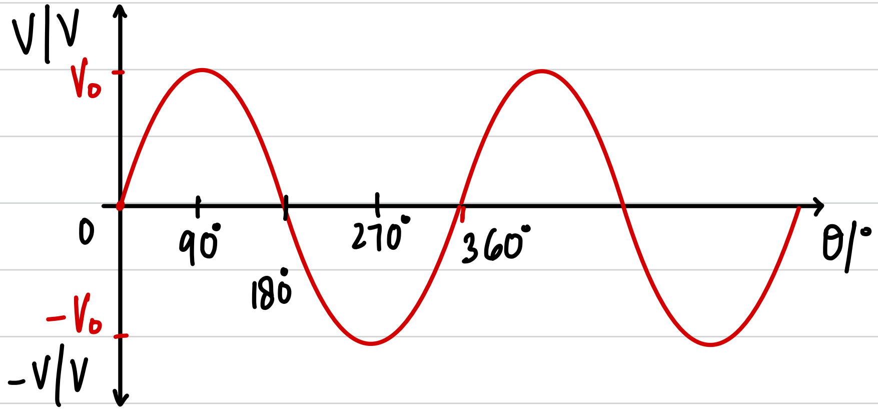
General Equation of Alternating Voltage and Current



$$Y = A\sin BX + C$$

A : Amplitude
B : No. of cycles in 360°
C : y-intercept (mean value)

$Y : V$ $\quad$ $A = V_o$
$X = \theta$ $\quad$ $B = 1$
$C = 0$

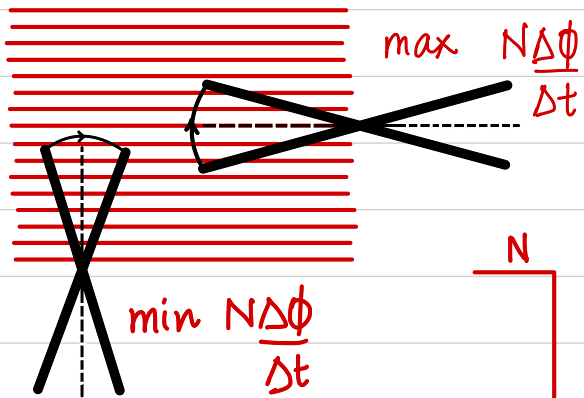
$$V = V_o \sin(1)\,\theta + 0 \rightarrow V = V_o \sin\theta$$

$\omega = \dfrac{\Delta\theta}{\Delta t}$ $\quad$ $\theta_i = 0°$ $\quad$ $t_i = 0s$ $\quad$ $\omega = \dfrac{\theta - 0}{t - 0}$

$\theta_f = \theta$ $\quad$ $t_f = t$

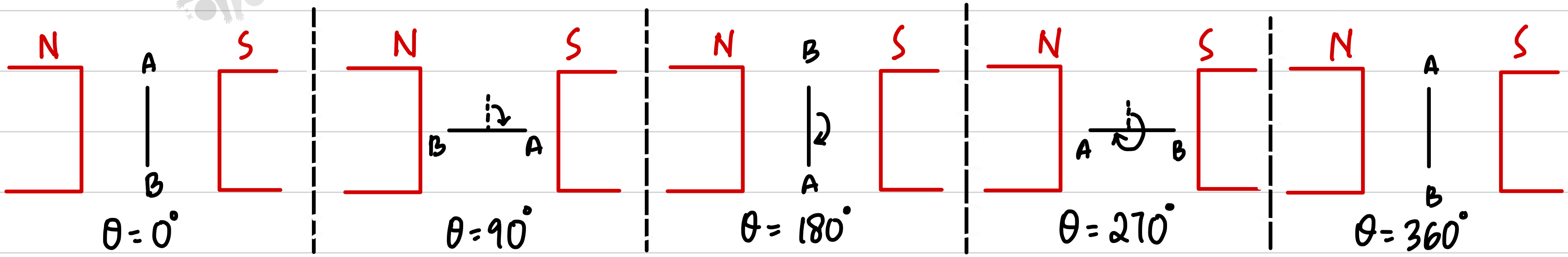
☑ Max Voltage : Coil crosses horizontal
☑ Min Voltage : Coil crosses vertical

