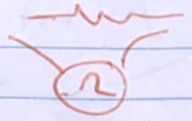
* **Experiment ①** Measurement Devices

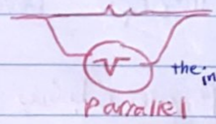
bread board are ussualy limited to low frequencies (less than 10 MHz)

Fine → knob that is used for more accurate values with smaller steps

⊕ high voltage terminal   ⊖ low voltage terminal

DC → Average value measurment
AC → rms value measurment


parallel


parallel — the internal impedence of the voltmeter is very large

R ↑ ∞
so I = 0 going through the voltmeter


series — Ammeter: very small internal resistance

R = 0
so V = 0

* **Experiment ③** Network Theroms

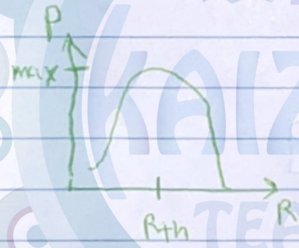
Voltage source —Kill→ short circuit
current source —Kill→ open circuit

ΣP = 0

power consumed = power generated

P ⟨ $P = IV$, $P = I^2R$, $P = \frac{V^2}{R}$

consumed ⊕
generated ⊖



power is not linear
فما بنربط لحسبها بال superposition

Mesh/nodal → are ussually for individual solutions
However superposition → is used to deal with linear circuits that have multiple independent sources

Sinusoidal signals

* Function Generator (Experiment ④)

Shape → sin shape
→ Rectangular
→ triangular (saw tooth)

output
coaxil kable ⟷ (twist) عشان ادخله
→ BC connector
→ Crocodile ⟨ Red ⊕, black ⊖

Amplitude (Ampl) → V_{pp} نغير
→ V peak to peak

knob غير مدرجة

إذا سحبت ال knob بصير mV

في Function Generator بقدر اغير Shape, Amplitude, Frequency

* الشاشة بتعطيني معلومات عن frequency Hz

كبسة ال frequency

1M   100K   10K   1K   100   10   1

5M maximum

ال Knob بيتحرك خمس حركات من كل شغلة

Inductor MH

Capacitor PF → بيكو

Oscilloscope Device
- can measure the istantaneous values of a sinusoidal signal as well as its peak, rms, and peak to peak values
- it displays ~~single~~ signals (waveform) that are functions of time
- AC part
- كل مربع اسمه Division
- كل الكبسات: scale zoom مجرد توضيح للإشارة

* لازم يتشبك Parralel مع اي اشارة
- احمر ⊕ مع احمر ⊕
- اسود ⊖ مع اسود ⊖

Ch1 Ch2

Horizontal 10

vertical 8

• → 0.2

frequency ∝ number of cycles (طردي)

position [0] zero

* تغير ال Amplitude للزيادة بمط الرسمة لفوق

- peak to peak: بعد عدد المربعات من

amplitude knob ↑ ∝ Vp ↑ (طردي)

period (لما الاشارة تعيد حالها)

4 مربعات مثلا
Scale 0.5
→ $V = 4 \times .5 = 2V$ Vpp

DC coupling

في قراءة ال Capacitor بكون بوحدة (PF)

it have two frequences
→ 120
→ 1K

Messure RLC meter
component meter

- 1st Digit
- 2nd Digit
- multipler
- Tolerance
- Voltage

PF

في ال Digital multimeter بكبس AC
I RMS

اذا كبست بال DC بكون بدي Average
DC → I average

inductor 3 MF
+ has a small internal resistance

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

لما ازيد ال Amplitude تزيد الاشارة (الرجفة) ولما ينقص ال Ampl بتقل الاشارة

لما ازيد ال frequency تزيد عدد ال cycles

Resistance
impedence
variation
ما الها

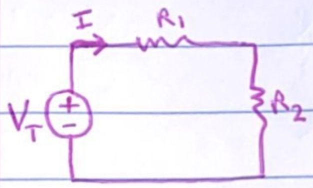
Experiment (1)

