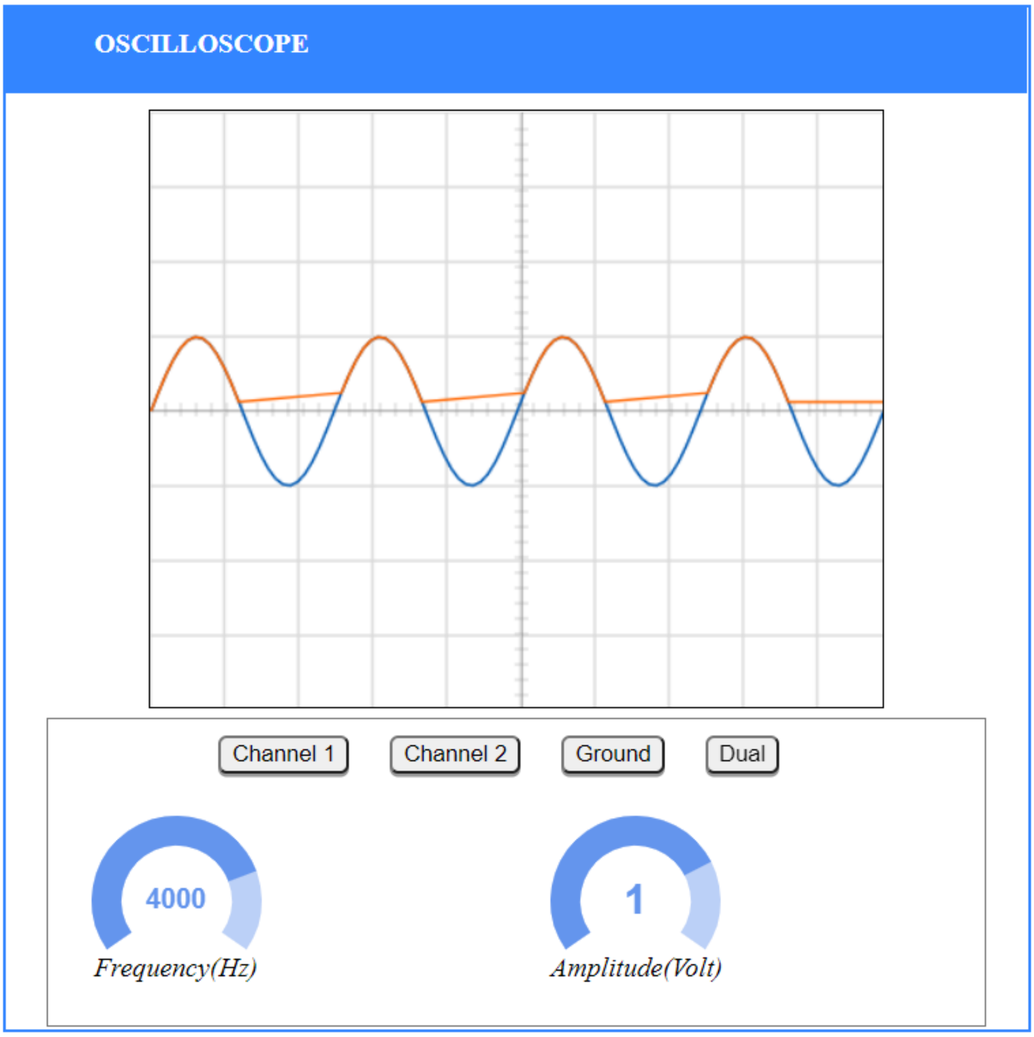


Figure 14: $Half\ Wave\ Rectifier\ for\ Frequency = 4000Hz$

$Frequency = (1/TimePeriod)$

$Time\ Period = (1/frequency)$

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

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

$Time(ms)/div = 0.1ms$

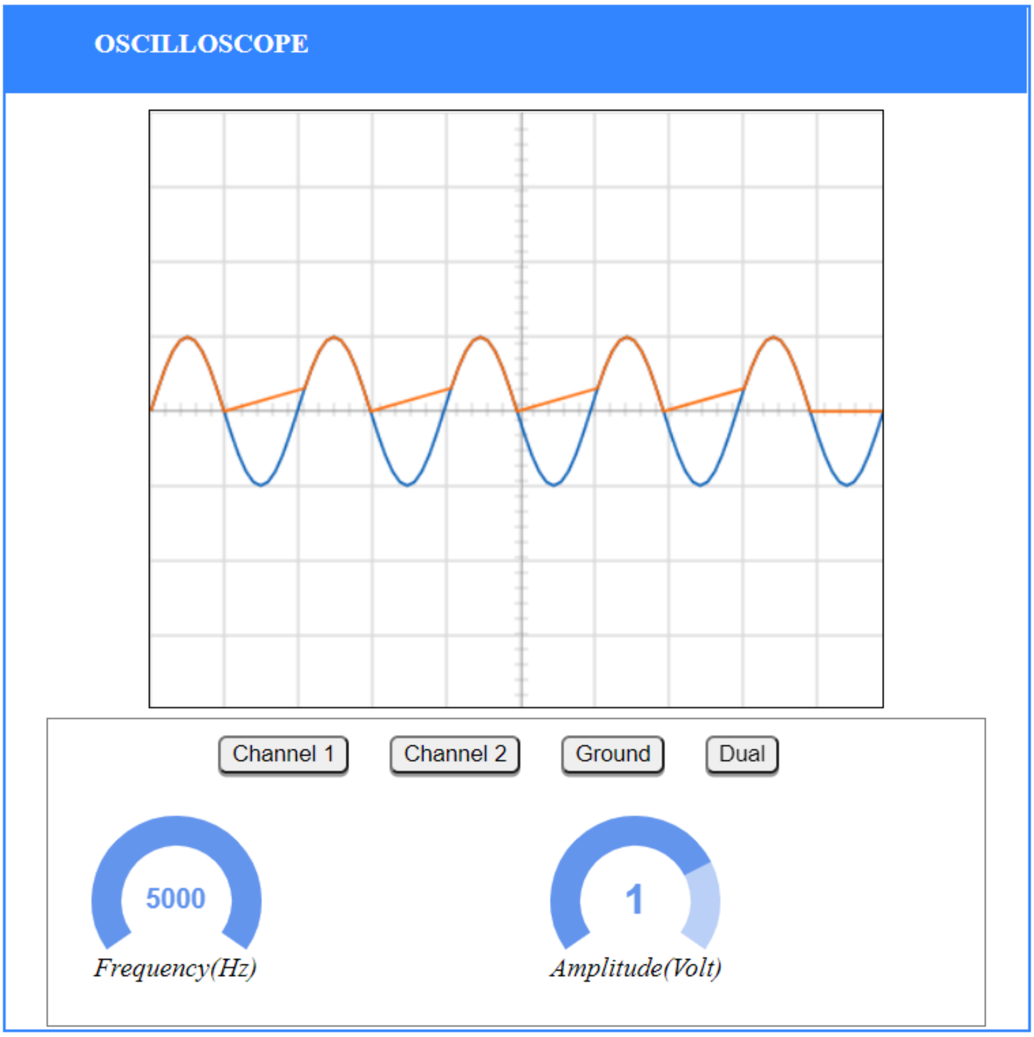


Figure 15: $Half\ Wave\ Rectifier\ for\ Frequency = 5000Hz$

$Frequency = (1/TimePeriod)$

