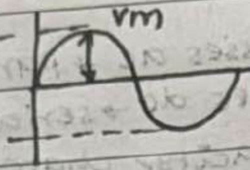
RECTIFIERS

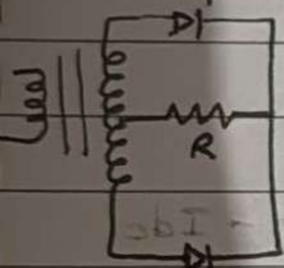
AC → pulsating DC

$v_{in} = v_m \sin \omega t$



FULLWAVE

centre-tap



$PIV \geq 2V_m$

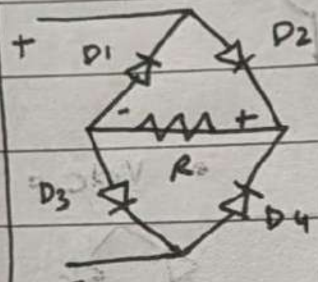
$V_o = V_m$

non-ideal

$PIV \geq 2V_m - V_K$

~~$V_o = V_m - V_K$~~

bridgewave



Ideal

~~$V_o = V_m$~~

$PIV \geq V_m$

~~Non-ideal~~

$V_o = V_m - 2V_K$

$PIV \geq V_m - V_K$

FWR

$$\boxed{V_{dc} = \frac{1}{\pi}\int_0^{\pi} V_m \sin \omega t \, d\omega t = \frac{2V_m}{\pi}}$$

$$V_{rms} = \left[\frac{1}{\pi}\int_0^{\pi} (V_m \sin \omega t)^2 d\omega t\right]^{1/2}$$

$$\boxed{V_{rms} = \frac{V_m}{\sqrt{2}}}$$

$\gamma = 0.48$

$f_o = 2f_i$

HALFWAVE

$$V_{avg} = \frac{\text{Area of curve}}{\text{base}}$$

$$= \int_0^{2\pi} \frac{V_m \sin \omega t}{2\pi}$$

$$\boxed{V_a = V_{avg} = V_{dc} = \frac{V_m}{\pi}}$$

$$I_o = I_{dc} = \frac{I_m}{\pi}$$

$$V_{rms} = \left[\frac{1}{2\pi}\int_0^{2\pi} (V_m \sin \omega t)^2 d\omega t\right]^{1/2}$$

$$= \left[\frac{V_m^2}{2\pi}\int_0^{\pi} \frac{1-\cos 2\omega t}{2} d\omega t\right]^{1/2}$$

$$= \boxed{\frac{V_m}{2} = V_{rms} \text{ [HWR]}}$$

non-ideal

$$V_{avg} = \frac{V_m - V_K}{\pi}$$

$$V_{rms} = \frac{V_m - V_K}{2}$$

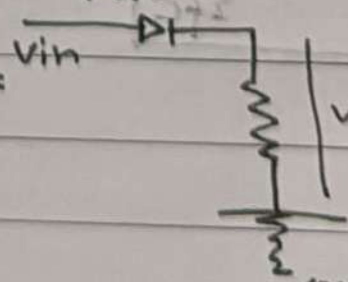
γ ripple factor.

$$\gamma = \frac{\text{rms of ac}}{V_{avg}} = \frac{\sqrt{V_{rms}^2 - V_{dc}^2}}{V_{dc}}$$

$$= 1.21$$

$$\boxed{(V_{rms})_{ac} = [V_{rms}^2 - V_{dc}^2]^{1/2}}$$

$$\eta = \frac{P_{dc}}{P_{ac}} = \frac{\text{load deliv}}{\text{input}}$$



$\boxed{f_o = f_i}$

SEMICONDUCTORS

DATE

- **Intrinsic conductors.**
  pure semiconducting materials without any significant impurities.
  → e^- gain energy as T↑, E↑ jump from valence to conduction band leaving behind holes.
  thermal generation of e^--h pair
  At thermal equilibrium $n_i = n_e = n_h$

- **Extrinsic conductors.**
  semiconductor materials in which impurities are added to alter electrical properties.
  Doping : process of adding impurities to pure semiconductors to increase conductivity.

DOPANTS → pentavalent ↓ n type · trivalent ↓ p type

pentavalent	trivalent
n type	p type
s.c with e^- as majority charge carriers as they are doped with pentavalent imp. (antimony, phosp, arsenic)	sc with holes as majority charge carriers doped with trivalent imp (boron, gallium, indium).
• doner atom gains +ve charge	• Acceptor ion -ve charge.

P/n Joined
Diode → conducts current in only one way p → n.

$\boxed{\text{No-bias}}$ → minority charge carriers combine, resulting in lack of free carriers near junction forming a depletion layer.
net flow of charge = 0 A.
V = 0 V

Reverse → +ve → n, -ve → p
results in widening of depletion layer as e^- in n and h^+ in p are drawn to their terminals.
this establishes a barrier to great for a carrier to overcome.
• the minority charge carriers result in $\boxed{\text{reverse saturation current}}$ Is

Forward → +ve → p -ve → n
the application of voltage will pressure the e^- in n type and h^+ in p type to recombine with ions near the layer. causing the layer to reduce. This results in heavy majority carrier flow while Is remains unaffected

Shockley's Eq.

$$I_D = I_S \left[e^{\frac{qV_d}{KT_n}} - 1 \right]$$

where $\frac{KT}{q} = V_T$ thermal voltage

$$I_D = I_S \left[e^{\frac{V_d}{nV_t}} - 1 \right]$$

where n = ideality factor (1 → 2)
$K = 1.38 \times 10^{-23}$ J/K boltzmann
T_K = Kelvin $q = 1.6 \times 10^{-19}$

Avalanche (high V↑) As V↑ across RB region, velocity of minority carriers responsible for Is increases. The energy gain will result in minority carriers colliding with the lattice. Ionisation takes place e^- of atoms absorb energy to leave parent atom. causing multiplication of carriers. Avalanche multiplication occurs and avalanche current is produced.