$V = IR$ Ohm's Law

$R_{series} = R_1 + R_2 + R_3 \dots$

For two Resistors → $R_{parallel} = \frac{R_1 \times R_2}{R_1 + R_2}$

Voltage Division

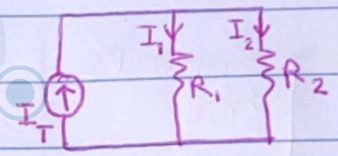


$I = \frac{V_T}{R_1 + R_2}$

$V_1 = \frac{V_T \times R_1}{R_1 + R_2}$

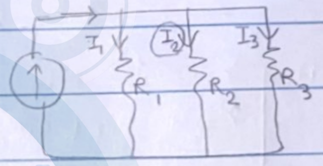
$V_2 = \frac{V_T \times R_2}{R_1 + R_2}$

Current Divider



$I_1 = \frac{I_T \times R_2}{R_1 + R_2}$

$I_2 = \frac{I_T \times R_1}{R_1 + R_2}$



$I_2 = \frac{\frac{1}{R_2} \times I_{Total}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

Experiment (2)

in DC → capacitor → (open circuit)

in DC → inductor → (short circuit)

Nodal Analysis

$\Sigma I_{in} = \Sigma I_{out}$

Number of equations = Number of Nodes

⊕ خطوات الحل

١) بحدد active node و reference node

٢) بجد التيار في كل مقاومة

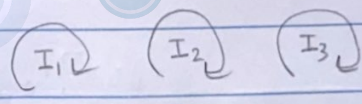
٣) بحل (KCL)

2 → 3 (5)

$\frac{V_2 - V_3}{5}$

Mesh Analysis

$\Sigma V = 0$ for each loop



مقاومة

$3(I_2 - I_3)$

بفرض التيار تبع ال mesh يلي بشتغل فيها هو الأكبر و بطرح من الثاني

Experiment (3)

superposition → Kill all sources exept one

Kill one source and Keep the other

$I = I' + I''$

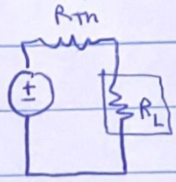
$V = V' + V''$

$P \neq P' + P''$ → because it is not Linear

$V_{thevinin}$

$V_{th} = V_{oc}$

V_{th} → remove R_L → Leave it open → Find V_{th}



$P = IV$

$P = I^2 R$

$P = \frac{V^2}{R}$

(+) consumed

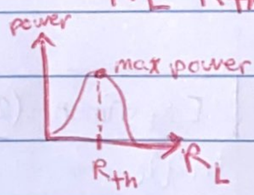
(−) generated

$R_{th} = R_{ab}$

$R_{thevinin}$ → remove R_L → Kill all sources → Find R_{th}

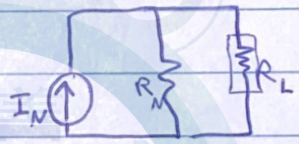
for maximum power

$R_L = R_{th}$



$I_N = I_{sc}$

I_{Norton} → remove R_L → Put short circuit → Find I_N



Experiment (4)

$w = 2\pi f = \frac{2\pi}{T}$

Capacitor
- → 1st Digit
- → 2nd Digit
- → multiplier
- → tolerance
- → voltage

(1st Digit, 2nd Digit, multiplier) in pF → 10^{-12}

Horizontal controls
- scale (Time per Division)
- position ↔

Inductor

Coil
choke
resists changes in electric current
(it have a small internal resistance)

- → 1st Digit
- → 2nd Digit
- → multiplier
- → tolerance
- → Voltage

(1st Digit, 2nd Digit, multiplier) in μF → 10^{-6}

Vertical controls
- scale (Volt per Division)
- position ↕

* $V_{peak\ to\ peak} = 2V_p$
* Root mean Squared → $V_{rms} = \frac{V_p}{\sqrt{2}}$
* Frequency → $f = \frac{1}{T}$ Hz

frequency $\frac{1}{\alpha}(X_C)$
علاقة عكسية

Experiment (5)
Capacitive Reactance

(R-C) circuits → series / parallel

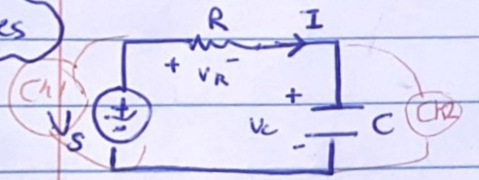
PF Lead

in (R-C) I_s leads V_s by θ

$V_S = V_P$ (source, peak)

