Al-Furat Al-Awsat
Technical University

جامعة الفرات الأوسط التقنية

Technical Institute of Karbala

المعهد التقني كربلاء

Electrical Techniques Department

قسم التقنيات الكهربائية

Electrical Circuits and Measurements

مقرر الدوائر والقياسات/1

First year

المستوى الاول

Assistante lecturer/ Kadhim Hatef Kadhim

lecturer/Mahmood Hakim Enad

إعداد: م.م كاظم هاتف كاظم

م . محمود حاكم عناد

بسم الله الرحمن الرحيم

((ربي اشرح لي صدري ويسر لي أمري واحلل عقدة من لساني يفقهوا قولي)) .

صدق الله العلي العظيم

The aim of theorem

1)To define the electric circuits and electrical measurement to the students .

لتعريف الدوائر الكهربائية وأجهزة القياس للمتعلم .

2) To prepare students for studying different calculations of alternating circuits and direct current circuits and different theories of measuring instruments.

لجعل المتعلم قادرا أن يتعلم مختلف الحسابات لدوائر التيار المتناوب ودوائر التيار المستمر ومعرفة مختلف النظريات والتعرف على أجهزة القياس الكهربائية , المختلفة..

References المصادر

1): Electrical Technology (Edward Hughes).

2): Electrical Technology (B.L Theraja) .

3) :Fundamental Electric circuits (David A . B ell)

4) Introductory circuit Analysis by Robert L. Boylestad

5): Basic circuits (A.M.F Brooks) pergaman press.

6): Introduction to Electric circuits (M.Roman witz) John willy.

7): Basic Electrical Engineering (Fitzgerald and Rlgginborthan). Mc-Graw- Hill

8): مبادئ علم الهندسة الكهربائية / دكتور محمد زكي و الدكتور مظفر النعمة

9): مشروع كتاب الدوائر والقياسات .

The first week (الأسبوع الأول)

تعريف الوحدات الأساسية للفولتية والتيار والمقاومة

و

العوامل التي تؤثر على قيمة المقاومة

over view - النظرة الشاملة

A- Population target

الفئة المستهدفة

 Student of first year

of

Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

B –Rationale مبررات الوحدة

- It is very important to study Units system
- Also to study the elements effect of at resistance.

C – Central Idea الفكرة المركزية

- Definition voltage , current and resistance
- units system
- The element effect at resistance .

الهدف من المحاضرة

D - Aim of lecture : To let the student be able to identify the analyses different elements effect at the resistance value .

Pretest ألاختبار القبلي

1): Define :-
(Resistance, current , Potential difference ,voltage , E.m.f.) .

2): Write Ohm's law

3) What is the meaning of the Ampere (A)?

Solution

: 1): R (The appetite of material to appose the flow of electrons, its unit . is (Ω)

I (The electric current means the flout of electrons through the conductor)

Potential difference :(The difference in potential between tow points in .an electrical system , its unit is volt (V)

Volt (V) : The unit of measurement applied to the difference in potential between two points

E.m..f. (the electro motive force means the sorce of voltage produced from Generator which causes current to flow).

2) **V = IxR (volts)** R=**V \ I**

3) (A) : The unit of measurement applied to the flow of charge through a conductor.

(نظام الوحدات)Units system

m-k-s-A system (international unit) (ألمعتمد منذ عام 1960م) نظام ألمتر – كيلوغرام –ثانية –أمبير

Quantity	unit	symbol
Length	meter	M
Mass	Kilogram	Kg
Time	Second	S
Current	Amper	A
درجة الحرارةTemperature	Kelvin	K
Luminous intensity شدة ألإضاءة	candela	cd

From these basic quantity we derive :- نستنتج

Quantity	unit	symbol
Electric charge	Coulomb	C
Electric potential	Volt	V
Resistance	Ohm	Ω
Capacitance	Farad	F
Inductance	Henry	H
Conductance	Siemens , mho	S
Frequency	Hertz	HZ
Power	watt	W

Notations:-

$1=10^{0}$	
$10=10^{1}$	$1/10=0.1=10^{-1}$
$100=10^{2}$	$1/100=0.01=10^{-2}$
$1000=10^{3}$	$1/1000=0.001=10^{-3}$

Power of 10	**prefix**	symbol
10^{6}	Mega	M
10^{3}	Kilo	K
10^{-3}	mille	m
10^{-6}	Micro	µ
10^{-9}	Nano	n
10^{-12}	pico	p
10^{9}	gaga	G

Examples:-

a) : 1000 000Ω = 1×10^{6} Ω =1 mega ohm =1MΩ

0.000001 farad=1×10^{-6} farad =1 Micro farad= 1μF

0.0001 second=0.1×10^{-3} second = 0.1 mille second =0.1 ms $10^{n} \times 10^{m} = 10^{(n+m)}$

b) :

$1000 \times 10\,000 = 10^{3} \times 10^{4} = 10^{3+4} = 10^{7}$

$0.00001 \times 100 = 10^{-5} \times 10^{2} = 10^{-3}$

$10^{n}/10^{m}=10^{n-m}$

C) . $100000/100 = 10^{5}/10^{2} = 10^{5-2} = 10^{3}$

$1000/0.0001 = 10^{3}/10^{-4} = 10^{3-(-4)} = 10^{7}$

$(10^{n})^{m} = 10^{n\times m}$

d) . $(100)^{4} = (10^{2})^{4} = 10^{2\times4} = 10^{8}$

$(1000)^{-2} = (10^{3})^{-2} = 10^{3\times-2} = 10^{-6}$

$(0.01)^{-3} = (10^{-2})^{-3} = 10^{-2\times-3} = 10^{6}$

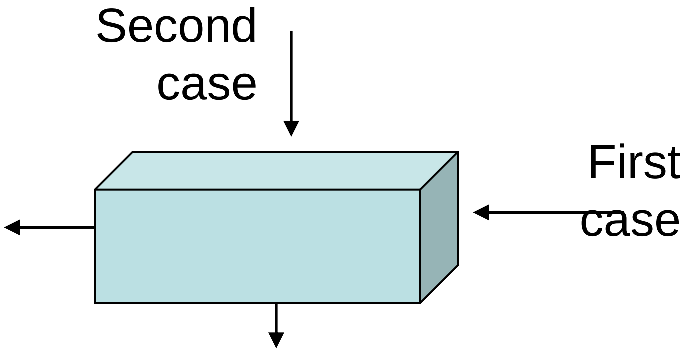
The elements effect of at resistance (العوامل المؤثرة على قيمة المقاومة)

1- The Resistance varies directly with (Length) { L } .
2- It varies inversely with (the cross section area) { A } .
3- It depends on the nature of the material { specificin (p) }.
4- It also depends on the temperature of the conductor { T } .

R Œ L/A $\therefore$ $R = \rho \cdot l/A\ (\Omega)$, $\rho = R.A/L = \frac{\Omega.m^2}{m} = \Omega.m$

When R: resistance, p= specificin or resistivity , L= length.
A =cross section area

Ex1: A rectangular carbon block has dimensions (1 cm ,1 cm ,50 cm) .
1- what is the resistance measured between the two square ends .
2- Between two opposing rectangular faces if $P = 3.5x10^{-5}\ \Omega.\ m$



Solution: •

1- $R= P . L /A\ (\Omega) =3.5x10^{-5}\ x0.5/(1x10^{-2}\ x\ 1x10^{-2})$

:. $R = 0.175\ \Omega$

2- $R= P . L /A\ \ \Omega =3.5x10^{-5}\ 1x10^{-2}/(1x10^{-2}x50x10^{-2})$

:. $R =0.00007\ \Omega$

Ex 2: The wire resistance equal to (40 Ω) and length (1km) if the resistivity$=2x10^{-8}\ \Omega.m$, calculate: the diameter of the circular type wire.

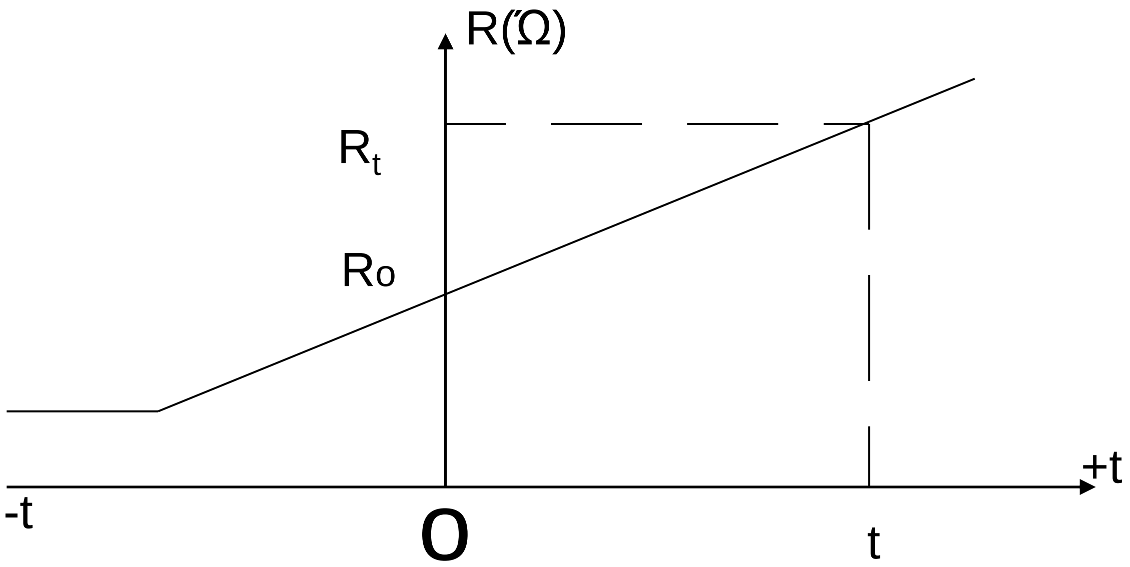
Solution : Area$=(r^2 /2).\pi$, $R= P . L /A\ \Omega$:.$A= P . L /R = (2x10^{-8}\ x1x10^{3}) /40$
$=0.5x10^{-6}\ m^2$

$A=(d^2 /4).\ \pi$ $d^2=4.A/\pi$:.$d= \sqrt{4x0.5x10^{-6}\ /3.14} =0.640x10^{-6}m$

The temperature effects at the resistance

تأثير درجة الحرارة على المقاومة

The resistance of the material depends on the temperature, When (T) increased, R also increased



Let the resistance of a conductor at 0Ċ=R_oΩ
Let the resistance of a conductor at tĊ=R_t Ω
Let the temperature cofficient of material at 0Ċ=$œ_o$ / k
Let the temperature cofficient of material at tĊ=$œ_t$ / k

1- $R_t=R_o(1+œ_o t)$

2- $R_2=R_1(1+œ_1(t_2-t_1))$

3- $œ_t=œ_o/(1+œ_o.t$

4- $œ_t=(R_t-R_o)/R_t.t$

Ex.3: A lamp of (100 watt) power, (240 volt) reaches(2000Ċ) if the temperature coefficient of the lamp at (15Ċ) is $œ=5x10^{-3}$ /k calculate the current through the lamp

Solution: $p=v^2/R$:. $R=(240)^2/100=576\Omega$

$R_2=R_1(1+œ_1(t_2-t_1))$:. $576=R_1[1+5x10^{-3}(2000-15)]$

$576=R_1(1+9.92)$, $R_1=576/10.92=52.7\ \Omega$:. $I=v/R=240/52.7=4.55A$

:.

Ex.(4): Palatine coil of resistance(3.717Ω) at (100Ċ). Calculate
1-The resistance at zero degree. 2- the temperature coefficient of resistance at 40Ċ **(H .W)**

Notes: 1- R_o= 2.781 Ω
2-$œ_t$= 0.00284/k

Ex5 : **A(1A) pass through a copper conductor the Potential difference through it is (10 v) at (20Ċ) after Sam times the current decrease to** (0.95A) , (**Potential difference** not changed) , Find the temperature of the conductor if the temperature coefficient of the copper at zero **Ċ** **(α_o)= 4.28x10^{-3}/k**

Solution: $R1=v/I_1=10/1=10\Omega$, $R2=v/I_2=10/0.95=10.53\ \Omega$,

$R_t=R_o(1+\alpha_o t)$ $\therefore R_1/R_2=R_o(1+\alpha_o t_1)/R_o(1+\alpha_o t_2)$

$\therefore 10/10.53=(1+4.28\times10^{-3}\times 20)/(1+4.28\times10^{-3}\times t_2)$ $\therefore t_2=33.4$Ċ

Ex(6). A copper conductor of (100m) length ,with a diameter of (1mm) ,if the resistivity of a copper is 0.0159 MΩ.m , find the resistance of the conductor.

مثال : موصل نحاسي طوله 100متر وقطره 1ملم اذا كانت المقاومة النوعية للنحاس 0,0159ميكا اوم xمتر, اوجد مقاومة النحاس .

solution

$R=\rho L/ A$:. $A= r^2 .\pi= (1/2 \ x10^{-3})x3.14 \ m^2$:. $R=(0.0159 \ x10^{-6} \ x100)/ 0.5^2.\pi x10^{-6}$

:. $R= 2.02\Omega$

Posttest ألاختبار ألبعدي

Ex:(7) An electric heater takes a current of (15A) from a (115v) source. The cables connecting the heater to the supply are each (43m) long. If the voltage drop along the cables is not exceed (12v) .Determine the diameter of suitable copper wire and select p=1.72x10-8 Ω.m

Solution

$R=E/I=12/15=0.8\Omega$, total length of wire $=2x43=86m$

$R=p.L/A$:. $A=p.L/R=(1.72x10^{-8}x86)/0.8=1.849x10^{-6}\ m^2$

$A=[(1/2).d]^2.\Pi$

$A=(d^2/4).\Pi$:. $d^2=4A/\Pi$:. $d=\sqrt{4A/\Pi}$

$d=\sqrt{(4x\ 1.849x10^{-6}}\ /\Pi=1.5mm$

الأسبوع الثاني (The second week)

دوائر التيار المستمر

Resistances connection

توصيل (ربط) المقاومات التوالي والتوازي والمختلط

over view - النظرة الشاملة

A- Population target

الفئة المستهدفة

- Student of first year of Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

B –Rationale مبررات الوحدة

- It is very important to study

Resistances connect ion:

Series circuit, Parallel circuits and complex connection

- Also to study Voltage divider rule ,

the current divider rule and Ohms' law

.

C – Central Idea الفكرة المركزية

- connect the resistance as series ,parallel and complex.
- **Voltage divider rule, the current divider rule.**
- **Ohms, law.**

D- Aim of lecture :

To let the student be able to identify the analyses different kind of resistance connection (series, parallel ,complex)

Pretest **ألاختبار القبلي**

1): If number of resistances connection in series write total voltage , current laws .

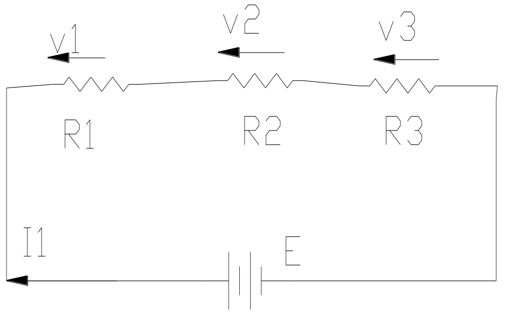
2) If number of resistances connection in Parallel wrights total voltage , current laws .

solution

1) $V_T = V_1 + V_2 + \ldots + V_n$, $I_T = I_1 = I_2 = I_n$

2) $I_T = I_1 + I_2 + \ldots + I_n$, $V_T = V_1 = V_2 = V_n$

1 Series circuit

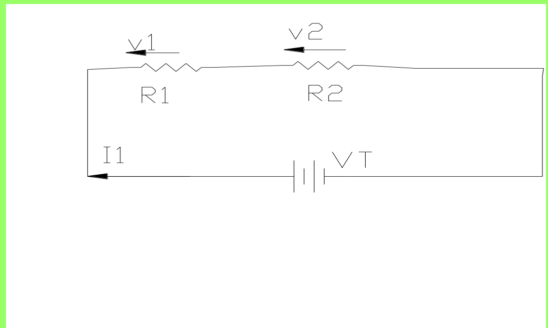


$I = I_1 = I_2 = I_3 = \text{---------} = I_n$ $V_T = V_1 + V_2 + V_3 + \text{-------} + v_n$

$R_T = R_1 + R_2 + R_3 + \text{--------} + R_n$

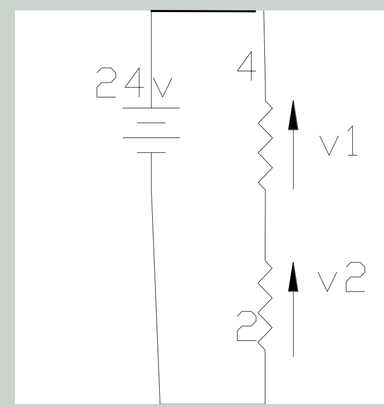
When : **n** number of resistances

Voltage divider rule قانون تقسيم الفولتية



$V_1 = I.R_1 = V_T.R_1/(R_1 + R_2)$ $V_2 = I.R_2 = V_T.R_2/(R_1 + R_2)$

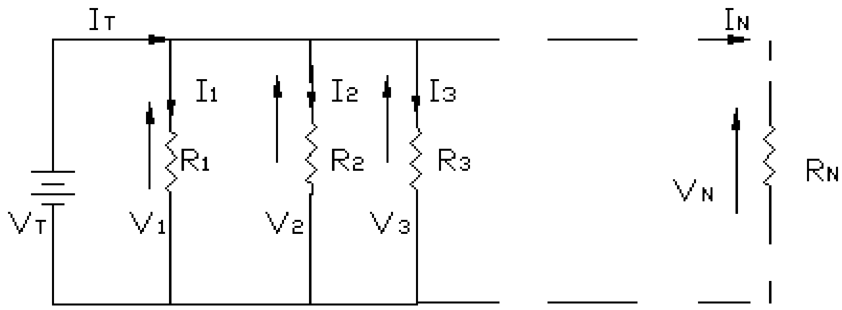
Ex: By using V.d. r. Find V1,V2



V1=VT.R1/R1+R2
=4x24/(4+2) =16v

V2=VT.R2/R1+R2
=2x24/(4+2)=8v

2 Parallel circuits دوائر التوازي



$V_T=V_1=V_2=V_3=V_n$

$I_T=I_1+I_2+I_3+ ---+I_n$

$1/R_T=1/R_1+1/R_2+1/R_3+ ----+ 1/R_n$

$G_T=G_1+G_2+G_3+ ------+ G_n$, {**$G=1/R$**}

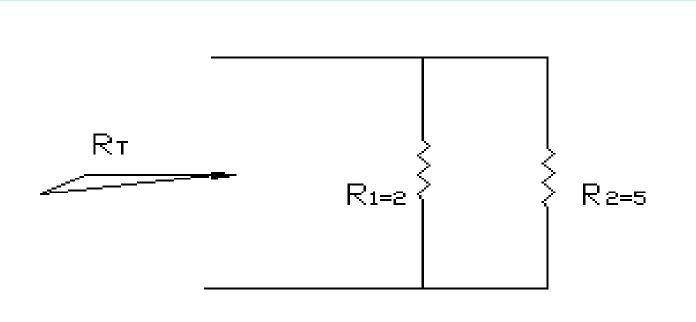
G : conductance الموصلية (مو)

For two resistance parallel connected as shown in fig.

