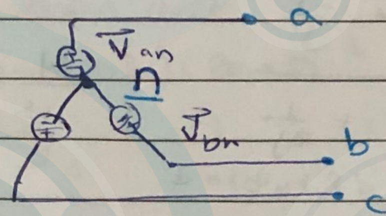
5/8/2020

[Three phase system : we have 3 sinusoidal voltages with equal amplitudes & freq but 120° phase shift between them.

التشبيكة بتكون Y or Δ

① Y configuration :



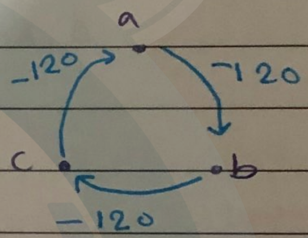
* اتجاه n بوزلساب *

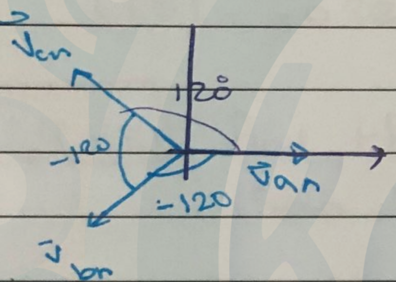
n : nuetral node

$\vec{V}_{an} : V \angle 0°$ V : rms

$\vec{V}_{bn} - V \angle -120°$

$\vec{V}_{cn} - V \angle -240°$





$$\vec{V}_{an} + \vec{V}_{bn} + \vec{V}_{cn} = ??$$

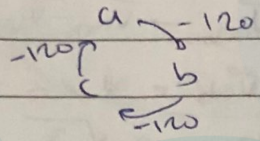
Note: $V\angle 0 + V\angle -120 + V\angle -240 = 0$

$\vec{V}_{an}$ / $\vec{V}_{bn}$ / $\vec{V}_{cn}$ ⟶ phase voltages

ex: if $\vec{V}_{an} = 120\angle 60$ volt

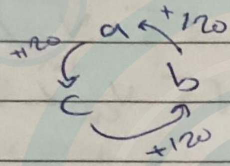
find $\vec{V}_{bn}$, $\vec{V}_{cn}$

Soln:



$\vec{V}_{bn} = 120\angle -60$

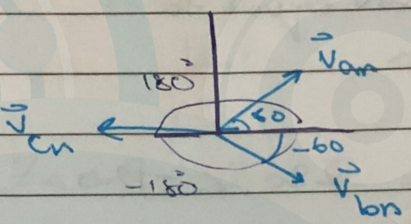
-120 بنزيح



a من

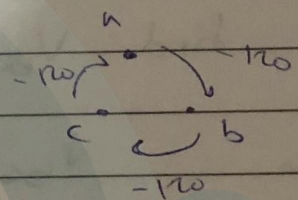
$\vec{V}_{cn} = 120\angle 180 \rightarrow 60+120 = 180$

b من $\rightarrow -60-120 = -180$



ex $V_{Bn} = 240\cos(\omega t + 10)$

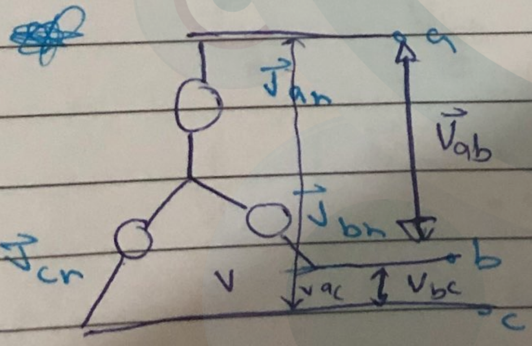
find $V_{an}(t)$, $V_{cn}(t)$



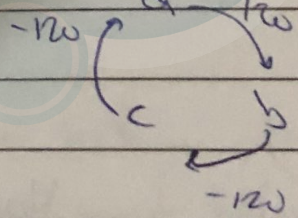
Soln: $V_{Bn} = 240\angle 10$

$V_{an} = 240\angle 130 = 240\cos(\omega t + 130)$

$V_{cn} = 240\cos(\omega t - 110)$



$\vec{V}_{ab}$ / $\vec{V}_{bc}$ / $\vec{V}_{ca}$ $\rightarrow$ line voltages



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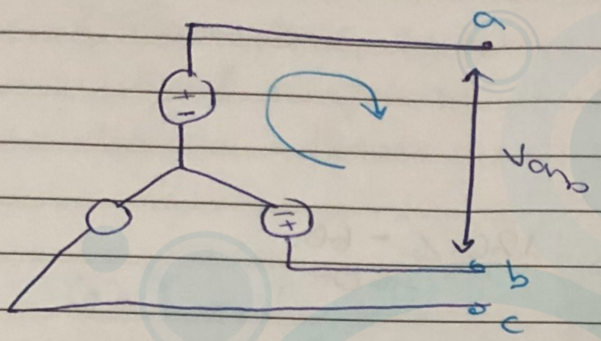


By KVL: $\vec{V}_{bn} - \vec{V}_{an} + \vec{V}_{ab} = 0$

$\vec{V}_{ab} = \vec{V}_{an} - \vec{V}_{bn}$

$\vec{V}_{ab} = V\angle 0 - V\angle -120$

مهم جداً

$\vec{V}_{ab} = \sqrt{3}\, V_{an} \angle 30$

$\vec{V}_{bc} = \sqrt{3}\, V_{bn} \angle 30$

$\vec{V}_{ca} = \sqrt{3}\, V_{cn} \angle 30$

* the line voltages are equal to $\sqrt{3} * V_n \angle 30$

(ex) if $V_{bn} = 220 \angle -120$, $V_{an} = 220\angle 0$ } phase voltages

find V_{bc}, V_{ca}

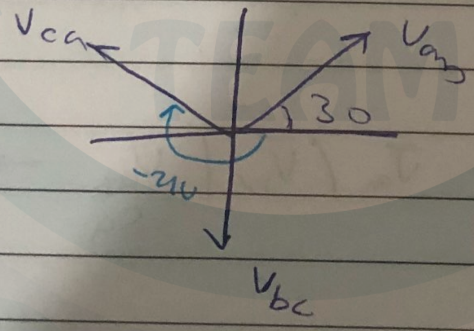
Sol

$V_{bc} = \sqrt{3}\, V_{bn} \angle 30$

$= \sqrt{3}\,(220\angle -120)\angle 30 = 381.1 \angle -90$ (V)