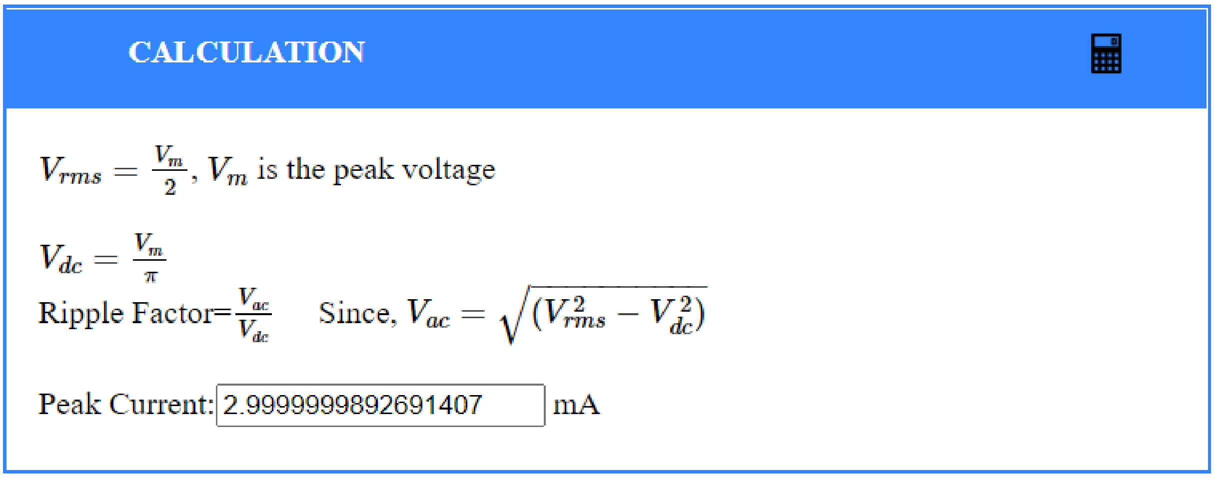
$Time\ Period = (1/frequency)$

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) $Peak\ Current,\ I_m = 2.9999mA$

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 2.9999/3.1415 = 0.9549mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 2.9999/2 = 1.4999mA = 1.5mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (1.5A)^2 \times 100\Omega \times 10^{-6}$