$1/R_T=1/2 +1/5 =7/10$:.$R_T=10/7=1.4\Omega$

OR: **$R_T=R_1.R_2/(R_1+R_2)$**

$=2x5/(2+5)=10/7=1.4\Omega$

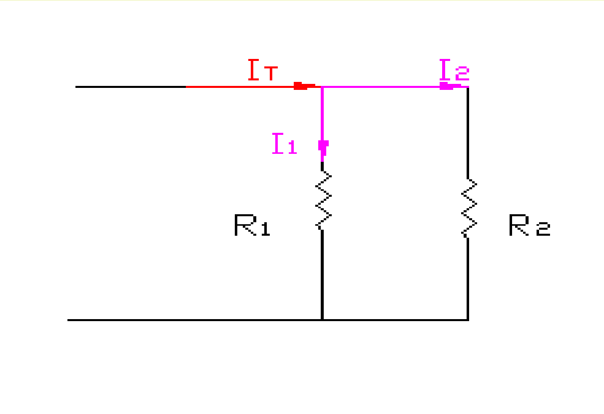


The current divider rule (قانون تقسيم التيارات)

$$I_1 = V/R_1 = I_T \times \frac{R_1 . R_2}{R_1}$$

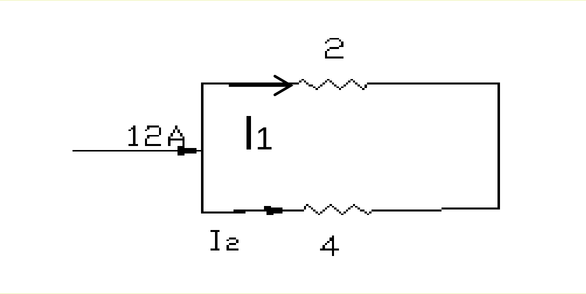
$$\therefore I_1 = \frac{R_2}{R_1+R_2} . I_T$$

$$\text{Also: } I_2 = \frac{R_1}{R_1+R_2} . I_T$$



EX(1) :Find I_1,I_2 For the cct. Shown ;

Solution; $I_1 = \frac{R_2}{R_1+R_2} \times I_T = \frac{4}{2+4} \times 12 = 8A$



$$I_2 = \frac{2}{2+4} \times 12 = 4A$$

Ohms' law

I= current in Ampere (A)

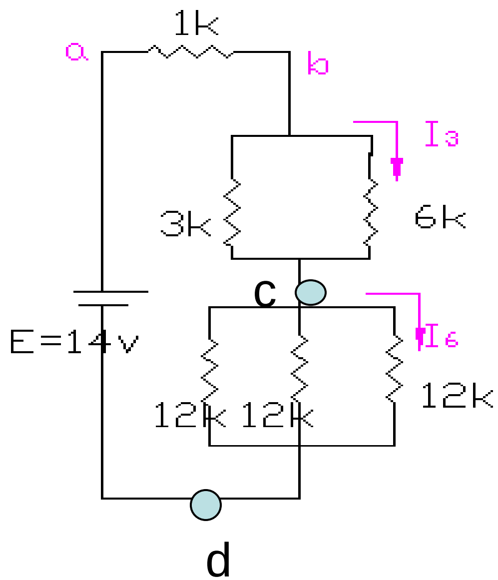
$$V = I \times R$$

THE POWER

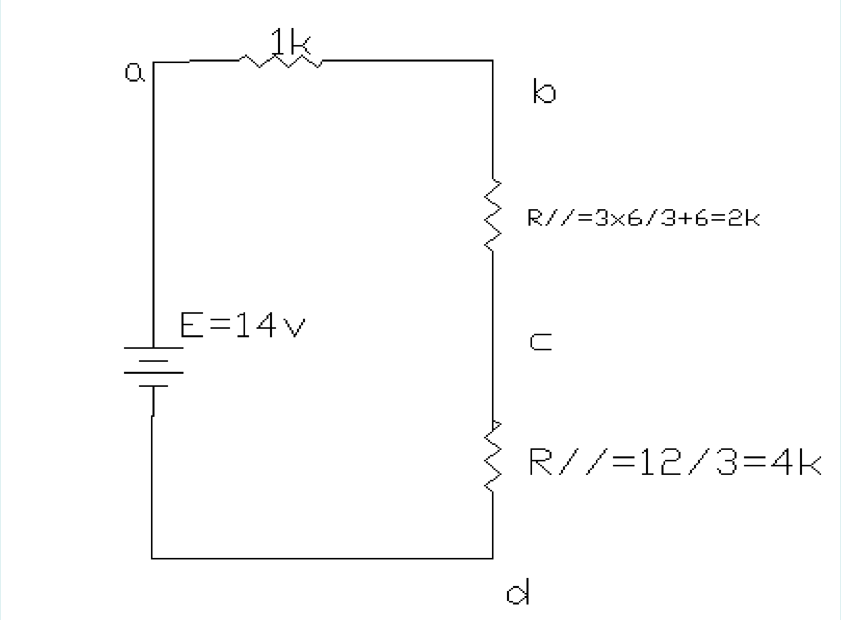
$P=V \times I$ (watt) **Also** **$P=I.R.I=I^2 . R$**

$$P = V.V/R = V^2 / R$$

Ex(2); Find V_{ad}, V_{ab}, V_{bc} ,V_{cd} ,I_3 ,I_6



solution



:. $R_T=7k\ \Omega$:. $I_T=14/7k=2mA$

:. $V_{ab}=2mA\times1k=2v$ $V_{bc}=2mA\times2K=4v$

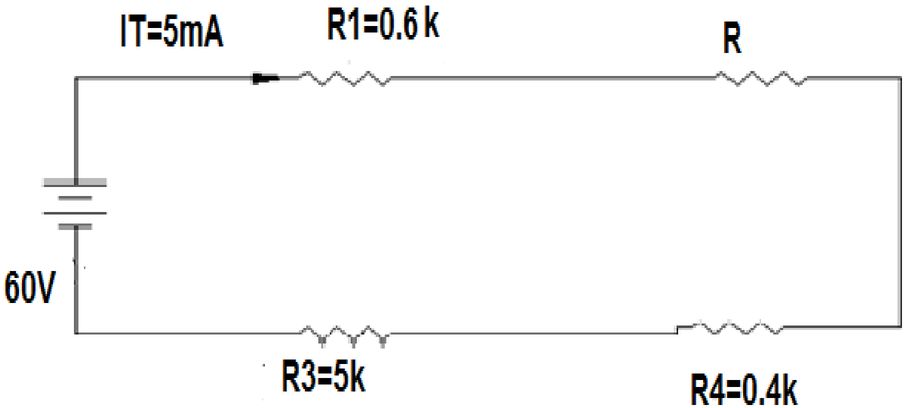
$V_{cd}=2mA\times4k=8v$

$I_3=2mA\times3k/3k+6k=0.666mA$

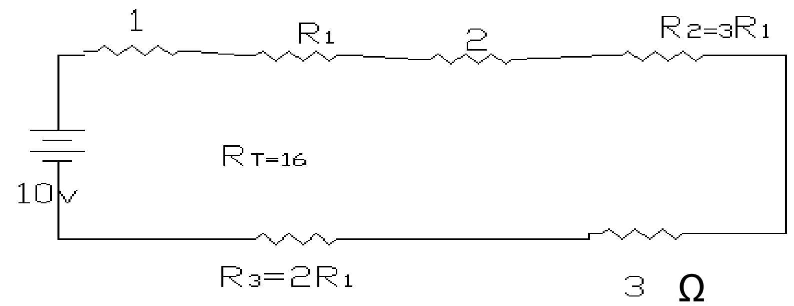
$I_6=8v/12k=0.666mA$

Posttest

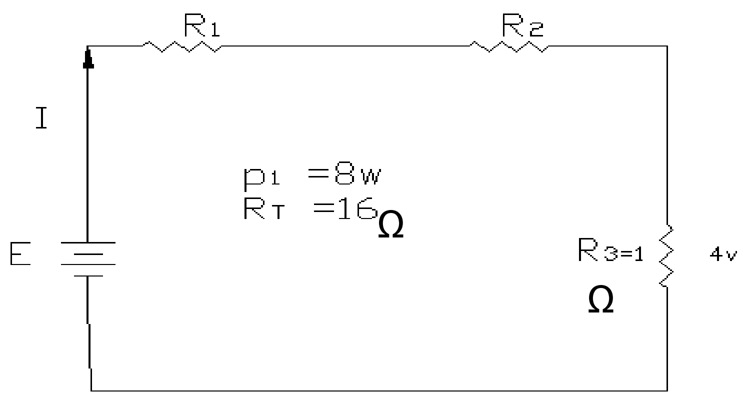
EX1 For the cct.Shown;Find RT,R



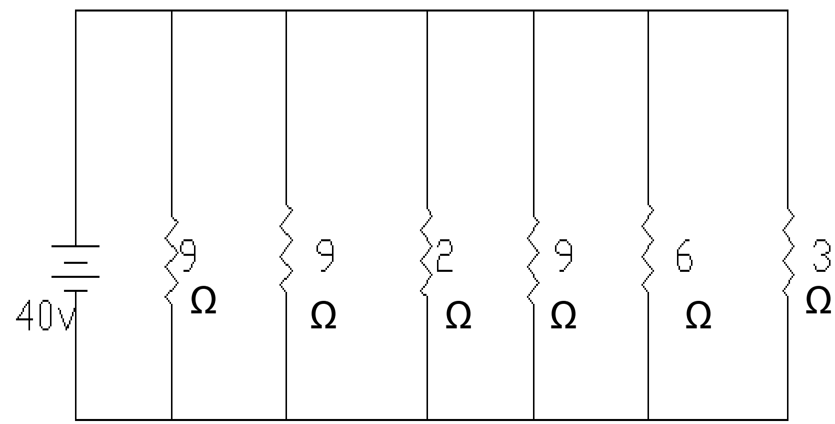
Ex2; Find (R1.IT)



Ex3; Find I ,E , R1, R2



Ex4; Find GT, RT



H.W.

Solution H. W

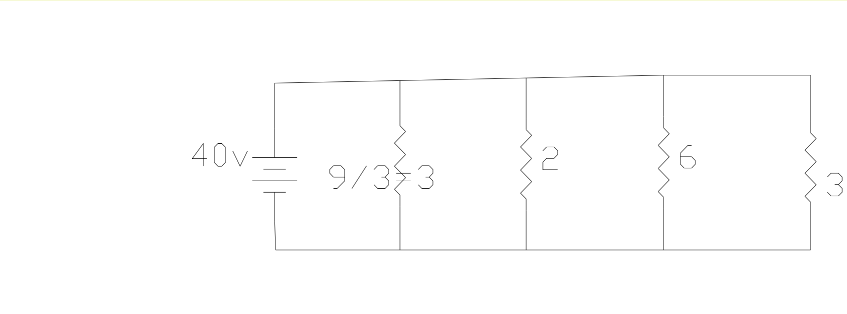
1) 60v=5x(0.6+R+0.4+5)
:. RT=60/5m=12k Ω :. RT=0.6+0.4+5+R :.
12k=6k+R R=12-6=6K

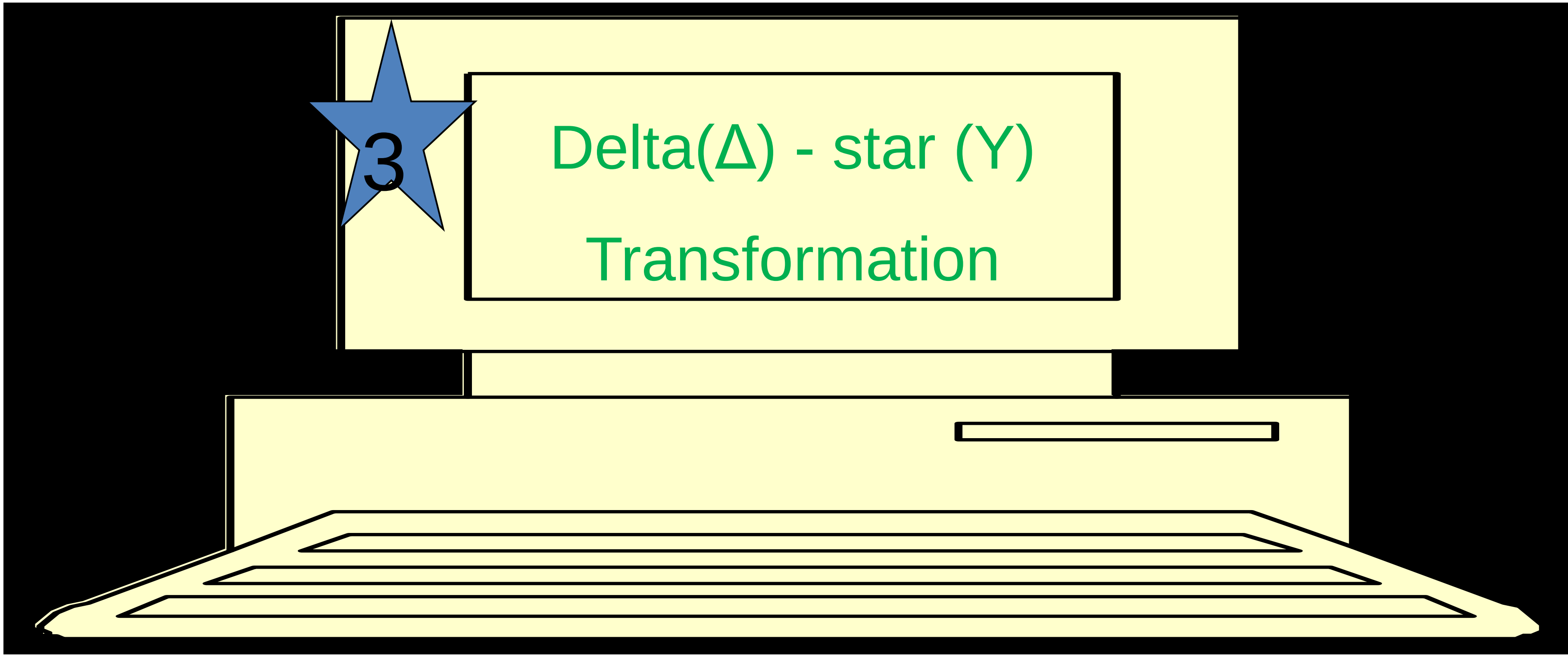
I_T =V/RT=10/16=0.625 A RT=16=1 +R_1 +2 +3 R_1 +3 +2 R_1 :. (2
16 =6+6 R_1 :. R_1 =10/6 =1.6 Ω (3

3)I_T =v/R=4/1=4A :. E=I_T xRT= 4x16=64v P=VI = I^2 xR :. 8=16xR_1
:.R_1 =8/16=0.5 Ω RT=16=0.5 + R_2 +1 :. R_2 =16-1.5=14.5Ω

4) G_T = 1/R_T mho

G_T = 2+6+3/2=9.5 mho
:.R_T =1/9.5= 0.1052 Ω

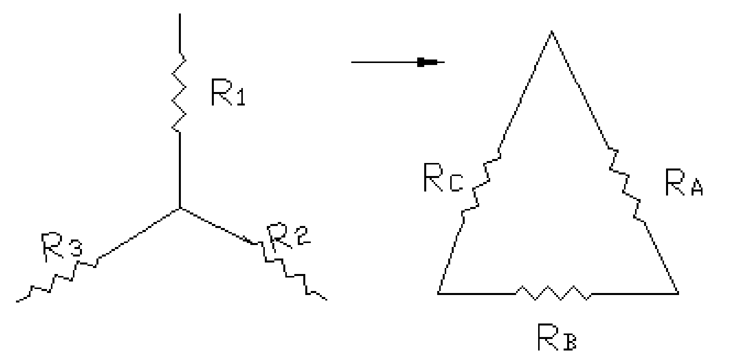




تحويل الربط ألنجمي وألمثلثي

(The third week) الأسبوع الثالث

Change star (Y) to delta (Δ)

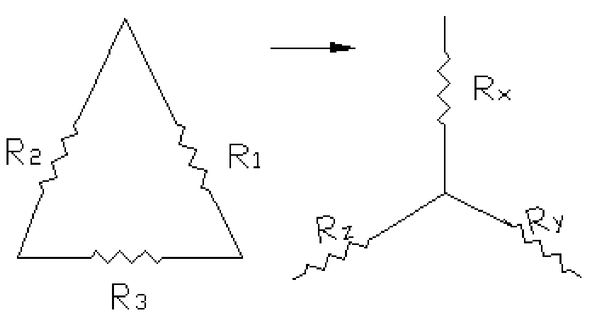


$$R_A = \frac{R_1R_2+R_2R_3+R_3R_1}{R_3}$$

$$R_B = \frac{R_1R_2+R_2R_3+R_3R_1}{R_1}$$

$$R_C = \frac{R_1R_2+R_2R_3+R_3R_1}{R_2}$$

Change delta to star (Δ) to(Y)

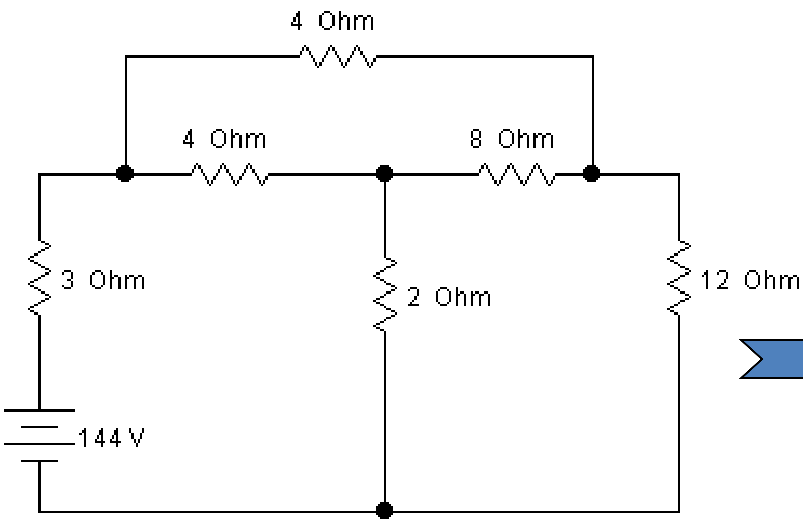


$$R_x = \frac{R_1 \ X \ \ R_2}{R_1+R_2+R_3}$$

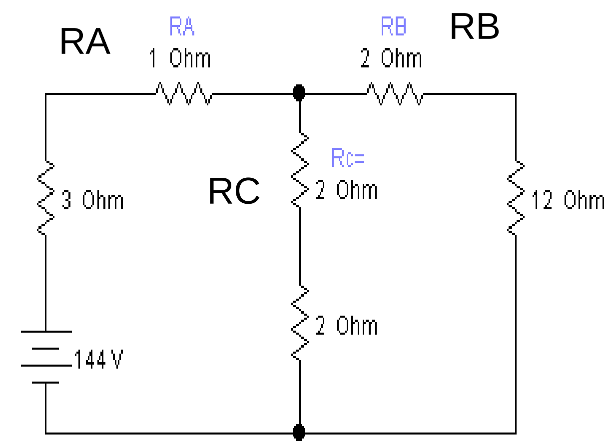
$$R_y = \frac{R_1 \ X \ \ R_3}{R_1+R_2+R_3}$$

$$R_z = \frac{R_2 \ X \ \ R_3}{R_1+R_2+R_3}$$

Example (3): For the cct. shown below calculate (I_T).



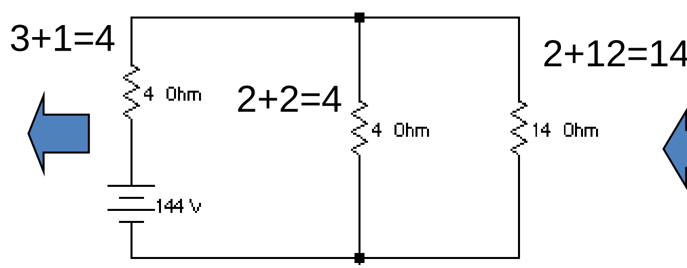
Solution ;



$$RA = \frac{4x4}{16} = 1 \text{ ohm}$$

$$RB = \frac{4x8}{16} = 2 \text{ ohm}$$

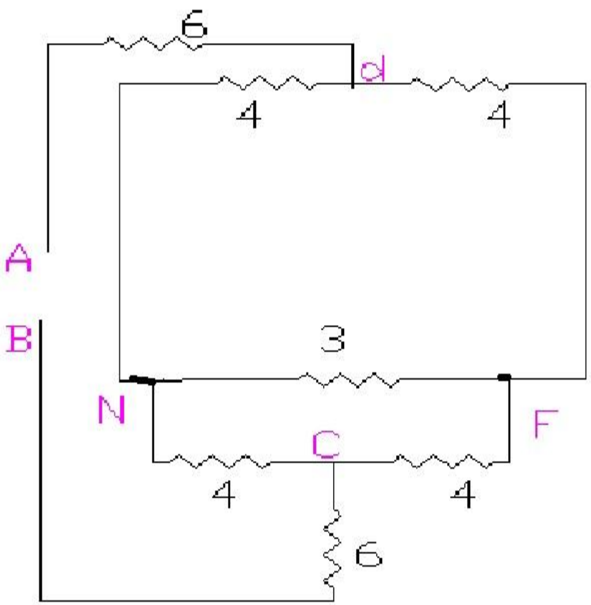
$$Rc = \frac{4x8}{16} = 2 \text{ ohm}$$

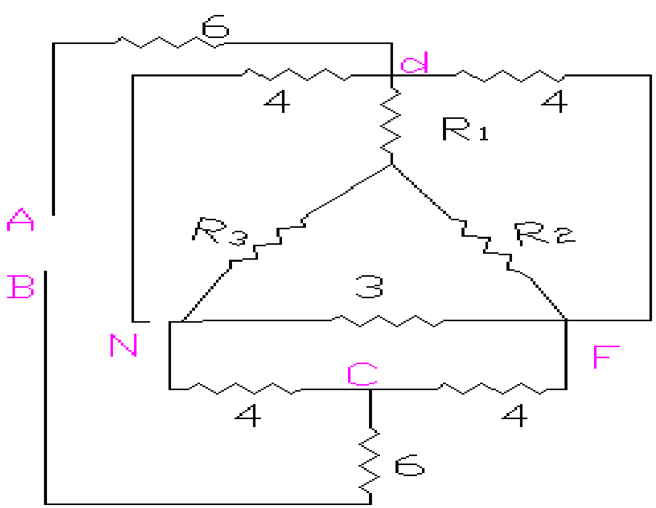


$$R_T = \frac{4x14}{4+14} + 4 = 7.111$$

$$I_T = 144/7.111$$
$$= 20.25 \text{ A}$$

EX (4): For the cct. Shown Find (RT) between A and B





solution

R1=4x4/(4+4+3)=1.45Ω
R2=4x3/(11)=1.09 Ω

R3=4x3/(11)=1.09 Ω

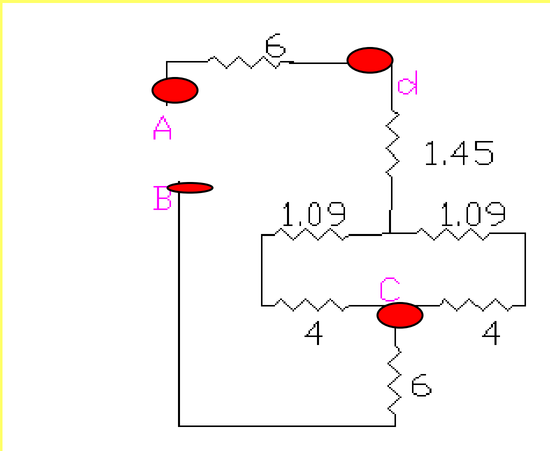
Rx=6+1.45= 7.45 Ω

Ry=1.09+4=5.09 Ω

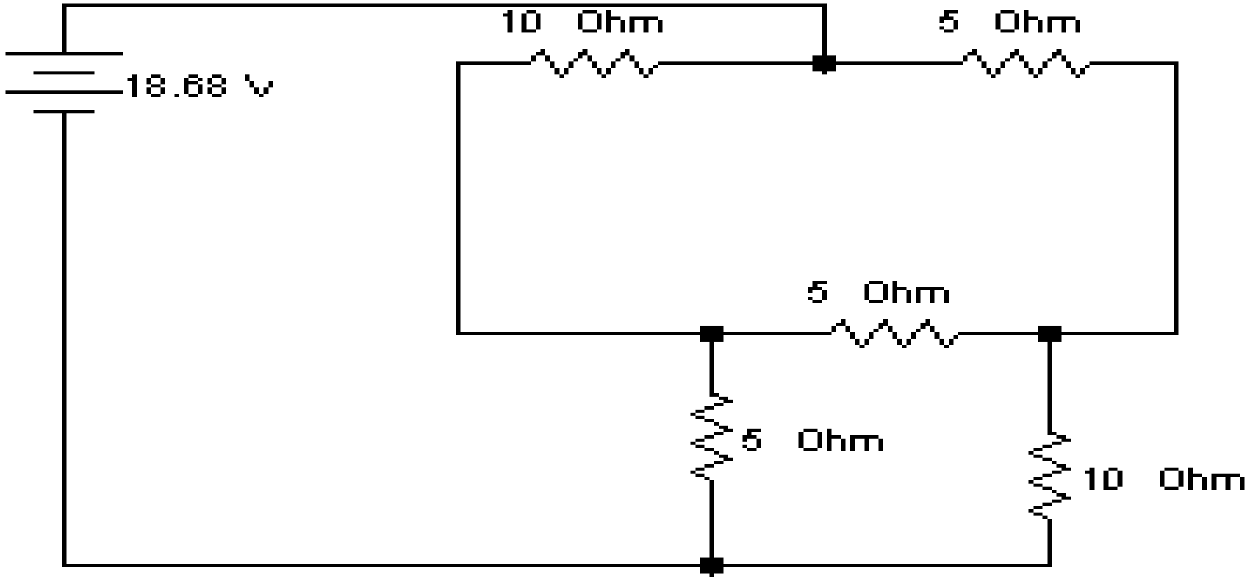
Rz =1.09+4=5.09 Ω

R//=(5.09x5.09)/(5.09+5.09)

