Electrical :-

Resistor

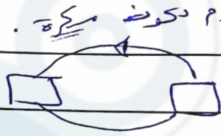
R

$\rho \propto \frac{1}{I}$

ρ

$$R = \rho \frac{L}{A} \rightarrow \Omega \quad (\text{ome})$$

لازم تكون مركبة



$$I = \frac{dQ}{dt} = \frac{\Delta Q}{\Delta t} \quad [A]$$

$$V_{difference} = V_{\oplus} - V_{\ominus}$$

يمتص

absorbed

(~~absorbed~~ power)

يستهلك

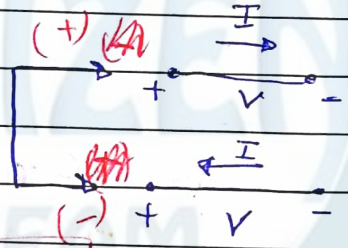
consumed power

$P = IV$

$\downarrow$

[W] watt

total power = zero

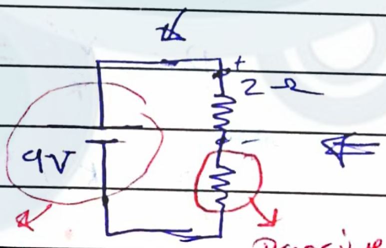


generated power

(Supplied power)

ohm's law:-

samplest circuit



passive element

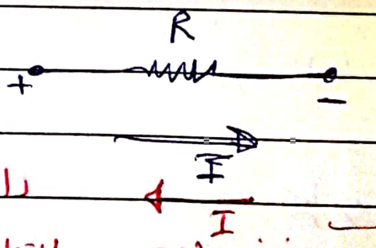
active element

(Voltage source)

active element

(Voltage source) $\rightarrow$ supplies energy

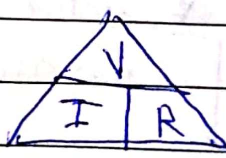
passive element $\rightarrow$ absorbs energy



$$V = IR$$

$$= -IR$$

$$I = \frac{V}{R}$$



دائماً بيبدأ الـ + لكل
التيار داخل على الموجب

نفرض إشارة
سالب

$$P_{cons.} = IV = \frac{V^2}{R} = I^2 R$$

$P_R \Rightarrow$ دائماً موجبة $\Rightarrow P_R = + ab = - sup$

* conductivity

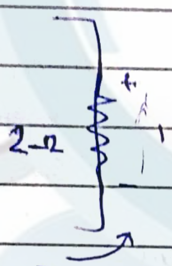
$$G = \frac{1}{R} \quad (S, ℧, \Omega^{-1})$$

mho

siemens

$$= \frac{I}{V}$$

Ex:-



2Ω $12\,V$

$I = ??$

$P = ??$

$V = RI$

$$I = \frac{V}{R} = \frac{12}{2} = -6\ A$$

لأن التيار داخل على السالب

$$P = \frac{V^2}{R} = \frac{(12)^2}{2} = +72\ W$$

abs. power

or

$$P = RI^2 = (2)(-6)^2 = +72\ W$$

abs power

or

$$P = IV = (12)(-6) *$$

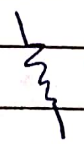
$= -72$ sup.

$= +72$ abs.

* Active element الدائرة بالطاقة بتكون من *

passive element

هم عبارة عن الـ sources



عبارة عن الـ

Five Apple

التوالي ← التيار ثابت
الجهد متجزأ

التوازي ← الجهد ثابت
التيار متجزأ

* Sources:-

→ independent
- → V → (+ −)
- → I → (independent current source)

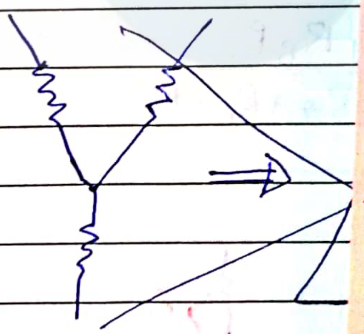
→ dependent
- → V → (voltage dependant source) ~~voltage controlled~~ (dep. V.S. V.C)
- → I → (dep. ~~voltage~~ current controlled current source)

* الطاقة لل power دايماً صفر

* Node → تربط one element أو أكثر مع بعض

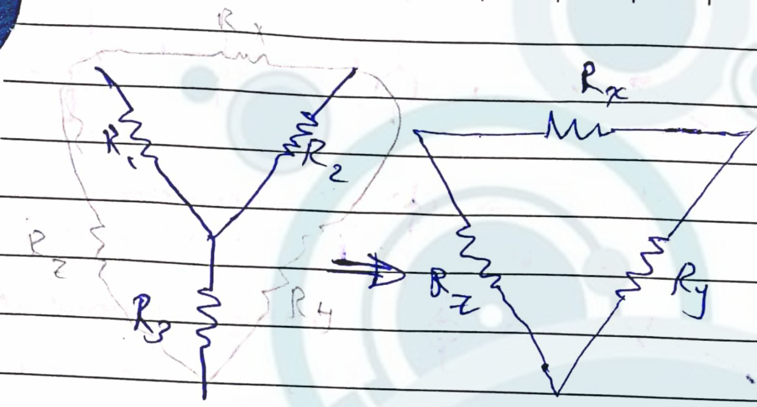
* KCL → $\sum I_{in} = \sum I_{out}$ For every node

KVL → $\sum V = 0$ For every closed loop.



equivalent resistance

- parallel
  $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} \cdots + \frac{1}{R_n}$
- series
  $R_{eq} = R_1 + R_2 \cdots + R_n$
- other form
  Δ
  Y

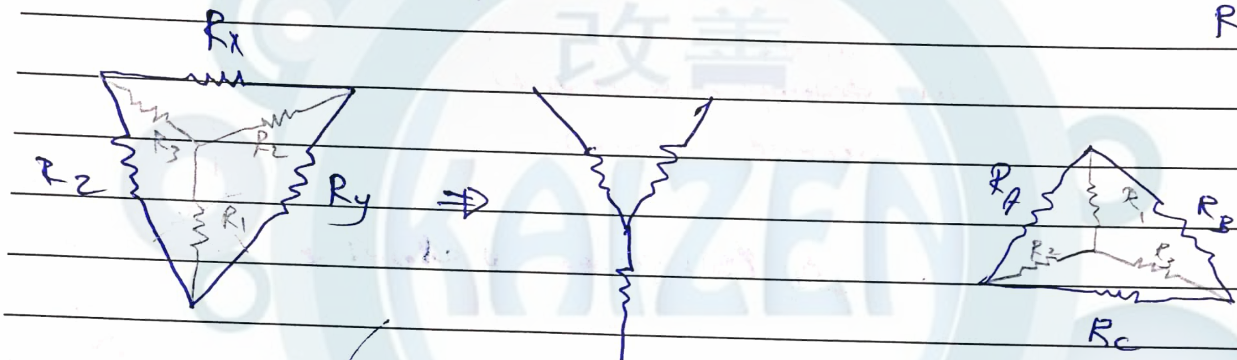


$$R_x = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_3}$$

الوحيدة ←

$$R_y = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_1}$$

$$R_z = \frac{R_1R_2 + R_2R_3 + R_1R_3}{R_2}$$



جيرانه

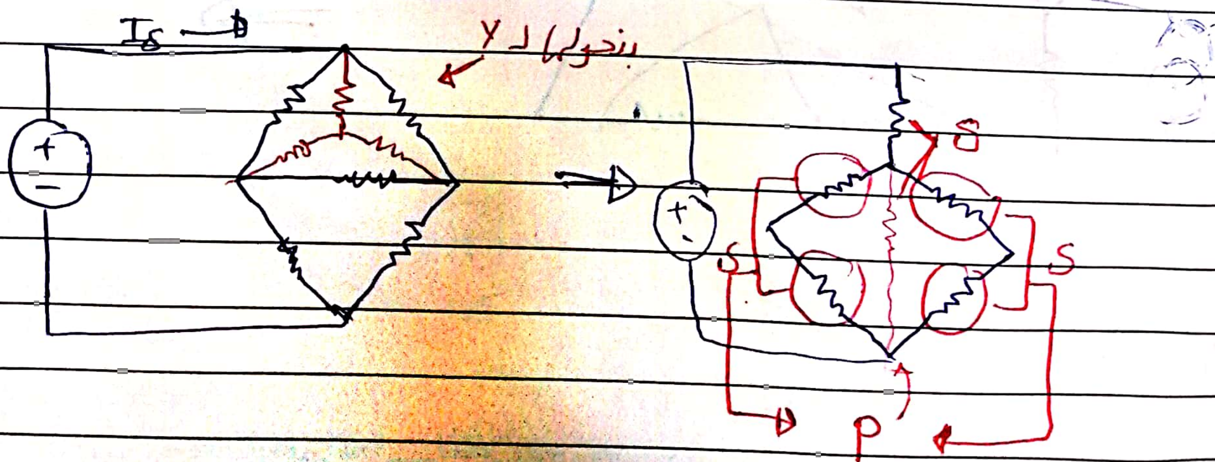
$$R_1 = \frac{R_A R_B}{R_A + R_B + R_C}$$

→ مجموعهم

$$R_2 = \frac{R_A R_C}{R_A + R_B + R_C}$$

$$R_3 = \frac{R_B R_C}{R_A + R_B + R_C}$$

ex:



Polarity

Rating power of R :-

$P = I^2 R$ (allowed power)

اذا كانت قيمة P اكبر من ال allowed بيحكي انو ال R damaged

$I_{max} = \sqrt{\frac{P_{max}}{R}}$ (allowed current)

* Short circuit and open circuit :-

→ wire عبارة عن

* $R = 0$

$V = 0$

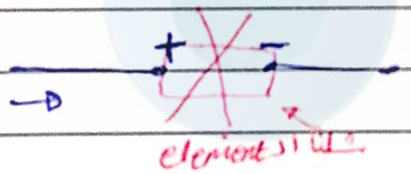
$V_e = V_{high} - V_{low}$

short circuit بما انه → (+) Polarity = (−) polarity

$V_+ = V_-$

$V_e = V_+ - V_- = \underline{\underline{0}}$

open circuit



* $\underline{I = 0}$ the current doesn't flow in an open part.