$\omega = \dfrac{\theta}{t}$ and $\theta = \omega t$

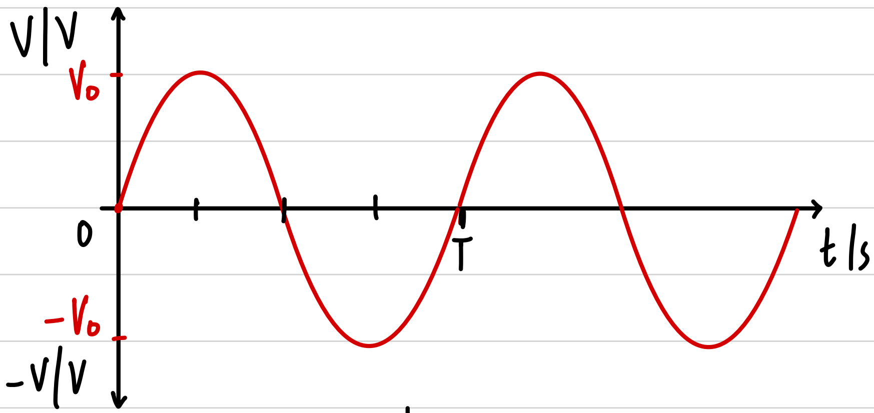


$$\boxed{V \propto \frac{N\Delta\phi}{\Delta t}}$$

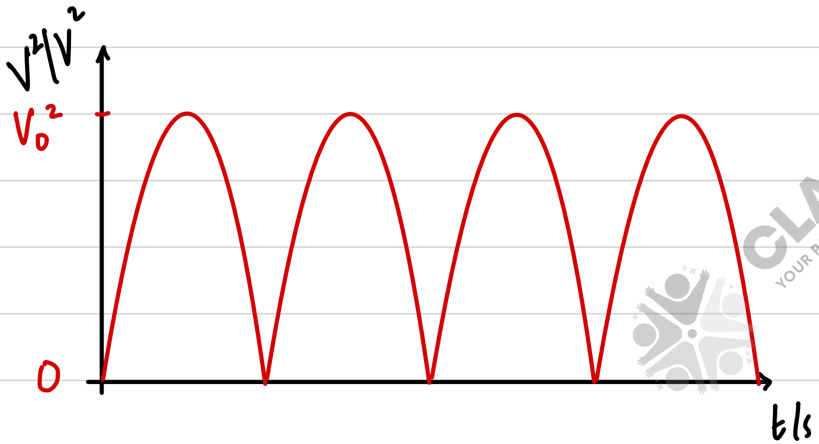
$V = V_o \sin\omega t$ $\quad$ similarly $\quad$ $I = I_o \sin\omega t$



Root-Mean-Square Voltage and Current



squaring



Simple Mean

$$V_{mean} = \frac{V_0 + (-V_0)}{2} = 0$$

Mean-Square Voltage

$$V_{ms} = \frac{0 + V_0^2}{2}$$

$$V_{ms} = \frac{V_0^2}{2}$$

taking square-root,

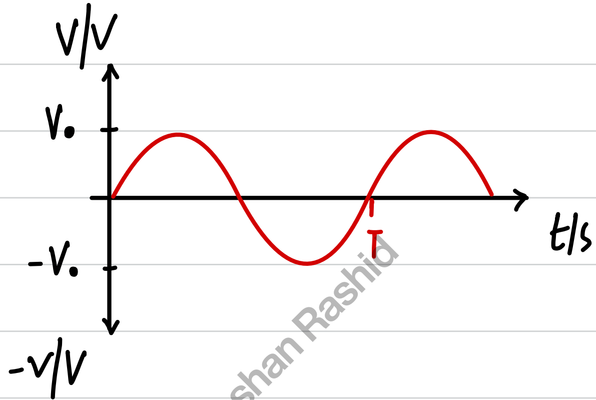
$$V_{rms} = \sqrt{\frac{V_0^2}{2}}$$ hence $$V_{rms} = \frac{V_0}{\sqrt{2}}$$

Similarly for current

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

V_{rms} / I_{rms}

The value of direct voltage/current corresponding to an alternating one that gives the same mean power output as an alternating voltage/current would.