i.e. $P_{ac} = 225 \times 10^{-4}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.9549A)^2 \times 100\Omega \times 10^{-6}$

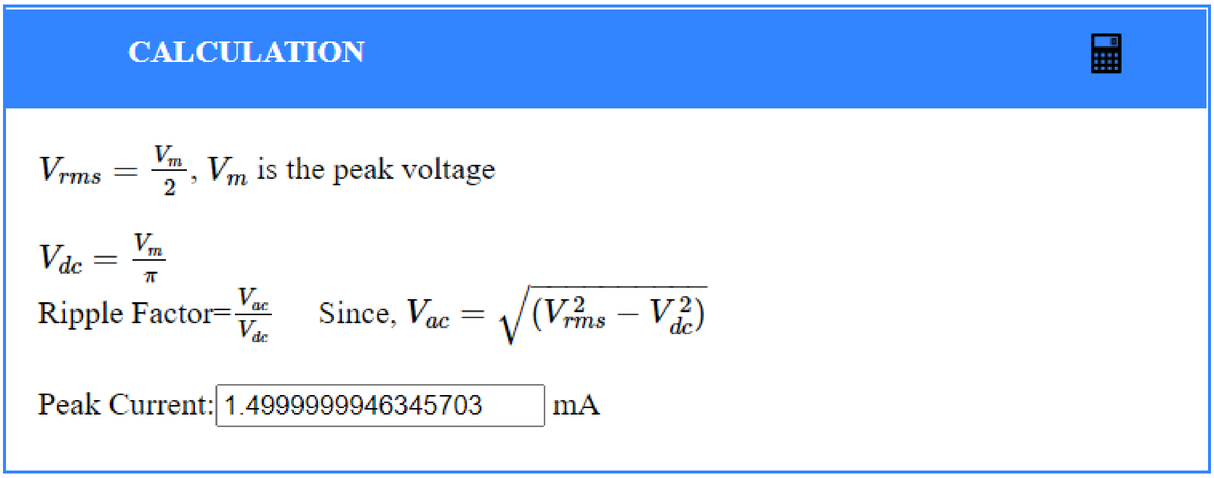
i.e. $P_{dc} = 91.19 \times 10^{-4}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =$40.52%

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((1.499 \times 10^{-3})/(0.954 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =$1.2090