$R = \infty$

dual to each other

$V \leftrightarrow I$

$R \leftrightarrow G$

$P \leftrightarrow S$ ⇐ duality

$\textcircled{+} \leftrightarrow \textcircled{\uparrow}$

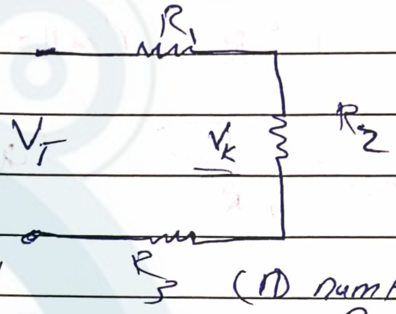
S.C ↔ O.C

V = 0   I = 0

$n = b - L + 1$

* Voltage Division Rule :-

$$V_k = V_T \frac{R_k}{\sum_{1}^{n} R}$$



(n) number of R

مثال $\rightarrow V_2 = \frac{R_2}{R_1 + R_2 + R_3} \cdot V_T$

$$V_1 = \frac{R_1}{R_1 + R_2 + R_3} \cdot V_T$$

* حتى اطبق هذه القوانين

✓ لازم يكونوا (R) مربوطات مع بعض على التوالي (series)

✓ لازم V_T معروفة

↓ (Voltage sorces) total

* current division Rule :-

✓ Total current must Be known

✓ all (R) are is parallel

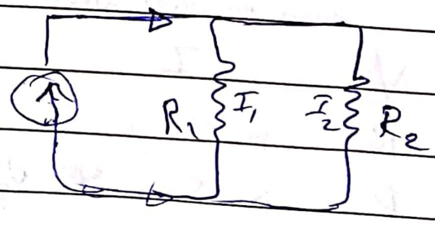
3-72

$$i_k = \frac{\frac{1}{R_k}}{\frac{1}{R_1} + \frac{1}{R_2} + \dots \frac{1}{R_n}} (I_{tot})$$

I_s

طريقة اسهل ومختصرة اكثر .

$$I_1 = \frac{R_2}{R_1 + R_2} i_{tot}$$



وبنحطه بـ (٢) و حذف وكمويش مع (٣)

Method of Analysis

- voltage division
- current division
- Nodal Analysis (KCL)
- mesh Analysis (KVL)

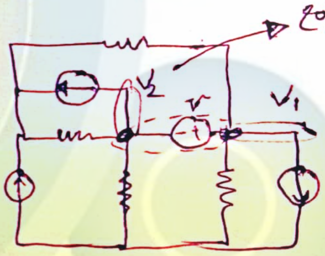
* supernode:-

اذا كان عندي 2nodels بيناتهم voltage source

لما اجي احل ذي كأني بعمل Jump لل node الثانية وبدمجهم مع بعض

بكتب $N(V_2)$ وبجمع ال $N(V_1)$

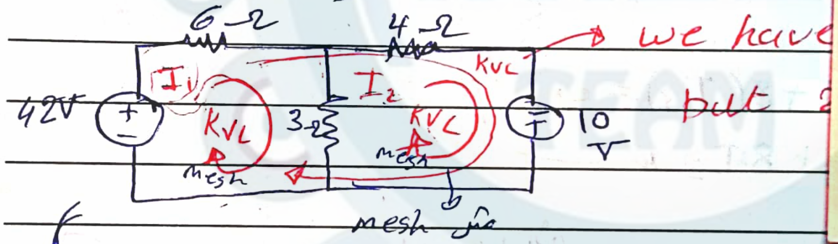
$N(V_2, V_1)$



mesh analysis:-

every mesh is a KVL

KVL ما بكون فيها اكثر من



meshes are given as clockwise.

$$-42 + V_6 + V_3 = 0 \rightarrow \text{mesh equation } (1)$$

$V_6 = 6(I_1)$, $V_3 = 3(I_1 - I_2)$

هاد الي بميزلي انو mesh

mesh معاتجاه

عكس الاتجاه الي مانزله

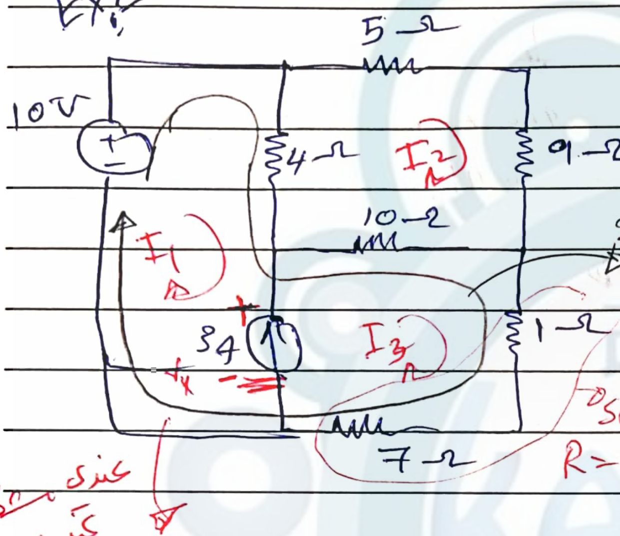
$$M(2) \Rightarrow V_4 + (-10) + V_3 = 0$$

$V_4 = 4(I_2)$, $V_3 = 3(I_2 - I_1)$

* كدا كل meshes نفس عدد المعادلات الي بنحتاجها.

* supermesh :-

Ex :-



2meshes اخذنا

⟹ supermesh

ونحطلها نفس الحوالي

→ series

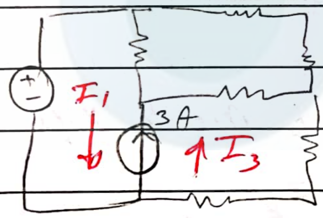
R = 8 Ω

$-10 + 4(I_1 - I_2) + V_x =$

KVL :- $-V_x + 10(I_3 - I_2) + 8(I_3) = 0$

$V_x = 10(I_3 - I_2) + 8(I_3)$

$\varepsilon.M \Rightarrow \quad 3 = I_3 - I_1 \quad --- \; (3)$ ← العلاقة الثالثة



$\Rightarrow \quad 3 = I_3 - I_1$

$-10 + 4(I_1 - I_2) + 10(I_3 - I_2) + 8(I_3) = 0$

$4I_1 - 14I_2 + 10I_3 = 10 \quad --- \; (1)$

$10(I_2 - I_3) + 4(I_2 - I_1) + 5(I_2) + 9(I_2) = 0$

$-4I_1 + 28I_2 - 10I_3 = 0 \quad --- \; (2)$

$I_3 - I_1 = 3 \quad --- \; (3) \qquad I_3 = I_1 + 3$

$(1) + (2) \Rightarrow \cancel{4I_1} - 14I_2 + \cancel{10I_3} = 10$

$\underline{\cancel{-4I_1} + 28I_2 - \cancel{10I_3} = 0} \quad \Longrightarrow$

$$\Rightarrow 14 I_2 = 10 \Rightarrow \boxed{I_2 = 0.7\ A}$$

$$4 I_1 - 14 I_2 + 10 I_3 = 10$$

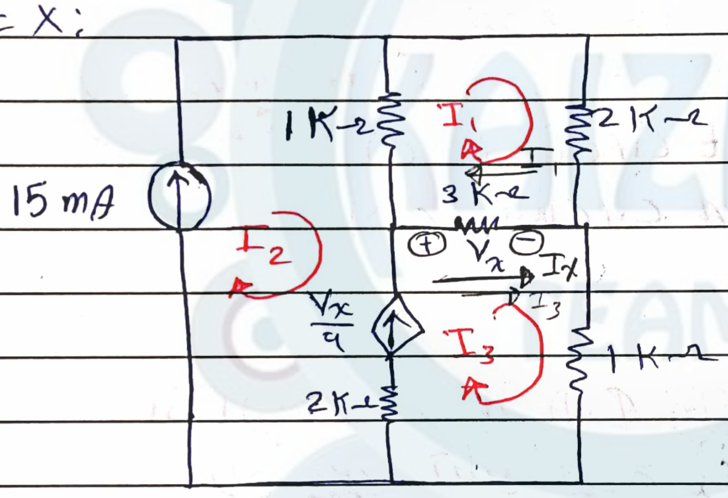
$$4 I_1 - 10 + 10(I_1 + 3) = 10$$

$$14 I_1 = 10 + 10 - 30$$

$$\boxed{I_1 = -2.5\ A}$$

$$\boxed{I_3 = 0.5\ A}$$

Ex:



مباشرة بطلع انو I_2 بساوي 15
لانها بتمر بال current source
تبعت ال 15mA

$$\boxed{I_2 = 15\ mA}$$

ما بقدر اكتب معادلة تبعت mesh ③ لانو في شي تبع ال I.C.S.V.C

$$\text{but} \Rightarrow \frac{V_x}{9} = I_3 - I_2 \rightarrow 15$$

$$\frac{V_x}{9} = I_3 - 15 \quad --- \ ①$$

$$\text{mesh}(1) \Rightarrow 1(I_1 - I_2) + 2(I_1) + 3(I_1 - I_3) = 0 \quad --- \ ②$$

$$V_x = R_3(I_x) \qquad i_x = I_3 - I_1$$

$$\Rightarrow V_x = 3(I_3 - I_1) \quad --- \ ③$$

٣ معادلات بـ ٣ مجاهيل

* Superposition → الفكرة انو بنوفذ كل element على حدى عشان يطلع قيمة i

$$I = I' + I'' + I''' + \dots$$

$$V = V' + V'' + V''' + \dots$$

* In order to get each individual contributor you have to kill all the other sources.

$V = V_+ - V_-$

$0 = V_+ - V_- \Rightarrow V_+ = V_-$

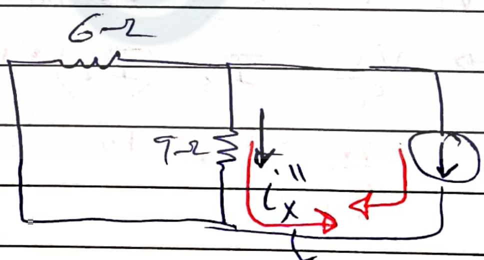
when we kill the

Voltage source ⇒ short circuit (S.C)

Current source ⇒ open circuit (O.S)

Killing the current source produces an open circuit

اذا اتجاه التيار , بال C.D بعاكس اتجاه التيار اللي بدي اوجده (i_x') راح تطلع قيمة i_x' بالسالب.



لازم اضيف السالب

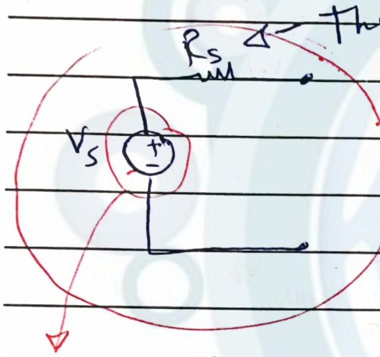
when we have dependent source in the circuit don't kill it → بكل الحالات لازم نخليه

* Source Transformation:-

Ohm's law For suitable Values.