As $P = IV$

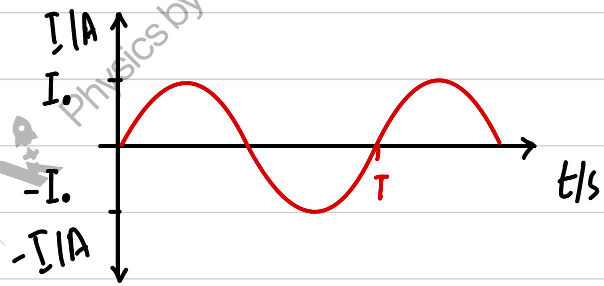
and

$V = V_0 \sin \omega t$

$I = I_0 \sin \omega t$

220V AC OR $\frac{220}{\sqrt{2}} = 156V$ DC

→ same mean power output ←



$P = (V_0 \sin \omega t)(I_0 \sin \omega t)$

$P = I_0 V_0 \sin^2 \omega t$

so

$P = P_0 \sin^2 \omega t$

$P_{mean} = I_{rms} V_{rms}$

$P_{mean} = I_{rms}^2 R$

$P_{mean} = \frac{V_{rms}^2}{R}$

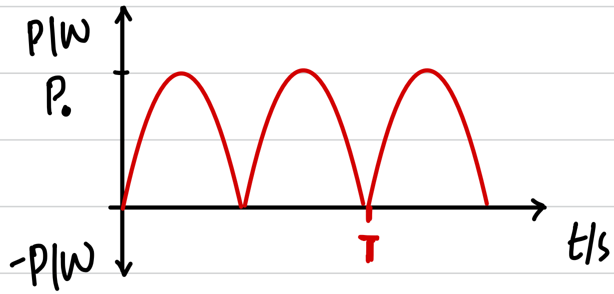
$P_{max} = I_0 V_0$

$P_{mean} = I_{rms} \times V_{rms}$

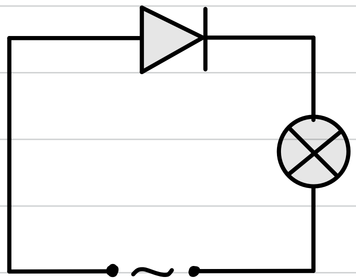
$= \frac{I_0}{\sqrt{2}} \times \frac{V_0}{\sqrt{2}}$