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 1.499/3.14 = 0.477mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 1.499/2 = 0.7495mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.7495A)^2 \times 200\Omega \times 10^{-6}$

i.e. $P_{ac} = 1.123 \times 10^{-4}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.477A)^2 \times 200\Omega \times 10^{-6}$

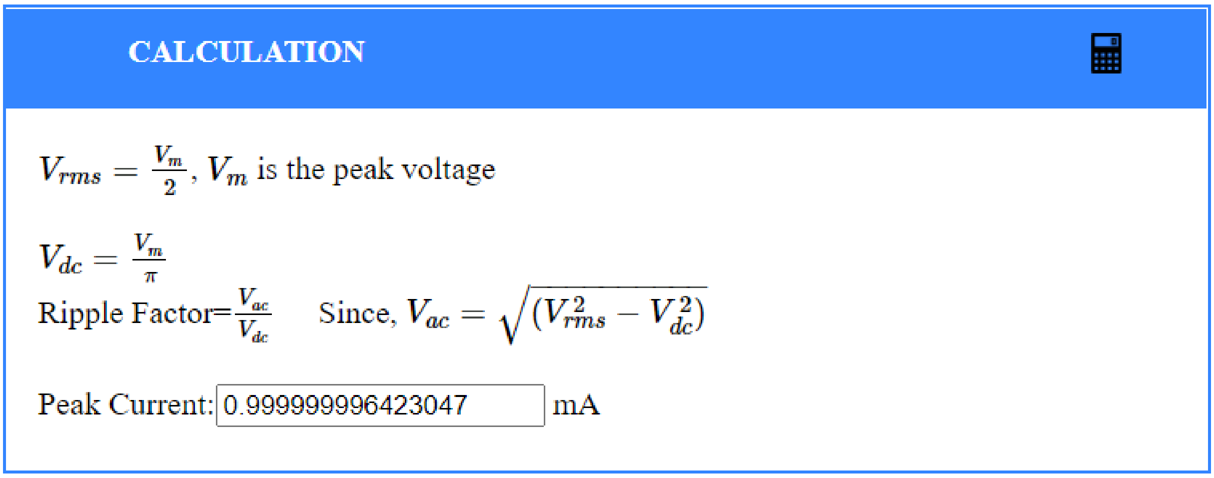
i.e. $P_{dc} = 0.455 \times 10^{-4}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =40.5\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.7495 \times 10^{-3})/(0.477 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =1.20$

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.999/3.14 = 0.318mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.999/2 = 0.4995mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.4995A)^2 \times 300\Omega \times 10^{-6}$

i.e. $P_{ac} = 0.748 \times 10^{-4}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =$ $(0.318A)^2 \times 300\Omega \times 10^{-6}$

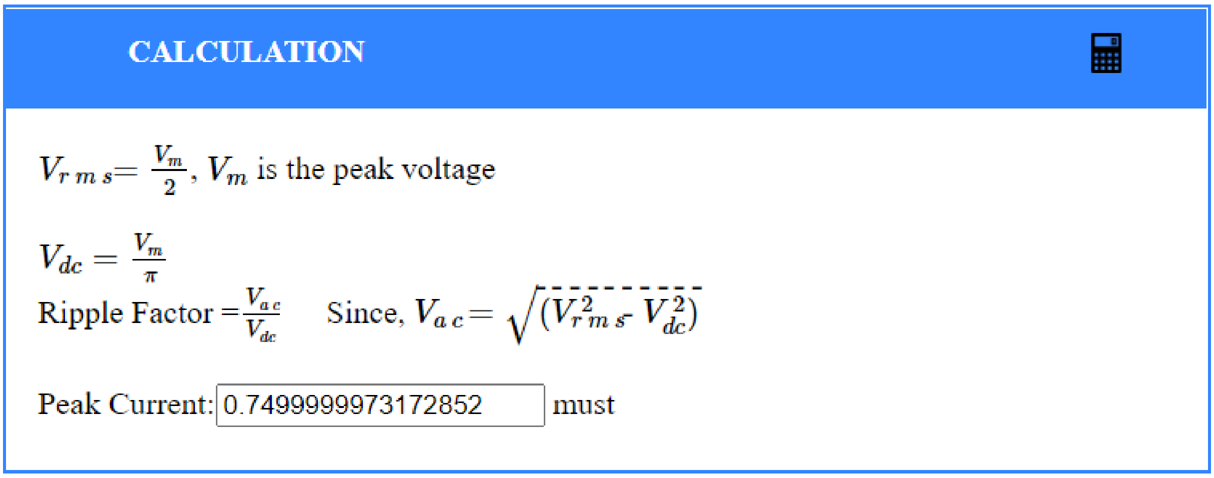
i.e. $P_{dc} = 0.303 \times 10^{-4}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =$40.5%