There is a practical voltage source.

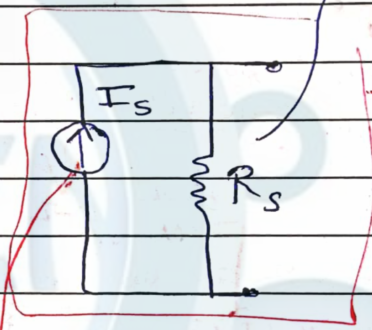
Thevenin



practical voltage source ~~connected~~ connected in ~~with~~ series with a resistance (R_s)

Ideal ~~VB~~ Voltage source.

Norton:



practical current source.

Ideal current source

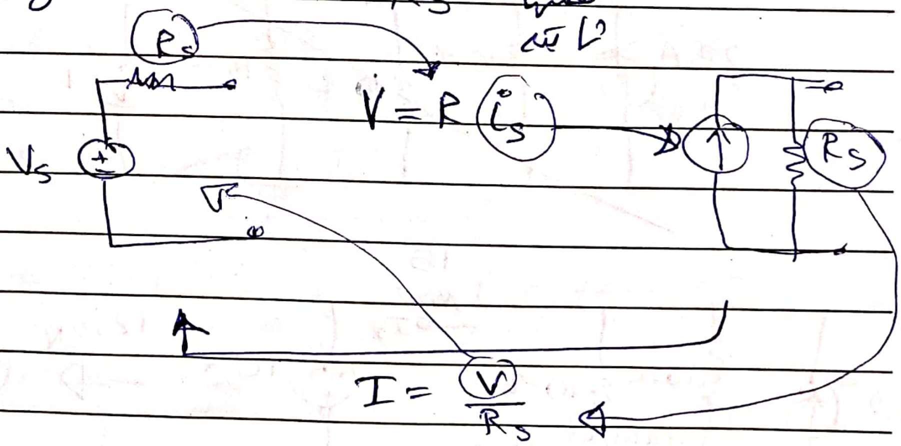
Ideal current source connected in parallel with a resistance (R_s)

~~Ideal~~ From practical current source to practical voltage source ⇒ R_s → نفسها لا تتغير

$R_s = R_s$

$V_s = I_s R_s$

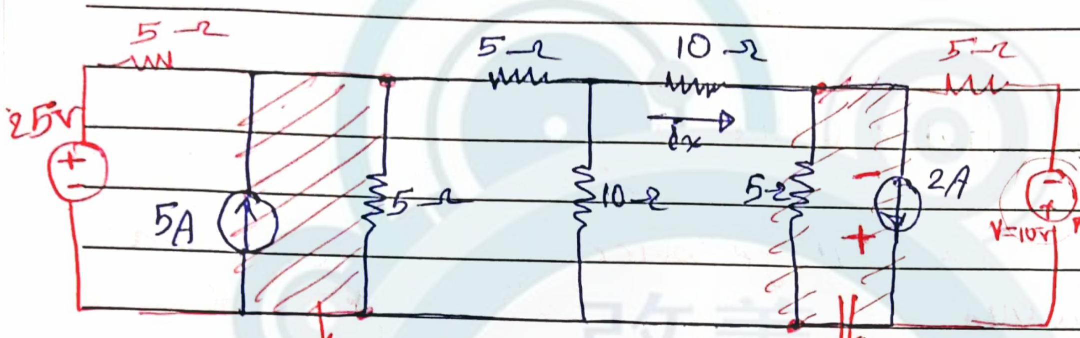
$I_s = \frac{V_s}{R_s}$



* الي بيدخل شبكة بال S.T ما بيغيرها ابدا بتركيا زي ما هي.

Five Apple

Ex:-



Find i_x ??

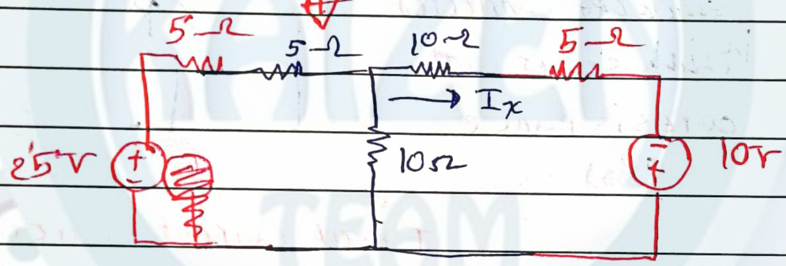
$V = iR \Rightarrow (2)(5)$

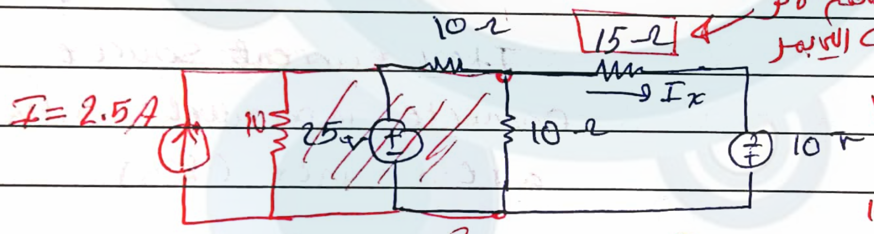
$V = 10V$

ال polarity مع اتجاه التيار

current source and parallel

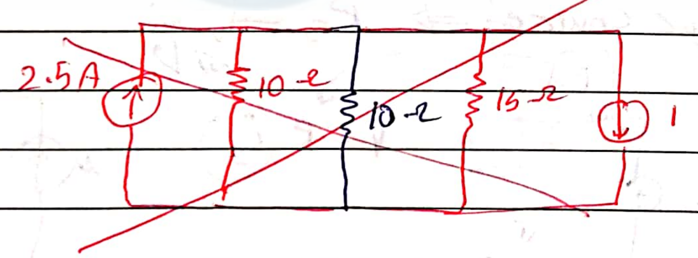
current source and parallel



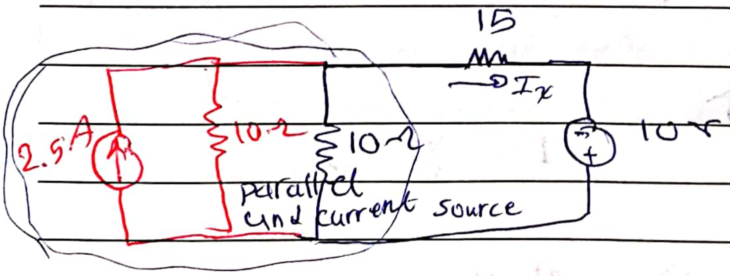


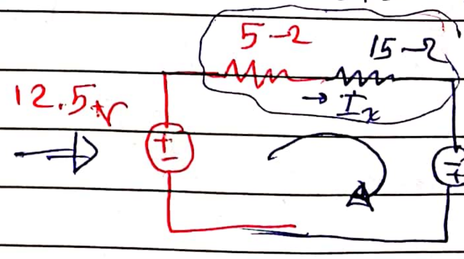
مجمعهم لأنو التيار نفسه الي عابر فيهم بس

اذا طلب مني ال V ما بقدر اجمعهم و برا ال 10Ω



series $R = 20\,\Omega$





$-12.5 - 10 + 20 I_x = 0$

$\boxed{I_x = 1.125\,A}$

* Thevenin and Nortan :-

⇒ circuits with only $\boxed{\text{independent}}$ sources :-

V_{Th} : (1) Remove R_L (open circuit)

(2) Find R_{Th}

(3) Find V For open circuit.

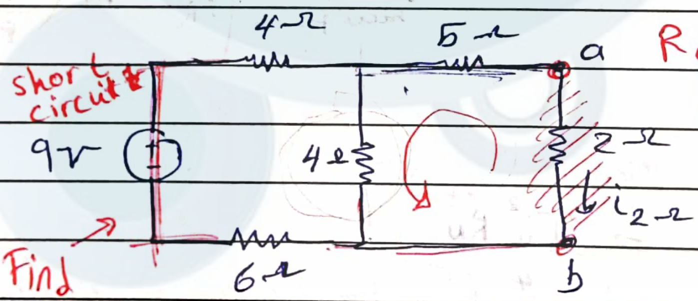
$V_{Th} = V_{o.c}$

O.C

we Find R_{Th} after Killing all of the indep. sources.

V.S → S.C , C.S → O.C

Ex:



$R_{ab} = R_{TH}$

$V_{o.c} = V_5 + V_4 \neq 0$

↑ in open circuit

⇓

$I = 0$

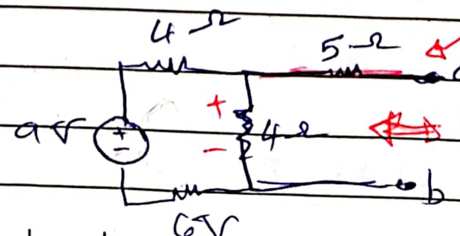
$V_{o.c} \neq 0$

(4,6)S ⇒ R = 10 Ω

(10, 4)P ⇒ R = 2.9 Ω

(2.9, 5)S ⇒ $\boxed{R_{TH} = 7.9\ Ω}$

$V_{5Ω} = Ri = 5(0) = 0$ (short circuit)

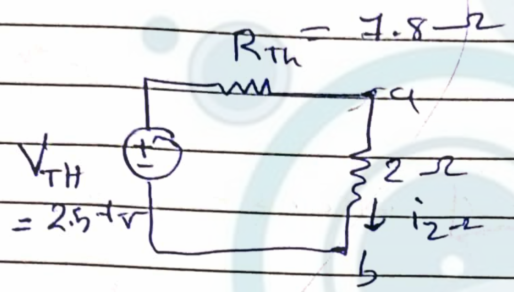


V.D

$V_{o.c} = V_{4Ω} = \frac{4}{14}(9) = \boxed{2.57\ V}$

Five Apple

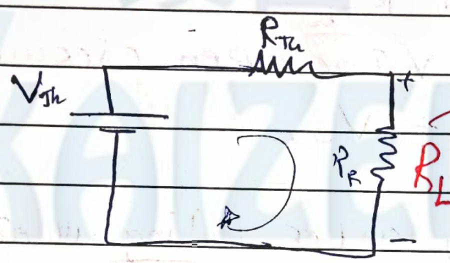
Scanned with CamScanner



$$\Rightarrow \quad i_2 = \frac{2.57}{9.8} = 0.26$$

* Maximum power Transferred.

$$\boxed{R_L = R_{Th}}$$



*what the Load that i need to get the max. power.

$$P_R = R_L I^2$$

$$i = \frac{V}{R} = \frac{V_{Th}}{R_L + R_{Th}}$$

what R_L to get the max power.

