Unit - 1 & Unit - 2

R_L → Load Resistor
V_m → Max Voltage [Graphical]
I_m → Max Current [Graphical]
V_K → Knee Voltage

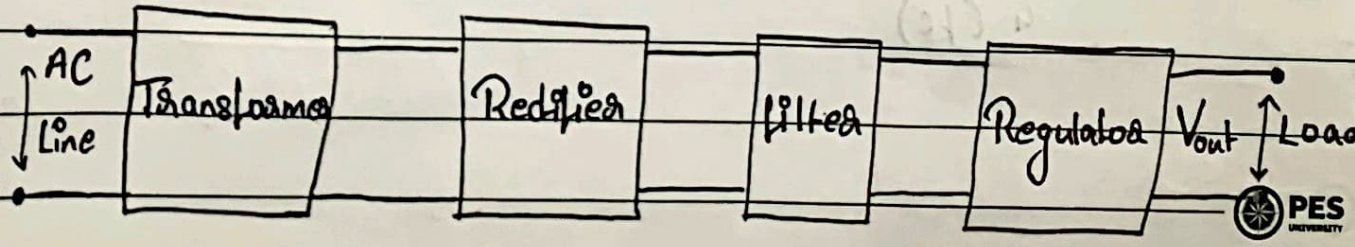
R_D → Diode Resistance.

DATE

Comparison b/w Rectified Circuits:

Parameter Name	Half-Wave Rectifier	Center-Tapped Full Wave Rect.	Bridged Rectifier
V_{DC} [DC Voltage]	$\frac{(V_m - V_K)}{\pi}$	$\frac{2(V_m - V_K)}{\pi}$	$\frac{2(V_m - 2V_K)}{\pi}$
I_{DC} [DC Current]	$\frac{I_m}{\pi}$	$\frac{2I_m}{\pi}$	$\frac{2I_m}{\pi}$
V_{RMS} [RMS Voltage after rectification]	$\frac{V_m}{2}$	$\frac{V_m}{\sqrt{2}}$	$\frac{V_m}{\sqrt{2}}$
I_{RMS} [RMS Current after rectification]	$\frac{I_m}{2}$	$\frac{I_m}{\sqrt{2}}$	$\frac{I_m}{\sqrt{2}}$
η [Efficiency]	$40.6 \frac{R_L}{(R_D + R_L)}$	81.2 ~~80.2~~ $\frac{R_L}{(R_D + R_L)}$	$81.2 \frac{R_L}{(R_D + R_L)}$
γ (Ripple factor)	1.21	0.48	0.48
PIV Rating	$> V_m$	$> 2V_m - V_K$	$> V_m - 2V_K$

Regulated Power Supply. [Draw Signal Graphs]



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Temperature Effects on Diodes:

* Forward Diode [Biased]:

$$\text{Temp} \propto \frac{1}{V_{knee}}$$

$2.5\,mV/1^{\circ}C$

* Reverse Diode [Biased]:

$$\text{Temp} \propto I_{Saturation}$$

$$(I_{sat})_{new} = (I_{sat})_{old}\,(2)^{\frac{\Delta T}{10}}$$

* Shockley's Diode Current Equation:

$$I_D = (I_{sat})\left[e^{\frac{V_D}{\eta V_T}} - 1\right]$$

$I_D \rightarrow$ Diode Current
$I_{sat} \rightarrow$ Saturation Current
$V_D \rightarrow$ Diode Voltage
$V_T \rightarrow$ Thermal Voltage
$\eta \rightarrow$ Ideality factor [$\Rightarrow$ for non-conducting Silicon = 2; everything else = 1]

→ Thermal Voltage:

$$V_T = \frac{kT}{q}$$

$k \rightarrow$ boltzmann const. $= 1.38 \times 10^{-23}\ J/K$
$q \rightarrow$ Charge $= 1.6 \times 10^{-19}\ C$

Extra Formulae:

→ γ [Ripple factor] $= \dfrac{(V_{ripple})_{rms}}{V_{DC}} = \dfrac{I_{DC}}{4\sqrt{3}\,(f_c)}$