$$\boxed{P_{mean} = \frac{P_{max}}{2}}$$

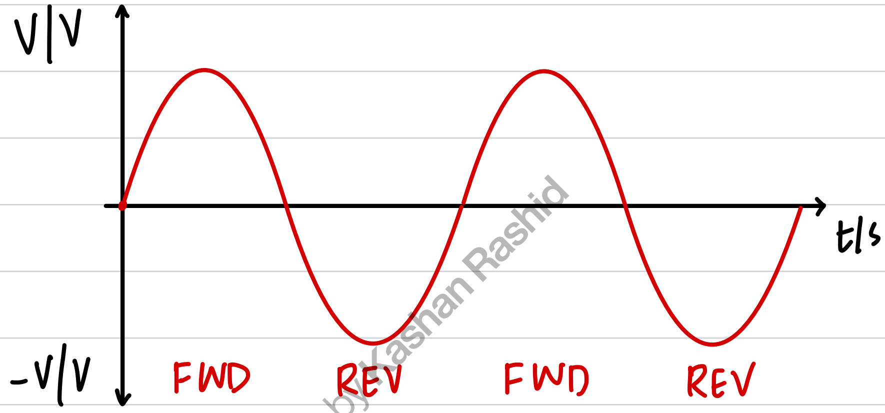
50%

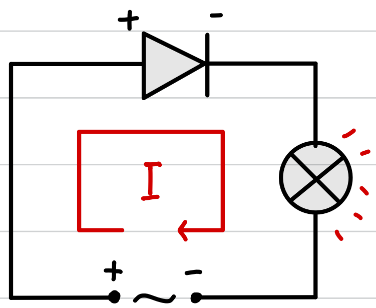


HALF WAVE RECTIFICATION



INPUT SIGNAL

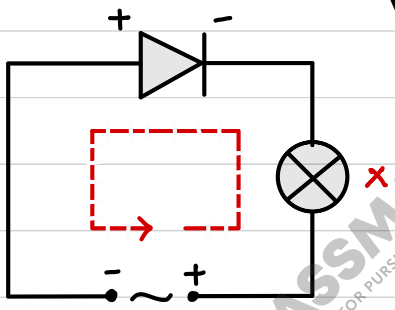




Forward Biased

All voltage on lamp

No voltage on Diode



Reversed Biased

All voltage on Diode

No voltage on Lamp

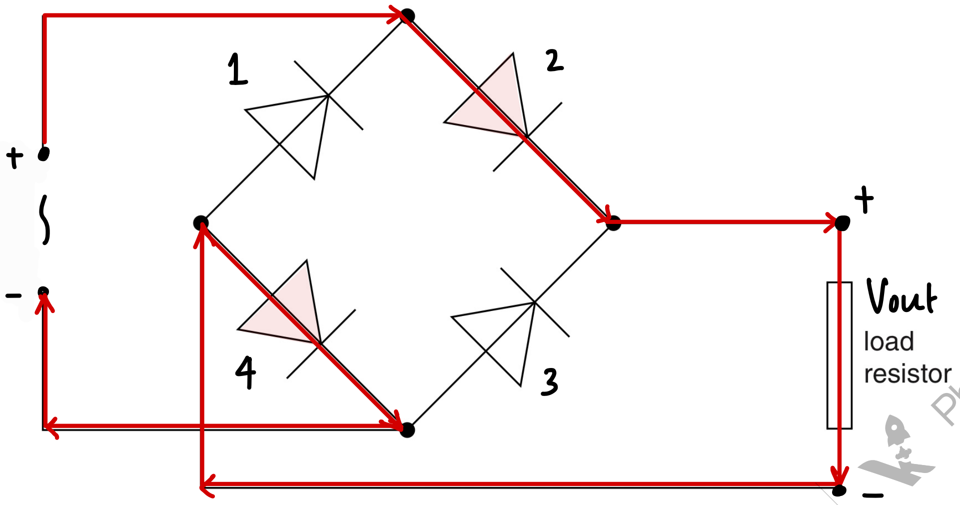
OUTPUT ON LAMP

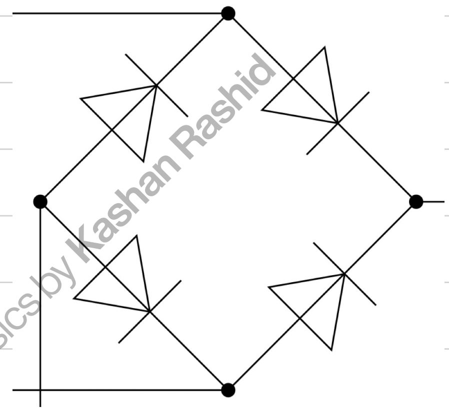
"Rippling DC with Lags"