$$\boxed{P_{R_L} = R_L \left(\frac{V_{Th}}{R_L + R_{Th}} \right)^2}$$

ازا كان معطيني $R_{Th} = 10$

$R_L = 7$

وحكالي طلعلي P_{max} هون

السؤال يكون غلط لأنو ما في

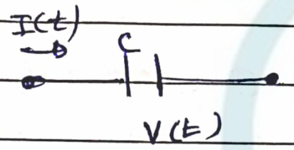
$R_{Th} = R_L$ لانو لازم P_{max}

$$P_{max} = \frac{V_{Th}^2}{4 R_{Th}} = \frac{I_N^2 R_N}{4}$$

(R_{Th} → R_L)

transfered to load

Capacitor :- (F)

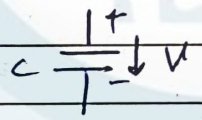


$$I_c(t) = c\,\frac{dV_c(t)}{dt} \Rightarrow V_c(t) = \frac{1}{c}\int_{t_0}^{t} i_c(t)\,dt + \underbrace{V(t_0)}_{\text{Initial condition}}$$

The capacitor in DC is represented by $\boxed{\text{open circuit}}$

$$E = \overset{\text{Joul}}{W} = \frac{1}{2}cV^2 = \frac{1}{2}QV = \frac{1}{2}\frac{Q^2}{c}$$

$\underset{\text{Charge}}{Q} = cV$



$$\text{power} = \frac{E}{t}, \quad p = IV$$

capacitors in series $\Rightarrow \frac{1}{c_{eq}} = \frac{1}{c_1} + \frac{1}{c_2} + \dots + \frac{1}{c_n}$

capacitors in parallel $\Rightarrow C_{eq} = C_1 + C_2 --- + C_n$

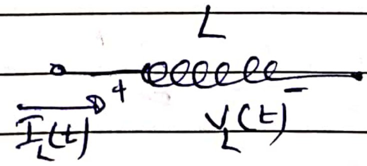
عكس R

Inductor (H) ← Henry

← duality عايزين نستخدم ال

$I_c(t) = c\,\frac{d\,V_c(t)}{dt}$

duality: $C \to L$, $I — V$



$$V_L(t) = L\,\frac{di(t)}{dt}$$

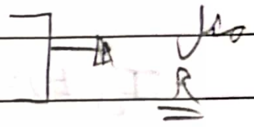
$$I_L(t) = \frac{1}{L}\int_{t_0}^{t} V_L(t)\,d(t) + i(t_0)$$

The inductor in DC circute is represented by $\boxed{\text{Short circuit}}$

O.C $\leftrightarrow$ S.C

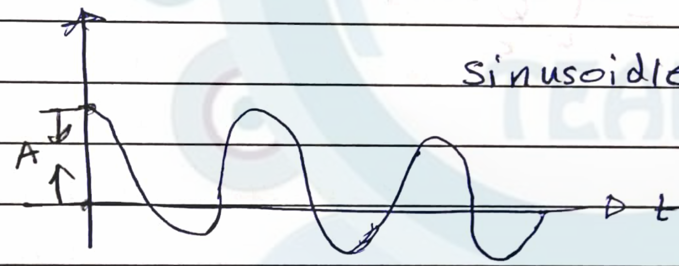
inductor in series $\Rightarrow L_{eq} = L_1 + L_2 - - - - + L_n$

inductor in parallel $\Rightarrow \frac{1}{L_{eq}} = \frac{1}{L_1} + \frac{1}{L_2} + - - - - + \frac{1}{L_n}$



* Alternative current (AC)

argum



sinusoidle wave

$\boxed{\text{sinusoidle لل average ال} \text{ بساوي صفر}}$ *

max value

phase shefe (degres or rad)

$$x(t) = A \cos(\omega t + \theta)$$

argument

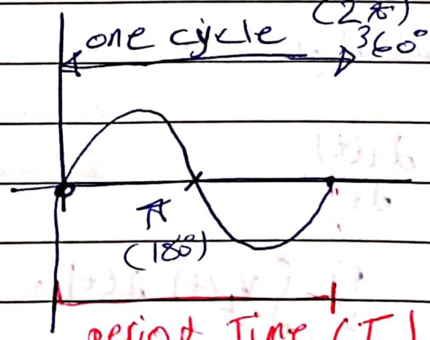
$x(t)$: ممكن تكون Voltage, power, Current

A: Amplitude, ممكن V_m, I_m, ...

ω: angular Frequency (velocity)

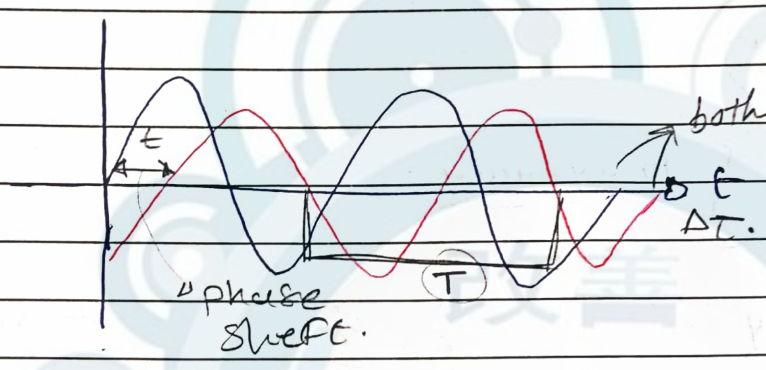
$\omega \to \frac{1}{s}$ $\quad t \to s$

Time period لل ω



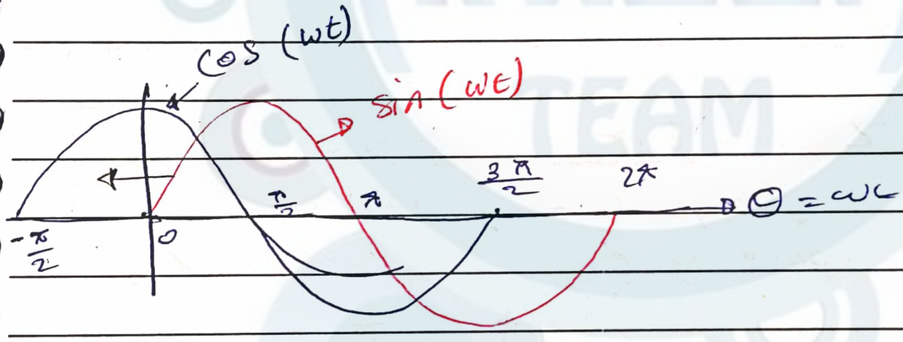
period Time (T) : Time that it takes For a signal to make a one cycle. (periodic signal)

$f = \frac{1}{T} \rightarrow \omega = 2\pi f$ (rad/s)



both all of these are a signal have a period. (360°)

$$\theta = \frac{\Delta t}{T} \times 2\pi \text{ (rad)} \text{ or } 360^\circ \text{ (degree)}$$

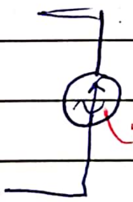


$\sin(\omega t + 90^\circ) = \sin[\omega t + \frac{\pi}{2}] = \cos(\omega t)$

حطينا موجب عشان الsine

عملنا shift على

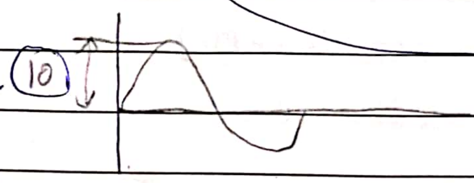
الpositive x-axis.



Amplitude — angular Frequency (ω)

$10\cos(377t + 30^\circ)$ → phase sheft (θ)

sinusoidle signal



peak → 10

peak to peak → min to max بنوزن من

I (2,8)

اذا طلع منا مثلاً t(2)

لما اعوض الـ 2 لازم

انتبه انو الزاوية بالـ deg

وبس ال rad انا

اخد اخلبهم رى

يعني

* complex number :-

$j = i = \sqrt{-1}$

$x = -j$

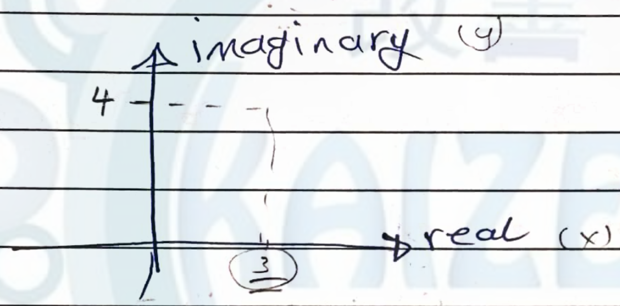
$x^2 = (-j)^2 = -1$

imaginary

$Z_1 = 3 + 4j$

real

imaginary



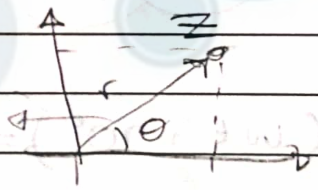
in general $\Rightarrow Z = x + jy = r \angle \theta$

rectangular coordinate $\Rightarrow$ polar coordinate

* $r = \sqrt{x^2 + y^2}$

$\theta = \tan^{-1}\left(\frac{y}{x}\right)$

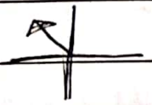
vector



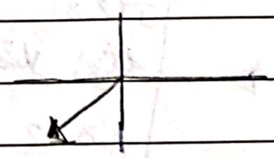
* $x = r\cos\theta$

$y = r\sin\theta$

ازا كنا بالربع الاول بنوخد θ
نفسها اللي بتطلع معي بالآلة الحاسبة
اما اذا كانت بالربع الثاني
لازم احطها $180 - |\theta|$
اللي بتطلع معي



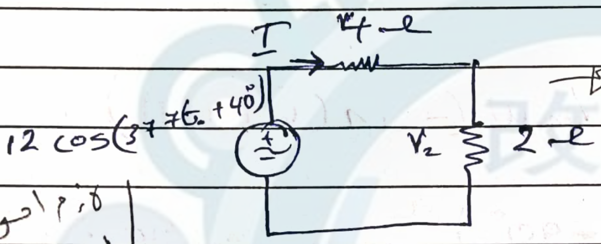
$-180 + |\theta|$



$V(t) = \underset{V_m}{12}\,\cos(377t + \underset{\theta}{40^\circ})$

$12\angle 40^\circ \Rightarrow$ phaser Form → من ال cos بس بيعاملها

Frequancy domain

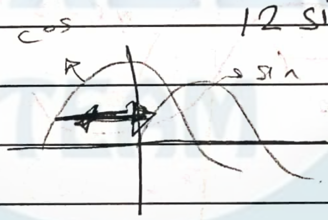


V.D → $V_2 = \frac{2}{2+4}(12\angle 40^\circ)$

نحولها polar → $12\angle 40^\circ$

اذا كانت sin

$12\sin(377t + 40^\circ)$



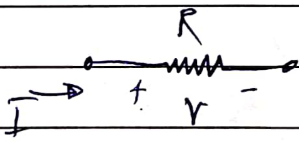
$12\cos(377t + \underbrace{40^\circ - 90^\circ}_{-50^\circ})$