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.4995 \times 10^{-3})/(0.318 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =$1.20

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.7499/3.14 = 0.238mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.7499/2 = 0.375mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.375A)^2 \times 400\Omega \times 10^{-6}$

i.e. $P_{ac} = 0.562 \times 10^{-4}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.238A)^2 \times 400 \times 10^{-6}$

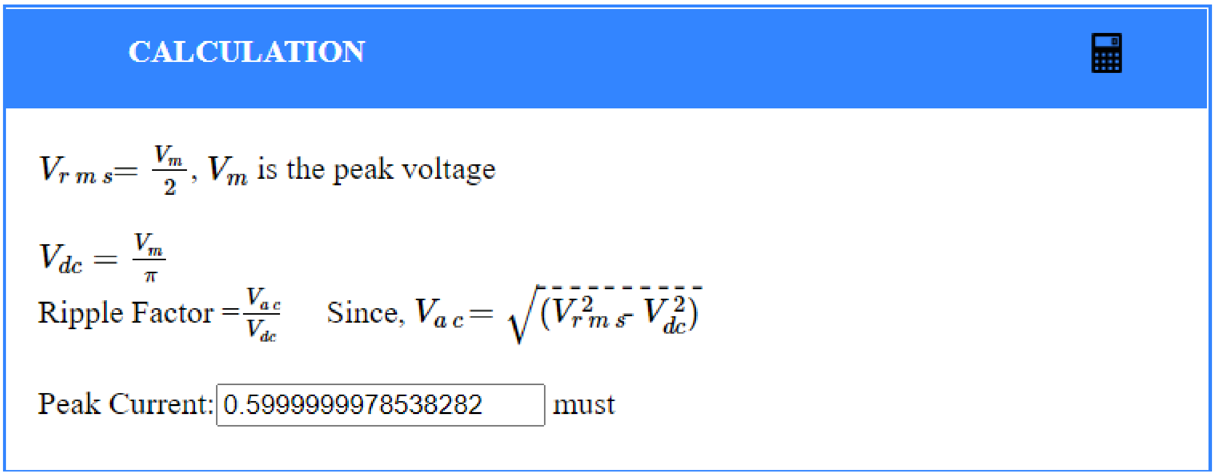
i.e. $P_{dc} = 0.226 \times 10^{-4}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =$40.21%

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.375 \times 10^{-3})/(0.238 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =$1.21

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.599/3.14 = 0.190mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.599/2 = 0.2995mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.2995A)^2 \times 500\Omega \times 10^{-6}$

i.e. $P_{ac} = 44.85 \times 10^{-3}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.19A)^2 \times 500\Omega \times 10^{-6}$