RC circuit

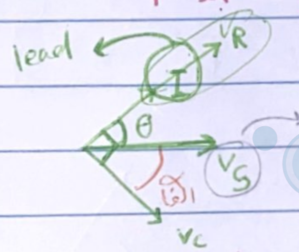
Series



بنحط
Ch ① supply
Ch ② output on capacitor

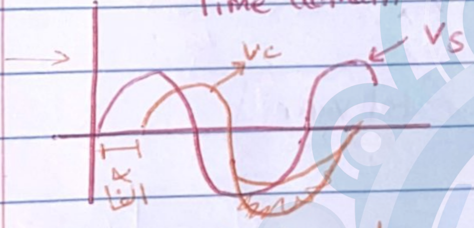
بنفترض ال supply
هو ال reference

phasor diagram



على ال refference

Time domain



V_S lead V_C by α
V_C lag V_S

Ch 1 (supply) lead Ch 2 (capacitor)

ohms law
$V = IR$

Equations

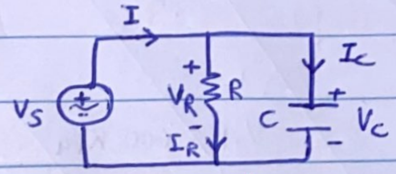
Total current: $I = \frac{V_R}{R} = |I| \measuredangle I$

Capacitor impedence: $X_C = \frac{|V_C|}{|I|}$

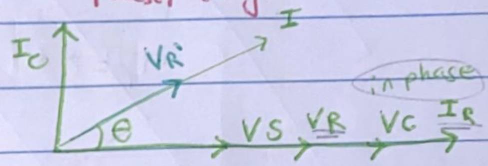
Total impedence magnitude: $|Z| = \frac{|V_S|}{|I|}$

Total impedence phase: $\measuredangle Z = \measuredangle V_S - \measuredangle I$

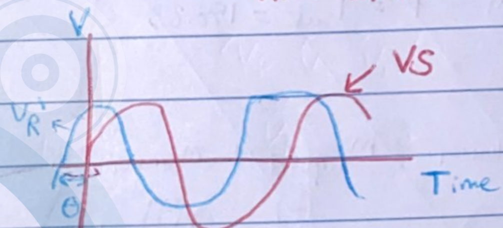
Parallel

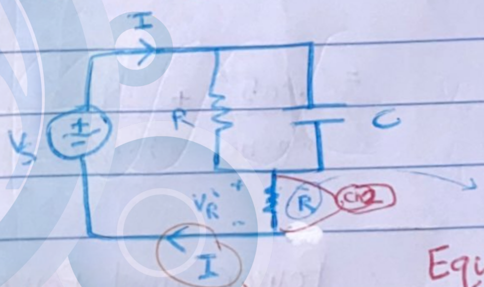


phasor diagram



Time domain $V_{R'}$ lead V_C





عشان اشوف التيار
على ال oscilloscope
بنحط R' وبتجيها
عالجهاز
10 Ω
very small Resistor

I and $V_{R'}$ → in phase
لكونهم نفس ال Amplitude

Equations

$I = \frac{V_{R'}}{R'}$

$V_R = V_S - V_{R'} = V_C$

$I_R = \frac{V_R}{R}$

$I_C = I - I_R$

$B_C = \frac{|I_C|}{|V_C|}$

$|Y| = \frac{|I|}{|V_S|}$

$\measuredangle Y = \measuredangle I - \measuredangle V_S$

Power and Power Factor

S → average complex power (VA)
P → average real power (W)
Q → average reactive power (VAR)

Average complex Power (V.A) → $S = P + jQ = V_{rms} I_{rms} \measuredangle(\measuredangle V - \measuredangle I) = \frac{1}{2} V_p I_p \measuredangle(\measuredangle V_s - \measuredangle I)$ ← $\measuredangle S$

Averge Real power (W) → $P = V_{rms} I_{rms} \cos(\measuredangle V - \measuredangle I) = \frac{1}{2} V_p I_p \cos(\measuredangle V - \measuredangle I)$

Average Reactive Power (VAR) → $Q = V_{rms} I_{rms} \sin(\measuredangle V - \measuredangle I) = \frac{1}{2} V_p I_p \sin(\measuredangle V - \measuredangle I)$