2.54Ω :.RT=16Ω

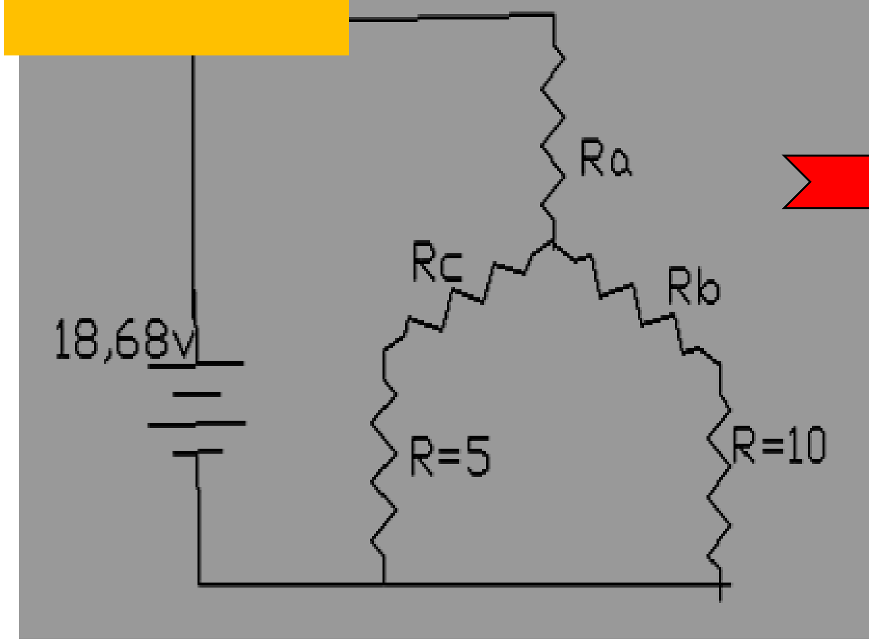


Ex5. Find (I_T) **H.W**



Notes: ***I_T = 2.66A***

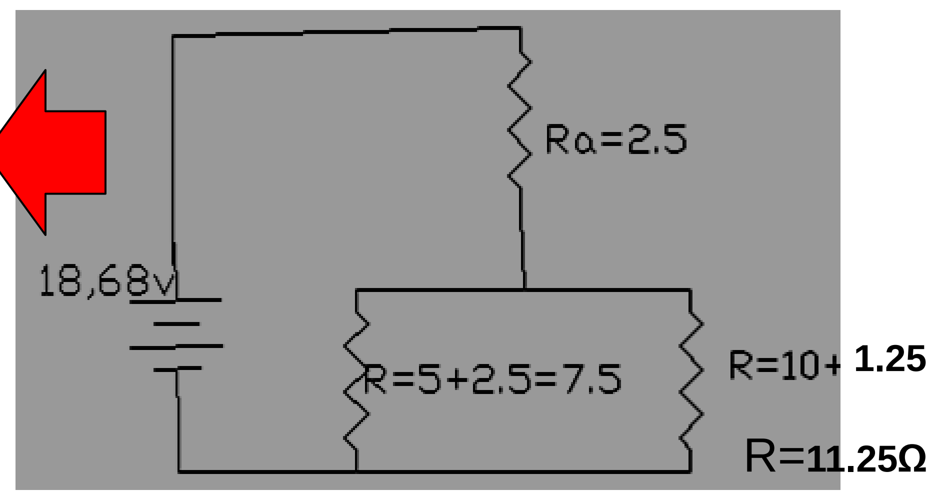
Solution Ex.5



Ra=(5x10)/20=2.5Ω

Rb=(5x5)/20=1.25Ω

Rc=(5x10)/20=2.5Ω



:.R_T =(11.25x7.5)/(11.25+7.5)+ 2.5

:. R_T=7 Ω

I_T=V/R_T=18.68/7= 2.66A

1

Kirchhoff's Laws(الأسبوع الرابع)

Kirchoff ،s theorem

قوانين كرتشوف

over view - النظرة الشاملة

A- Population target

الفئة المستهدفة

- Student of first year

of

Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

B –Rationale مبررات الوحدة

- It is very important to study Kirchhoff's laws
- Also to study Maxwell's method. .

C – Central Idea الفكرة المركزية

- Definition Kirchhoff's current law in any electric point .
- Definition Kirchhoff's voltage law in any electric closed circuit .
- To learn Maxwell's loops by using Kirchhoff's voltage law.

D-Aim of lecture

To let the student be able to identify the analyses net work by using Kirchhoff's laws .

Pretest الاختبار القبلي

Define : electric Node(Point), electric closed circuit

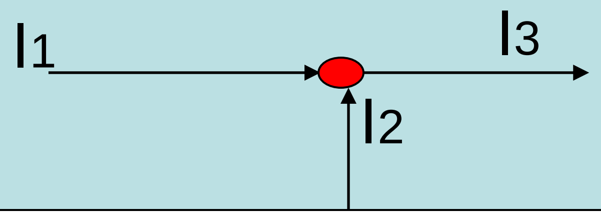
Solution

العقدة (أو النقطة) الكهربائية: هي المكان التي يتم فيها استلام وتوزيع تيار كهربائي واحد أو أكثر electric Node (Point)

الدائرة الكهربائية المغلقة electric closed circuit **هي الدائرة التي يكمل فيها التيار الكهربائي دورته مغذيا الأحمال الموجودة في نفس الدائرة.**

Kirchhoff's laws

1- القانون الاول : مجموع التيارات الداخلة الى نقطة كهربائية يساوي مجموع التيارات الخارجة من تلك النقطة (أو المجموع الجبري للتيارات الداخلة الى نقطة كهربائية والخارجة منها يساوي صفرا)0

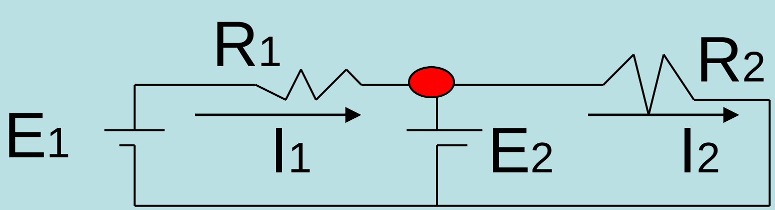


$I_1+I_2=I_3$ or

$I_1+I_2-I_3=0$

2- القانون الثاني :في كل دائرة كهربائية مغلقة, مجموع الارتفاعات بالجهد يساوي مجموع الانخفاضات

أو(في كل دائرة كهربائية مغلقة المجموع الجبري للارتفاعات بالجهد والانخفاضات يساوي صفرا).



At first cct. $E_1-E_2=R_1 x I_1$ or;

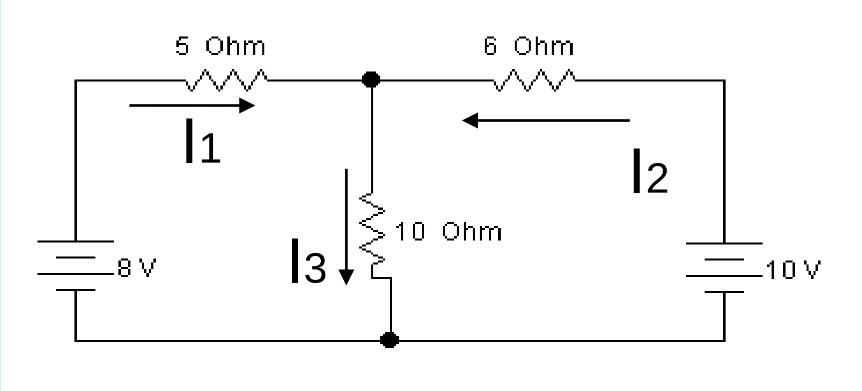
$E_1-E_2-(R_1 x I_1)=0$

At second cct. $E_2=I_2 x R_2$ or:

$E_2-(I_2 x R_2)=0$

EX(1): for the cct. shown find the currents flows in each resistance

solution



$I_1+I_2=I_3$….(1)   8= 5 I_1+10I_3…(2)

10=10I_3+6I_2….(3) then 8= 5I_1+10(I_1+I_2)

8=15I_1+10I_2…(4) and at eq.(3)

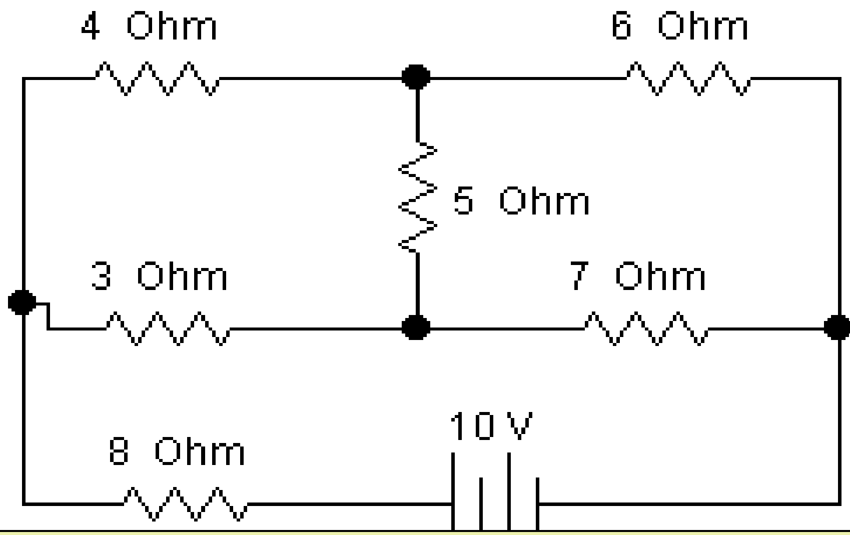
6I_2+10(I_1+I_2)=10   6I_2+10I_1+10I_2=10

Then **16I_2+10I_1=10**…. (.. /2) , 5I_1 + 8I_2=5 ,(x3) **15I_1+24I_2=15**

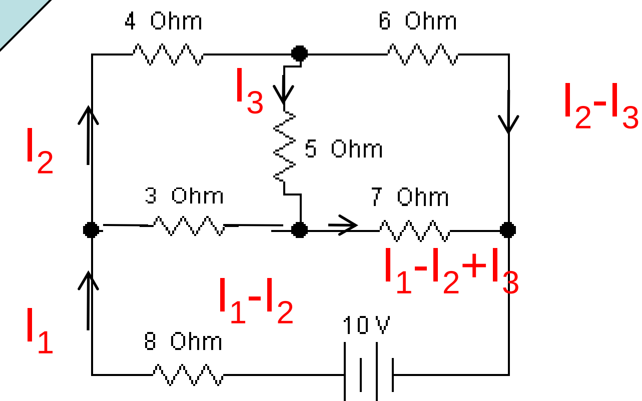
(الطرح)**-15I_1+(-)10I_2=-8..**

14I_2=7 , I_2=0.5A and in eq ..(4) 15I_1+5=8 ,I_1=0.2A ,I_3=0.2+0.5=0.7A

Posttest (A): ***Using Kirchhoff's theorem to calculate the current at each Resistance .*** ***(H.W)***



solution



$10=8I_1+3(I_1-I_2)+7(I_1-I_2+I_3)$

$\therefore 10=18I_1-10I_2+7I_3$ …..(1)

$0=4I_2+5I_3-3(I_1-I_2)$

$\therefore -3I_1+7I_2+5I_3=0$……(2)

$0=6(I_2-I_3)-7(I_1-I_2+I_3)-5I_3$

$\therefore 0=-7I_1+13I_2-18I_3$ ……..(3)

2

Maxwell's Loops

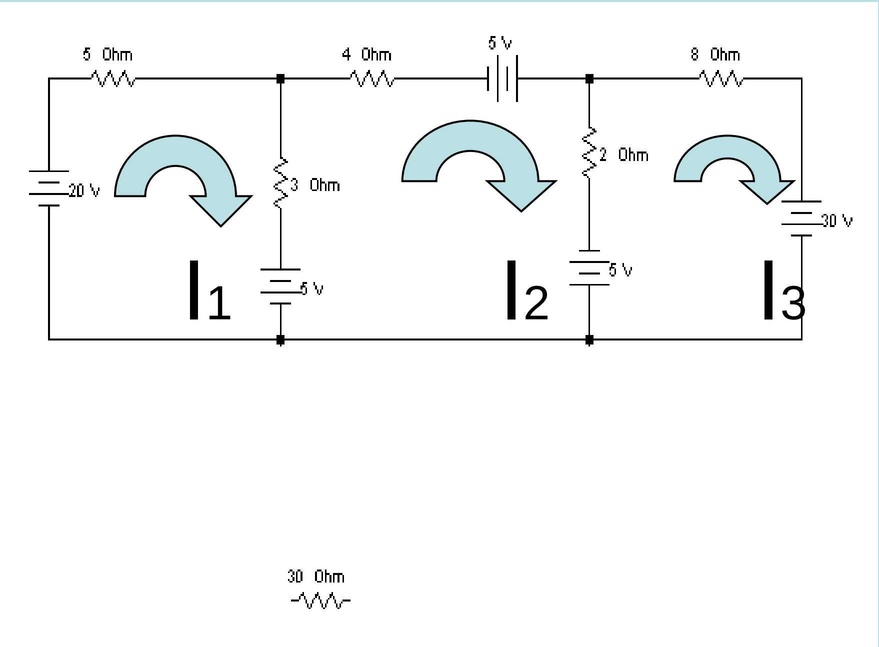
Currents method

مدارات ماكسويل

طريقة التيارات

Aim of lecture : To let the student be able to identify the analyses net work by using Maxwell's method.

Ex(2) : For the circuit shown using Maxwell's loop to find (I_1, I_2, I_3)



I_1=54.64A , I_2=145.3A ,I_3=24.64A

solution

At loop(1):

$(5+3)I_1-3I_2=20-5$

$8I_1-3I_2=15$……(1)

At loop (2):

$(3+4+2)I_2-3I_1-2I_3=5+5+5$

$-3I_1+9I_2-2I_3=15$…..(2)

At loop (3):

$(2+8)I_3-2I_2=-30-5$

$-2I_2+10I_3=-35$…..(3)

Then we find I_1, I_2, I_3

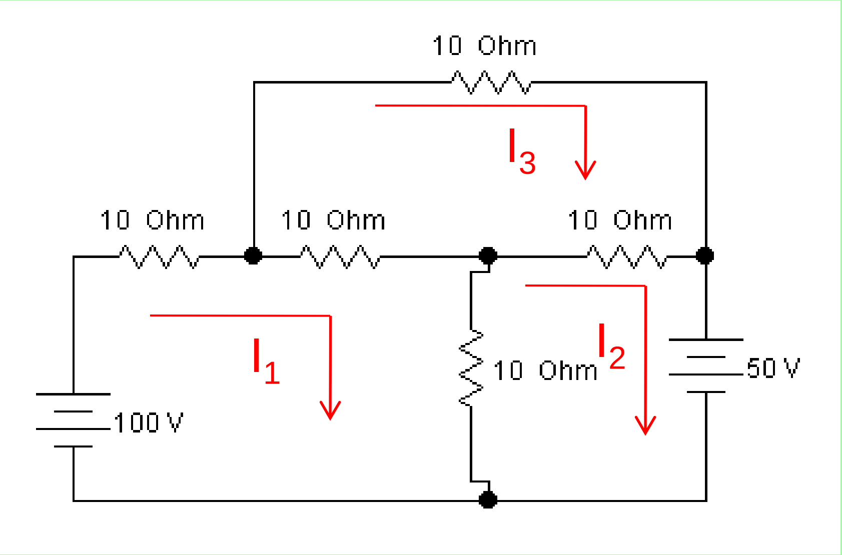
(B) : For the circuit shown using Maxwell's loop to find (I_1, I_2, I_3)

Solution

$30I_1-10I_2-10I_3=100$ …(1)

$20I_2-10I_1-10I_3=-50$ ....(2)

$30I_3-10I_1-10I_2=0$ …(3)



$\therefore 10I_3-I_1-I_2=0$, (eq.2-eq.1);
$40I_1-30I_2=150$

$\therefore 4I_1-3I_2=15$…(4) eq.(1)x3and the result + with eq.(3);

(الأسبوع الخامس)

Thevinin's theorem

- نظرية ثفنن

over view - النظرة الشاملة

A- Population target

الفئة المستهدفة

 Student of first year
of
Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

B –Rationale مبررات الوحدة

- It is very important to study Thevinins theorem.
- Also to study how apply the three step to the save theorem .

C – Central Idea الفكرة المركزية

- Definition Thevinins theorem .
- How we find the current at each resistance in the net work by the above theorem.

D- Aim of lecture

To let the student be able to identify the analyses net work by using Thevinins' theorem.

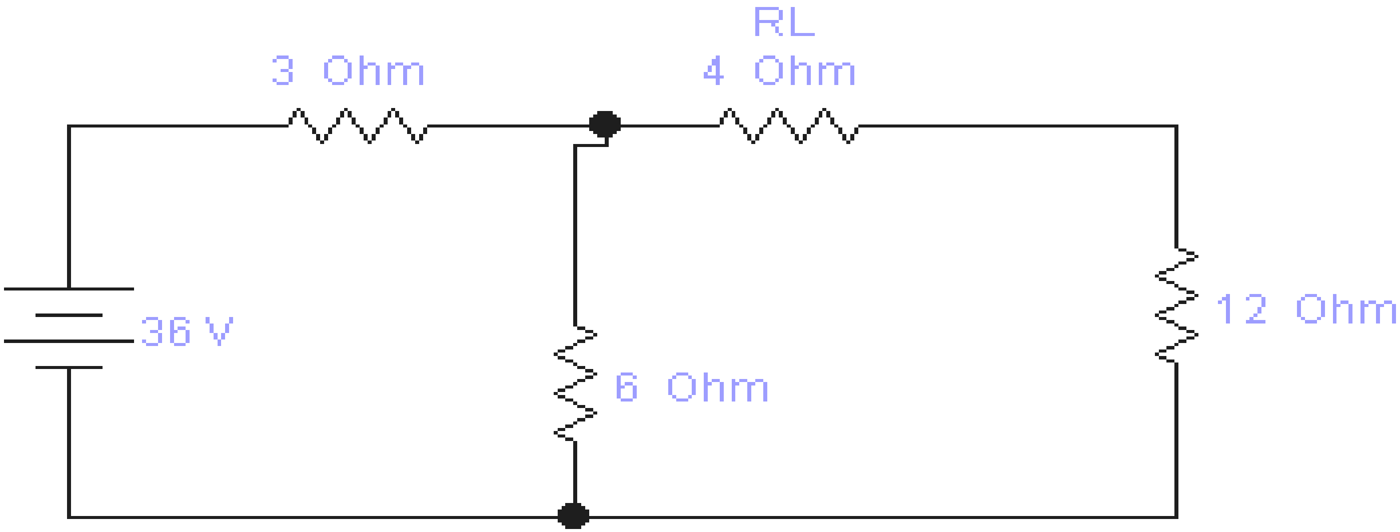
ألاختبار القبلي Pretest

عرف: مقاومة الحمل,الدائرة المكافئة Define : Load resistance, The equivalent circuit

Solution

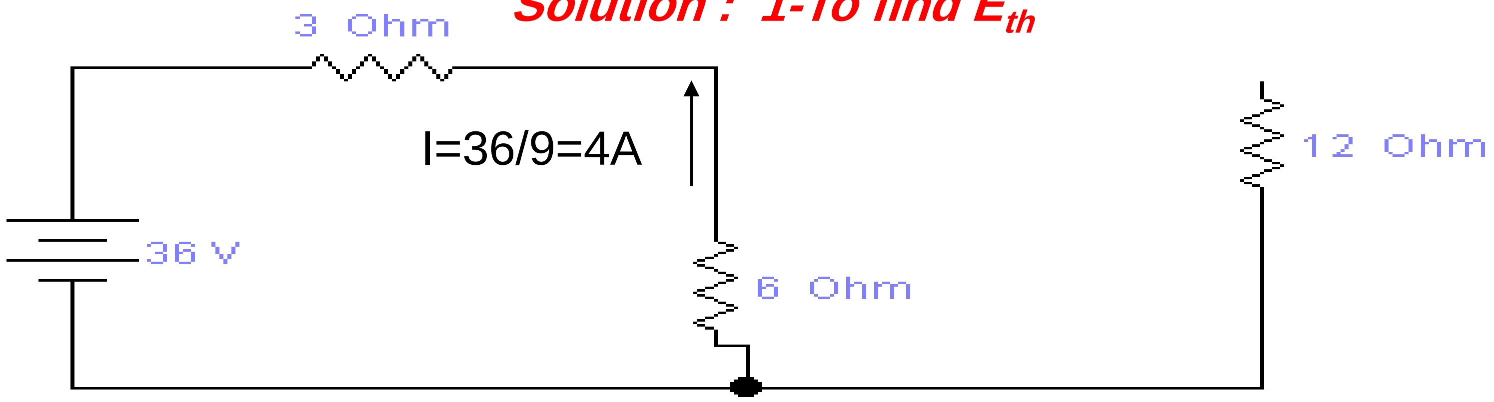
Load resistance هي المقاومة المطلوب ايجاد التيار المار بها من بين باقي مقاومات الدائرة الكهربائية