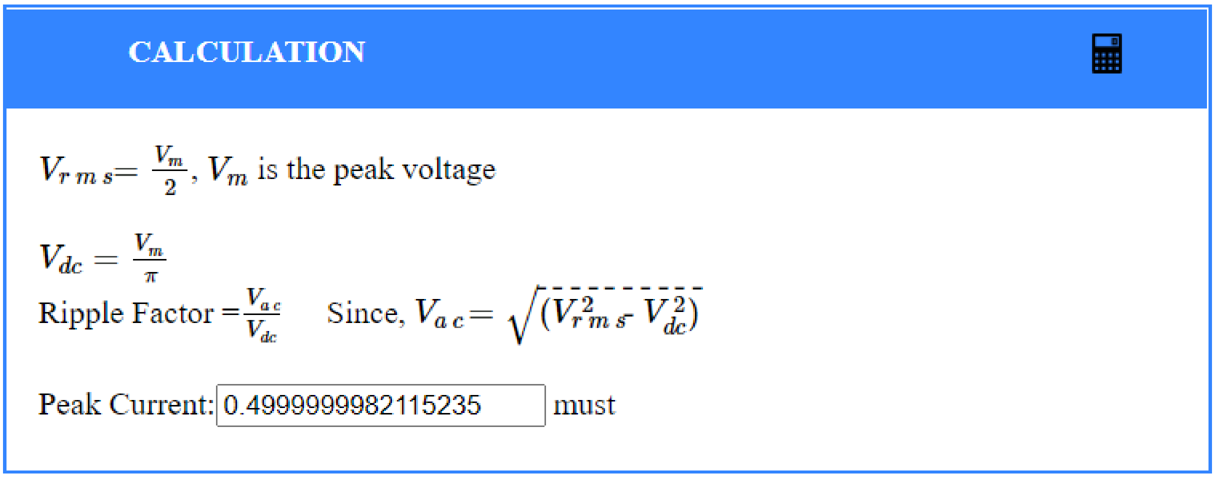
i.e. $P_{dc} = 18.05 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =40.24\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.2995 \times 10^{-3})/(0.190 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =1.21$

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.499/3.14 = 0.1589mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.499/2 = 0.249mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.249A)^2 \times 600\Omega \times 10^{-6}$

i.e. $P_{ac} = 37.2 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.1589A)^2 \times 600\Omega \times 10^{-6}$

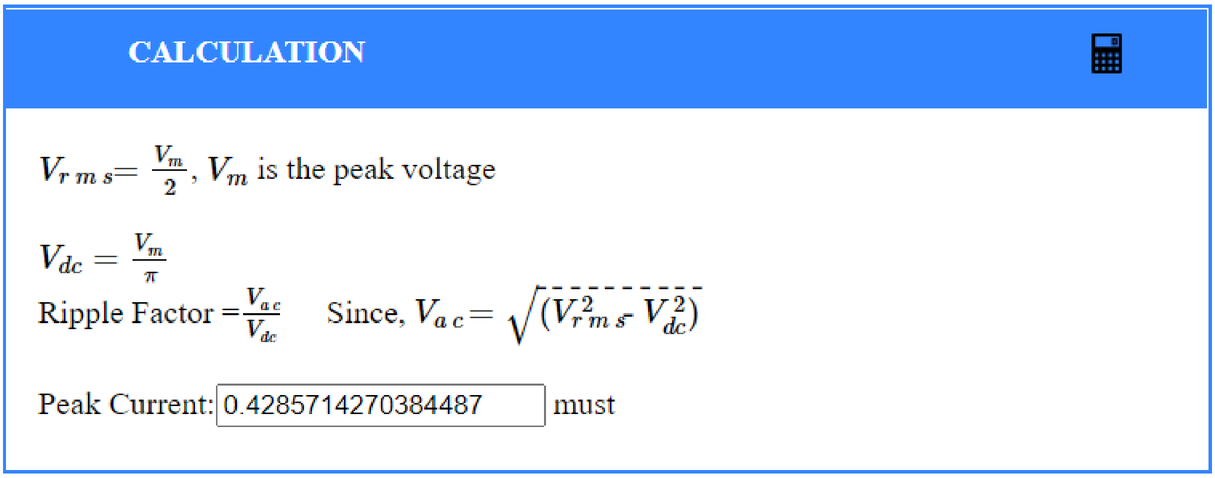
i.e. $P_{dc} = 15.14 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =40.7\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.249 \times 10^{-3})/(0.1589 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =1.20$

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.428/3.14 = 0.136mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.428/2 = 0.214mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.214A)^2 \times 700\Omega \times 10^{-6}$

i.e. $P_{ac} = 32.05 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.136A)^2 \times 700\Omega \times 10^{-6}$