$12\angle -50^\circ$

$\sin(\omega t) = \cos(\omega t - 90)$

$\cos(\omega t) = \sin(\omega t + 90)$

① Resistor



$V(t) = V_m\cos(\omega t + \theta)$

$I(t) = I_m\cos(\omega t + \theta)$

$V = IR$

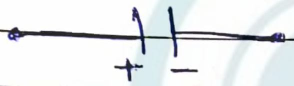
I and V are in phase (phase shift = 0)

$V(t) = V_m\angle\theta$

$I(t) = I_m\angle\theta$

$V_m\angle\theta = (I_m\angle\theta)R$

② capacitor



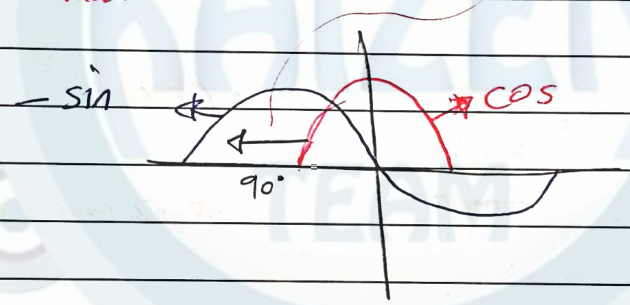
$V(t)$

$$V(t) = V_m \cos(\omega t + \theta)$$

$$I(t) = C\frac{dV(t)}{dt} = C\left(V_m \omega \left(-\sin(\omega t + \theta)\right)\right)$$

$$I(t) = \underbrace{V_m(\omega C)}_{I_{max}} \cos(\omega t + \theta + 90^\circ)$$

فرق 90° درجة
بين ال sin وال cos



$$V_c = V_m \angle \theta$$

$$I_c = I_m \angle \theta + 90^\circ$$

بتزداد بمقدار ها
90 درجة عن زاوية ال Voltage

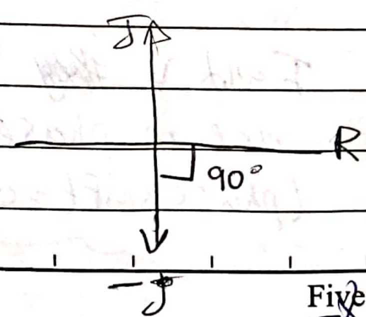
ملاحظة

*** Impedance of capacitor (ohm)**

$$X_c = \frac{V_c}{I_c} = \frac{V_m \angle \theta}{I_m \angle \theta + 90^\circ} \rightarrow$$ وحدتها (Ω)

$$= \left|\frac{V_m}{I_m}\right| \angle -90^\circ$$

$r \angle \theta$



complexity بال $\rightarrow -jX_c$

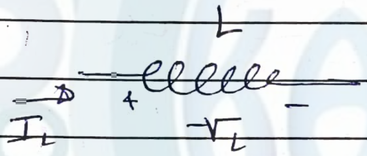
$$X_c = \frac{V_m}{V_m V_c} = \frac{1}{\omega c}$$

$$\frac{V_m}{I_{max}}$$

$$\boxed{Z_c = \frac{1}{j\omega_c} = -j\,\frac{1}{\omega c} = -j X_c} \quad (\Omega)$$

حولناها F ← Ω باستخدام Impedance

③ Inductor



$$V_L(t) = L\frac{di}{dt}$$

$$I_L(t) = I_m \cos(\omega t + \theta)$$

$$V_L(t) = I_m(\omega L)\cos(\omega t + \theta + 90^\circ)$$

استخدام ال duality

$$Z_L = \frac{V_L}{I_L} = \frac{\omega L\, I_m \angle \theta + 90^\circ}{I_m \angle \theta^\circ}$$

$$= \omega L \angle 90^\circ$$

$$\boxed{Z_L = +j\omega L = +j X_L} \quad (\Omega)$$

H → Ω
باستخدام الimpedance

Five Apple

Scanned with CamScanner

$R = \infty$?

حتى احل معادلتين من الدرجة الأولى جبريًا

$$\begin{array}{cc|c} x & y & \\ A & B & E \\ C & D & F \end{array}$$

$$x = \frac{ED - BF}{AD - BC}$$

$$y = \frac{AF - EC}{AD - BC}$$

* Maximum Transferred power to load $P_{L\,max}$

$$Z_L = Z_{Th}^{*}$$

conjegt (*)
↓
Change the sign of imaginary part

$4 + 3j \Rightarrow 4 - 3j$

* if the sources didn't have a same (ω) we must use superposition

↓

آخر شي ما بنربط جمع الـ phasor

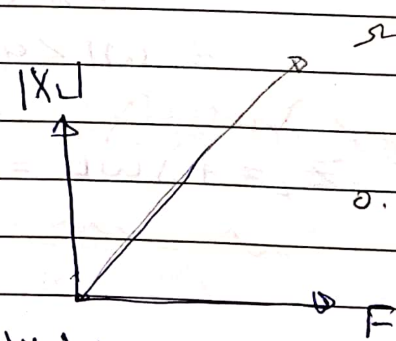
* بالنسبة لـ $\Delta - Y$ نفس الخطوات قبل بس الفرق انو complex not real #s

π ← بيكون على شكل π نفس الـ Δ

بتعتمد على الـ Frequnance

$$* \; X_L = \omega L = 2\pi F L$$

(at high Freq. ⇒ O.C)

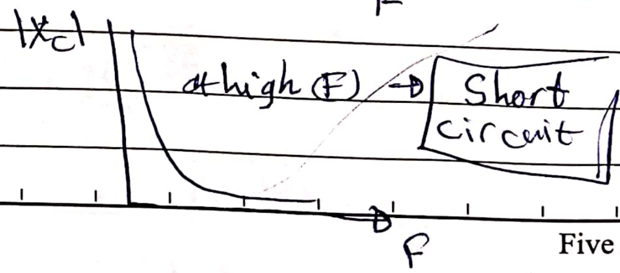


$$* \; X_C = \frac{1}{\omega C} = \frac{1}{2\pi F C}$$

العلاقة عكسية

راح توصل بالنهاية لـ 0

تعتبر S.C



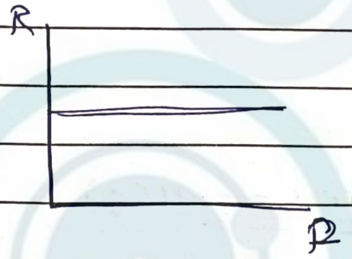
Five Apple

$$Z = R \mp jX$$

* R

↑

ما بتتأثر بالـ Freq.



$\boxed{Z_R = R}$ ⇒ pure resistive

$\boxed{Z = +jX_L}$ ⇒ pure inductive

$\boxed{Z = -jX_C}$ ⇒ pure capacitive

$50 - 30 = 20$

50 ⊖ 30

i leads V

lage

⊖

$30 - 50 = -20$

* Admittance:

$Y = G + jB$ → susceptance

↑

conductance

$Z = R \pm jX$

↑ resistance

↑ reactance

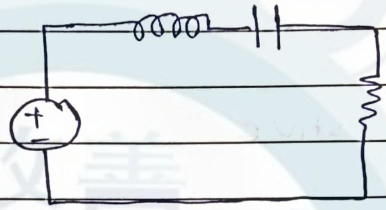
$Y = \frac{1}{Z}$, $G = \frac{R}{Z}$

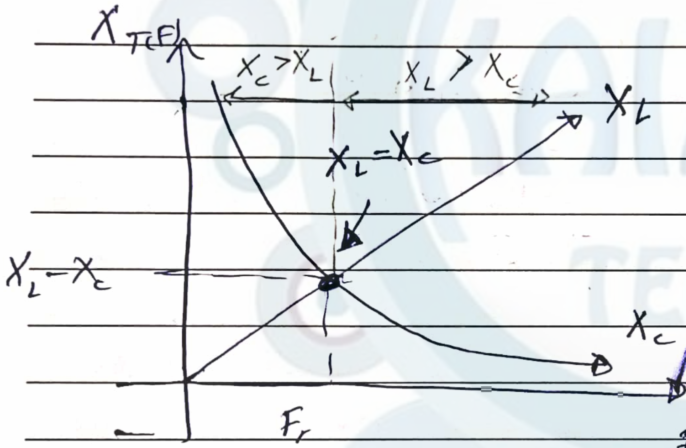
$B = -\frac{X}{Z}$

Five Apple

RLC Circuit

* Series RLC Circuit (series resonance)





F↑ $Z = R + jX_L + jX_C$

$= R + j[X_L - X_C]$ → Zero

$$\boxed{Z = R}$$

$$Z = R + j\left[wL - \frac{1}{wC}\right]$$

1. At high Frequencies:-
   $Z = R + jX$ — Inductive behavior

2. At low Frequencies:-
   $Z = R - jX$ — capacitive behavior

3. At $F = F_r$ (F_r) $X_L = X_C$
   $W_L = \frac{1}{WC}$ — Pure Resistive
   $Z = R$ — $\theta = 0$ — V_s and I_s are in phase

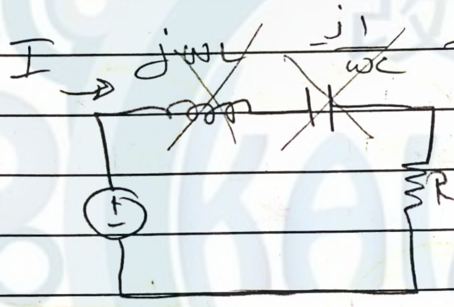
$RMS = \frac{I_{max}}{\sqrt{2}}$

$X_L = X_C$

$WL = \frac{1}{WC}$

$2\pi f_\circ L = \frac{1}{2\pi f_\circ C} \Rightarrow \boxed{F_\circ = \frac{1}{2\pi\sqrt{LC}}}$ (HZ) $\Rightarrow$ resonance Freq. (F_r or $F_\circ$)

$\boxed{W_\circ = \frac{1}{\sqrt{LC}}}$ (rad/s)