The equivalent circuit هي الدائرة التي يختزل فها عدد المقاومات الى مقاومتين فقط في الدائرة الكهربائية مهما كان عدد مقاومات الدائرة وتسحب مقاومة الحمل تيارا يكافئ(يساوي) تيار مقاومة الحمل في الدائرة الأصلية



EX. (1): - In the cct. Shown above Find(I_L) by using Thevinins' theorem

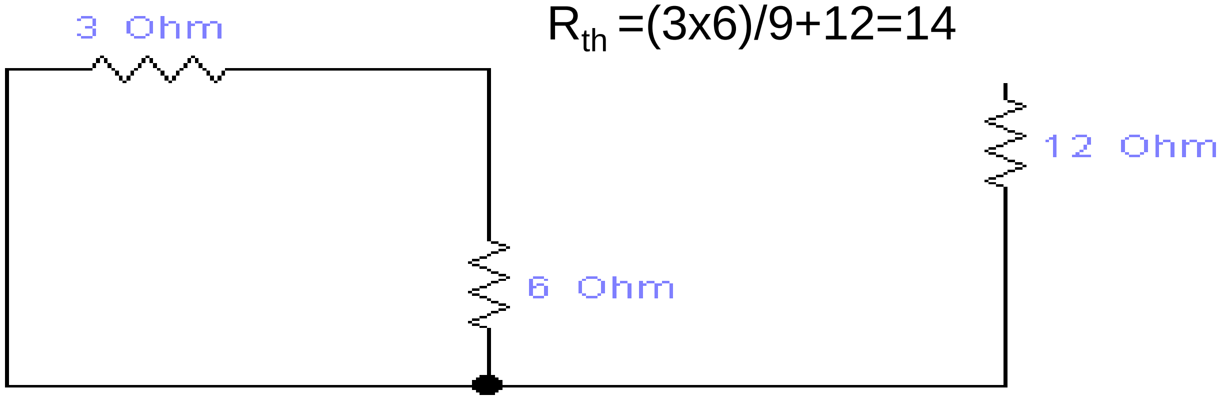
Solution : 1-To find E_{th}



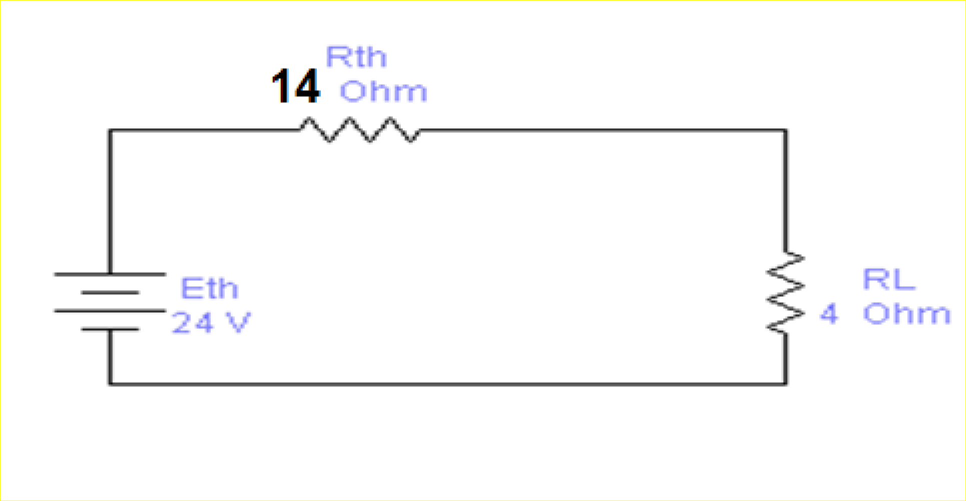
E_{th} = 4Ax 6=24v

2- To find R_{th}

R_{th} =(3x6)/9+12=14

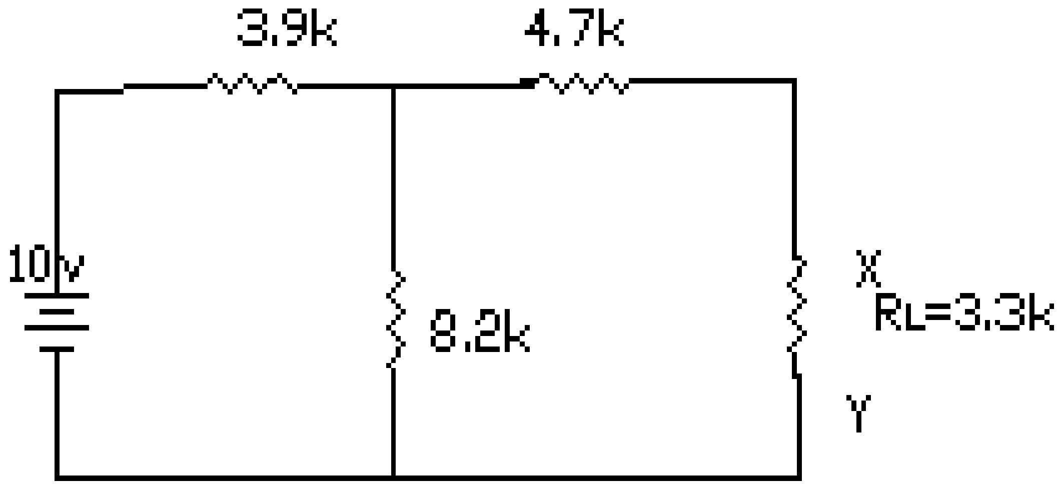


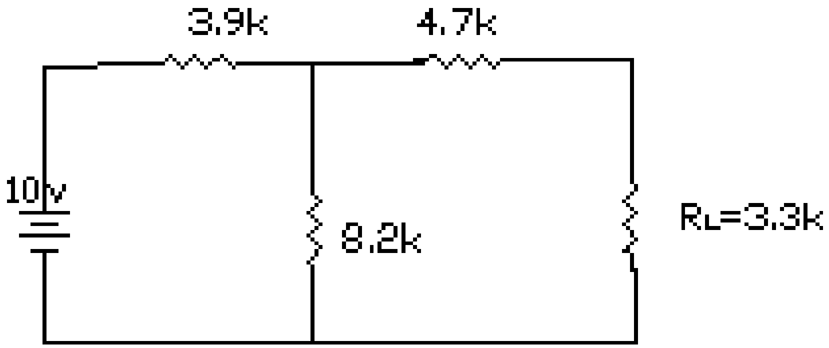
3-Thevenins Equivalent



$$I_L = 24/(14+4) = 1.333\ A$$

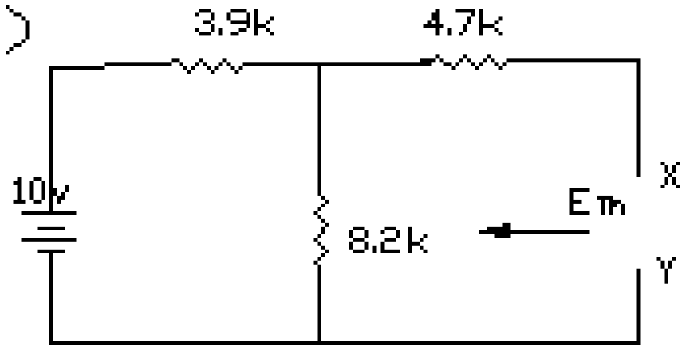
Ex.(2) : For the cct shown below find (V_L) by using Thevinins theorem



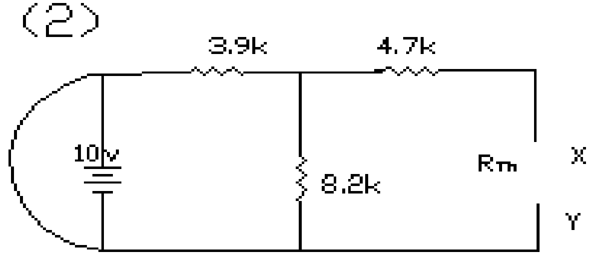


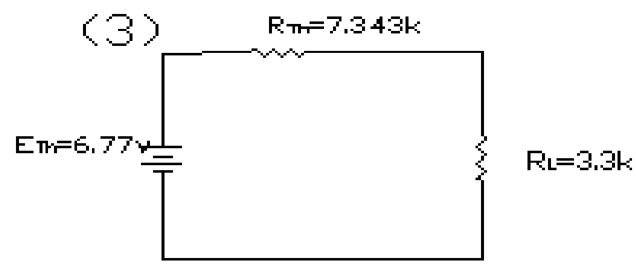
Solution

(1)



Eth= (10v) x(8.2kΩ)/(3.9)x(8.2)=6.77v





$R_{Th} = (8.2x3.9)/(8.2+3.9)+4.7$

$= 7.343k\Omega$

$I_L = (E_{Th})/(R_{Th}+R_L) = 6.77/(7.343+3.33)$

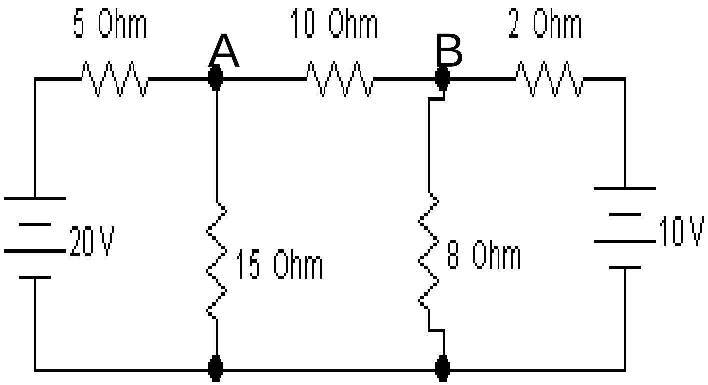
$= 0.636mA$

$\therefore V_L = I_L \times R_L = 0.636mA \times 3.3\ k\Omega$

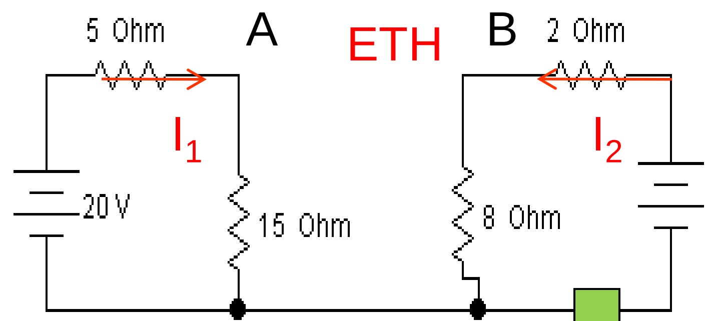
$= 1.908\ v$

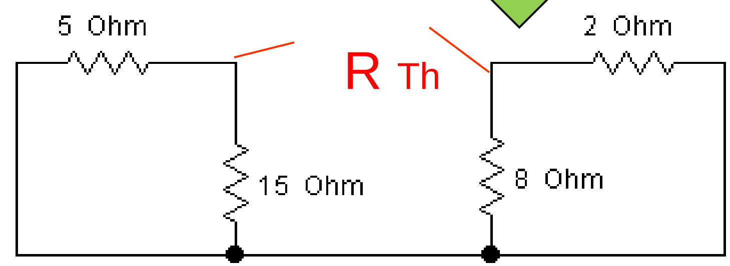
Posttest ألاختبار ألبعدي

<u>Home work :</u> Using Thevenins, theorem To Find (I_L) .



Solution





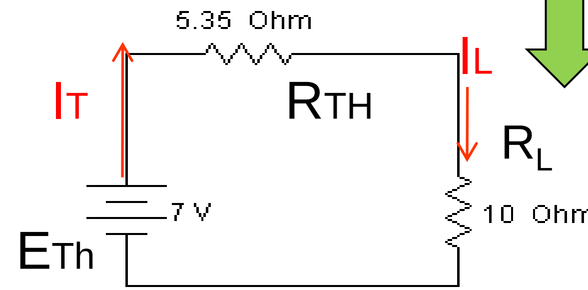
$I_1=20/(5+15)=1A$, $V_{at15\Omega}=1x15=15v$

$I_2=10/(2+10)=1A$ $\therefore V_{at8\Omega}=1x8=8v$

$\therefore E_{th}=15-8=7v$

$R_{Th}=(5x15)/(5+15)+(8x2)/(8+2)=5.35\Omega$

$\therefore I_L=I_T=7/(5.35+10)=0.456$ A



الأسبوع السادس

Norton's theorem

نظرية نورتن

over view - النظرة الشاملة

A- Population target

الفئة المستهدفة

 Student of first year

of

Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

B –Rationale مبررات الوحدة

- It is very important to study Norton's theorem.
- Also to study how apply the three step to the save theorem .

C – Central Idea الفكرة المركزية

- Definition Norton's theorem .
- How we find the current at each resistance in the net work by the above theorem .

D- Aim of lecture

To let the student be able to identify the analyses net work by using Norton's theorem.

Pretest ألاختبار القبلي

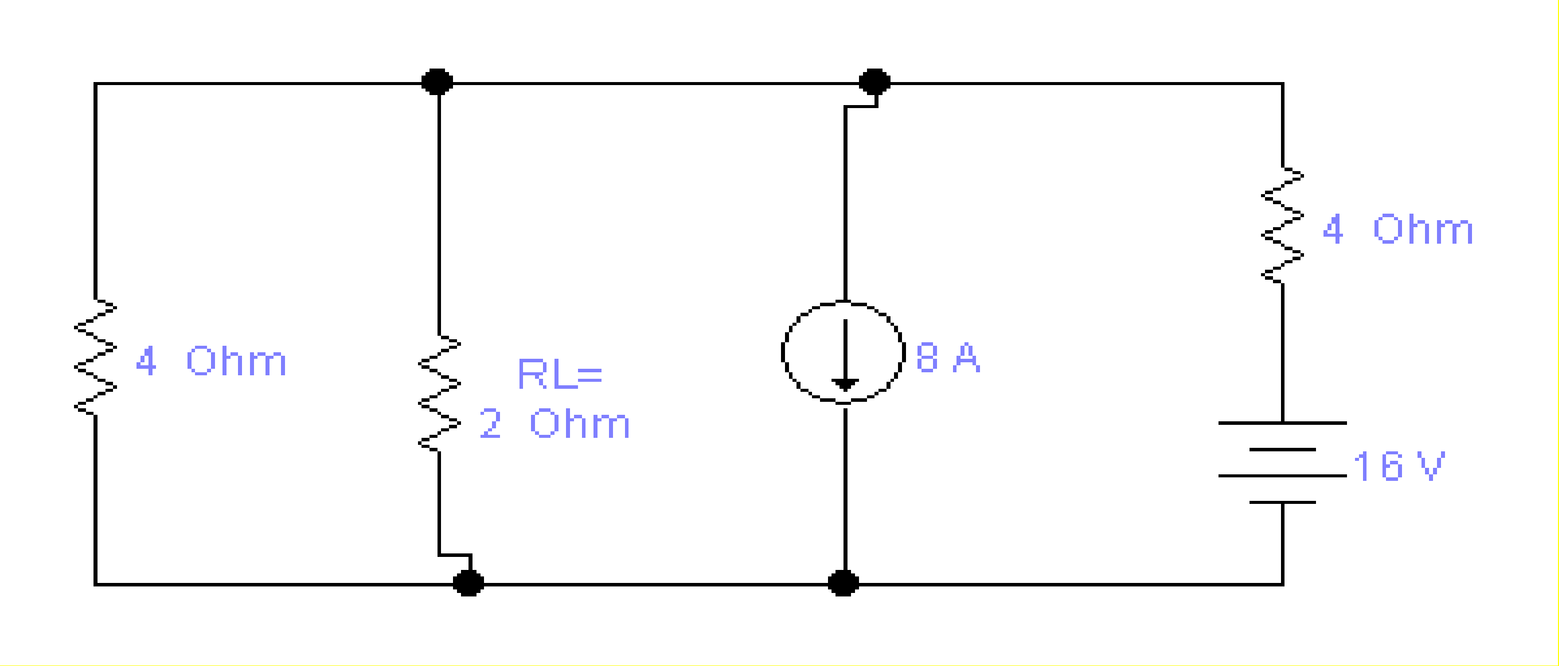
Define : short circuit , Open circuit

solution

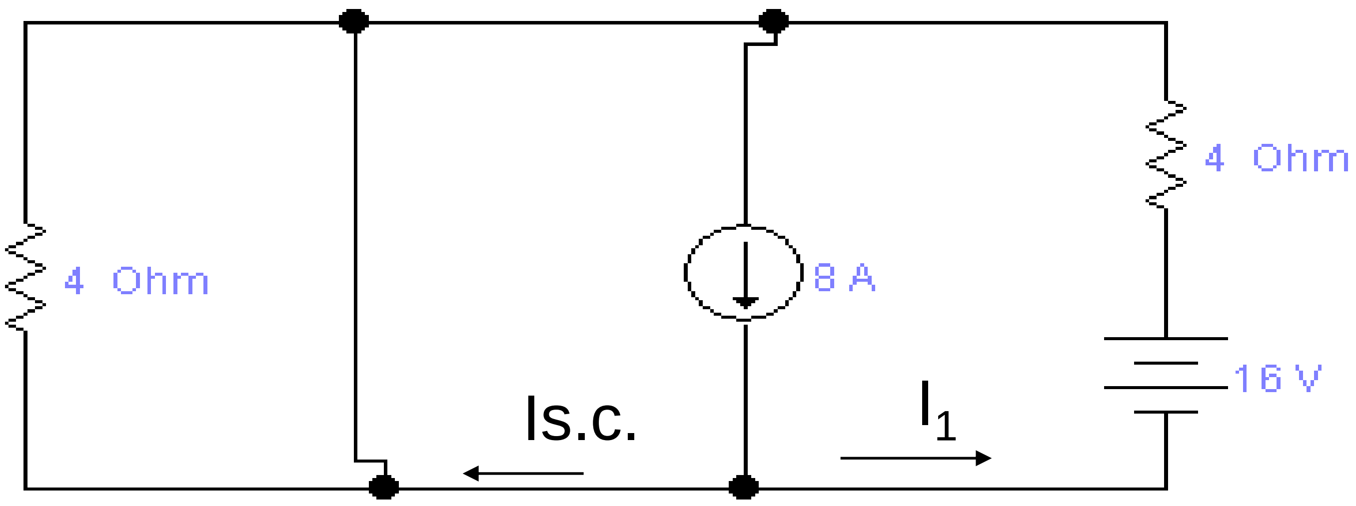
Short circuit : هي دائرة القصر التي يمر فيها جميع التيارات لنفس الدائرة الكهربائية لعدم وجود مقاومة فيها أي أن قيمة مقاومتها تكون صفرا .

Open circuit هي الدائرة المفتوحة التي تكون مقاومتها مالا نهاية وقيمة التيار المار فيها يكون صفرا .