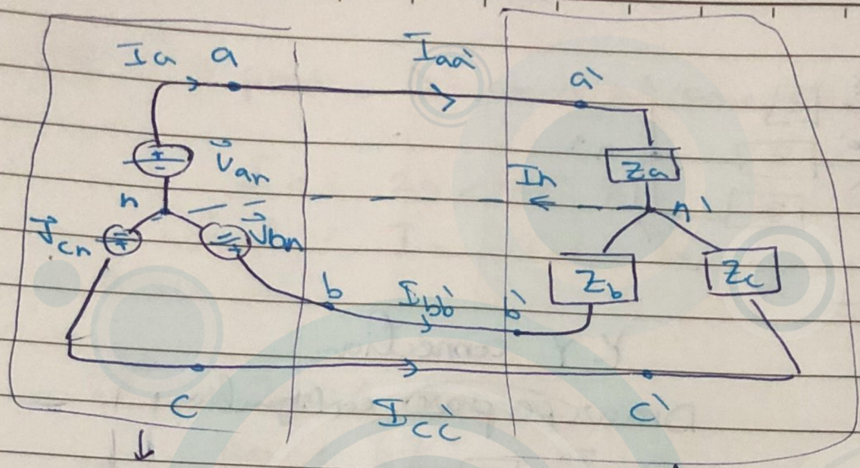
$\vec{V}_{ca} = \sqrt{3}\, \vec{V}_{cn} \angle 30 = \sqrt{3}\, \vec{V}_{cn} \angle 30$

$= \sqrt{3} * 220 \angle -240 \angle 30 = 381.1 \angle -210$ (V)



$V_{ab} = \sqrt{3}\, V_{an} \angle 30 = \sqrt{3}\,(220\angle 0)\angle 30$

$= 381.1 \angle 30$



Three phase Source

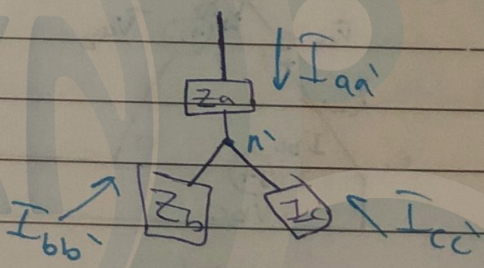
Three phase load

assume Balanced Load → $Z_a = Z_b = Z_c = Z$

I_a → phase current

$I_{aa'}$ → line current

$I_{phase} = I_{line}$ → [illegible]



$I_a + I_b + I_c = 0$

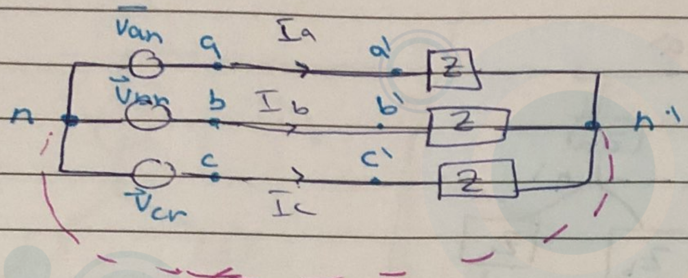
$$\frac{\vec{V}_{an}}{Z} + \frac{\vec{V}_{bn}}{Z} + \frac{\vec{V}_{cn}}{Z} = 0 = I_n$$

$$\frac{1}{Z}\left(\vec{V}_{an} + \vec{V}_{bn} + \vec{V}_{cn}\right) = I_n$$

0

$I_n = 0$ → current in the wire between $(n-n') = 0$

$V_{nn'} = 0$ → any element between n & n' is not used in calculation

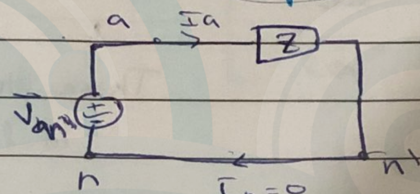


$I_n = 0$

$V_{nn'} = 0$

Y-Y connection

Draw (perphase) configuration



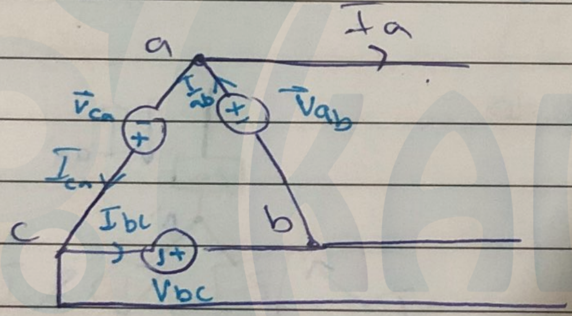
← (1) موجود

$I_n = 0$

$V_{nn'} = 0$

ممكن أضع b أو c

* تشبيكة ثانية



* note → Δ connection is rarely used

$I_{ab} \neq I_a$

apply kcl

$I_{ab} = I_a + I_{ca}$

$I_a = I_{ab} - I_{ca}$

$\Rightarrow I_a = \sqrt{3}\, I_{ab} \angle -30$

$I_b = \sqrt{3}\, I_{bc} \angle -30$

$I_c = \sqrt{3}\, I_{ca} \angle -30$

$I_a / I_b / I_c$ → line current

I_{ab}, I_{bc}, I_{ca} → phase current

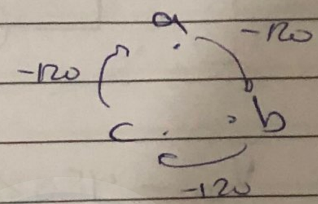
[$V_{phase} = V_{line}$

ex 3 phase, Δ - connected power supply

$I_c = 20\angle 53^\circ$ A

find : I_a, I_{ab}, I_{bc}, I_b, I_{ca}

soln:

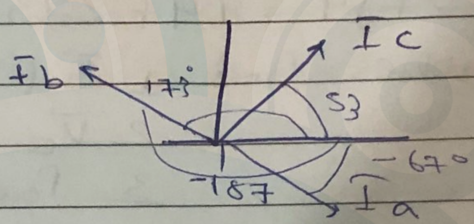


$\vec{I}_a = \vec{I}_c \angle -120$

$20\angle -67^\circ$

$\vec{I}_b = 20\angle 173^\circ$

$= 20\angle -187$

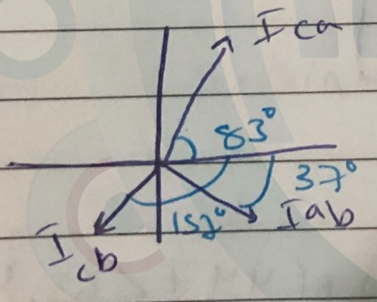


→ $\vec{I}_a = \sqrt{3}\, I_{ab} \angle -30$

→ $\bar{I}_{ab} = \dfrac{20\angle -67}{\sqrt{3}\angle -30} = 11.55\angle -37$ A

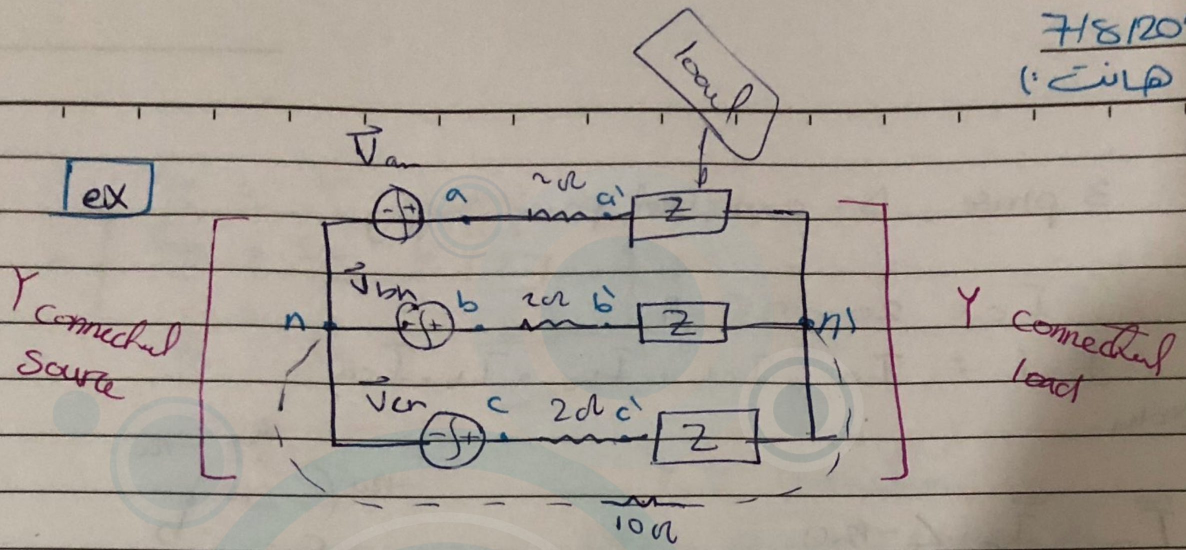
→ $\vec{I}_b = \sqrt{3}\, I_{bc} \angle -30 \Rightarrow I_{bc} = 11.55\angle -157^\circ$

→ $\vec{I}_c = \sqrt{3}\, I_{ca} \angle -30 \rightarrow \vec{I}_{ca} = 11.55\angle 83 = 11.55\angle -27$



7/8/2020
هانت :)

ex



$\vec{V}_{an} = 480\angle 0$

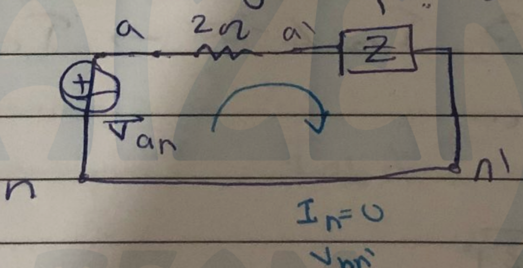
$Z = 2+j4 = 4.47\angle 63.4^\circ\ \Omega$

assume rms values find:
1. $\vec{S}$ @ the load
2. $\vec{V}_{ca}$
3. Power losses in wires
4. PF @ load
5. PF @ source
6. $\vec{S}$ @ source

Solu →

① Draw per phase system

* أول إشي Phase واحد & وبعدين الكل.



By KVL

$-V_{an} + 2I_a + ZI_a = 0$

$I_a = 84.85\angle -45$ A

$V_Z = V_{a'n'} = I_a * Z = (84.85\angle -45) * (4.47\angle 63.4)$

$= 379.5\angle 18.4$ volt

$\vec{S}_{load} = V_{a'n'} I_a^* = (379.5\angle 18.4)(84.85\angle 45)$

(Phase A)

$= 32.2 * 10^3 \angle 63.4$ VA

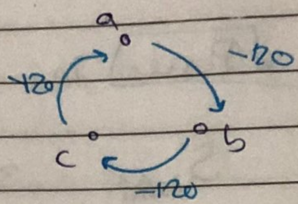
$S_{load\,(total)} = 3 * 32.2 * 10^3 \angle 63.4$

لكل ٣ Phases

$= 96.6 * 10^3 \angle 63.4$ VA

Power losses
R ≥ بتكون خطأ

7/8/2020



(2) $\vec{V}_{ca} = \sqrt{3}\ \vec{V}_{cn} \angle 30$

given $\vec{V}_{an} = 480\angle 0$

$\vec{V}_{cn} = \vec{V}_{an} \angle 120$

$\vec{V}_{cn} = 480 \angle 120$

$\vec{V}_{ca} = \sqrt{3} * 480 \angle 120 * \angle 30 = 831.4 \angle 150°$ (V)

لوطلب → $\vec{V}_{c'a'} = \sqrt{3}\ V_{c'n'} \angle 30$

$\vec{V}_{a'n'} = 379.5 \angle 18.4$ من فرع الحمل طلعنا

$\vec{V}_{c'n'} = \vec{V}_{a'n'} = 379.5 \angle 18.4 \angle 120 = 379.5 \angle 138.5$

$\vec{V}_{c'a'} = \sqrt{3} * 379.5 \angle 138.5 \angle 30 = 657.3 \angle 168.4$ (V)

(3) Power losses in wires

Power loss in Phase a $= |I_a^2| * 2 = 84.85^2 * 2 = 14.4$ kw

power losses total $= 3 * 14.4 = 43.2$ kw

(4) PF @ load $= \cos(\theta_v - \theta_i)$ @load $= \cos(18.4 - -45)$

$= .45$ lag

(5) Pf @ source $= \cos(\theta_v - \theta_i)$ @ source $= \cos(0 - -45) = .75$ lag

(6) $\vec{S}$ source $= \vec{V}_{an} * \vec{I}_a^* = 480\angle 0 * 84.85\angle 45$

$= 40.73 * 10^3 \angle 45$ VA

$\vec{S}_{total} = 3 * 40.73 * 10^3 \angle 45 = 122.2 * 10^3 \angle 45$ VA

∝ $S_{source} = S_{load\ total} + S_{losses\ total}$

Power in 3 phase system

$\bar{S}_{total} = 3\, V_{phase}\, I^{*}_{phase}$

$= \sqrt{3}\, \vec{V}_{line}\, I^{*}_{line}$

$= P_{total} + jQ_{total}$

$P_{total} = 3\, V_{phase}\, I_{phase} \cos(\theta_v - \theta_i)$

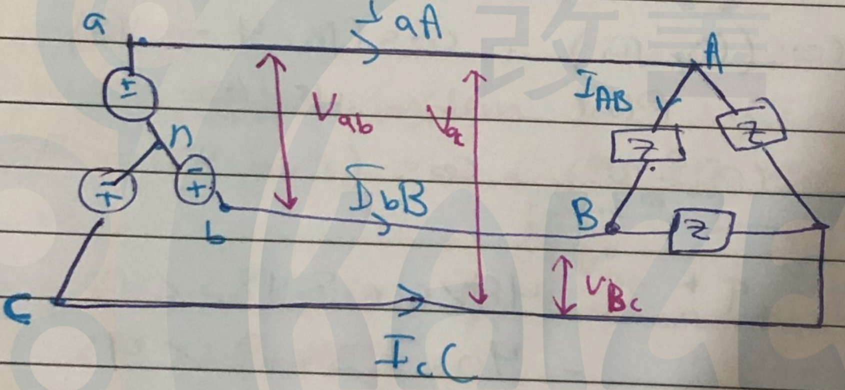
$= \sqrt{3}\, V_{line}\, I_{line} \cos(\theta_v - \theta_i)$