Zener → quantum mechanical tunnelling. e^- pulled into CB. due to (E-8) strong electrical fields that generate carriers.

PIV → maximum reverse bias potential that can be applied before entering breakdown region. Peak Inverse.

Is doubles for every 10°C ↑.

PES

Voltage$_{FB}$ decreases by 2.5mV by every 1°C increase

Imp

Avalanche	Zener	V_T at 25°C
T↑ V↑	T↑ V↓.	25.7mV

$$I_2 = I_1 \times 2^{\frac{(T_2 - T_1)}{10}}$$ → I saturation current

forward current rating → max current that can flow without damaging diode.

As T↑, VK↓ → voltage required to conduct current
→ min voltage required to break depletion layer
→ V at which current starts flowing rapidly.

Is for 1°C

Is = 1.0718

RESISTANCE

DC

application of dc voltage to s.c diode → results in an operating point that remains unaffected with time.

$R_D = \frac{V_D}{I_D}$ resistance at and below Vk will be greater than the R from vertical graph.

AC

application of sinusoidal input causes Q operating pt to vary up and down.

$$R_{(ac)d} = \frac{\Delta V_{(ac)d}}{\Delta I_{(ac)d}}$$

$$r_d = \frac{26mV}{I_d}$$ only for vertical rise.

Average Resistance

If input produces a broad swing (large variation).

$$r_{avg} = \frac{\Delta V_d}{\Delta I_d}\Big|_{pt - pt} = \frac{V_2 - V_1}{I_2 - I_1}$$

Diode Approx

1) open switch | close (ideal diode)
2) RB → open FB → cell (simplified)
3) piece-wise → consider resistance after diode.

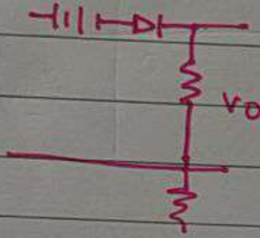
DATE

CLIPPERS

nsc (negative series clipper)
(positive series clipper) PSC

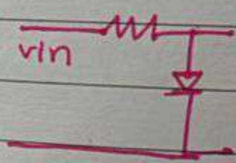
SERIES

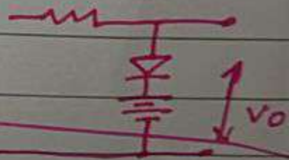
- unbiased
  - • FB → nsc
  - • RB → PSC
- biased (voltage applied)
  - • FB → nsc



PARALLEL.

- unbiased
  - • FB → PSC
  - • RB → nsc
- biased
  - Voltage applied.
  - • clips PS → V and ns → Vin.

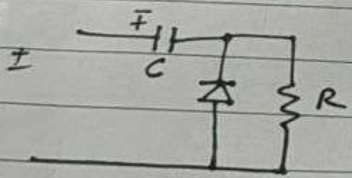




CLAMPERS

AC → DC

$\tau = RC$ → how fast capacitor charges or discharges.



FILTERS

shunt capacitor

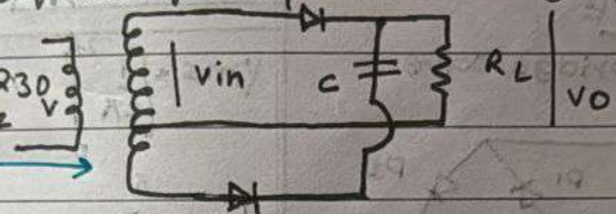
capacitor blocks dc and passes ac → parallel

inductor blocks ac and passes dc → series

τ = time required for capacitor charge & discharge.

$\boxed{\tau = RC}$

EXP →

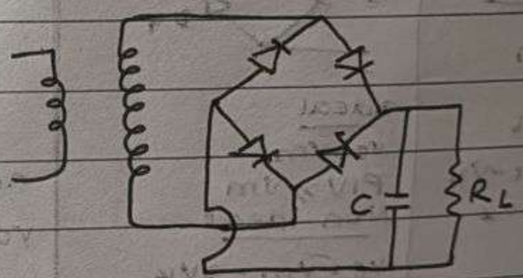


FWR

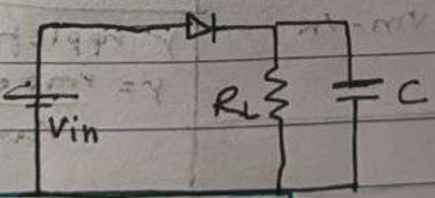
$r = \frac{1}{4\sqrt{3} f C R_L}$ $C\uparrow$ $r\downarrow$

- $V_{dc} = V_m - \frac{I_{dc}}{4fC}$

- $V_{r(rms)} = \frac{I_{DC}}{4\sqrt{3} fC}$



HWR



$r = \frac{V_{r(rms)}}{V_{dc}}$

$\boxed{r = \frac{1}{2\sqrt{3} f C R_L}}$

- $\boxed{V_{rms} = \frac{I_{dc}}{2\sqrt{3} fC}}$

- $\boxed{V_{dc} = V_m - \frac{I_{DC}}{2fC}}$