Ex. :- Find (I_L) for the cct shown using norton theorem



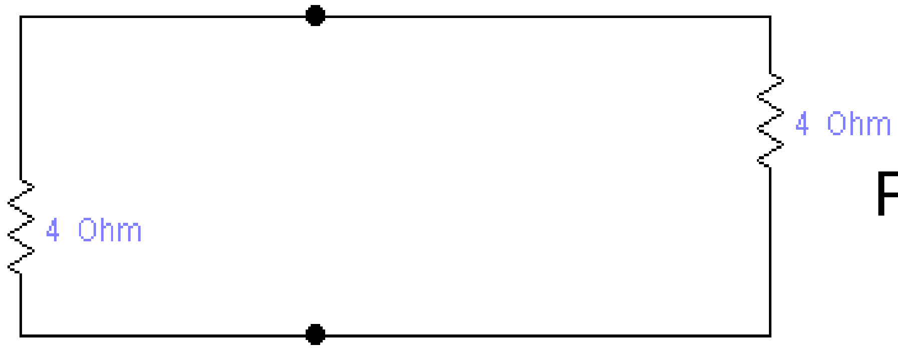
Solution; 1- To find $I_{s.c}$



$I_1 = 16/4 = 4A$ $\quad$ $8 - I_1 - I_{s.c} = o$ (K.c.L)

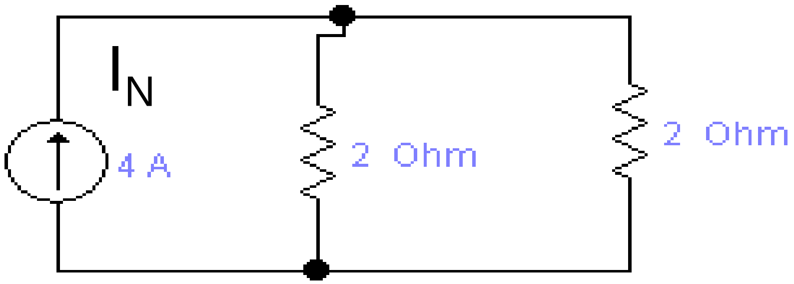
then; $I_{s.c.} = 4A = I_N$

2- TO find R_N :



R_N=(4x4)/ 8= 2Ώ

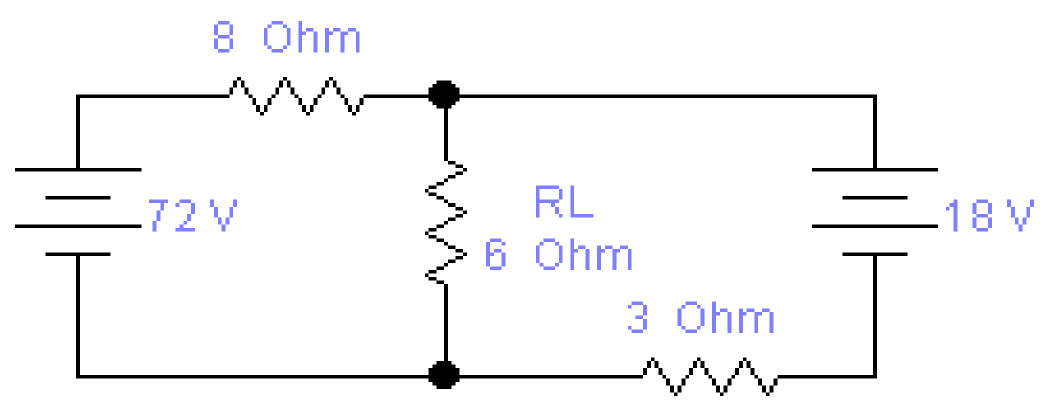
3- Drawing Norton's equivalent and calculate $I_{at\ RL=2\ ohm}$



I_L=(4x2)/(2+2)=2A

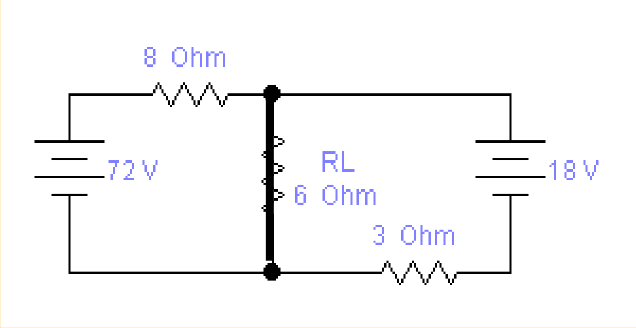
Posttest ألاختبار ألبعدي

Home work: For the cct. Shown find ($I_{L\ at\ 6\Omega}$) using Norton's theorem



Solution

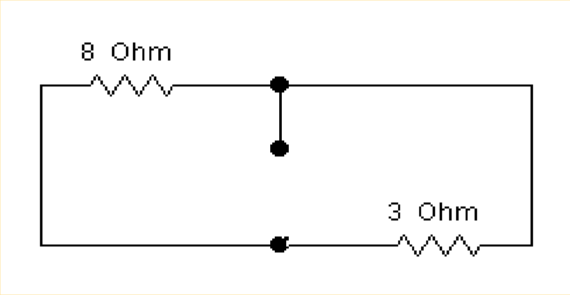
1



$I_{s.c} = I_1 + I_2$, $I_1 = 72/8 = 9A$

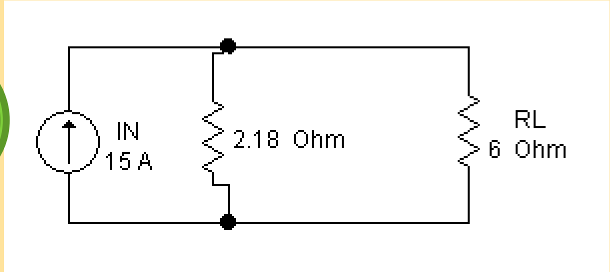
$I_2 = 18/3 = 6A$ $I_N = I_{s.c} = 15A$

2



$R_N = 3x8/11 = 24/11 = 2.18\Omega$

3



$I_L = (15x2.18)/(2.18+6) = 4A$

الأسبوع السابع

Suppers position theorem

نظرية التراكب أو التطابق

Aim of lecture : To let the student be able to identify the analyses net worke by using Suppers position theorem
.

over view - النظرة الشاملة

A- Population target

الفئة المستهدفة

 Student of first year

of

Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

B –Rationale مبررات الوحدة

- It is very important to study Suppers position theorem

.

C – Central Idea الفكرة المركزية

- Definition Suppers position theorem
- To calculate the load current flows from each source and to find the result from the total currents.

Pretest ألاختبار القبلي

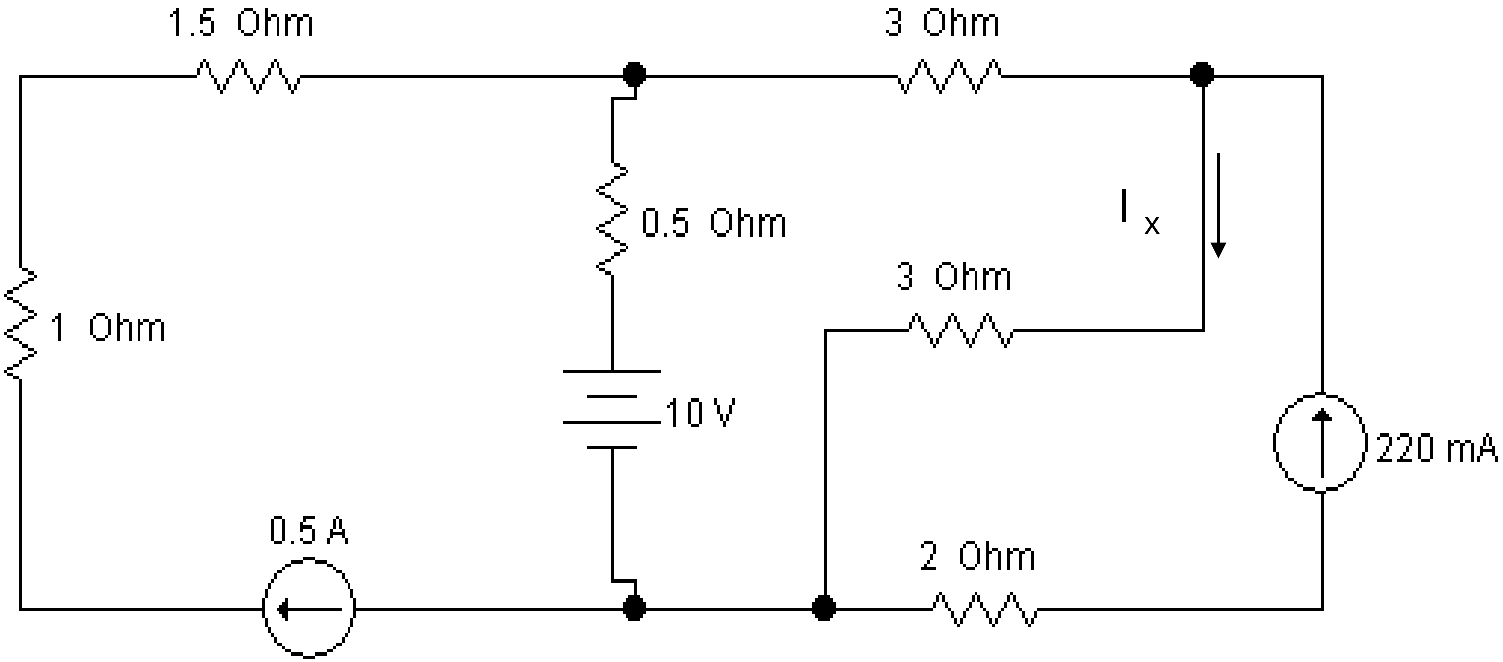
Define : Current load (IL) ,draw Norton equivalent

Solution

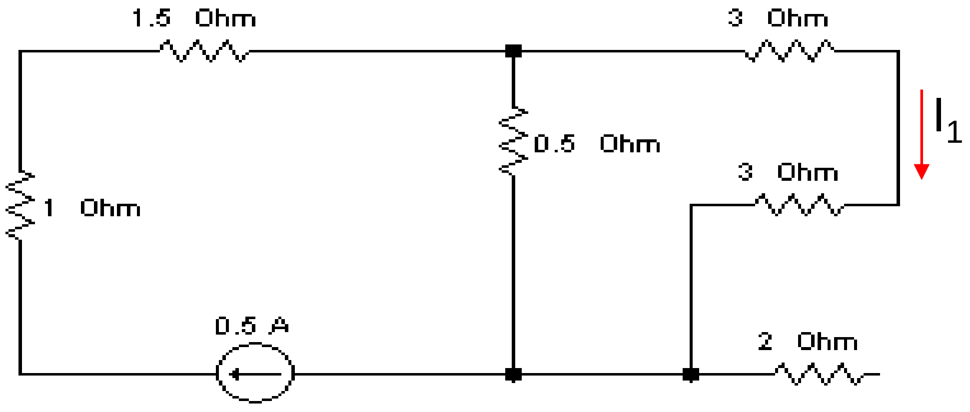
I_L (تيار الحمل) : هو التيار المار في الدائرة الكهربائية عبر مقاومة الحمل

$$I_L = I_n \times R_N / (R_N + R_L)$$

Ex. For the cct. Shown using supper position theorem to find (I_x)

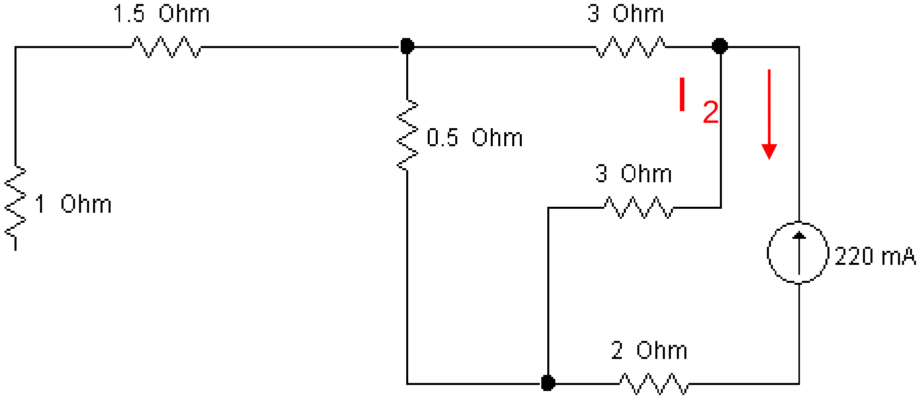


Solution:- 1- Effect of 0.5A only



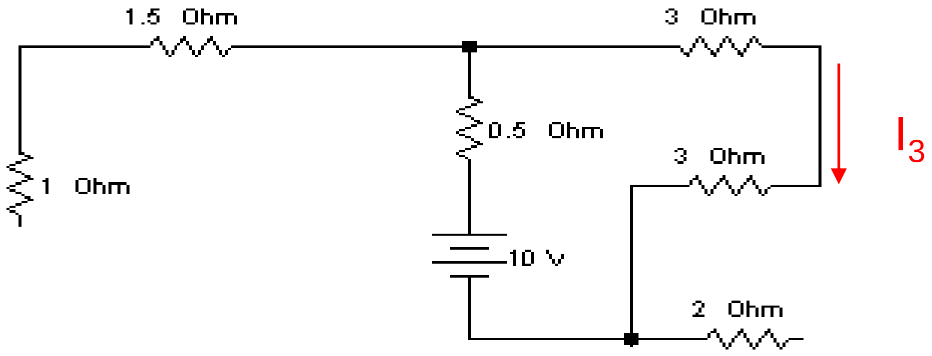
I_1= 0.5x(0.5)/ 0.5+(3+3)=0.038 A ↓

2- Effect of 220mA only



I_2=0.22x(3+0.5)/3.5+3=0.118A ↓

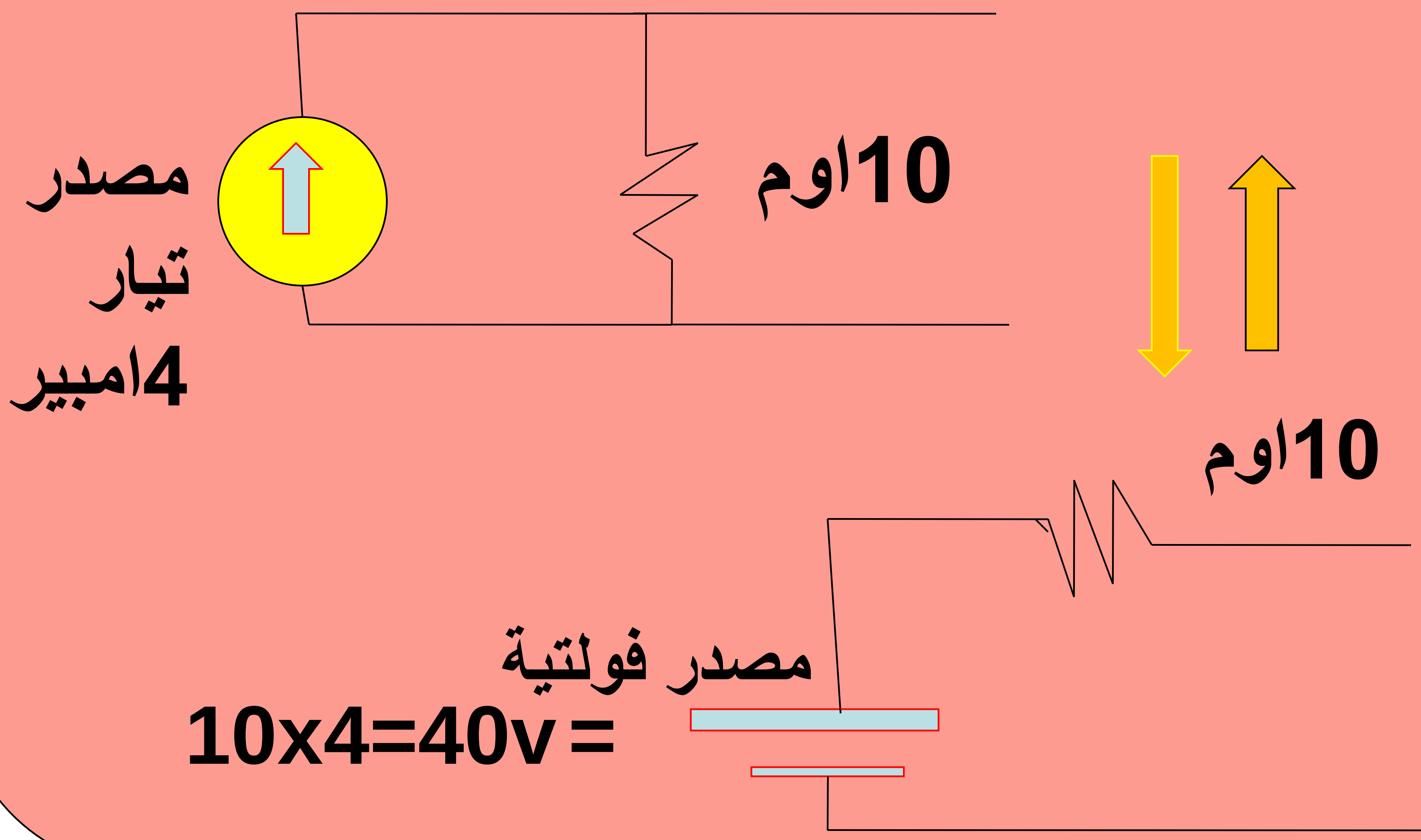
3- Effect of 10v only



I_3=10/(0.5+3+3)=1.538A ↓

Then $I_x = I_1 + I_2 + I_3 = 1.694A$ ↓

كيفية تحويل مصدر التيار إلى مصدر فولتيه وبالعكس



Note

Maximum power transfer

- انتقال أعظم قدرة

When $R_L = R_{in}$ there is $P_{maximum}$ transfer to the load

$R_L = R_{in}$

$I_L = V/(R_{in}+R_L) = V/2R_{in}$ But $P = I^2.R$

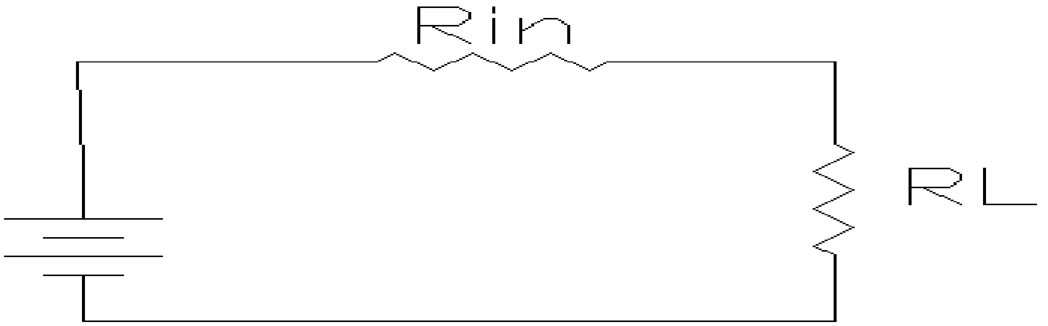
-

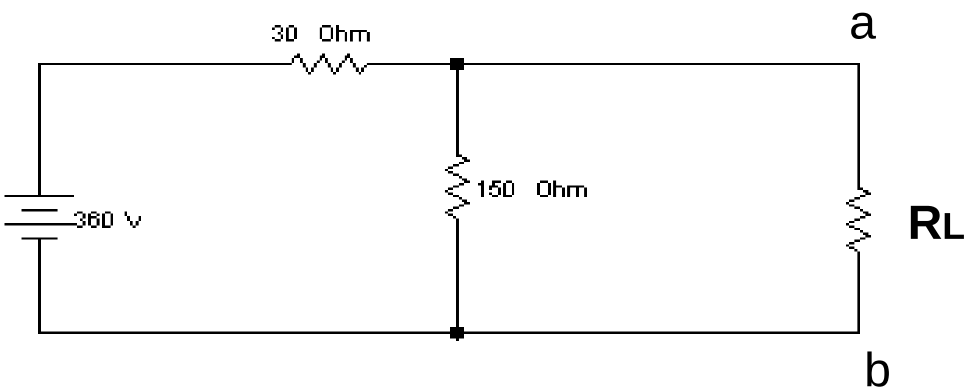
$P_{max.} = I_L^2 . R_L$

$P = (V/2R_L)^2 \times R_L = V^2/4R_L$

Then ; at Thevinins equivalent

$\mathbf{P_{max} = V_{o.c}^2 / 4R_{th}}$





Ex. : ***Find*** R_L

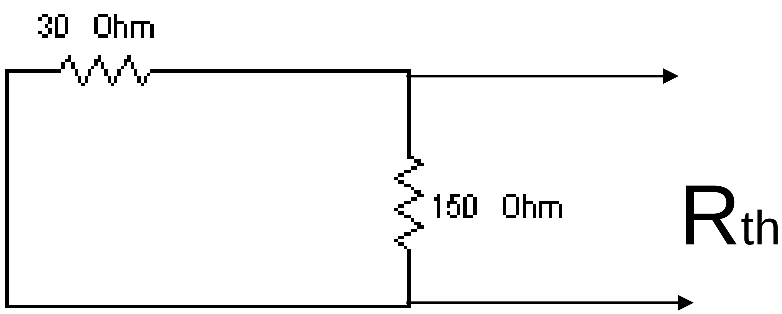
for max. p . T

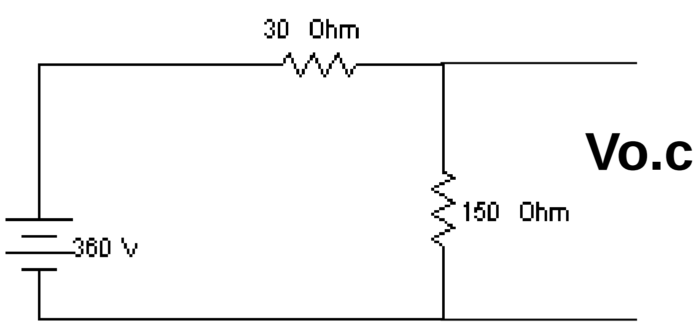
and calculate P_{max}.

Solution

$R_L = R_{th}$ then

$R_{th} = (30 \times 150)/30+150 = 25 \text{ ohm} = R_L$





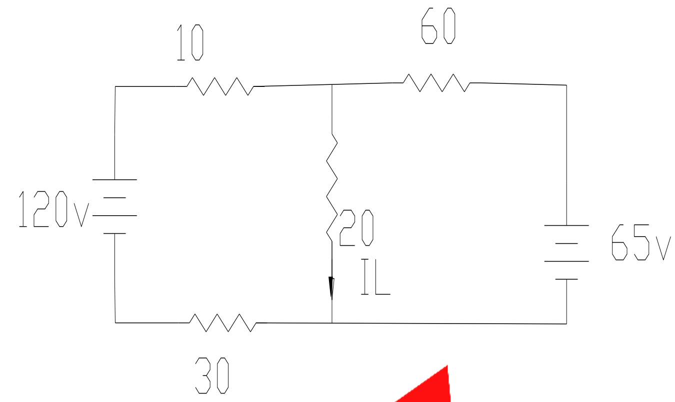
$V_{o.c} = 150 \times 360 /(30+150) = 300v$

$P_{max} = V_{o.c}^{2} / 4 R_{th} =$

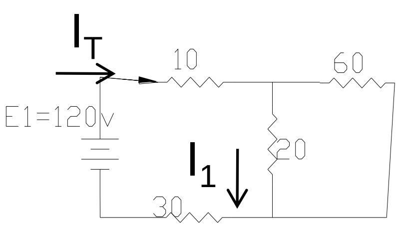
$(300)^{2}/(4 \times 25) = 900 \text{ watt}$

Posttest الاختبار ألبعدي

For the cct. Shown find IL by using supper position theorem



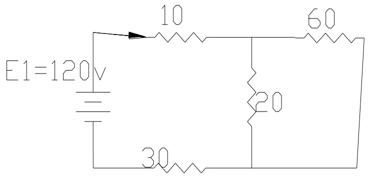
Solution



(I1)

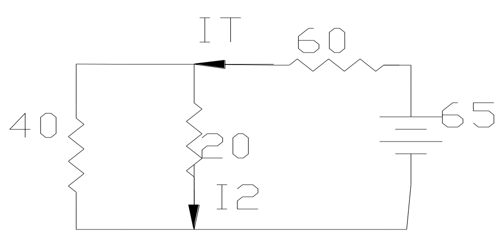
$E_1=120v$, $E2=0$, $R_T=(60//20)+10+30=(20x60)/80+40=55\Omega$

$I_T=120/55=2.182A$, $:.I_1=60/(60+20)x2.182=1.64A$



(I2)

$E_1=0$, $E_2=65v$, $R_T=[(10+30)//20]+60$
$=(40x20)/60+60=73\Omega$



$I_T=65/73=0.89A$, $:.I_2=40/(40+20)\ x0.89=0.59A$

$:.I_L=I_1+I_2=1.64+0.59=2.23A\downarrow$

الأسبوع الثامن

Alternating current (A . C)

التيار المتناوب (المتذبذب)

Aim of lecture : To let the student be able to identify and Study Alternating circuits'. And finding Instantaneous value , Maximum value ,Root mean square value , Average value .

over view - النظرة الشاملة

A- Population target

الفئة المستهدفة

- Student of first year

of

Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

B –Rationale   مبررات الوحدة

- It is very important to study **Alternating current (A . C)**

- Also to analysis the sine wave .