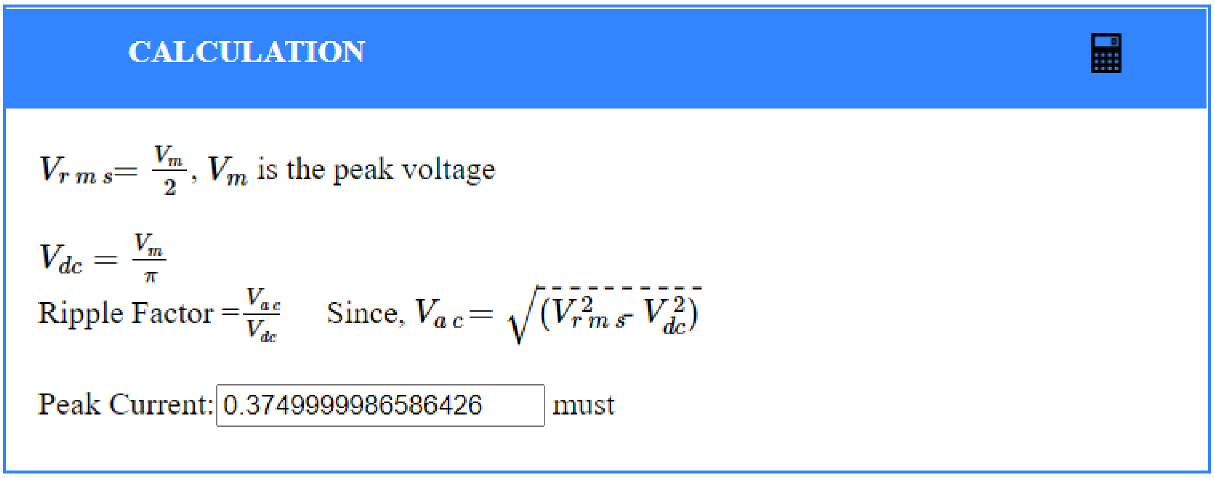
i.e. $P_{dc} = 12.94 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =$40.3%

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.214 \times 10^{-3})/(0.136 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =$1.21

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



1) $Peak\ Current,\ I_m = 0.3749mA$

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.3749/3.14 = 0.119mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.3749/2 = 0.187mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.187A)^2 \times 800\Omega \times 10^{-6}$

i.e. $P_{ac} = 27.97 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =(0.3749A)^2 \times 800\Omega \times 10^{-6}$

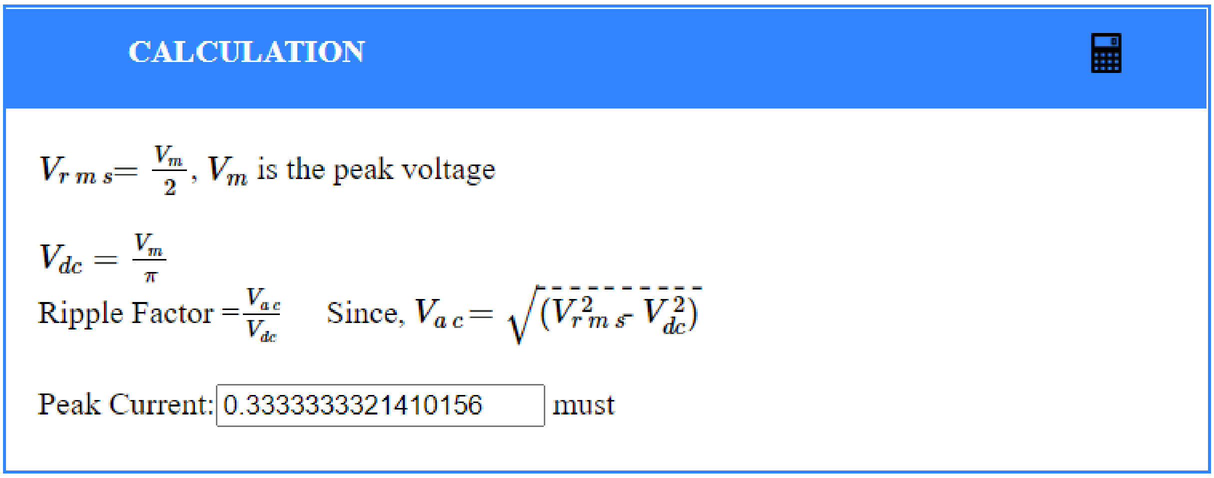
i.e. $P_{dc} = 11.32 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =40.4\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.187 \times 10^{-3})/(0.119 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =1.20$