VOLTAGE ON DIODE

Full Wave Rectification

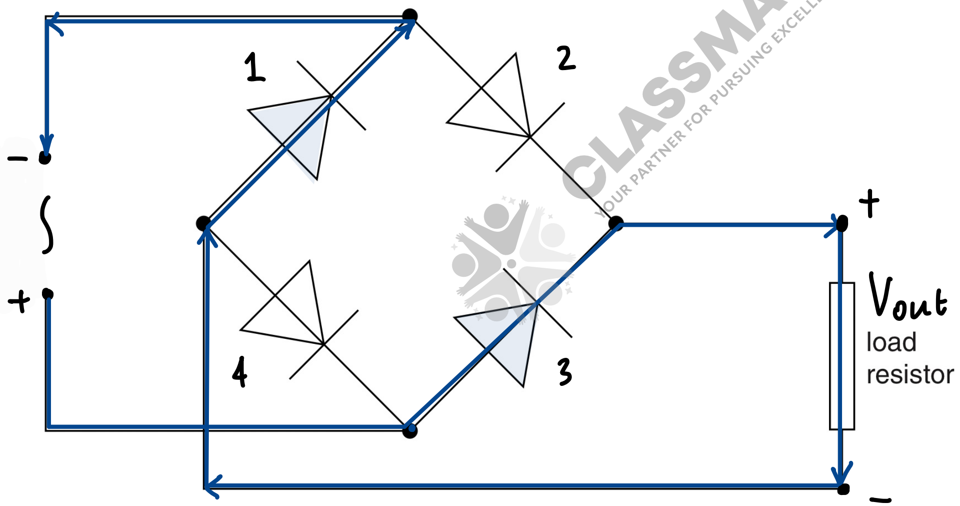
Postive Half Cycle

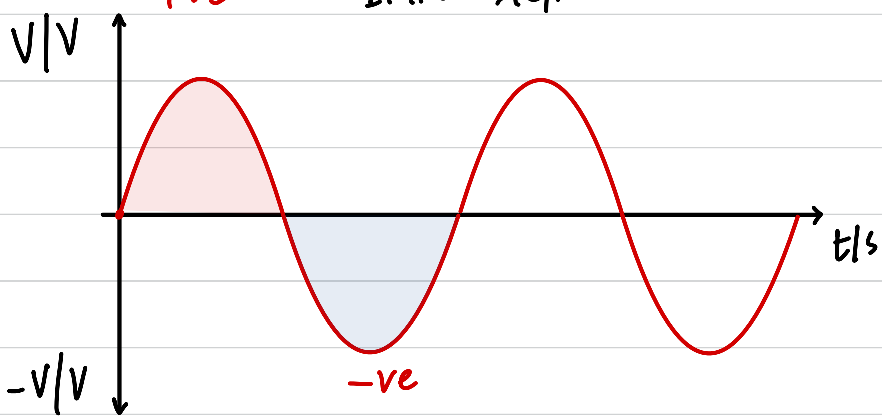




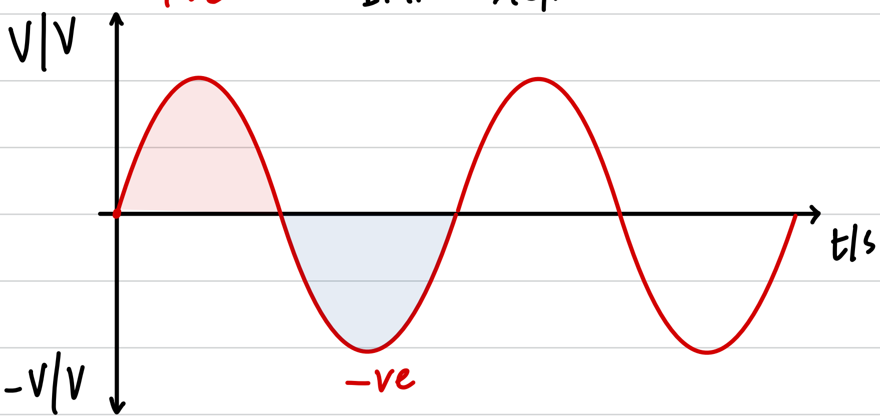
Bridge Rectifier

Negative Half Cycle