C – Central Idea الفكرة المركزية

- Definition the sine wave
- To learn how the sine wave generated
- To learn haw we find R.m.s current and average value

Pretest ألاختبار القبلي

Define :1- frequency

2- Angular frequency 3- ∏

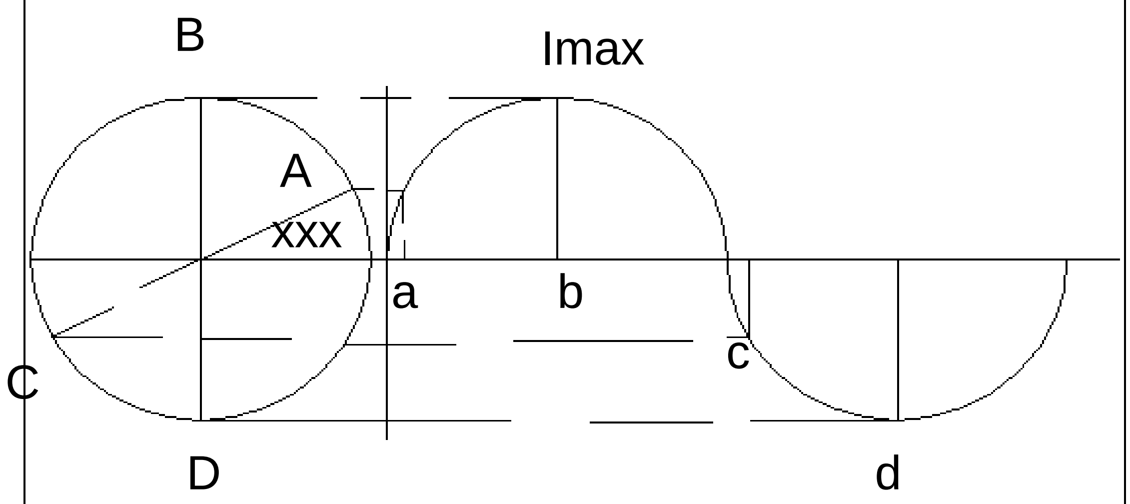
Solution

1- f : عدد الذبذبات الحاصلة خلال الثانية الواحدة ويقاس (ذ/ثا) أو هرتز

2- ω التردد الزاوي/ أي أن الموجة تتذبذب بشكل زاوي وليس بشكل خطي ويقاس (زاوية نصف قطرية/ثانية)

3- ∏ : وهي النسبة الثابتة (3,14) أما بالزوايا فمقدارها (180درجة)

W=2 ∏f



Sine wave

Sin θ= A/ Imax   :. A=Imax sin θ

T: time period (s)

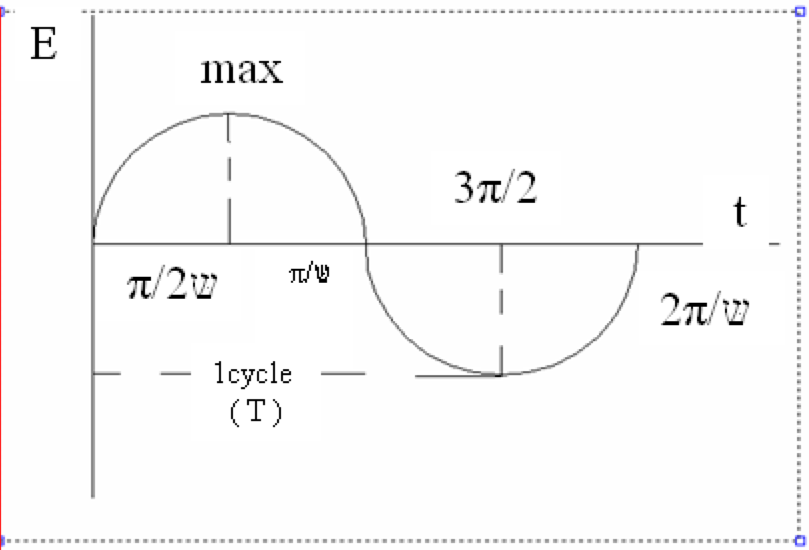
Max: maximum value of current or voltage

f : frequency (Hz)

$T = 1/f$

$\omega = 2\pi/T = 2\pi f$

ω : angular frequency (radian / second)



Average value (Means value)

$$I_{av.} = \frac{i_1 + i_2 + \cdots + i_n}{n}$$

$$I_{av.} = 1/T \int_0^T i_{(t)} \, .dt \quad ; \quad V_{av.} = 1/T \int_0^T e_{(t)} \, .dt$$

Instantaneous value

$$i(t) = I_{max.} \, Sin\,(\omega t) \quad ; \quad v(t) = V_{max.} \, Sin\,(\omega t)$$

i:- Instantaneous value of current

V :- Instantaneous value of voltage .

Maximum value :- It is the maximum Value of the instantaneous values . ($I_{max.}$, $V_{max.}$) .

Root mean square (r.m.s.) ($I_{r.m.s.} = I_{effect}$) .

$$I_{r.m.s.} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + \text{--------} + in^2}{n}}$$

For full wave we fawned the effect value as follow :-

$$I_{r.m.s.} = \sqrt{\frac{1}{T}\int_0^T i^2.\, dt} \quad ; \quad v_{r.m.s.} = \sqrt{\frac{1}{T}\int_0^T v^2\, dt}$$

Form factor (kf)

$K_f = I_{r.m.s.} / I_{av.}$ and

$K_f = V_{r.m.s.} / V_{av}$.

Peak factor (Amplitude factor)

$K_p = k_a = I_{max.} / I_{r.m.s.}$ and

$K_p = k_a = V_{max.} / V_{r.m.s.}$

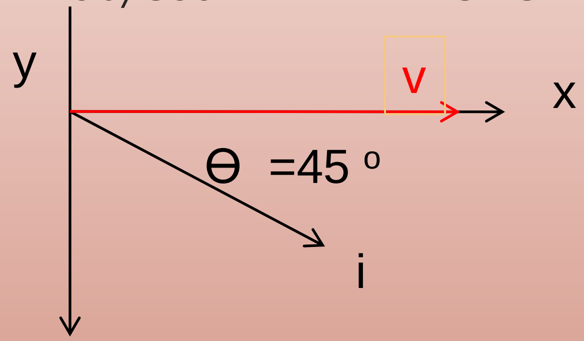
Example (1): In A.c. sinusoidal voltage with peak (24v) applaud to a circuit then the current (3A) if the voltage lead the peak current by (45 ^{o}) and frequency (50 HZ) write the equation for V(t), I (t) and draw form and phase diagram .

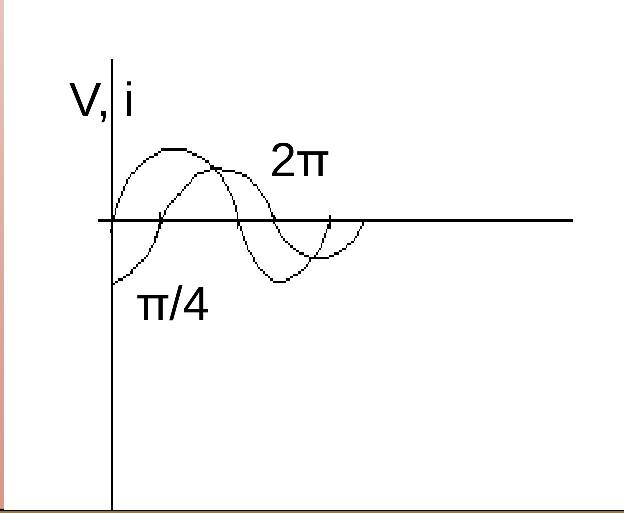
Solution :-

Vm= 24v ; Im= 3A : ϴ =45 º : f = 50 Hz

v= Vm sin ωt   i=Im sin(ωt-π/4)   ω =2.π f =2x3.14x50

ω =314 rad/sec.   :. V=24 sin314 t   i=3 sin(314t-π/4)





Ex 2: Find(r.m.s.) : Av. :Kf : Kp : f for the voltage

$v = 100 \sin 314t$

Solution:-

$V = V_m \sin\omega t$ $V_m = 100$ $\omega = 314$

$V_{r.m.s} = V_m / \sqrt{2} = 0.707 \times V_m = 0.707 \times 100 = 70.7$ v

$V_{av.} = 2V_{max} / \pi = 0.636 \times V_{max.} = 0.636 \times 100 = 63.6$ v

$K_f = V_{r.m.s.} / V_{av.} = 70.7 / 63.6 = 1.11$

$K_p = V_{max} / V_{r.m.s.} = 100/70.7 = 1.414$, $\omega = 2\pi f$ $\therefore f = \omega / 2\pi = 314/2\times3.14 = 50$ Hz

لحساب القيمة الفعالة لموجة تيار جيبية نتبع الأتي :

$$I^2_{r.m.s.}=1/2\pi\int_0^{2\pi} I^2 d\theta = 1/2\pi\int_0^{2\pi} (I_m \sin\theta)^2 \, d\theta =$$

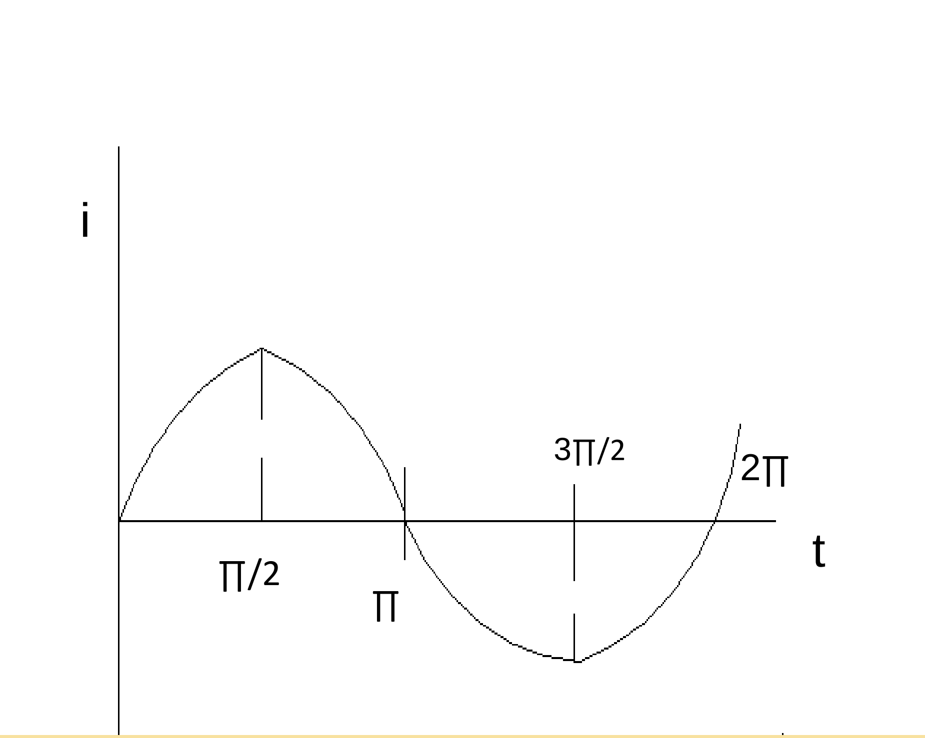
$$I^2_m /2\pi\int_0^{2\pi} \sin\theta^2 \, d\theta \quad \text{But: } \sin\theta^2 = 1/2(1-\cos 2\theta) \quad \text{then:}$$

$$I^2_{r.m.s.}=I^2_m /4\pi \int_0^{2\pi} (1-\cos 2\theta)d\theta = I^2_m /4\pi \left[(\theta - \sin 2\theta)/2\right]_0^{2\pi}$$

$$= I^2_m /4\pi \, [2\pi - 0] \; \therefore I_{r.m.s.}=I_m/\sqrt{2}=0.707 I_m$$

وبنفس الطريقة يمكن إيجاد $V_{r.m.s.}$ ← $V_{r.m.s}=0.707V_m$

Ex(3):. Calculate average value of current and effective value for the sine wave shown below :



solution

متوسط القيمة لموجة تيار جيبي الشكل = صفر لان :

$$I_a = 1/T \int_o^T i(\theta)d\theta = 1/(2\Pi-0)\int_o^{2\Pi} I_m \sin\theta d\theta = I_m/2\Pi \int_o^{2\Pi} I_m \sin\theta d\theta$$

$$= I_m/2\Pi[-\cos\theta]_o^{2\Pi} = -I_m/2\Pi[1-1] = 0$$

$I_{r.m.s.} = \sqrt{\frac{1}{T}\int_0^T i^2 dt}$, $T=2\Pi$. $i = I_m \sin\omega t$, $dt = d\omega t$. dt $I_{r.m.s.}=$

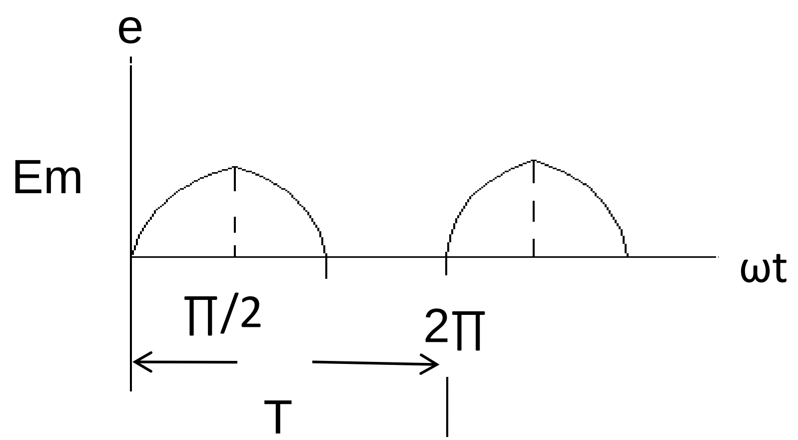
$$I^2_{r.m.s.} = 1/2\Pi \int_o^{2\Pi} I^2_m.\sin^2\omega t\, d\omega t = I^2_m/2\Pi \int_o^{2\Pi} \sin^2\omega t\, d\omega t =$$

$$I^2_m/2\Pi \int_o^{2\Pi} [(1-\cos 2\omega t)/2]d\omega t = I^2_m/4\Pi \int_o^{2\Pi} [(1-\cos 2\omega t)]d\omega t =$$

$$I^2_m/4\Pi[\omega t - \sin 2\omega t/2]_o^{2\Pi} = I^2_m/4\Pi[(2\Pi-0)-(0-0)] = I^2_m/4\Pi x 2\Pi = I^2_m/2$$

$\therefore I_{r.m.s.} = I_m/\sqrt{2} = 0.707 I_{max}$

Ex (4): For the wave shown find (Eav , Er.m.s ,Kf ,Kp)



1

$$E_{av} = 1/T \int_o^T e.dt$$

(T=2∏ , e=Emsinωt , dt=dωt)

$$E_{av} = 1/2\pi \int_o^{2\pi} E_m \sin\omega t\, dt$$

$$= E_m/2\pi \int_o^{\pi} \sin\omega t . d\omega t$$

$$= E_m/2\pi \left[- \cos\omega t\right]_o^{\pi}$$

$$=E_m/2\pi[-(-1-1)]$$

$$=2E_m/2\pi=E_m/\pi$$

وكذلك يكون :

$$I_{av}=I_m/\pi$$

2

$$E^2_{r.m.s}=1/T\int_o^T e^2\,.dt \quad , \quad e=E_m\sin\omega t \, , \; dt=d.\omega t \, , \; T=2\pi$$

$$= 1/2\pi\int_o^{2\pi} E^2_m \sin^2 \omega t.d\omega t=E_m^2 /2\pi\int_o^{2\pi} \sin^2\omega t.d\omega t$$

$$=E^2_m/2\pi\int_o^{2\pi}[(1-\cos2\omega t)/2]d\omega t=E^2_m /4\pi\Big[\omega t-(\sin2\omega t)/2\Big]_o^{\pi}$$

$$=E^2_m /4\pi[(\pi-0)(0-0)]=E_m^2 /4 \qquad :. \; E_{r.m.s}=E_m/2$$

(لمقوم نصف موجة)

Form factor $(K_f)=E_{r.m.s}/E_{av.}=0.5E_m /E_m/\pi=0.5\pi \; :.K_f=0.5\pi$

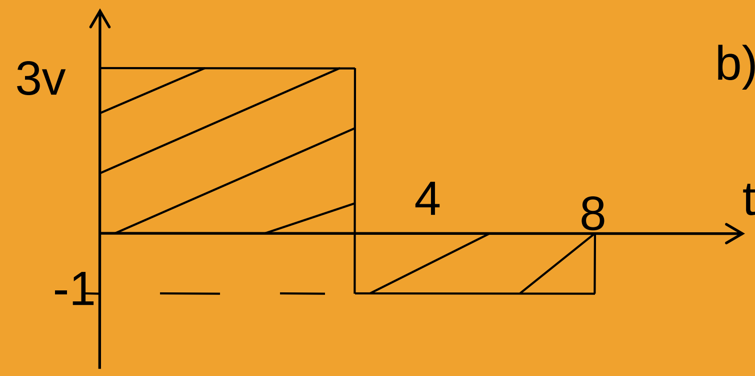
Peak factor$(k_p=k_a)=E_m/E_{r.m.s}=E_m/0.5E_m=1/0.5=2 \; :.K_p=2$

أمثلة تطبيقية

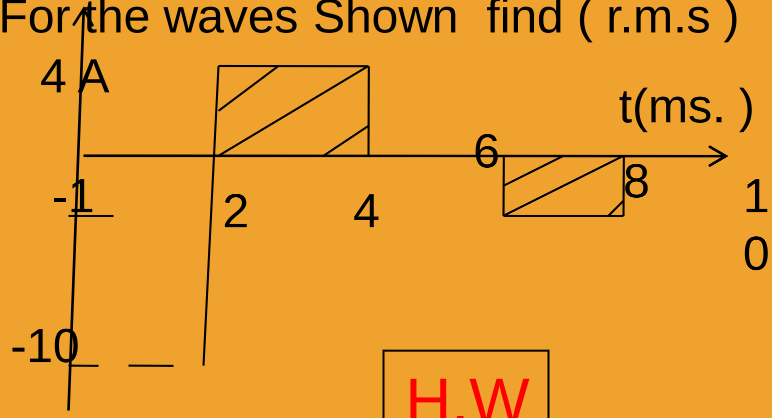
Examples about(A.c) circuits

Ex. 5 :- For the waves Shown find (r.m.s)

a) :



b):



H.W

$$Vrms = \sqrt{\frac{(4*3^2)+(4*-1^2)}{8}}$$

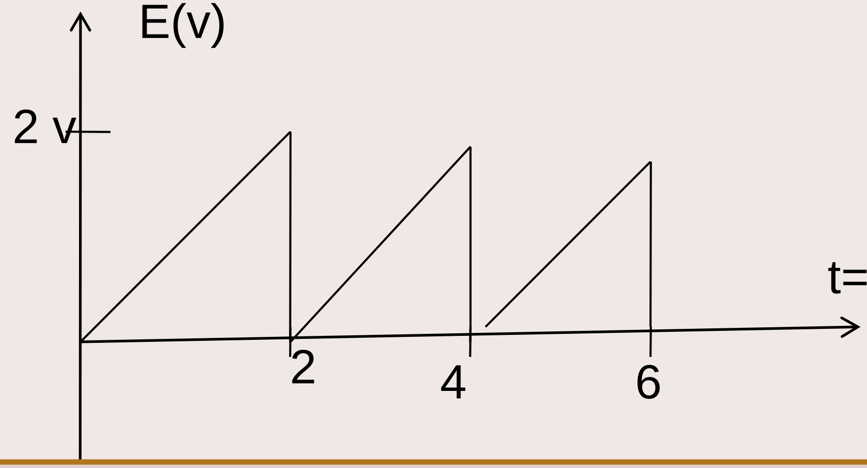
$\sqrt{\frac{40}{8}} = \sqrt{5}$ = 2.236 volts

b

Solution :-

i= 5.4 Ampere

Ex. 6 : For the wave form shown find the Peak factor (kp) . Then find form factor (kf) .