Apparent Power → $|S| = V_{rms} I_{rms} = \frac{1}{2} V_p I_p$

$PF = \cos(\measuredangle V - \measuredangle I)$ → which is (Lead) for capacitive Loads

$X_L \propto$ frequency
طردي

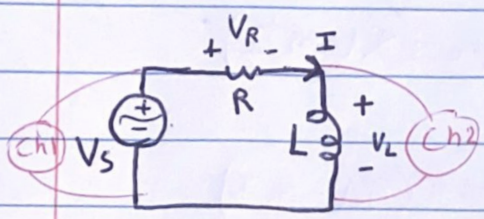
*Experiment (6) Inductive Reactance

(R-L) circuit → series / parrallel

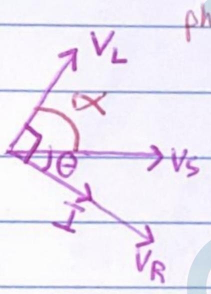
(R-L) circuit → P.F → Lag

in (R-L) V_s lead I_s always

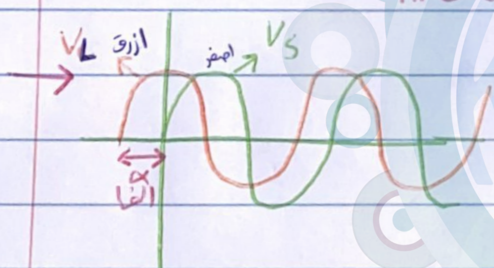
Series



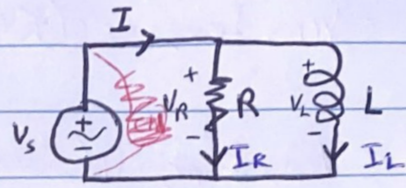
phasor diagram

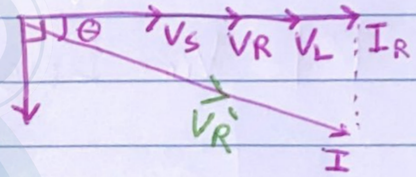


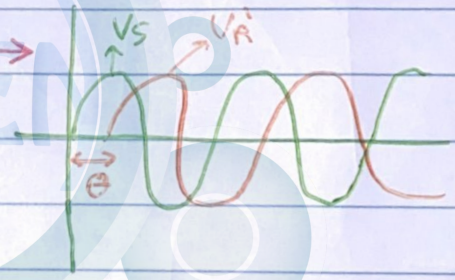
time domain



Parrallel







V_s lead V_R', أو I

V_R' أو I lag V_s

ossliscope shows voltage related to time

y → voltage

Equations (Series)

$I = \frac{V_R}{R} = |I| \angle I$

$X_L = \frac{|V_L|}{|I|}$

$Z = \frac{|V_s|}{|I|}$

$\angle Z = \angle V_s - \angle I$

Equations (Parallel)

$I = \frac{V_R'}{R'} = |I| \angle I$

$V_R = V_s - V_R' = V_L = |V_R| \angle V_R$

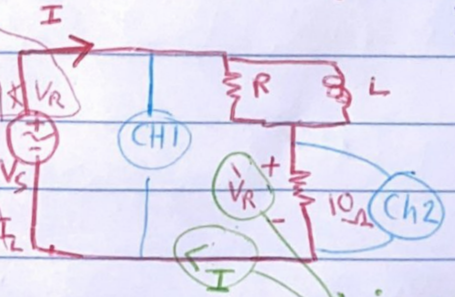
$I_R = \frac{V_R}{R} = |I_R| \angle I_R$

$I_L = I - I_R = |I_L| \angle I_L$

$B_L = \frac{|I_L|}{|V_L|}$

$Y = \frac{|I|}{|V_s|}$

$\angle Y = \angle I - \angle V_s$



$I = \frac{V_R'}{10\Omega}$

V_R', I → in phase

$R' = 10\Omega$ فبحط very small Resistor

phase shift ليش بدي أعرف كم ال

عشان احايل عالجهاز

Power and Power Factor

Average complex power (V.A) ← $S = P + jQ = V_{rms} I_{rms} \angle(\angle V - \angle I) = \frac{1}{2} V_p I_p \angle(\angle V - \angle I)$