→ $V_{DC} = V_m - \dfrac{I_{DC}}{4\,(f_c)}$

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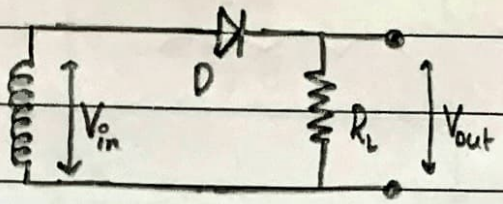
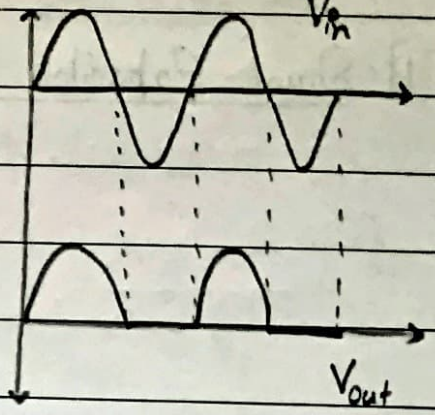
Rectifiers: [Half-Wave, Centre Tapped, Bridged Rectifiers]

1] Half-Wave Rectifier:

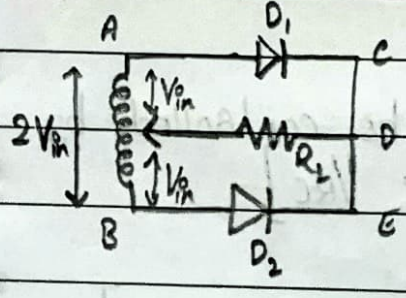


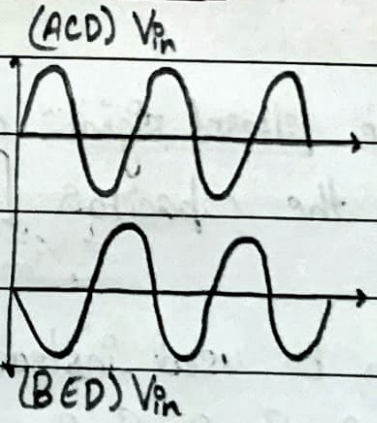
V_{in} → Pure AC Signal

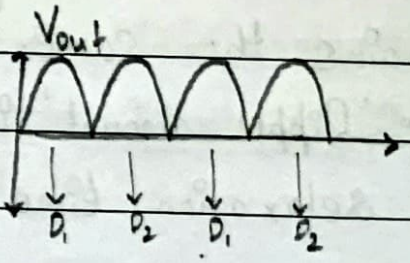
V_{out} → Pulsating DC



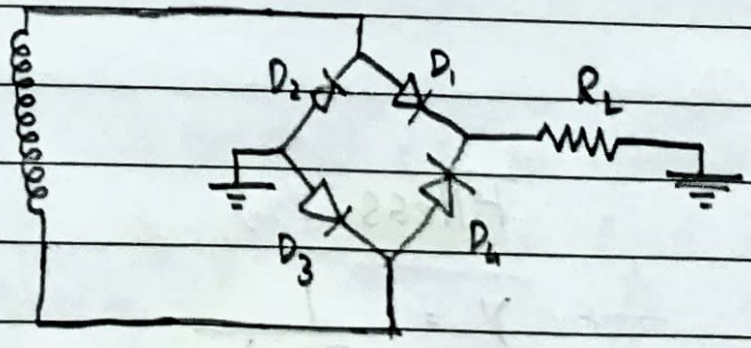
2] Centre-Tapped Full-Wave Rectifier:

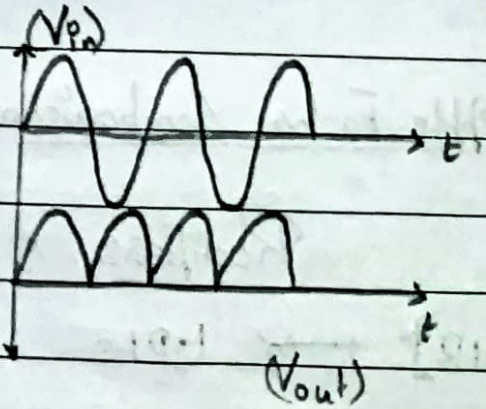






3] Bridge-Rectifier:





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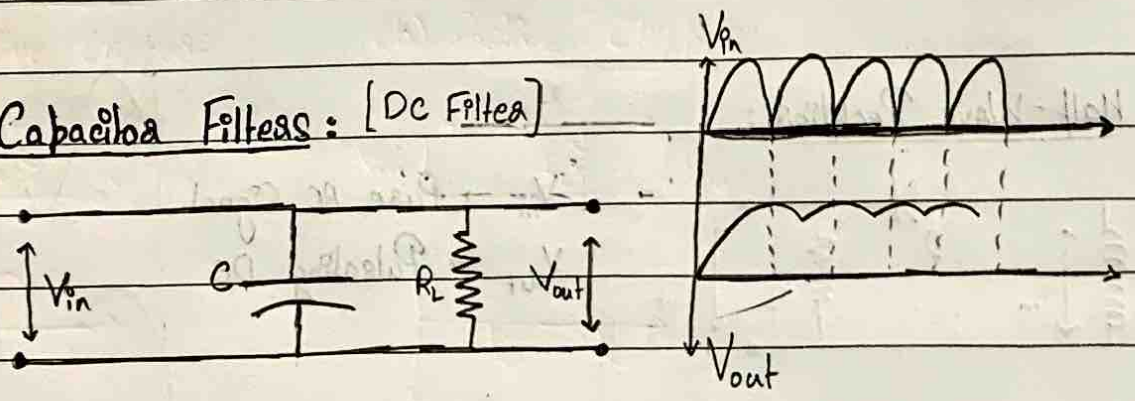
Filters:

1] Shunt Capacitor Filters: [DC Filter]



- The (V_{out}) Filtered Signal's phase has been shifted while frequency remains the same.
- The 'Ripple amount' in the filtered signal can be controlled by the relaxation time of the capacitor [$\tau = 1/RC$]

> Note: An Inductor can be used instead of a capacitor.
> The inductor is placed in ~~Series~~ Series.
> ⇒ Series Inductor Filter

⇒ Ripple Factor Comparison:

Rectifiers (γ)	Filters (γ%)
[HWR] ⟶ 1.21	⟶ $\gamma = \frac{1}{2\sqrt{3}(fC)R_L}$
[FWR] ⟶ 0.48	⟶ $\gamma = \frac{1}{4\sqrt{3}(fC)R_L}$

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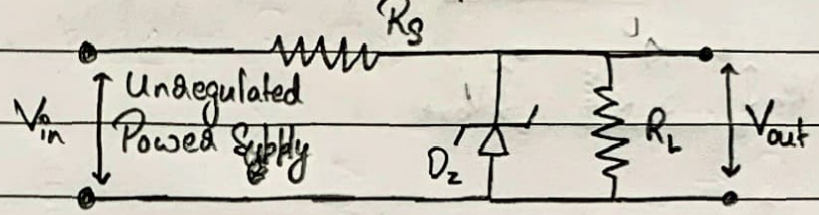
Voltage Regulator [using Zener Diode]



⇒ Conditions to be met:

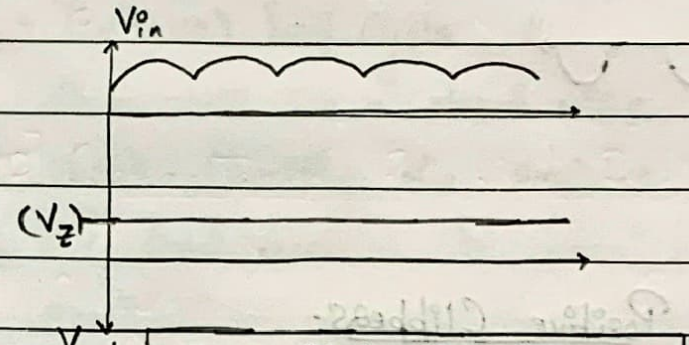
→ Diode must be R. Biased

→ $V_{in} > V_z$

→ $(I_z)_{min} < I_z < (I_z)_{max}$

→ $(V_R)_{max} > V_z$

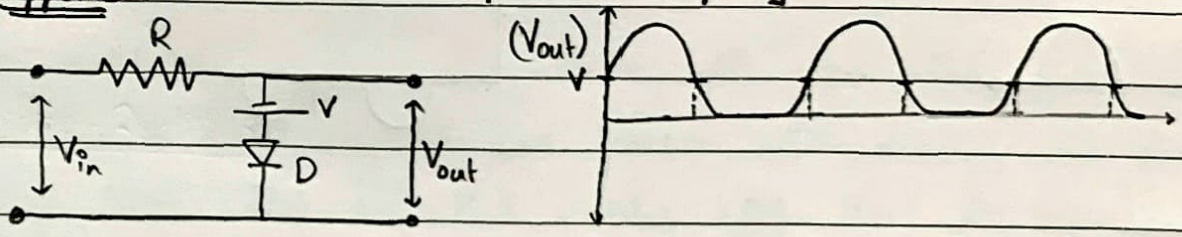
(Assume No Diode)



• Zener Diode: $(P+)$ — $P+$ | $N+$ — $(N+)$

• Zener Diode can accept more current with the same Voltage as it is an non-ohmic Device.

Clippers: [Similar to Half-Wave Rectifier]



• The Input AC Signal gets an additional DC Voltage 'V'. In the (+ve) half-cycle, both the signal add up to shift the AC signal by 'V'.

In the (-ve) half-cycle, the DC Voltage keeps the Diode forward biased until the AC signal's voltage is greater than or equal to 'V'.

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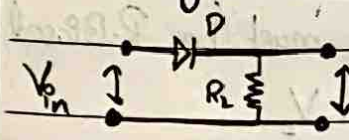
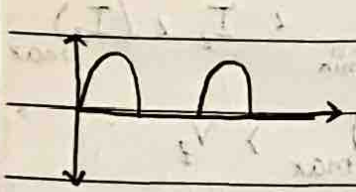
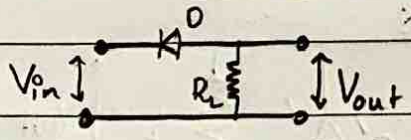
1] Series Clippers:

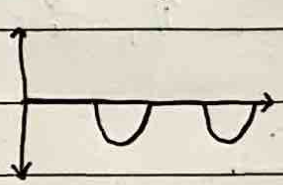
(a) Negative Clippers:





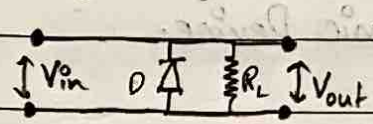
(b) Positive Clippers

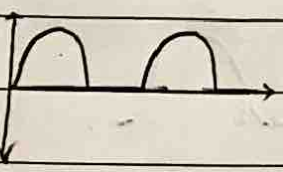




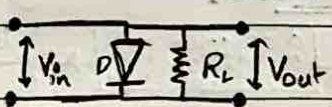
2] Parallel / Shunt Clippers:

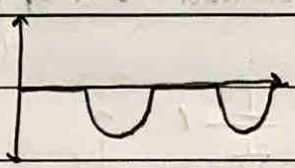
(a) Negative Clippers:



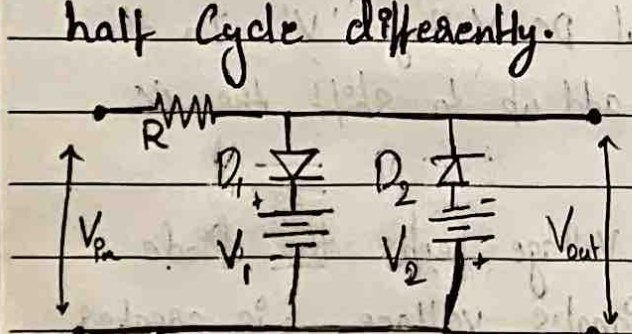


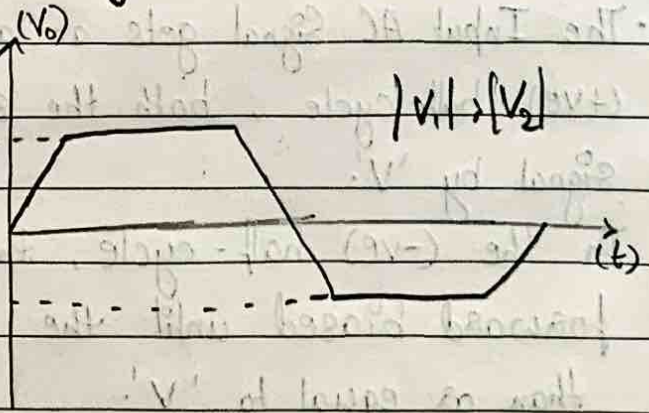
(b) Positive Clippers:





- Clippers can be used to clip the voltages for (+ve) & (-ve) half cycle differently.





- 'V_1' is assumed to be greater than 'V_2'

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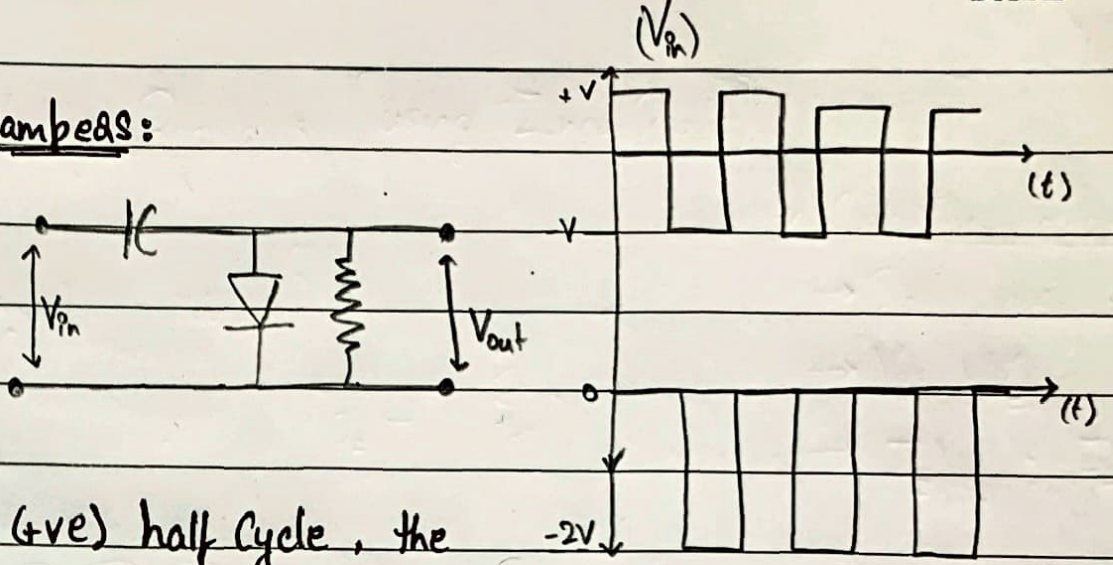
Clampers:



- The (+ve) half cycle, the diode acts like a closed wire, shoat-circuiting the resistor & hence the output voltage across the load resistor is zero, while the capacitor charges to reach equilibrium with the source Voltage.

  → $\tau \Rightarrow 0$, as there is no resistor that is acting in the (+ve) half-cycle. $[\tau \to 0\ [\tau = RC]$ as $R = 0]$

- The (-ve) half-cycle, the diode will offer infinte resistance hence we can neglect the branch with diode, and the voltage from the capacitor works <u>with</u> the AC signal.