Solution :- k_p= Em/Eav. : Em = 2v T =2 Eav.=$1/T \int_0^T e(t)\,dt$, e=mx+y

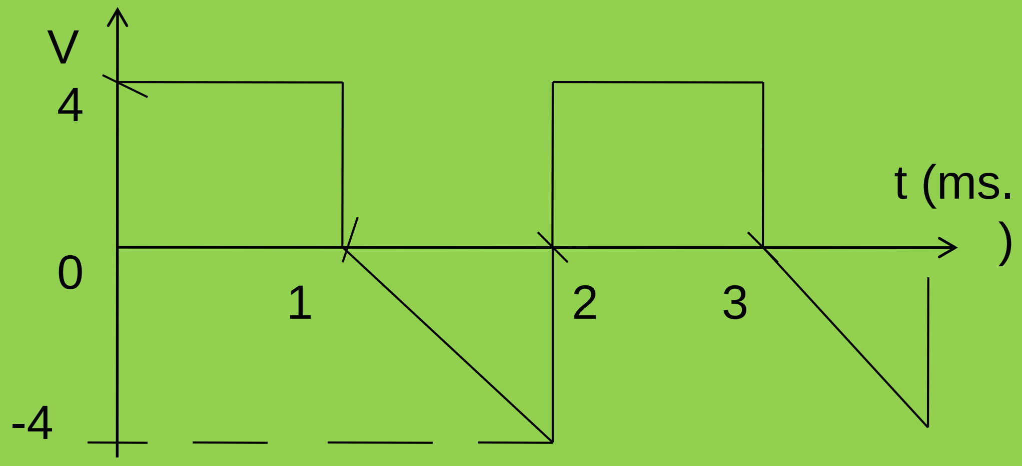
=(2/2)t + y=t+0=t :.Eav. = $1/2 \int_0^2 t\,dt = \frac{1}{4}\left(t^2\right)_0^2$ = (1/4)x4= 1volt :. **k_p=2**

$$E_{r.m.s} = \sqrt{1/T \int_0^T e^2(t)\,dt}$$

, :. $E^2_{r.m.s}$= $1/4\left(\int_0^2 t^2\,dt\right) = (1/4)\,x\left(t^3/3\right)_0^2$

:. $E^2_{r.m.s}$ =8/12 :. $E_{r.m.s.} = 2/\sqrt{3}$, **kf=Er.m.s. /Ea.v. = $2/\sqrt{3}$**

Ex 7 :- For the wave shown find (Vr.m.s.) :



solution

$$V_{r.m.s.}=\sqrt{1/T\int_0^T v_{(t)}^2\,.dt}\quad,\quad T=2\ ,\ v_1=mx+y=0+4=4\ ,\ v_2=mx+y=-4t+4$$

$$\therefore V^2_{r.m.s.}=1/4\left(\int_0^1 16.dt+\int_1^2 16t^2.dt-\int_1^2 32t\,dt+\int_1^2 16.dt\right)$$

$$=1/4\left[16\,(t)\Big|_0^1+16/3\,(t^3)\Big|_1^2-16(t^2)\Big|_1^2+16\,(t)\Big|_1^2\right]$$

$$=\sqrt{16/3}\qquad \therefore V_{r.m.s.}=4/\sqrt{3}\ \ v$$

Ex 8: FIND K_f, K_p for the wave shown

solution $(Y-y_1)/(X-X_1)=(y_2-y_1)/(X_2-X_1)$

$\therefore (e_1-0)/(t-0)$

$=(2-0)/(1-0) \therefore e_1/t=2 \therefore e_1=2t$

Also: $(e_2-2)/(t-1)=(0-2)/(2-1)$

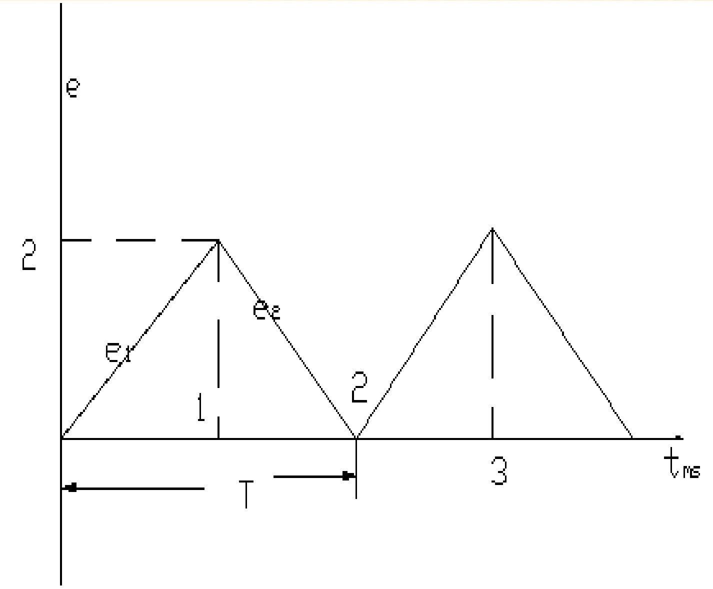
$\therefore e_2-2=-2t+2 \therefore e_2=-2t+4$

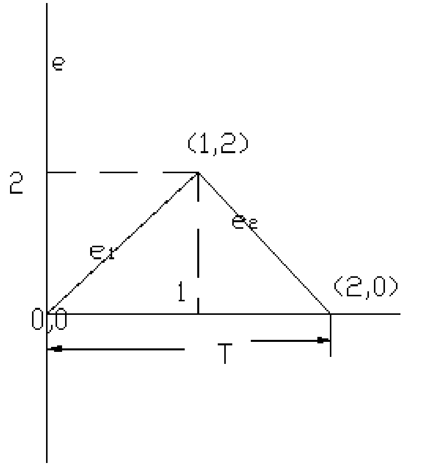
$$Er.m.s^2 = \frac{1}{T}\int_0^T e^2 \, .dt$$

$$= \left(\frac{1}{2}\right)\left[\int_0^1 (2t)^2 .dt + \int_1^2 (4-2t)^2 \, .dt\right]$$

$$= \left(\frac{1}{2}\right)\left[4\left(\frac{t^3}{3}\right)_0^1 + 16(t)_1^2 - 16(t^2/2)_1^2 + 4(t^3/3)_1^2\right]$$

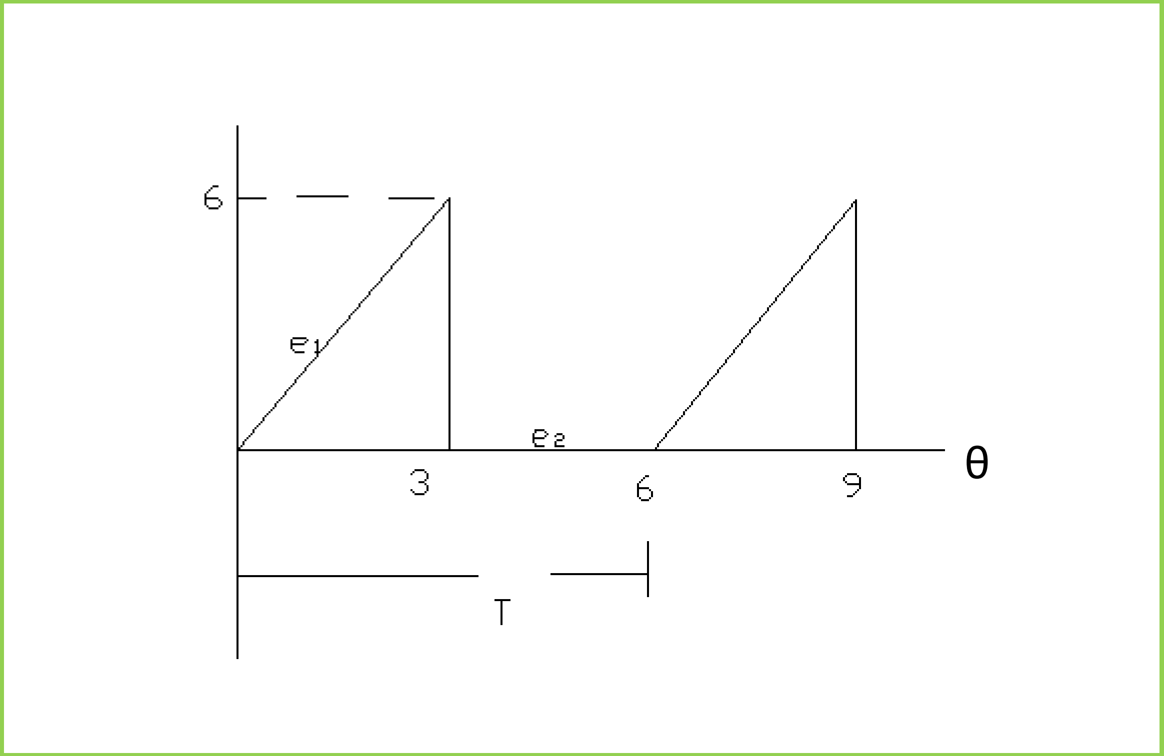
$\therefore Er.m.s^2 = 4/3 \therefore Er.m.s = 2/\sqrt{3}$





Ex9 : find Kf, Kp for current wave

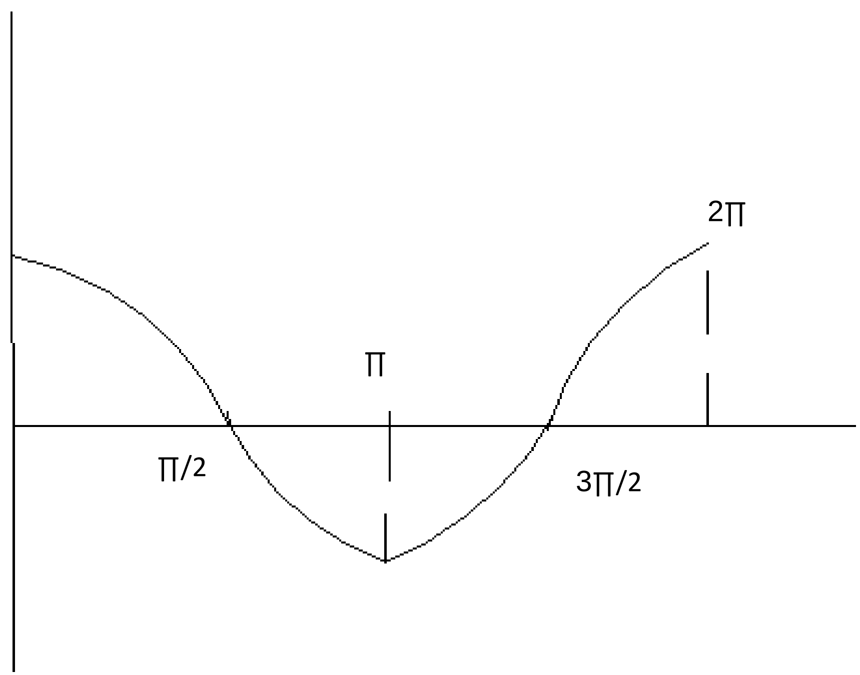
H.W



Solution $K_f=1.633$, $K_p=\sqrt{6}$

Posttest ألاختبار ألبعدي

Example : Find average value ,Kf ,Ka for half wave shown :



solution

$I_{av} = 1/T \int_0^{\pi} I\, dt$ when $T = \pi$, $i = I_m.\sin\omega t$, $dt = d.\omega t$

$I_{av} = 1/\pi \int_0^{\pi} I_m \sin\omega t.d.\omega t = I_m/\pi \int_0^{\pi} \sin\omega t d\omega t =$

$I_m/\pi[-\cos\omega t]_0^{\pi}$:. $I_{av} = -I_m/\pi(-1-1) = 2I_m/\pi = 0.636 I_m$

$K_f = I_{r.m.s.}/I_a = 0.707\, I_{max}/0.636\, I_m = 1.11$

$K_a = K_p = I_{max}/I_{r.m.s.} = I_m/0.707 I_m = 1.41$

Also// $V_{av} = 2V_m/\pi = 0.636 V_{max}$

الأسبوع التاسع

Alternating Values

Aim of lecture :

To let the student be able to identify and Study vector values

ألكميات ألمتناوبة

- النظرة الشاملة over view

A- Population target

الفئة المستهدفة

 Student of first year
of
Electrical Techniques Department

طلبة قسم التقنيات الكهربائية ـ السنة الأولى

B –Rationale مبررات الوحدة

- It is very important to study Alternating Values

الفكرة المركزية C – Central Idea

- Definition Alternating Values

.

- To learn pooler simple and

J- operator.

Pretest

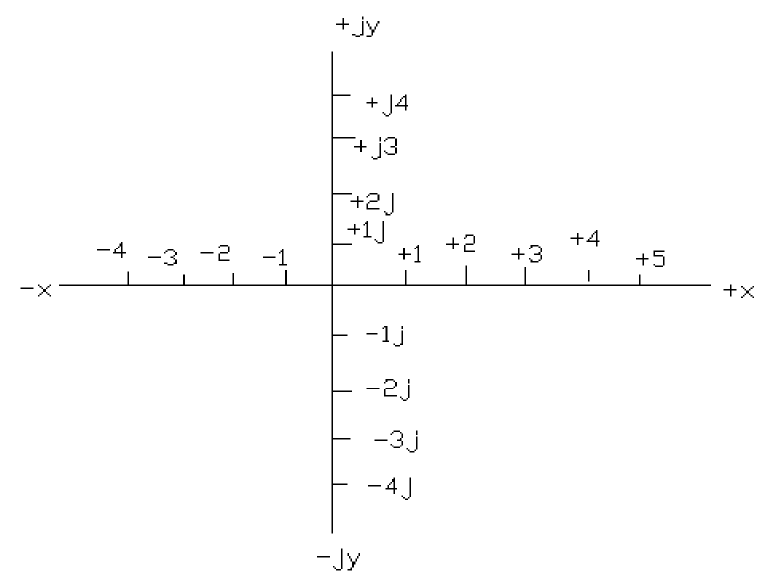
Define: The polar symbol , J - operator

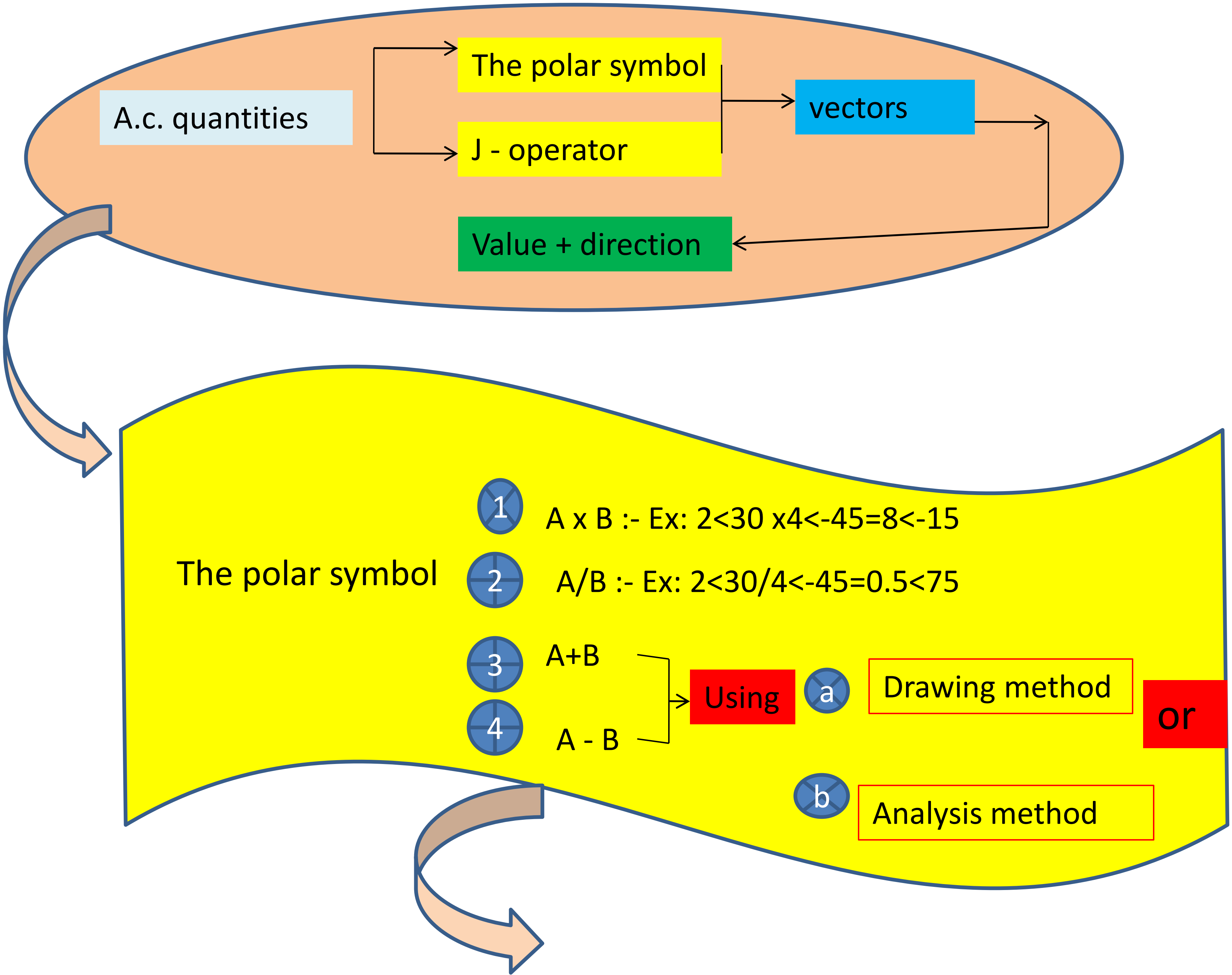
solution

The polar symbol : ويكون فيه المركب مكون من مقدار
واتجاه مثلا ($V=120<30^{o}$ v)

J – operator : وهو مقدار تخيلي يدير المركب 90درجة إذا ضرب في المركب دون تغيير لقيمة المركب . ويساوي $\sqrt{-1}$

مثلا: $Z=60+j50\ \Omega$





A.c. quantities
The polar symbol
J - operator
vectors
Value + direction
The polar symbol
1
A x B :- Ex: 2<30 x4<-45=8<-15
2
A/B :- Ex: 2<30/4<-45=0.5<75
3
A+B
4
A - B
Using
a
Drawing method
or
b
Analysis method

a

Drawing method

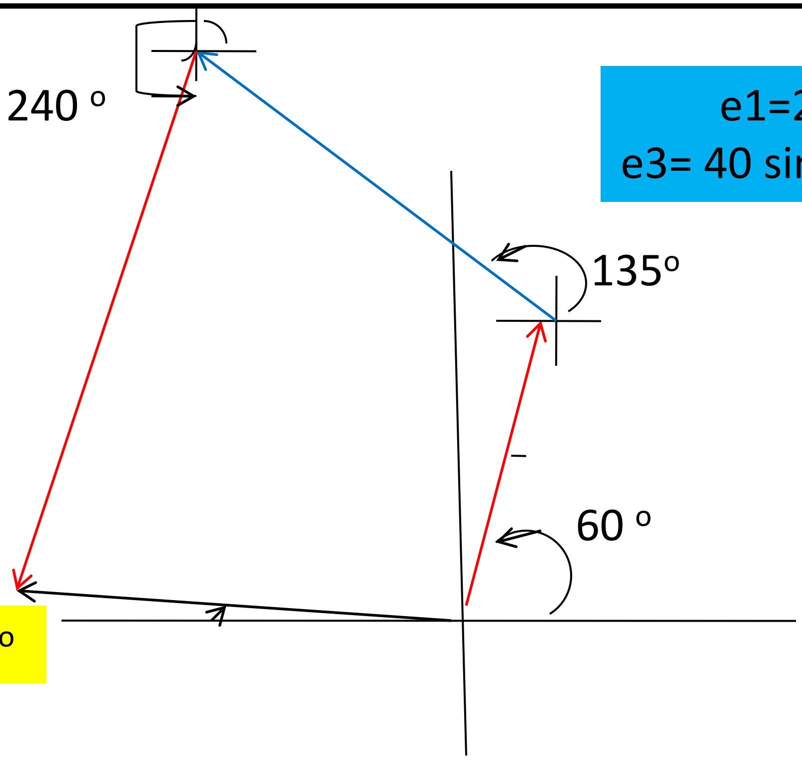
Ex:-Find $\vec{e} = \vec{e1} + \vec{e2} + \vec{e3}$ When:

e1=20 sin(ωt + 60) ; e2= 30 sin (ωt+135) ; e3=40 cos (ωt +150)

Solution

e1=20<60 ; e2 30<135

e3= 40 sin(ωt +150 +90) =40<240



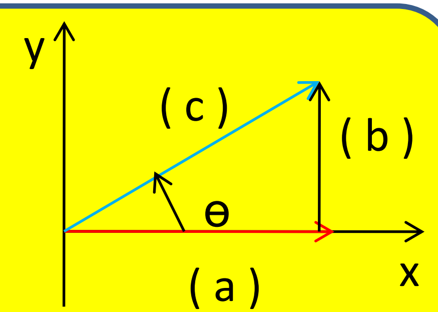
:. e= 27.34 v <-8.17°

θ=-8.17 °

b Analysis method

$a = c \times \cos\theta$

$b = C \times \sin\theta$



Ex . 1 : Find the resultant of A. c. current for :

$i_1 = 3\angle 30$ $i_2 = 4\angle 60$ using Analysis method

$I\cos\theta = i_1\cos\theta_1 + i_2\cos\theta_2 = 3\cos 30 + 4\cos 60 = 4.59$

$I\sin\theta = i_1\sin\theta_1 + i_2\sin\theta_2 = 3\sin 30 + 4\sin 60 = 4.964$

$\therefore I = \sqrt{(I\sin\theta)^2 + (I\cos\theta)^2} = 6.76$, $\theta = \tan^{-1} I\sin\theta / I\cos\theta = 47.24^o$

Ex:- Two currents i_1 and i_2 are given by the expression :

$i_1 = 10 \sin(\omega t + \pi/4)$ $i_2 = -8 \sin(\omega t - \pi/3)$ FIND

1/ $i_1 + i_2$ 2/ $i_1 - i_2$

H.W

The results

1/ $I = 15 < 74^o$ A 2/ $I = 11.07 < 0.99^o$ A

solution

1

$I = i_1 + i_2$

$I\sin\theta = 10\sin 45^o - [(-8)\sin -60^o] = 8.509 + 2.43848 = 6.07$

$I\cos\theta = 10\cos 45^o + [(-8)\cos -60] = 5.2532 + 7.6193 = 12.8725$:.