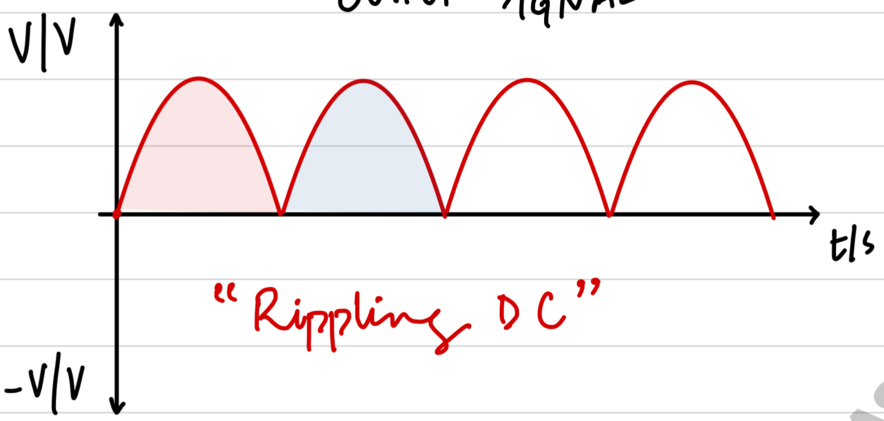




INPUT SIGNAL



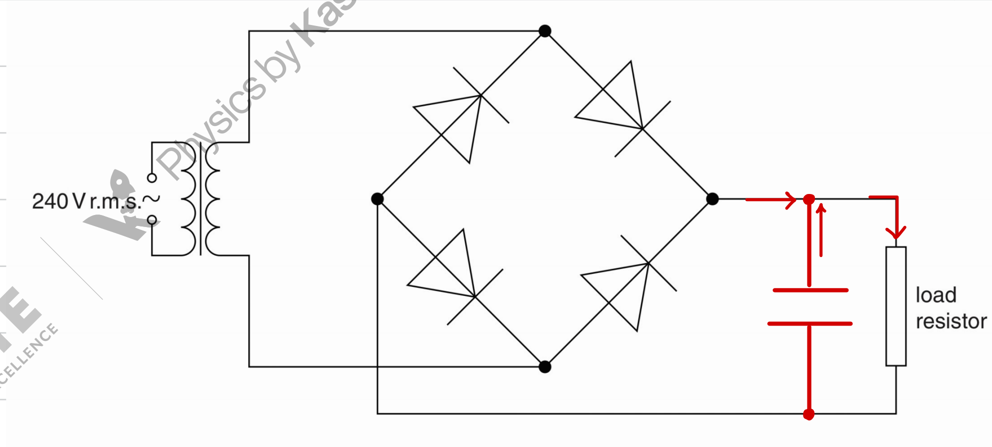
OUTPUT SIGNAL

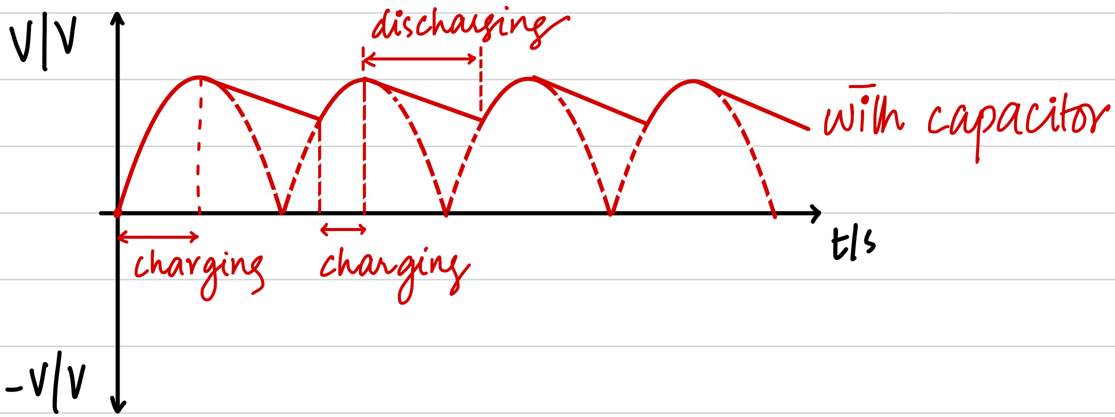


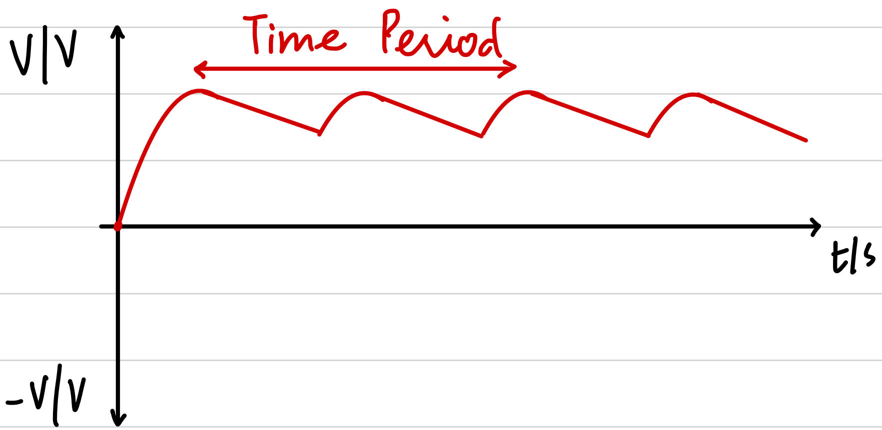
"Rippling DC"

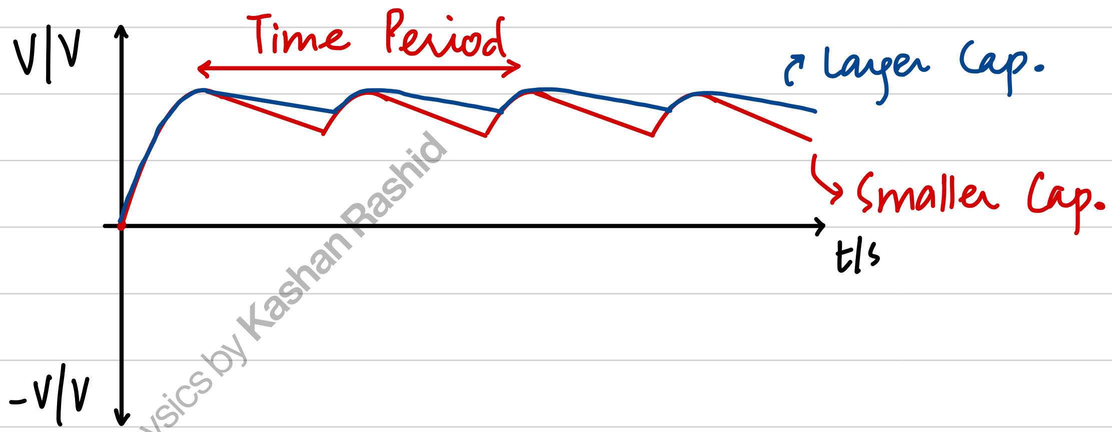
Smoothing

Decreasing the drop in the output voltage by attaching a capacitor in parallel to the resistor.









Adding capacitor increases the mean output voltage and hence also increases the mean power output.