$Q = 3\, V_{phase}\, I_{phase} \sin(\theta_v - \theta_i)$

$= \sqrt{3}\, V_{line}\, I_{line} \sin(\theta_v - \theta_i)$

$pf = \cos(\theta_v - \theta_i)$ → lead / → lag

Y–Δ connection



Z_{load} = balanced

$V_{AB} = V_{ab}$

$\vec{I}_{AB} = \dfrac{\vec{V}_{ab}}{Z} = \dfrac{\sqrt{3}\, \vec{V}_{an} \angle 30}{Z}$

$\vec{I}_{BC} = \dfrac{\vec{V}_{bc}}{Z} = \dfrac{\sqrt{3}\, \vec{V}_{bn} \angle 30}{Z}$

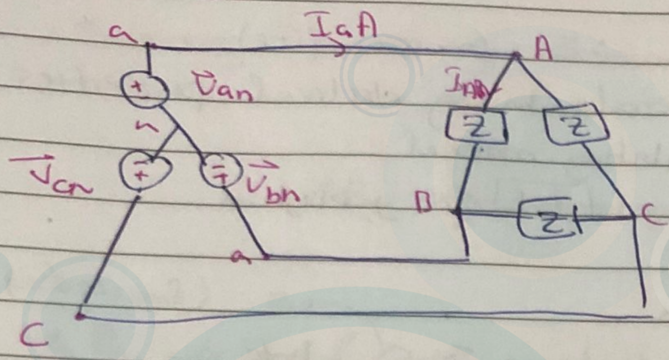
$\vec{I}_{CA} = \dfrac{\vec{V}_{ac}}{Z} = \dfrac{\vec{V}_{cn}\sqrt{3}\angle 30}{Z}$

or

$I_{aA} = \sqrt{3}\, \vec{I}_{AB} \angle -30$

Example 7/8/2021

(ex)



given: $Z = 8 + 4j\ \Omega$ $\vec{V}_{an} = 100\angle 10$ volt

find ① $\vec{I}_{AB}$ ② S_{total} (source)

Sol →

method ①

$$\vec{I}_{AB} = \frac{\vec{V}_{ab}}{Z} = \frac{\sqrt{3}\ \vec{V}_{an}\angle 30}{Z}$$

$$= \frac{\sqrt{3}\ (100\angle 10)\angle 30}{8+4i}$$

$$\vec{I}_{AB} = 19.36\angle 13.4\ A$$

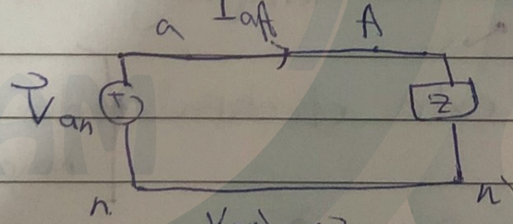
method ②

conversion from Δ to Y

$$Z_1 = \frac{Z * Z}{3Z} = \frac{Z}{3} = 2.67 + j1.33$$

connection is Y → Y

* Draw per phase



$V_{nn'} = 0$

* ركزوا

آخر الاختبار

سهل

$$I_{aA} = \frac{\vec{V}_{an}}{Z} = 33.53\angle -16.6\ A$$

$$I_{aA} = \sqrt{3}\ I_{AB}\angle -30$$

$$\vec{I}_{AB} = 19.36\angle 13.4\ A$$

* $S_{total} = 3\ V_{phase} * I^*_{phase}$

$= 3\ (100\angle 10)(33.53\angle +16.6) = 10.06\ kw\ \angle 26.6\ VA$

Five Apple

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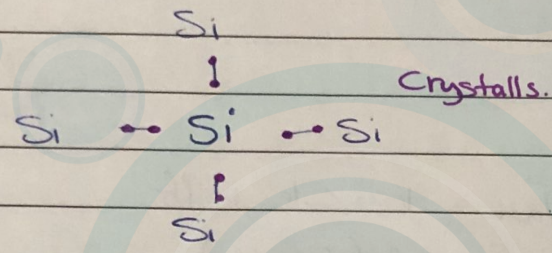
9/8/2020

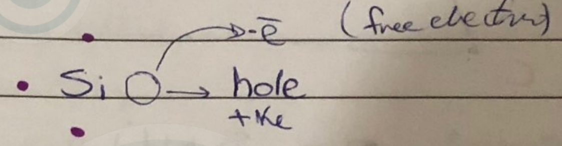
الأحد ... هامة :

* Semiconductor - Devices : Si , Germanium (Ge)

semi conductors are materials having electrical properties betwen conducting & insulating material

عمدارالأخير فيه [4 ē] ← بيشاركوا مابعض





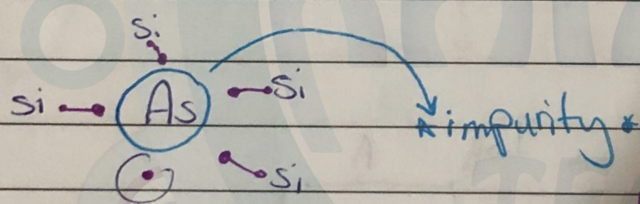
hole: When electron leaves the atom it creates a hole with + sign.

* Two types of charge carrier
 1. Free electron → -ve sign
 2. hole → +ve sign

} → they both travel in opposite direction

* Doping: a way to control of # of charges by adding impurities to the structure of semi conductor

- impurities could be from group 5 of periodic table (5 ē in the last level

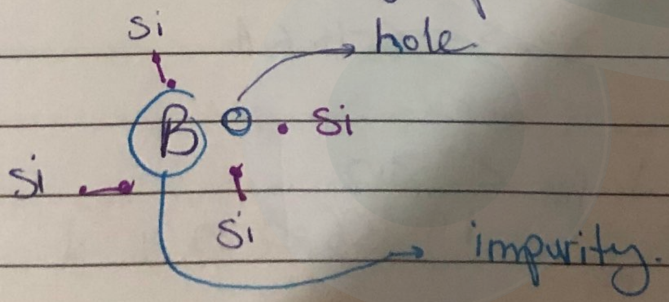


↳ extra electron

بتطير ↓

[donar → n-type semi conductor
majority carrier is ē (-ve sign)

* group 3



acceptor → p type semi conductor

majority ~~carrier~~ is hole (+ve sign)

9/8/2020

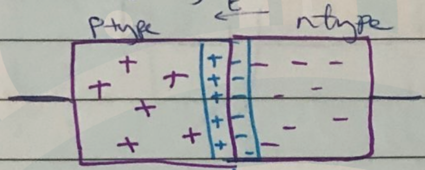
Summary: So n-type semiconductor : majority is electron (−ve) sign [− − − / − − −]