ازا تساوت راح يلغو بعض ال load vs

راح يقل وبالتالي R

راح يزداد التيار

راح يوصل ال max

$\boxed{I_{max}}$

$\Downarrow$

$I \Big|_{\boxed{F = F_\circ}} = \boxed{I_{max}}$

$V_L = I(jX_L) = Ijx$

$V_C = I(-jX_C) = -Ijx$

متساويين

V_C will cancel V_L

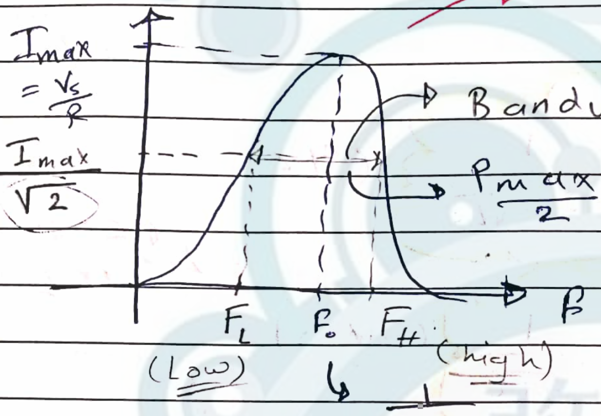
$V_R = IR = R_s$

$X_L = X_C \Rightarrow WL = \frac{1}{WC} \Rightarrow Z_{min} = R$

$I_{max} = \frac{V_{supply}}{R}$

$WL = \frac{1}{WC} \Rightarrow W^2 = \frac{1}{LC} \Rightarrow W = \frac{1}{\sqrt{LC}}$

$$I_{(at\ \omega_L \& \omega_H)} = \frac{I_{max}}{\sqrt{2}}$$



$$F_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$B = F_H - F_L \qquad B = \frac{R}{L}$$

$$Q = \frac{F_0}{B} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

Quality Factor.

* $P_{max} = I_{max}^2 R \Rightarrow \frac{P_{max}}{2} = \frac{I_{max}^2 R}{2}$

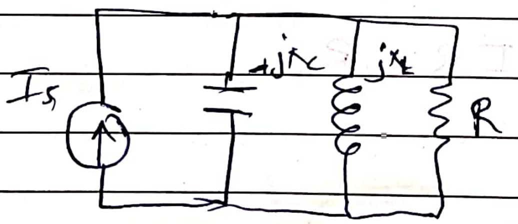
* IF $Q > 10$: $B = \frac{R}{L}$ [rad/s]

$$Q = \frac{\omega_0}{B} \text{ (rad/s)}$$

$$F_{low} = F_0 - \frac{B}{2}$$

$$F_H = F_0 + \frac{B}{2}$$

* Parallel RLC Circuit :-



$$X_L = X_C$$

$$\omega L = \frac{1}{\omega C}$$

$$F_0 = \frac{1}{2\pi\sqrt{LC}} \text{ (Hz)}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$P = |S| \cos\theta$ (VI)

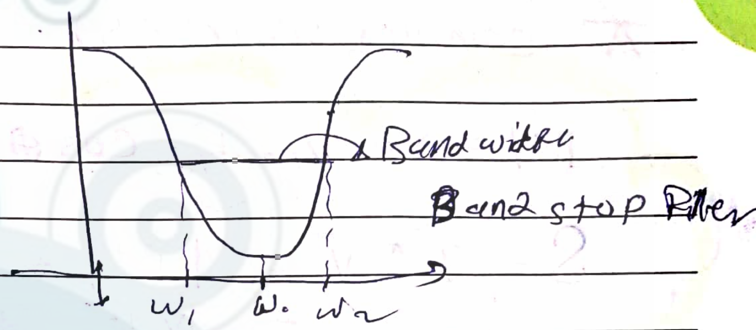
$\frac{P}{|S|} = P.F$ P.F

$T = \frac{2\pi}{\omega}$

المحاضرة ٢

$Z_{max} = R$

$I_{min} = \frac{V}{R}$



$*B = \omega_2 - \omega_1 = \frac{1}{RC}$

$* \omega_0 = \sqrt{\omega_1 \omega_2}$

$Q = \frac{F_0}{B}$

$F_H = F_0 + \frac{1}{2}B$

$F_L = F_0 - \frac{1}{2}B$

$Q > 10 \rightarrow \omega_1, \omega_2 = \omega_0 \mp \frac{B}{2}$

$Q = \frac{\omega_0}{B} = \frac{f_0}{B}$

* effective value (RMS)

$X_{rms} = $ Dc value for DC

$\tilde{V} = V_{rms} = \begin{cases} \frac{V_m}{\sqrt{2}} & \text{sinusoidal} \\ V_m & \text{square} \\ \frac{V_m}{\sqrt{3}} & \text{triangle} \end{cases}$

$X_{rms} = \frac{X_m}{\sqrt{2}}$ for sinusoidal only

$P_{avg} = \tilde{I} \cdot \tilde{V}$

$V(t) = V_1 \cos(\omega t + \theta) + V_2 \cos(\omega t) + V_3 \sin(\omega t + \theta) + \cdots + V_0$ DC

$V_{rms} = \sqrt{V_{(dc)}^2 + \frac{\sum V_i^2}{2}}$

اذا بدي اكتب ال P_{avg} بدلالة I_{rms}

$\hookrightarrow P = I_{rms} V_{rms} \cos(\theta_v - \theta_i)$

* complex power (S)

$$|S| = S = V_{rms} I_{rms} \cos\theta$$

$$S = \tilde{I}^* \tilde{V} = |\tilde{I}^2| Z$$

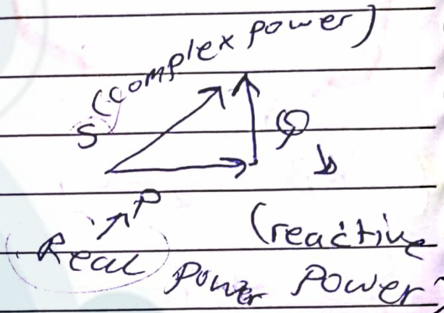
$$= \frac{|\tilde{V}|^2}{Z^*}$$

$$P = |S| \cos\theta = \tilde{I}_R^2 R = \frac{\tilde{V}_R^2}{R}$$

$$\tilde{Q} = |S| \sin\theta = \tilde{I}_x^2 X = \frac{\tilde{V}_x^2}{X}$$

↳ reactive power

dissipated power



$|Z| = \sqrt{R^2 + X^2}$

$Z = R \mp jX$

$S = \sqrt{P^2 + Q^2}$

$\boxed{S = P \mp jQ}$

power Factor (P.F) $= \cos\theta = \frac{P}{|S|}$

* instantaneous power:-

$$p(t) = V(t) \cdot i(t)$$

$$= V_m \cos(\omega t + \theta_v) \cdot I_m \cos(\omega t + \theta_i)$$

$$= \boxed{\frac{V_m I_m}{2} \left[\cos(2\omega t + \theta_i + \theta_v) + \cos(\theta_v - \theta_i)\right]}$$

$$p(t) = \underbrace{\frac{1}{2} I_m V_m \cos(\theta_v - \theta_i)}_{DC-term} + \frac{1}{2} I_m V_m \cos(2\omega t + \theta_i + \theta_v)$$

DC term → average, Real, Active power

reactive power → (Q)

$$Q = \frac{1}{2} I_m V_m \sin(\theta_v - \theta_i)$$

$\sin\theta = 0$ ⟸ R توی مدار ⟸ Q

$Q \to L \; (+)$ ✓

$Q \to C \; (-)$ ✓

$Q \to R$ ✗

$|S| \angle \theta_s$ $\qquad$ $\vec{S} = P \mp jQ$

↑

apparent power

کلها زاویه ⟸

ارزش مصرف

p.f را

$$p.f = \cos\theta = \cos(\theta_v - \theta_i)$$

$\theta \to L \; (+)$

$\theta \to C \; (-)$

$$S = V_{rms} \cdot I^{*}_{rms}$$

$I = |I| \angle \theta$

$I^{*} = |I| \angle -\theta$

① instantinous power :-

$$P(t) = v(t) \cdot i(t)$$

$$= V_m \cos(\omega t + \theta_v) * I_m \cos(\omega t + \theta_i)$$

$$= \frac{V_m I_m}{2} \cos(2\omega t + \theta_i + \theta_v) + \frac{V_m I_m}{2} \cos(\theta_v - \theta_i)$$

② Avg. power :-

$$P_{avg} = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i)$$

ازا بدي اربطها بـ Z $\Rightarrow P_{avg} = \frac{1}{2} I_m^2 |Z| \cos(\theta_v - \theta_i)$

$$= \frac{1}{2} \frac{V_m^2}{|Z|} \cos(\theta_v - \theta_i)$$

$$Z_{total\,(load)} = r \angle \theta$$

$$\theta_{total} = \theta_v - \theta_i$$

لو arms $\Rightarrow P_{avg} = V_{rms} I_{rms} \cos(\theta_v - \theta_i)$

$$= I_{rms}^2 |Z| \cos(\theta_v - \theta_i)$$

$$= \frac{V_{rms}^2}{|Z|} \cos(\theta_v - \theta_i)$$

③ complex power :-

$$S = V_{rms} I_{rms}^* = P + jQ$$

$$P = V_{rms} I_{rms} \cos(\theta_v - \theta_i)$$

$$Q = V_{rms} I_{rms} \sin(\theta_v - \theta_i)$$

Summery :-

$$S = V_{rms} I_{rms}^*$$

$$= V_{rms} I_{rms} \cos(\theta_v - \theta_i) + j \tilde{V} \tilde{I} \sin(\theta_v - \theta_i)$$

$$= \underbrace{|I_{rms}|^2 R}_{P} + j \underbrace{|I_{rms}|^2 X}_{Q}$$

dissipated power
↳ متوسط الـ power
$|I_{rms}|^2 R$

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

4 Power Factor

$$pF = \cos(\theta_v - \theta_i)$$

$$pF = \frac{P}{V_{rms} I_{rms}} = \frac{P}{|S|}$$

$|S| = \sqrt{P^2 + Q^2}$

Case for P.F ⇒ ① $pF = 1$ ⇒ pure resistive load

$\theta_v = \theta_i$, $\cos(\theta_v - \theta_i) = \cos 0 = 1$

$\sin(\theta_v - \theta_i) = 0$

↳ $Q = 0$

② $pF = 0$ ⇒ pure inductive load.

$Q > 0$ $pF =$ lag متأخر

$pF = 0$ $\cos(\theta_v - \theta_i) = \cos 90 = 0$

⇒ pure capacitive load.