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.333/3.14 = 0.106mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.333/2 = 0.1665mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.1665A)^2 \times 900\Omega \times 10^{-6}$

i.e. $P_{ac} = 24.95 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L = (0.106A)^2 \times 900\Omega \times 10^{-6}$

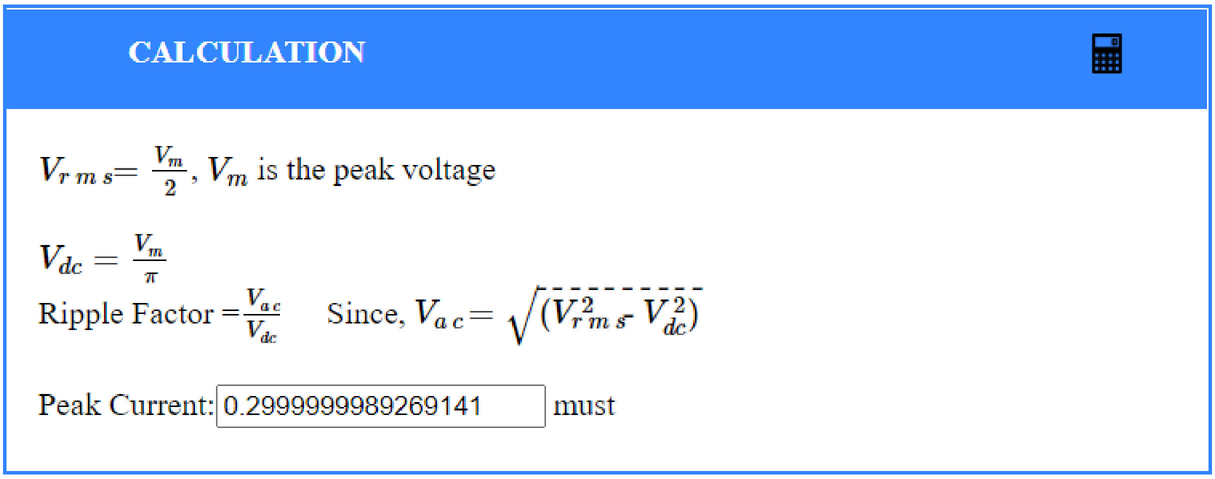
i.e. $P_{dc} = 10.11 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 = 40.5\%$

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.1665 \times 10^{-3})/(0.106 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor = 1.2$

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



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

2) $Average\ DC\ Current,\ I_{av} = I_m/\pi = 0.299/3.14 = 0.095mA$

3) $RMS\ Current,\ I_{rms} = I_m/2 = 0.299/2 = 0.149mA$

4) $Input\ AC\ Power,\ P_{ac} = I_{rms}^2 \times R_L = (0.149A)^2 \times 1000\Omega \times 10^{-6}$

i.e. $P_{ac} = 22.5 \times 10^{-6}W$

5) $Output\ DC\ Power,\ P_{dc} = I_{av}^2 \times R_L =$$(0.095)^2 \times 1000\Omega \times 10^{-6}$

i.e. $P_{dc} = 9.025 \times 10^{-6}W$

6) $Efficiency = P_{dc}/P_{ac} \times 100 =$40.3%

7) $Ripple\ factor = \sqrt{(I_{rms}/I_{av})^2 - 1} = \sqrt{((0.149 \times 10^{-3})/(0.095 \times 10^{-3}))^2 - 1}$

i.e. $Ripple\ factor =$1.2