P-type semiconductor: majority is hole (+ve) sign [+ + + / + + +]

* Pn junction & semi conductor Diode

P-type → majority is holes +ve sign [+ + +]

n-type → majority is electrons



منطقة متعادلة كهربائية

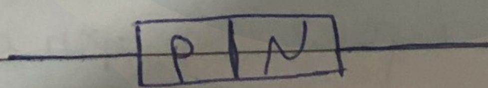
depletion region : region where free electron recombine with hole. (no charge carrier)

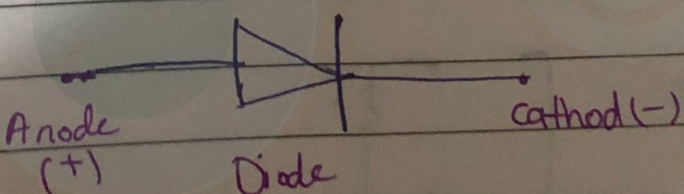
* منه بصير عنا فرق جهد.

→ Charge seperation causes potential to exist @ pn junction & called gamma V = V_γ

V_γ → (.6 − .7) → Si
V_γ → (.2 − .3) → Ge

* connecting Pn Junction to external source





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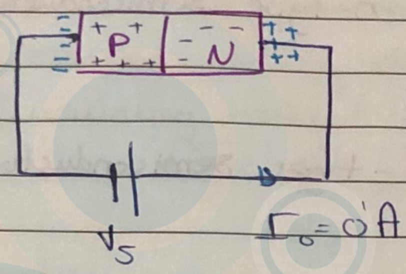
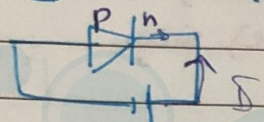
① Reverse Biase

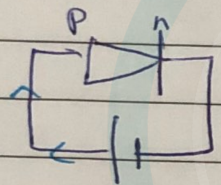


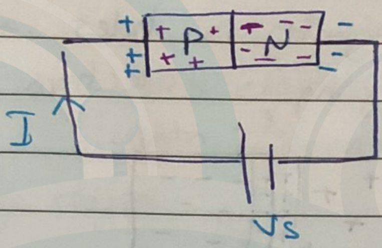
larger depletion region

Diode آشباك بالعكس



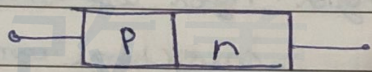
② Forward Biase

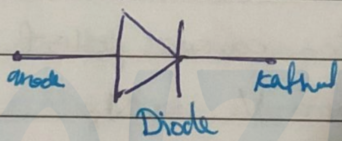




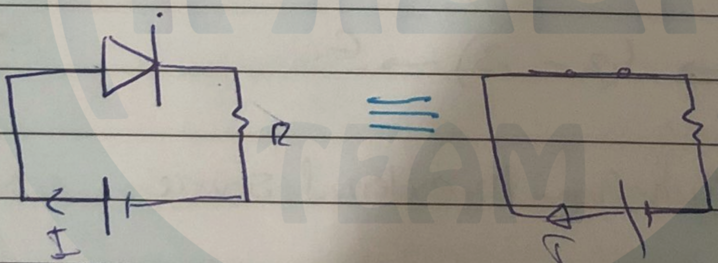
Small depletion region

* Ideal Diode

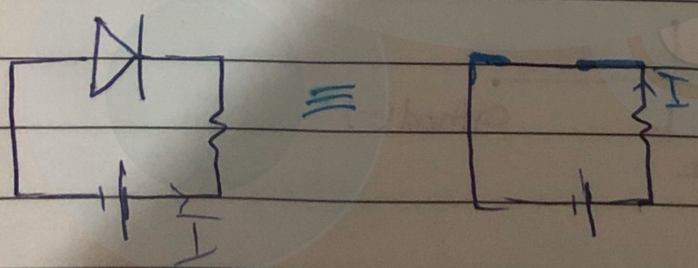


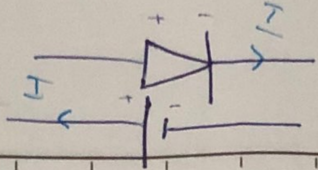


① Forward biase : Diode is replaced by short circuit



② Reverse biase: Diode is replaced by open circuit



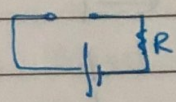


Polarity

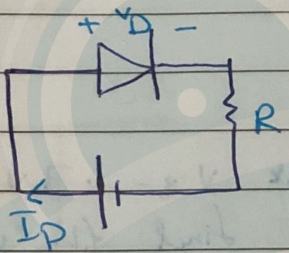
⊛ Practical Diode

① Forward Biase: Diode is replaced by supply with value of:

V_γ → (.6 – .7) Si
V_γ → (.2 – .3) Ge



$i_D = 0$



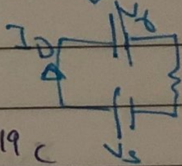
Forward

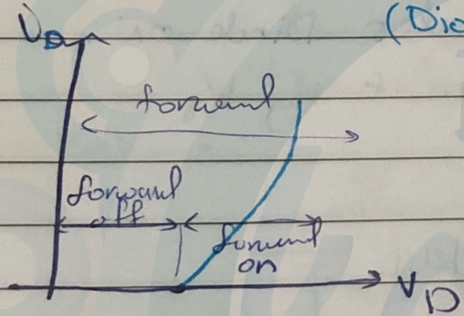
① forward off if $V_D < V_\gamma$

② forward on if $V_D > V_\gamma$

$$I_D = (I_o(e^{qV_D/tk} - 1))\ A$$

(Diode equ) ← $I_o(e^{qV_D/tk} - 1)$





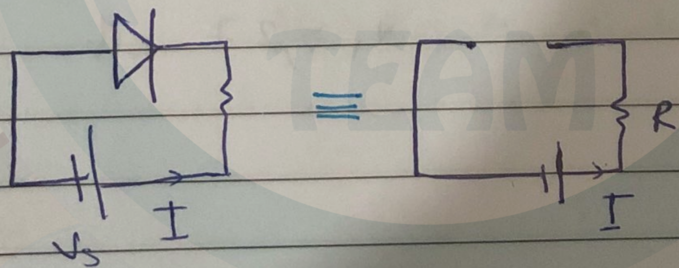
q: electron charge = 1.6×10^{-19} C

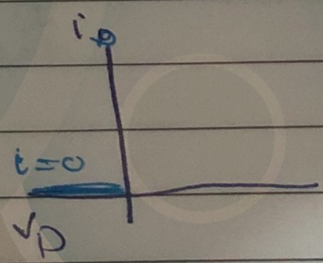
T = temperature kelvin

k: Boltzman constant 1.381×10^{-23} J/K

I_o = saturation current (μA)