$Q < 0$

$pF = \cos(\theta_v - \theta_i) = \cos(90) = 0$

③ inductive load pF → lagging

capacitive load pF → leading

ex: $pF = 0.8$ lag

$|S| = 1000$ VA

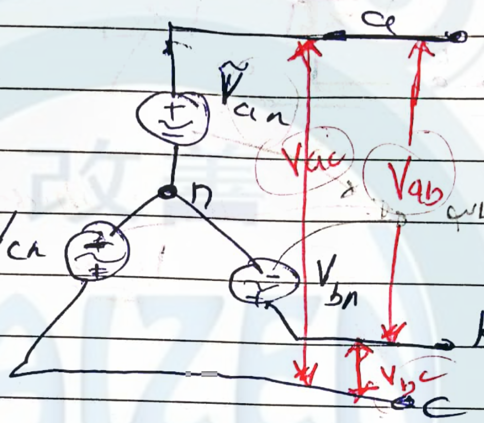
$S = |S| \angle + \cos^{-1}(pF)$

inductive load

3-phase system:-

Source	load
Y	Y
Y	Δ

Y configuration:



V_{ab}, V_{ac}, V_{bc} ⇒ line Voltage

* اللي اتجاهه ال n بوخد سالب

n: Nuetral node

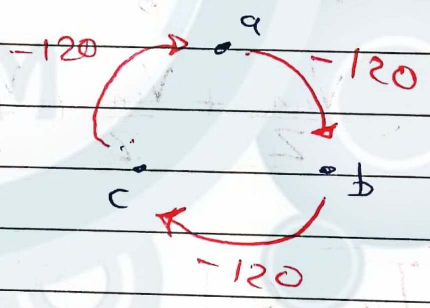
$V_{an} = V\angle 0^\circ$

$V_{bn} : V\angle -120^\circ$

$V_{cn} : V\angle -240^\circ$

$+120^\circ$

↳ phase Voltages.



phase shift $= 120^\circ$

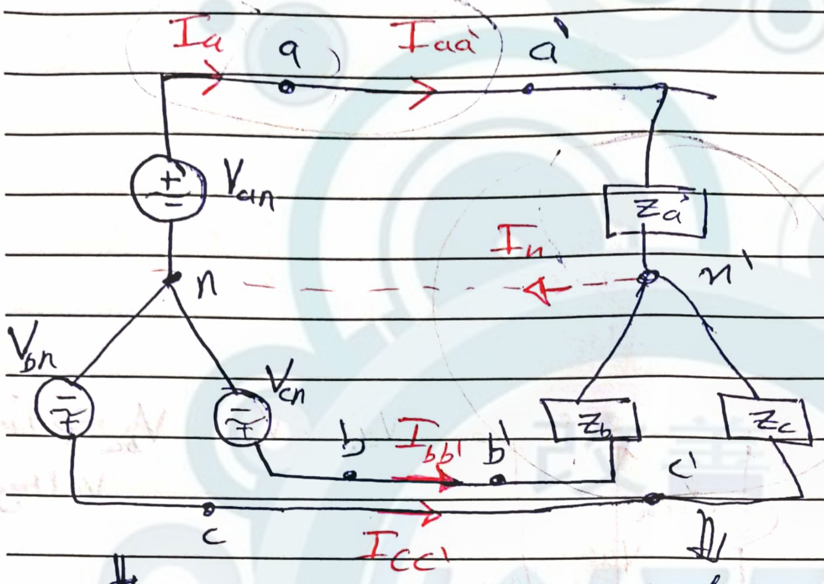
$$\vec{V}_{an} + \vec{V}_{bn} + \vec{V}_{cn} = 0$$

line Voltages ⇒ $V_{ab} = V_{an} - V_{bn}$

$$V_{ab} = \sqrt{3}\, V_{an} \angle 30$$
$$V_{bc} = \sqrt{3}\, V_{bn} \angle 30$$
$$V_{ca} = \sqrt{3}\, V_{cn} \angle 30$$

⇒ The are equal to $\sqrt{3}\, V_n \angle 30$

$I_{phase} = I_{line}$ ـ طالما كده



Three phase **source**

Three phase **load**

$$\boxed{Z_a = Z_b = Z_c}$$

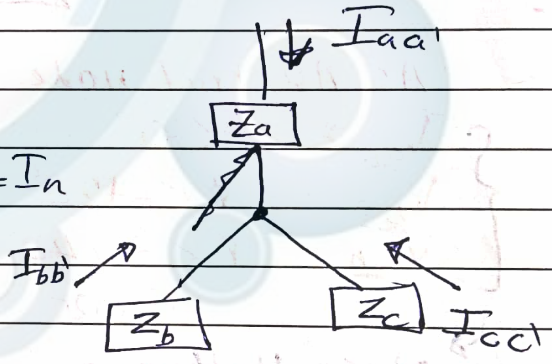
$I_a \Rightarrow$ phase current

$I_{aa'} \Rightarrow$ line current

$$I_a + I_b + I_c = 0$$

$$\boxed{I_p = \frac{V_p}{Z}}$$

$$\frac{V_{an}}{Z} + \frac{V_{bn}}{Z} + \frac{V_c}{Z} = 0 = I_n$$

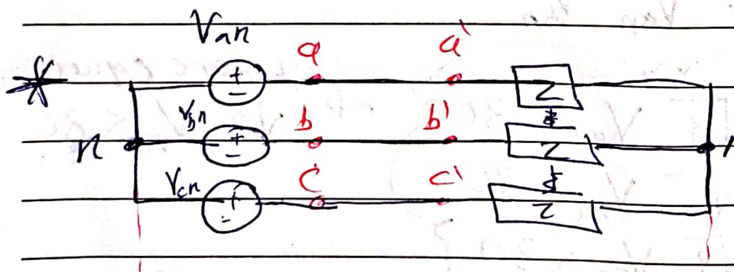


$$\boxed{I_n = 0}$$

Current in the wire between n, n' = 0

$\underline{V_{nn'} = 0}$

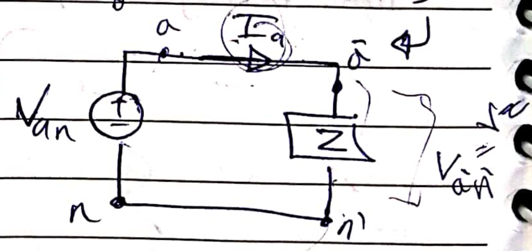
phase* واحد دمج
على الكل



$I_n = 0$

$V_{nn'} = 0$

أول خطوة



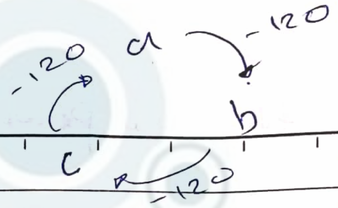
ممكن آخر b أو c

3 phases

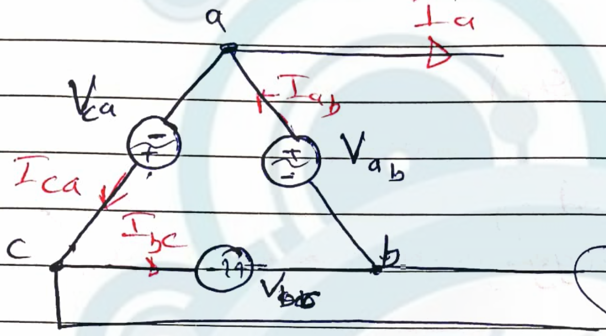
$S_{load(total)} = 3 * S$

$S_{load} = V_{an} \, I_a^*$

$= V_p$



* Δ



$I_a, I_b, I_c \rightarrow$ line current
$I_{ab}, I_{bc}, I_{ca} \Rightarrow$ phase Voltage

$I_{ab} \neq I_a$

$$\boxed{V_{phase} = V_{line}}$$

$$I_a = \sqrt{3}\, I_{ab} \angle -30$$
$$I_b = \sqrt{3}\, I_{bc} \angle -30$$
$$I_c = \sqrt{3}\, I_{ca} \angle -30$$

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

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

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

* power in 3-phase system:-

$$S_{total} = 3\, V_{phase} * I^*_{phase}$$
$$= \sqrt{3}\, V_{line} * I^*_{line}$$
$$= P_{total} + j\, Q_{total}$$

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

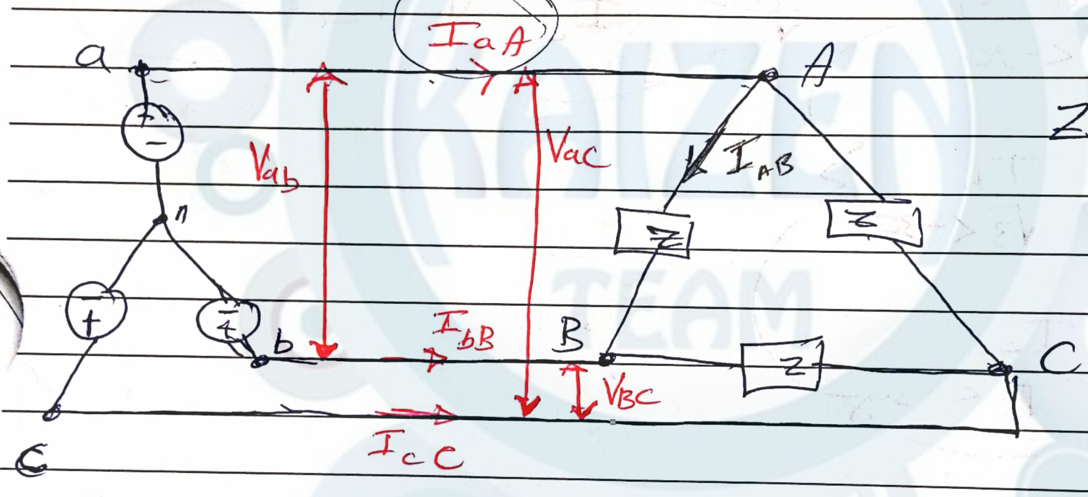
R تكون خفضة في power losses *

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

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

$$PF = \cos(\theta_v - \theta_i) \rightarrow \text{leading}$$
$$\qquad\qquad\qquad\qquad \llcorner \rightarrow \text{lagging}$$

* $\boxed{Y-\Delta}$



Z_{load} = balance

$$V_{AB} = V_{ab} \quad , \quad I_{AB} = \frac{V_{ab}}{Z} = \frac{\sqrt{3}\, V_{an} \angle 30}{Z}$$

$$I_{BC} = \frac{V_{bc}}{Z} = \frac{\sqrt{3}\, V_{bn} \angle 30}{Z}$$

$$I_{CA} = \frac{V_{ca}}{Z} = \frac{\sqrt{3}\, V_{cn} \angle 30}{Z}$$

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

* اسهل الحل انو احولها ع من Δ → Y

$$Z = \frac{Z \times Z}{3Z}$$

Germanium

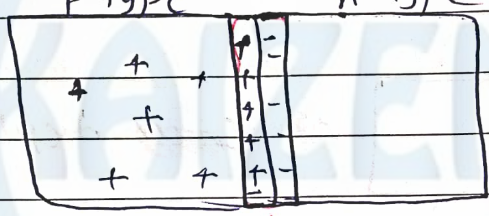
* Semiconductor - Devices: Si, Ge

Semiconductor are materials having electrical propertie between conducting & insulating material.