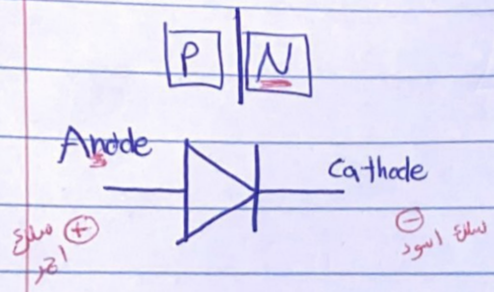
Real power (W) ← $P = V_{rms} I_{rms} \cos(\angle V - \angle I) = \frac{1}{2} V_p I_p \cos(\angle V - \angle I)$

Reactive power (VAR) ← $Q = V_{rms} I_{rms} \sin(\angle V - \angle I) = \frac{1}{2} V_p I_p \sin(\angle V - \angle I)$

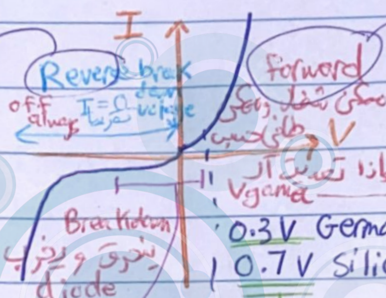
Power Factor ← $PF = \cos(\angle V - \angle I)$ it is lagging in inductive loads

Apparent power ← $|S| = V_{rms} I_{rms} = \frac{1}{2} V_p I_p$

Experiment (7)
Diode Applications



anode — indicator (cathode) عبارة عن فضية



Diode open circuit ← Reverse

forward → Diode short circuit

ممكن يشغل وممكن لا حسب ال V

إذا تعدى ال Vgama → on يكون

0.3 V Germanium

0.7 V Silicon

→ Vgama Threshold voltage

Breakdown: يحرق ويخرب ال diode

قبل التعدي عن 0.3 / 0.7 يكون V قليلة جداً ويكون I→0 التيار يؤول للصفر (open circuit)

DMM digital multimeter

→ معرفة النوع silicon germanium

→ معرفة اين ال cathode (anode, cathode)

عن طريق Digital Multimeter

قريبا من Silicon 0.7 // germanium 0.3 //

احمر · common اسود

shift → diode

إذا اعطاني -OL- مثلا طلعت 0.60

إذا تعدينا ها بتكون forward

يكون overload يعني Reversed biased يعني open circuit (معكوس)

in Reversed

V_{diode} → (−) minus → diode off

open circuit

$V_{diode} = V_{supply}$

إذا طلع رقم مو -OL-

⊕ anode — ⊖ cathode

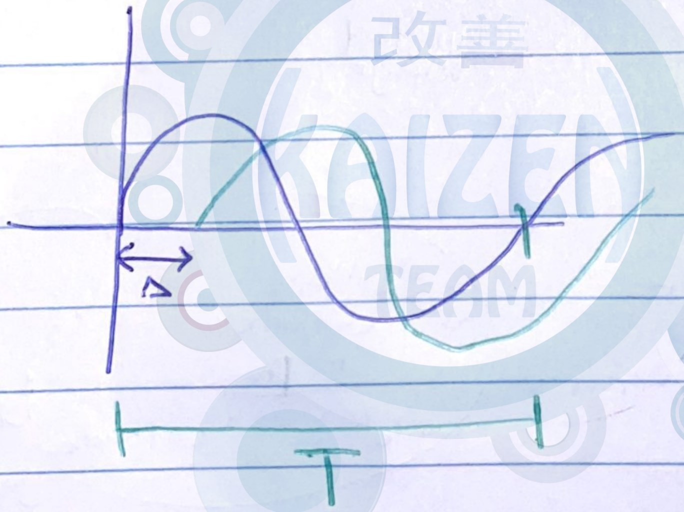
forward → on / off

$$V_{dc} = \frac{V_{peak}}{\pi}$$

$$\tau = R \times C$$

Time constant

$$T = \frac{1}{f}$$



$$\theta = \frac{\Delta(\text{Div}) \times 360^\circ}{T(\text{Div})}$$