② Reverse Biase: Diode is replaced by open circuit





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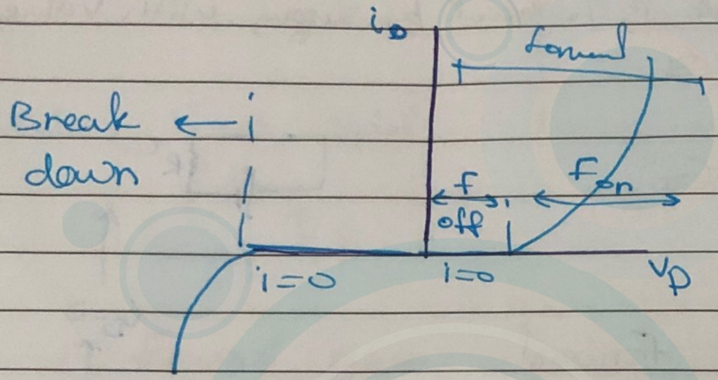
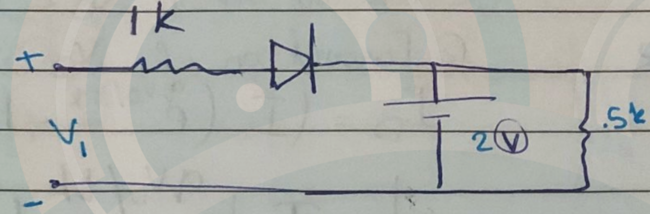
I–V characteristic for diode



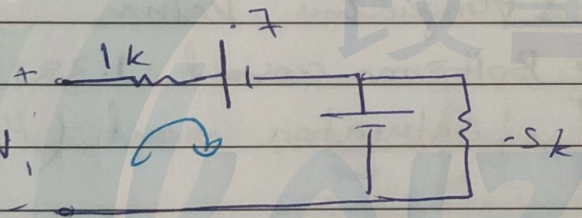
(ex)



$V_\gamma = .7$ V

find the voltage V_1 that makes Diode ON.

Soln → since Diode is ON → replace it by V_γ



By KVL

$-V_1 + 0 + 1k + .7 + 2 = 0$

$V_1 = 2.7$ volt

on [illegible] Test [illegible]

to make diode ON

$V_1 \geq 2.7$ volt

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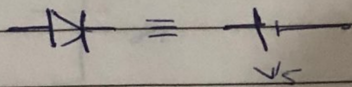
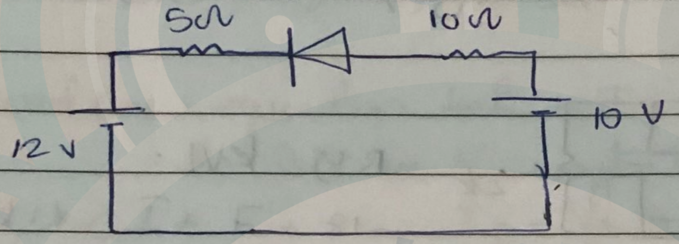
* Steps to solve to know if Diode is on

1. replace diode by open circuit
2. find V_D on diode
3. if $V_D > V_\gamma$ ⇒ diode is on
   ⇒ replace it by voltage source have value of V_γ



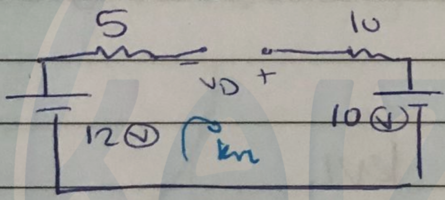
4. if $V_D < V_\gamma$ ⇒ diode is off
   ⇒ replace it by open circuit.

ex)



$V_\gamma = .7\ V$ → find if diode on or off

Solu →



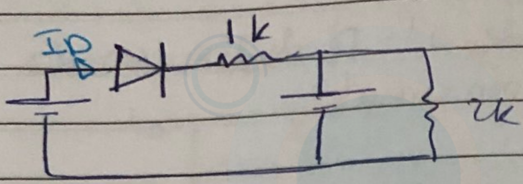
By KVL → $-12 + 5*0 - V_D + 10*0 + 10 = 0$

open circuit [illegible] ← $I = 0$

$V_D = -2$ volt

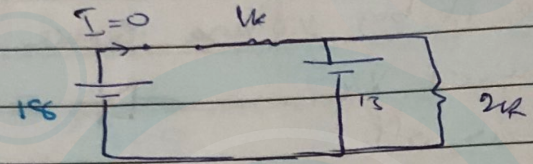
$V_\gamma > V_D$ ∴ diode is off

ex 2



$V_\gamma = .7$ find I_D

Solu:

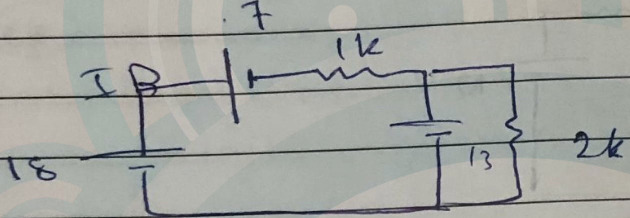


By KVL =

$-18 + V_D + 0 + 13 = 0$

$V_D = 5$

$V_D > V_\gamma \therefore$ Diode is on

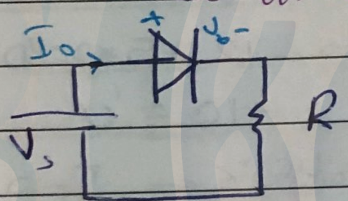


By KVL:

$-18 + .7 + I_D (1k) + 13 = 0$

$I_D = 4.3\ mA$

* load line



using KVL

$-V_s + V_D + I_D R = 0$

$I_D = \frac{V_s}{R} - \frac{V_D}{R} \longrightarrow ①$

* [I_D & V_D are unknowns

$I_D = I_o (e^{qV_D/KT} - 1) \longrightarrow ②$

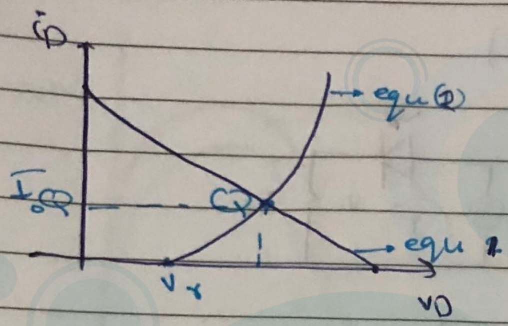
* معادلتين بمجهولين

* ما بنفع باستخدام الكالك ← حلهم ← بلزم منحنيات graphs

Load line

10/8/2020 :)

Chaq ddesh lab :)