$\boxed{- - -}$ n-type ~~s~~ semicond.: majority is electron (-ve) sign

$\boxed{+ + +}$ P-type semicond.: 〃 〃 (+ve) 〃

p type n type

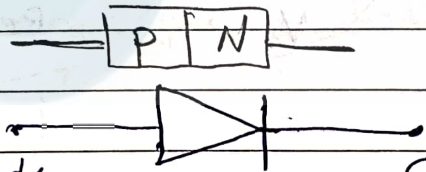


منطقة متعادلة كهربائية

depletion region ~~region~~

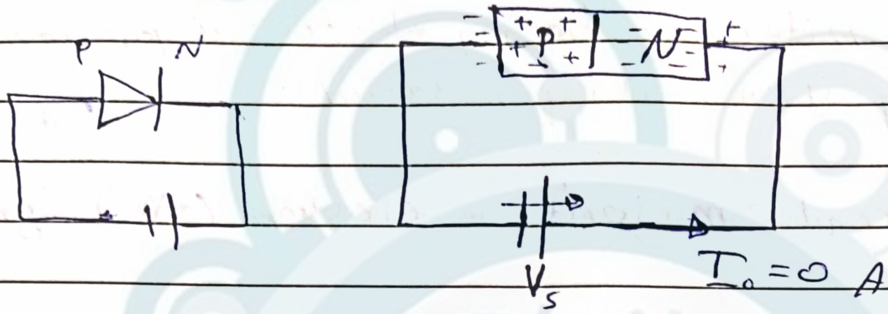
V_γ → $(0.6 - 0.7) \Rightarrow Si$

V_γ → $(0.2 - 0.3) \Rightarrow Ge$



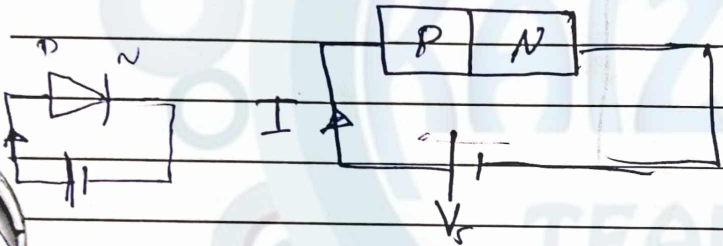
Anode (+) Diode Cathod (−)

① Reverse Biase



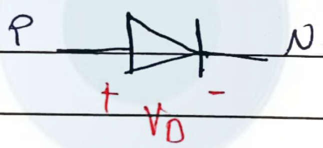
large depletion region

② Forward Biase



Small depletion region

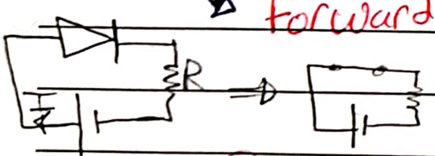
* ideal diode :- $V_D = V_P - V_N = 0$



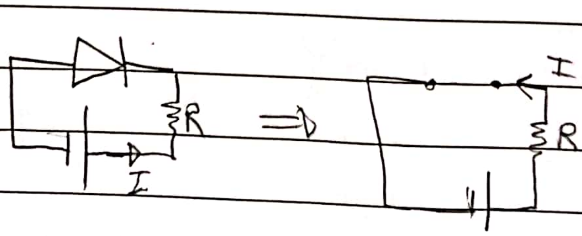
$V_P > V_N \rightarrow$ Forward bias
$V_N > V_P \rightarrow$ Reversed //

① Forward Bias : diode is replaced by Short circuit

تغير تيار Si → 0.7 V
Ge → 0.3 V



② Reverse Bias: diode is replaced by open circuit



* practical Diode:-

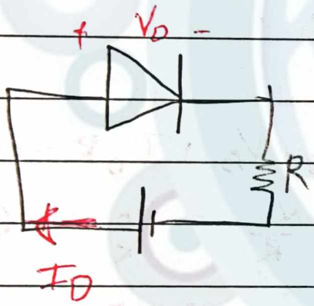
① **Forward Biase**: Diode is replaced by supply with value of : V_γ
- → (0.6 – 0.7) Si
- → (0.2 – 0.3) Ge

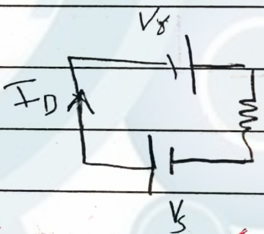
② **Reverse Biase**: open circuit

Forward: ① Forward off if $V_D < V_\gamma$ $(i_D = 0)$

② Forward on if $V_D > V_\gamma$

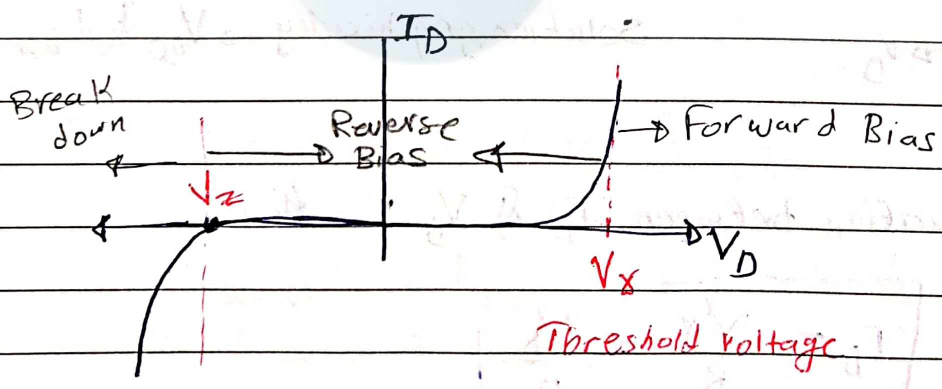
↳ $I_D = (I_o (e^{qV_D/kT} - 1))$





I_o = saturation current (μA)

I-V characterstic for diode



* steps to solve to know if Diode is on :-

① replace diode by open circuit.

② Find V_D on diode

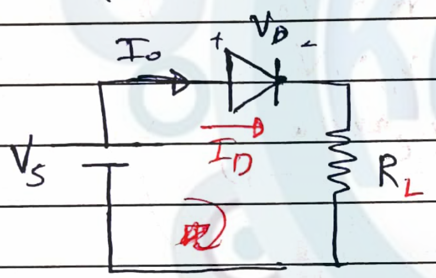
③ IF $V_D > V_\gamma$ = diode is on

= replace it by voltage source have value of V_γ

④ iF $V_D < V_\gamma$ = diode is off

= replace it by open circuit. ($I=0$)

* load line:-

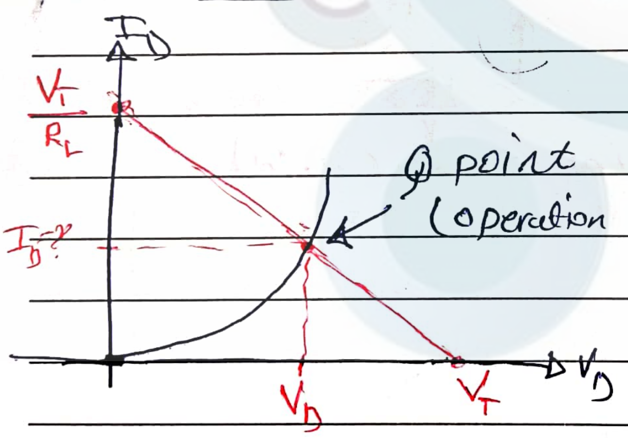


$I_D, V_D \Rightarrow$ unknowns.

using KVL $\Rightarrow -V_S + V_D + I_D R = 0$

$$I_D = \frac{V_S}{R} - \frac{V_D}{R} \quad \text{--- ①}$$

$$I_D = I_o\left(e^{qV_D/KT} - 1\right) \quad \text{--- ②}$$



نحلها بإستخدام ال graphs.

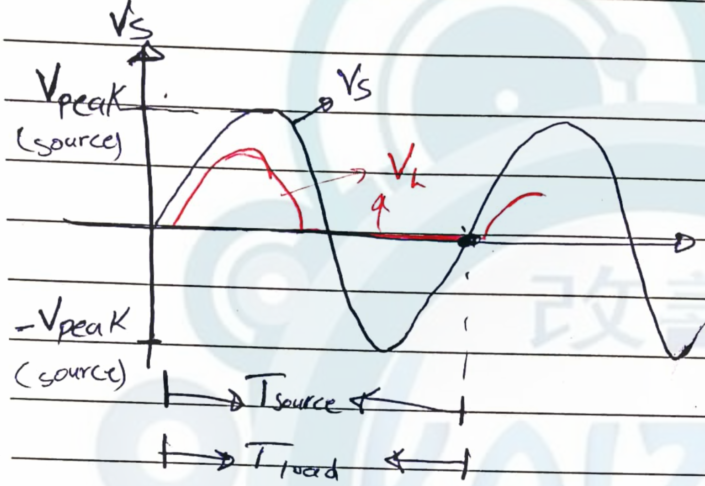
solution graphically $\rightarrow V_{DQ}$ & I_{DQ}

load line: equation between I_D & V_D for this

load line equ.

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

* half wave rectifier (HWR)



$\Rightarrow T_{source} = T_{load}$

$f_{source} = f_{load}$

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

$$\boxed{V_{L\,avg} = \frac{V_{L\,peak}}{\pi}}$$

$$\Rightarrow \boxed{I_{L\,avg} = \frac{V_{L\,avg}}{R}}$$

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

$$\Rightarrow \boxed{I_{L\,peak} = \frac{V_{L\,peak}}{R}}$$

DC ← AC [illegible] *

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

$\boxed{V_{peak} = \sqrt{2}\, V_{rms}}$

* Full wave rectifier (FWR) using bridge

$\Rightarrow T_{source} = 2T_{load}$

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

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

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

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

$\Rightarrow I_{L\,avg} = \frac{V_{L\,avg}}{R_L}$

Five Apple