"Time Period : 1st crest to 3rd crest in a rectified signal"

11 A bridge rectifier contains four ideal diodes A, B, C and D, as shown in Fig. 11.1.

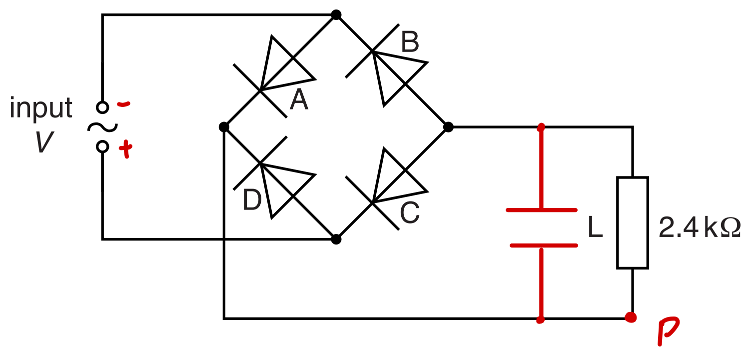


Fig. 11.1

The output of the rectifier is connected to a load L of resistance 2.4 kΩ.

(a) On Fig. 11.1, mark with the letter P the positive terminal of the load. [1]

(b) The variation with time *t* of the potential difference *V* across the input to the rectifier is shown in Fig. 11.2.

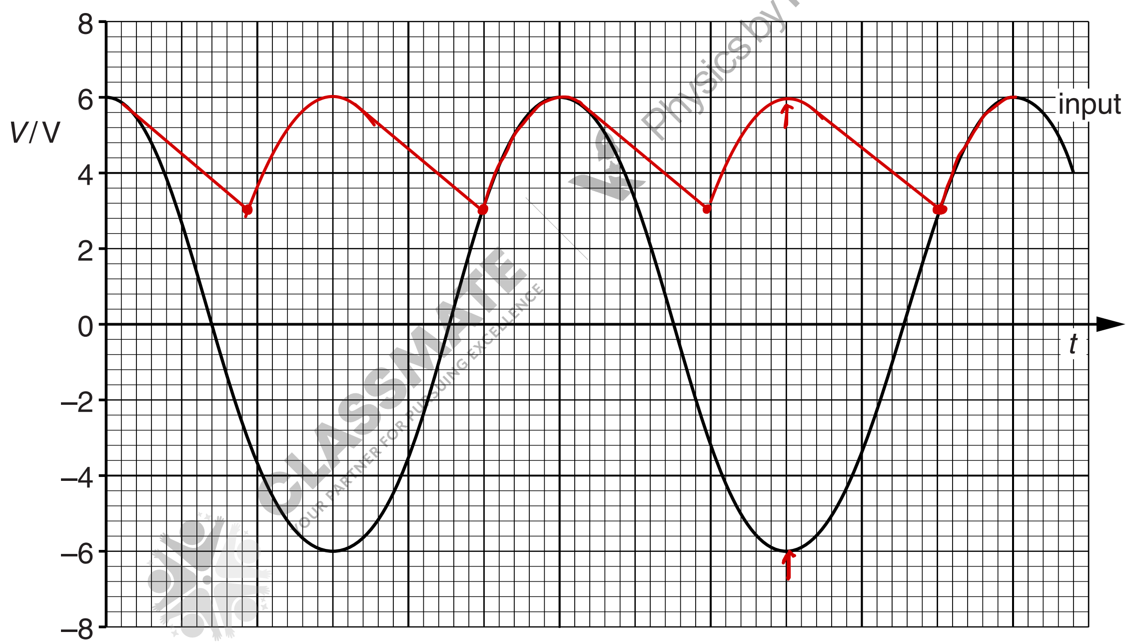


Fig. 11.2

Calculate the root-mean-square (r.m.s.) current in the load L.

$V_0 = I_0 R$

$6 = I_0 (2400)$

$I_0 = 0.0025\ A$

$I_{rms} = \frac{I_0}{\sqrt{2}}$

$= \frac{0.0025}{\sqrt{2}}$

$= 0.00177$

r.m.s. current = 1.78×10^{-3} A [2]

(c) The potential difference across the load L is to be smoothed using a capacitor.

(i) On Fig. 11.1, draw the symbol for a capacitor, connected to produce smoothing. [1]

(ii) The minimum potential difference across the load L with the smoothing capacitor connected is 3.0 V.

On Fig. 11.2, sketch the variation with time *t* of the potential difference across the load L. [3]

[Total: 7]