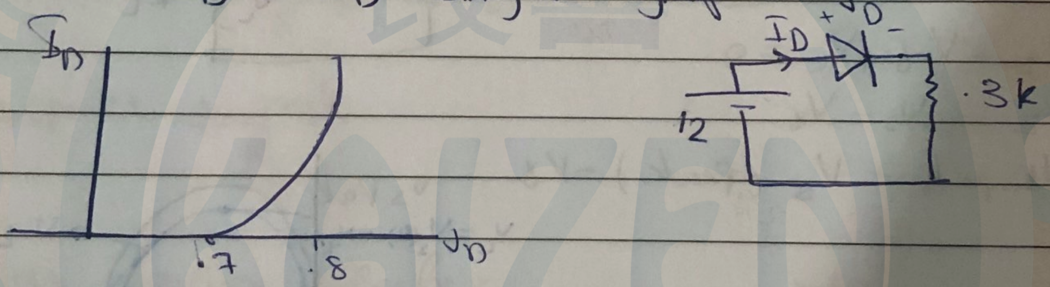


CQ : Quisent point (نقطة الركود)
Solution graphically → V_{DQ} & I_{DQ}

load line : equation betwn I_D & V_D
for this ex → load line eq :

$$I_D = \frac{V_\gamma}{R} - \frac{V_D}{R}$$

(ex) Find I_D & V_D using the graph

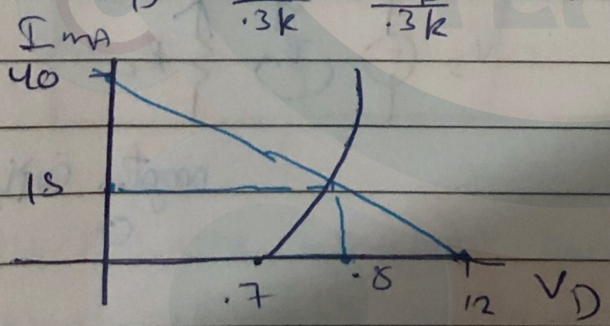


Soln → to find load line use KVL

$-12 + V_D + .3k * I_D = 0$

$I_D = \frac{12}{.3k} - \frac{V_D}{.3k}$ → if $I_D = 0$ $V_D = 12$ V

if $V_D = 0$ $I_D = \frac{12}{.3} = 40$ mA



from graph ≃

V_{DQ} = .79 volt
I_{DQ} = 15 mA
(@ Q point)

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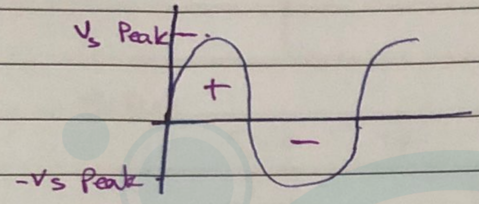
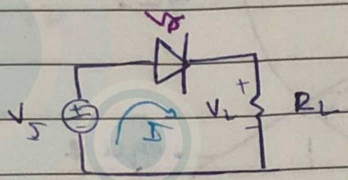
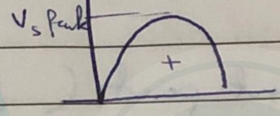
Applications for diode

✱ 1 Half wave rectifier (HWR)





(A) During the +ve cycle



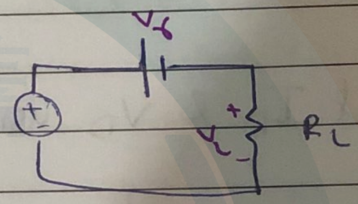
By KVL → to test if diode ~~is on~~ on off →

$-V_s + V_D + 0 = 0$

$V_D = V_s$

to make diode on → $V_D > V_\gamma$

$V_s > V_\gamma$ → should be

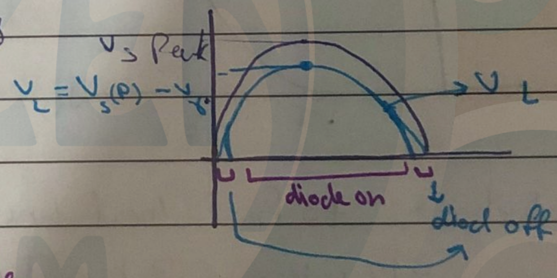


By KVL when diode is on

$-V_s + V_\gamma + V_L = 0$

$V_L = V_s - V_\gamma$

$V_{L\,peak} = V_s(\text{peak}) - V_\gamma$

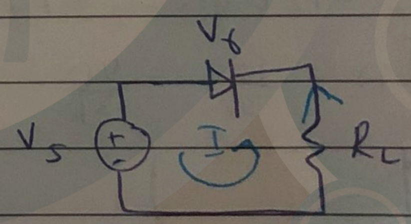


(B) During the negative cycle

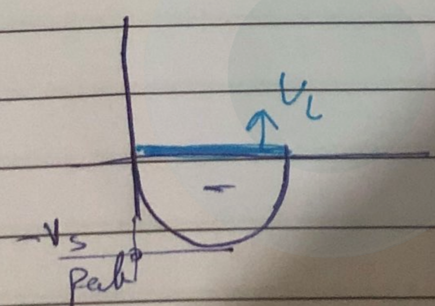
Diode is Reversed

⇒ off ⇒ open circuit

$I = 0 \quad V_L = 0$



negative cycle
0



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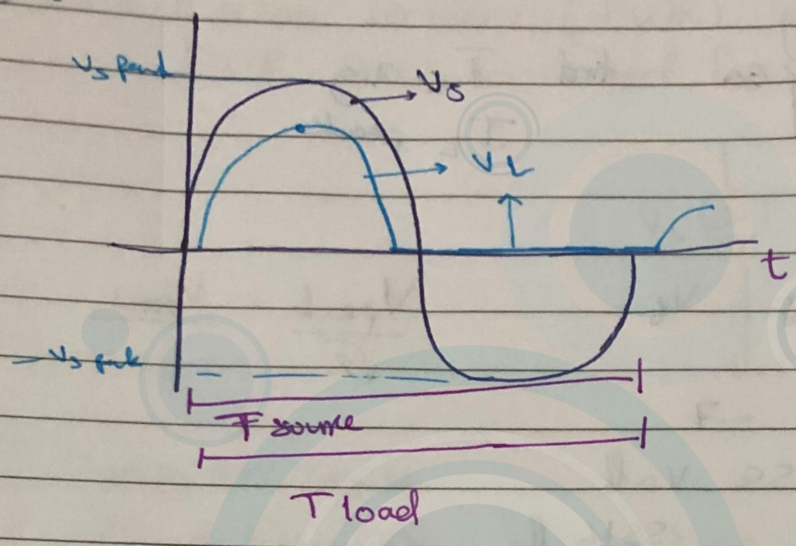
نحن :



$\rightarrow \therefore T_{source} = T_{load}$

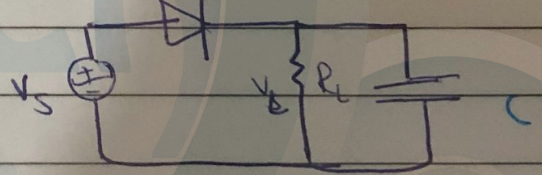
$\rightarrow f_{source} = f_{load}$

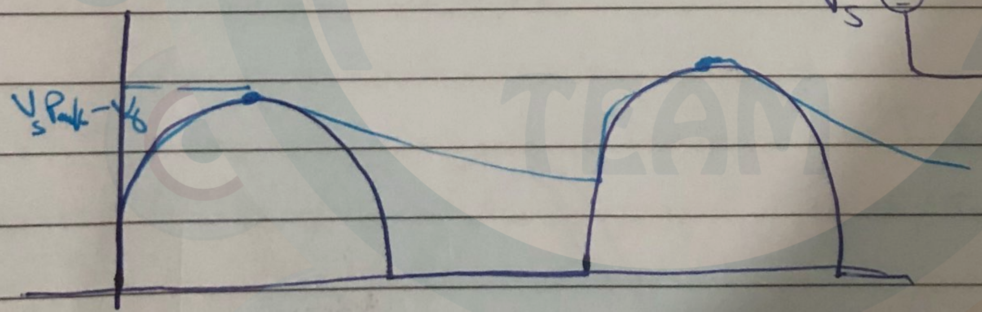
$\rightarrow V_{L\,avg} = \frac{1}{T}\int_0^T V_L(t)\,dt = V_{L\,avg} = \frac{V_{L\,peak}}{\pi}$

$\rightarrow I_{L(avg)} = \frac{V_{L\,avg}}{R}$

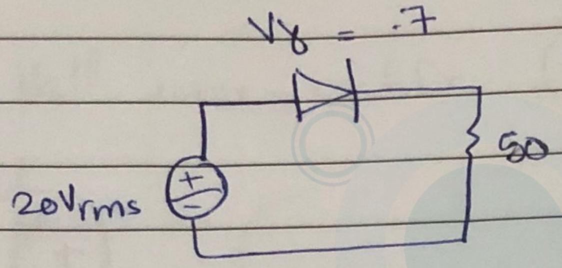
$\rightarrow I_{L(peak)} = \frac{V_{L\,peak}}{R}$

* adding capacitor effects:





HWR : one way to convert from AC to DC but this method is ineffecient ex



find I_L avg

I_L peak

Soln: HWR

$V_{L\,peak} = V_{s\,peak} - V_\gamma$

$\frac{V_{peak}}{\sqrt{2}} = V_{rms}$

① $V_{L\,peak} = 20\sqrt{2} - .7$

$= 27.58$ volt

● $I_{L\,peak} = \frac{V_{L\,peak}}{50} = .5516\ A$

② $V_{L\,avg} = \frac{V_{L\,peak}}{\pi} = \frac{27.58}{\pi} = 8.78\,V$

$I_{L\,avg} = \frac{V_L\,(avg)}{50} = .175\ A$

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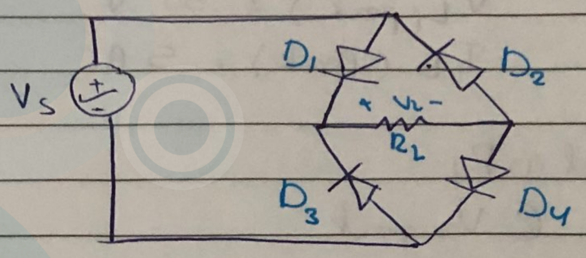
② Full wave rectifier (FWR) using bridge

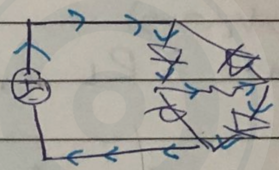
FWR: used to convert from AC to DC with efficint way



ⓐ During +ve cycle

D_1 & D_4 on

D_2 & D_3 off



By KVL

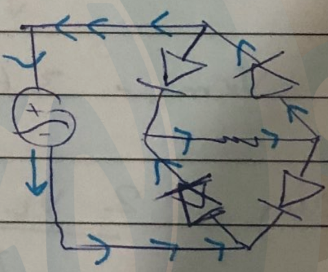
$$-V_s + V_\gamma + V_L + V_\gamma = 0$$

$$V_L = V_s - 2V_\gamma$$

$$V_{L\,peak} = V_{s(peak)} - 2V_\gamma$$

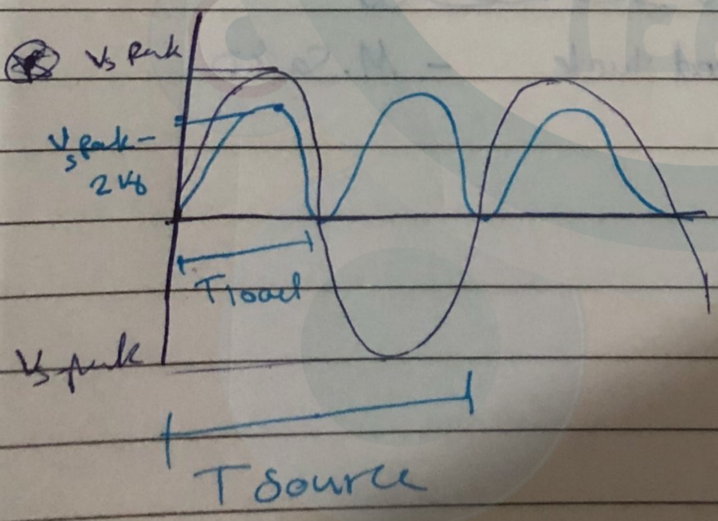
ⓑ During (-ve) cycle

$$V_{L\,peak} = V_{s\,peak} - 2V_\gamma$$



D_3 & D_2 → on

D_1 & D_4 → off



$$T(source) = 2T(load)$$

$$1/T_{source} = 1/2T_{load}$$

$$2f_{source} = f_{load}$$

$$V_{L}\ peak = V_{s\,peak} - 2V_\gamma$$

$$V_{L\,avg} = 2V_{L\,peak}/\pi$$

$$I_{L\,avg} = V_{L(avg)}/R_L$$

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Ex: FWR, Bridge, V_{γ} (all bridges) = .6 V

$V_{L(peak)} = 50$ V

$I_{L(peak)} = 5$ A

find (1) R_L

(2) V_s peak

(3) $V_{s(rms)}$

(4) $V_{L(avg)}$

Soln: $R_L = \frac{V_L \text{ peak}}{I_L \text{ peak}} = \frac{50}{5} = 10\,\Omega$

$V_L \text{ peak} = V_s \text{ peak} - 2V_{\gamma}$

$50 = V_s \text{ peak} - 2 * .6$

$V_s \text{ peak} = 51.2$ volt

$V_{s(rms)} = \frac{V_{s(peak)}}{\sqrt{2}}$

$V_{rms} = 36.2$ volt

$V_L \text{ avg} = \frac{2 V_{L(peak)}}{\pi} = 31.83$ volt

☺ تمنياتي بالتوفيق ☺

Good luck - M.Sako