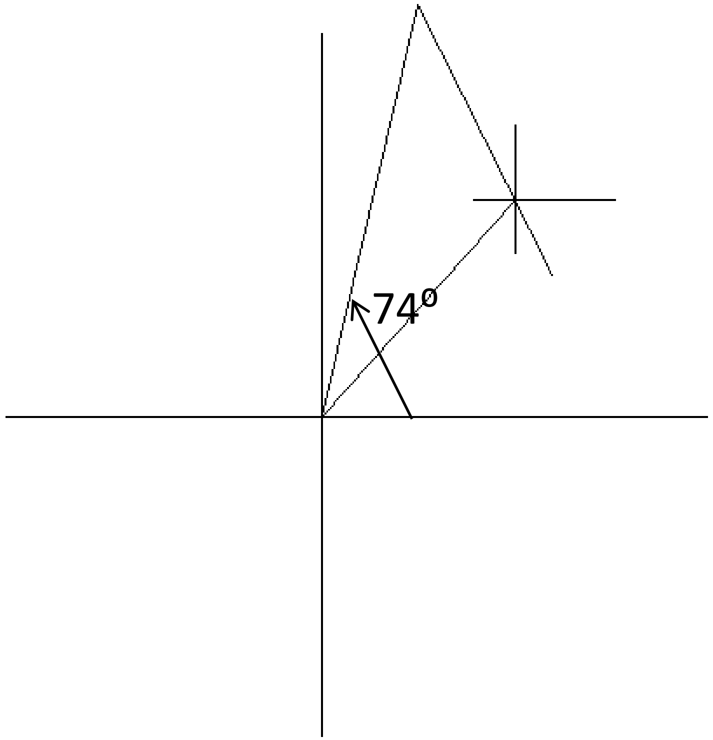
$I = \sqrt{I^2 sin\theta} + \sqrt{I^2 cos\theta} =$ 14.23A

A Analysis method

$\theta = \tan^{-1}(5.2532/36.844) = 74^o$

B Drawing method

:.$I = 14.23 < 74^o$



2

$i_1 - i_2$

(A) By analysis method

$I\sin\theta=10\sin(\omega t+\pi/4)-[(-8)\sin(\omega t-\pi/3)]=7.071-[-8x-0.86]=7.071-6.88=0.991$

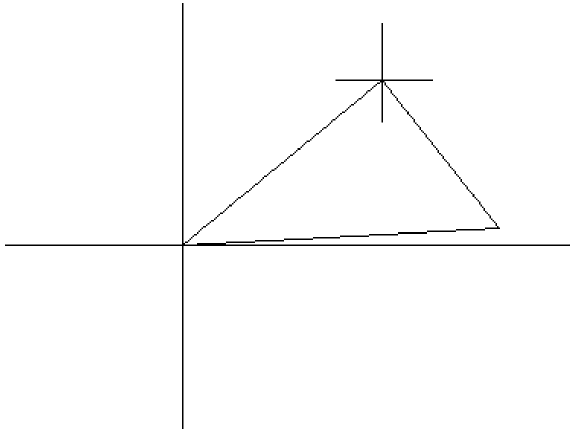
$I\cos\theta=10\cos45-[(-8)\cos(-60)]=7.071-[(8)x0.15)]=7.071-[(-8)x0.5]=7.07+4=11.071$

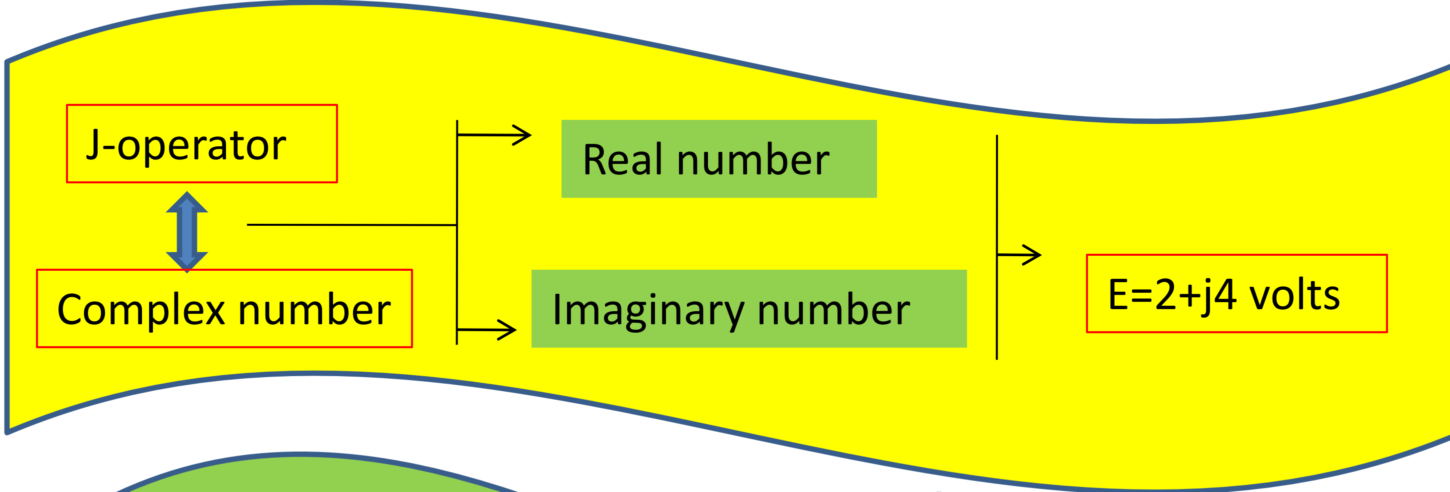
$$I=\sqrt{I^2\sin\theta}+\sqrt{I^2\cos\theta}=\sqrt{(0.191)^2}+\sqrt{(11.071)^2} = 11.077A$$

$\theta = \tan^{-1}(0.191/11.071)=0.99^o$

(B) By drawing method

$:. I=11.07<0.99^o$





1. A+B=(4+j5) +(2-j3)=6+j2

2. A – B = (4+j5) – (2 -j3) =2+ j8

3. A x B = (4+j5) X (2 -j3) =8-j12+j10+15 =23 –j 2

4. A / B = (4+j5)/ (2- j3) = (4+j5)/ (2- j3) x (2+j3)/ (2+j3)
   = (8+j12+j10- 15) / ($2^2 + 3^2$) =(-7/13) + (j22/13)

Polar and j-operator relation

When we want **to change from polar symbol to j - operator**

Ex. $i = 16 \angle -43^{o}$ ⇒ $= 16 \cos -43 + j16 \sin -43$

And When we want **to change from j - operator to polar symbol**

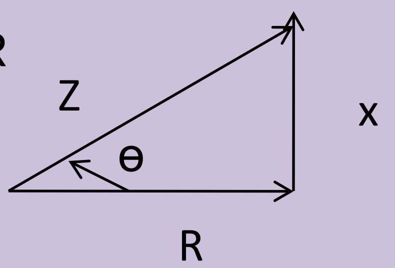
Ex. $V = 3 - j4$ ⇒ $|V| = \sqrt{3^{2} + (-4)^{2}} = 5$

$\theta = \tan^{-1} -4/3 = -53.1^{o}$ $\therefore V = 5 \angle -53.1$

A.c. quantities

1/ Impedance (Z)

R=Zcosɵ , X=Zsinɵ , $Z = \sqrt{R^2 + X^2}$,$\Theta = \tan^{-1} X/R$



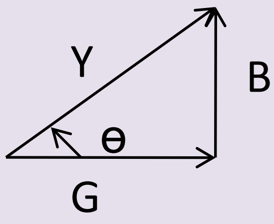
For : R=4 ,X=3 :.$Z = \sqrt{16 + 9} = 5$,$\theta = \tan^{-1} 3/4 = 37^o$

:. $Z = 5 \angle 37^o \ \Omega$, $Z = 4 + j3 \ \Omega$

2/Admittance (Y) :It is aseciptancal of impedance in (simence -S-) = 1 / Z

G=1/R Moh , B= 1/ X Moh , **$Y = \sqrt{G^2 + B^2}$ (S) ,$\theta = \tan^{-1} B/G$**

:.$Y = |Y| \angle \theta$, $Y = G + jB$

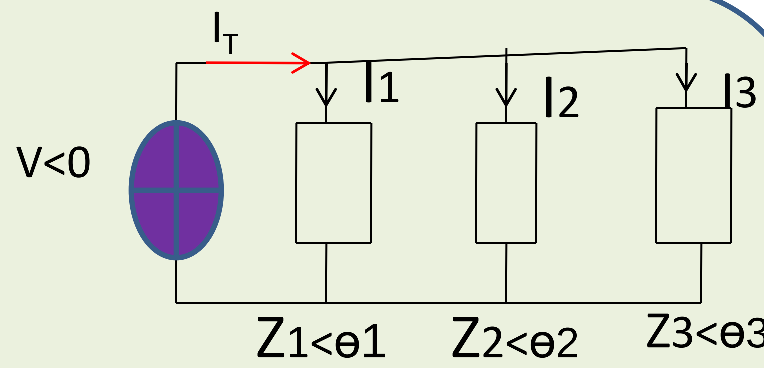


(a) Impedance in parallel :-

$1/Z<\theta = 1/Z_1<\theta_1 + 1/Z_2<\theta_2 + 1/Z_3<\theta_3$

$I<\theta = I_1<\theta_1 + I_2<\theta_2 + I_3<\theta_3$

$v<\theta = V_1<\theta_1 = V_2<\theta_2 = v_3<\theta_3$

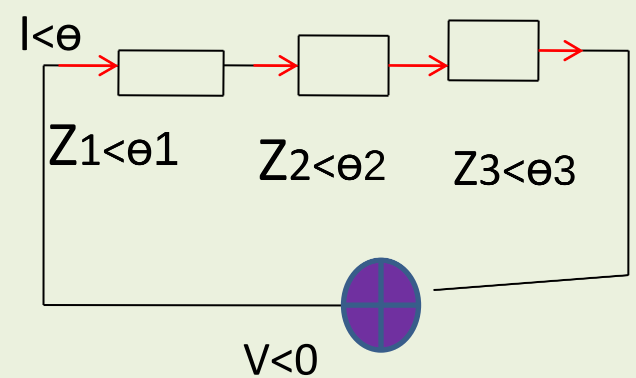


(b) Impedance in series :-

$Z<\theta = Z_1<\theta_1 + Z_2<\theta_2 + Z_3<\theta_3$

$v<\theta = V_1<\theta_1 + V_2<\theta_2 + v_3<\theta_3$

$I<\theta = I_1<\theta_1 = I_2<\theta_2 = I_3<\theta_3$

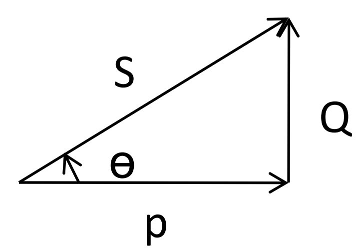


3 / A.c. power , When : S =apparent power

Q= applied power (reactive), P =actual power (active)

S=v.I (v.A) $= \sqrt{P^2 + Q^2}$, Q=v.I sin ɵ (var), P=v.Icosɵ(watt)

$\Theta = \tan^{-1} Q/P$:.S=IsI<ɵ AND S=P +JQ



Posttest

Ex : Find the resultant voltage for :

$e1= 20 \sin(\omega t + 30)$

$e2=10\sin(\omega t+ \pi/3)$

$e3= 15 \cos(\omega t +30)$

$e4=30 \sin(\omega t - 90)$

Using analysis method

H.w

solution

$e= 13 \sin(\omega t + 7)$

THEN

Using drawing method to find the Sam resultant

a) Analysis method

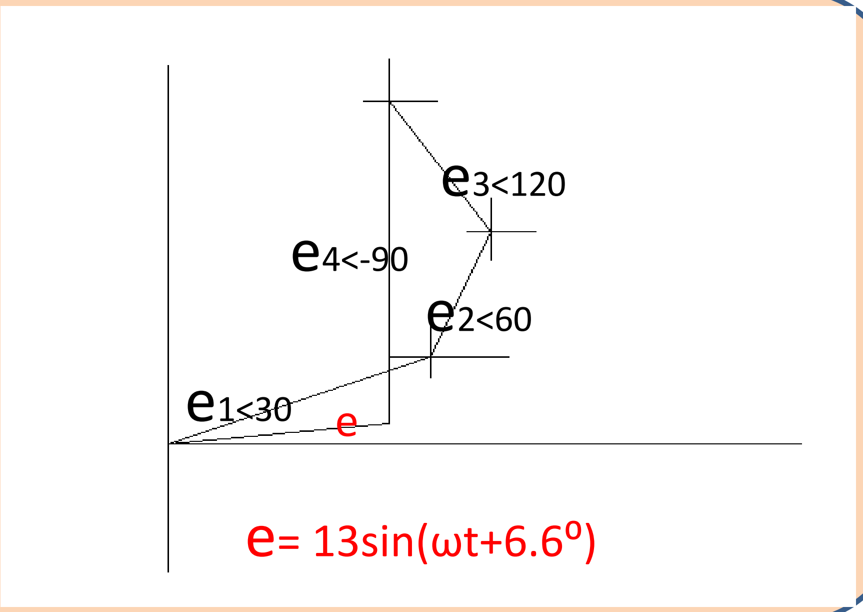
solution: $e_1 = 20\angle 30^o$, $e_2 = 10\angle 60^o$, $e_3 = 15\sin(\omega t+120) = 15\angle 120^o$, $e4 = 30\angle -90^o$

$$e\cos\theta = 20\cos 30 + 10\cos 60 + 15\cos 120 + 30\cos(-90^o) = 17.8 + 5.877 + (-4.6) + 4.69 = 23.77v$$

$$e\sin\theta = 20\sin 30 + 10\sin 60 + 15\sin 120 + 30\sin(-90^o) = 9.07 + 80.9 + 14.2 + (-29.6) = 1.76\ v$$

$$e = \sqrt{(e\cos\theta)^2 + (e\sin\theta)^2} = 13v \quad , \quad \theta = \tan^{-1}\left(\frac{e\sin\theta}{e\cos\theta}\right) = 6.6v$$

b) Drawing method



الأسبوع العاشر

The components of A.c. circuit

تأثير التيار المتناوب على مكونات الدائرة

Aim of lecture

To let the student be able to identify and Study the components of A.c. circuits

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- النظرة الشاملة over view

A- Population target

الفئة المستهدفة

 Student of first year
of
Electrical Techniques Department

طلبة قسم التقنيات الكهربائية ـ السنة الأولى

مبررات الوحدة B –Rationale

- It is very important to study **The components of A.c. circuit**
- Also to study how we connect the Components in series and parallel .

الفكرة المركزية C – Central Idea

- Definition **The components of A.c. circuit**
- To calculate the current in parallel and the voltage in series.

Pretest

Define : Phase shift , Phase diagram ,Phase angle(ϕ) , inductance(L), Capacitance (c), Inductive reactance (XL), Capacitive reactance (Xc),Impedance(Z)

Solution:

Phase shift: / الفرق بالطور لنفس الموجة للتيار او للفولتية عن الزاوية الصفرية

Phaser diagram: / مخطط اتجاهي يمثل اتجاه وزاوية كلا من التيار والفولتية

Phase angle(ϕ)/ مقدار الزاوية التي تشكل فرق الطور بين التيار والفولتية :

inductance(L) / مقدار الحث الذي ينتجه الملف الكهربائي عند مرور التيارالكهربائي ويقاس بوحدة الهنري

Capacitance (c) / سعة المتسعة وتقاس بوحدة الفاراد إلا ان الفاراد وحدة كبيرة جدا فعادة تعطى بوحدة المايكرو فراد أو الملي فاراد لذا يجب تحويل الوحدات إلى الفراد

Inductive reactance (XL):/ كمية المعاوقة التي يبديها الحث من الملف للتيار الكهربائي وتقاس بوحدة (الاوم) ويتناسب مقدارها طرديا مع الحث $XL=2\pi f L$

Capacitive reactance (Xc)/ كمية المعاوقة التي تبديها المتسعة للتيار الكهربائي المار خلالها وتقاس بوحدة (ألاوم) $XC=1/(2\pi f c)$

Impedance(Z)/ كمية الممانعة الكلية التي تبديها عناصر متنوعة (مقاومة مع ملف , مقاومة مع متسعة ,جميع العناصر مشتركة) للتيار الكهربائي المار خلالها بغض النظر عن نوع الربط للعناصر المذكورة – (توالي أو توازي أو مختلط أونجمي أومثلثي ... ألخ)

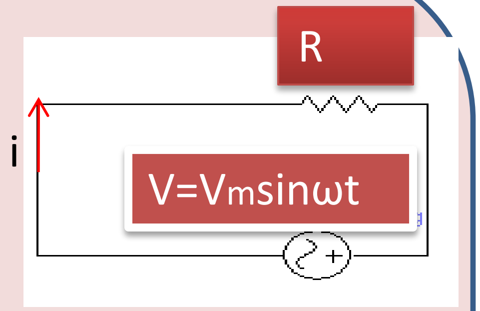
The components of A.c. circuit

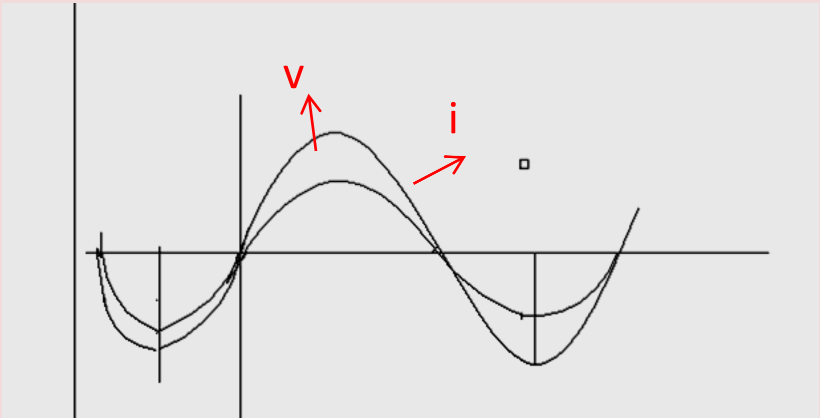
1 Pure Resistor

$V = V_m . \sin\omega t$, $i = v/R$ ohms' Law

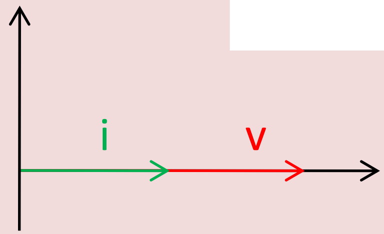
$\therefore i = (V_m . \sin \omega t)/R$, $I_m = V_m/R$

$\therefore i = I_m . \sin \omega t$



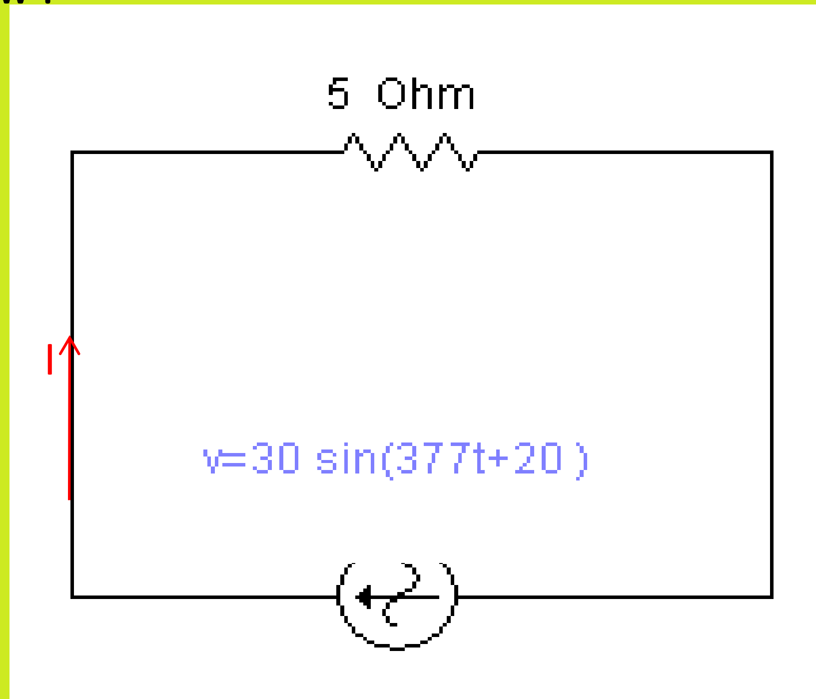


Wave form



Phaser diagram .we saw V and I in the same phase

Ex(1). Find the equation of the current (find the sinusoidal expression for the current) for the cct. shown. Draw .

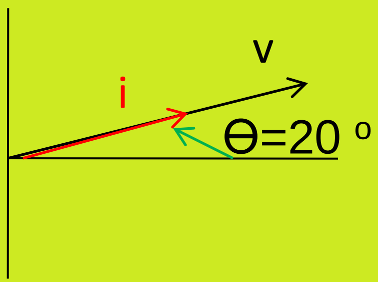


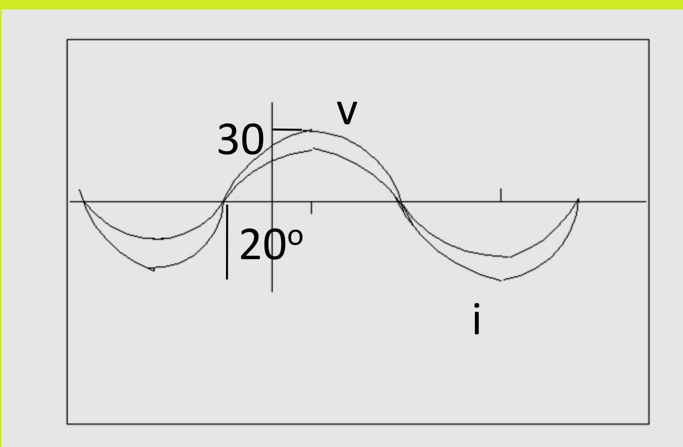
Solution : $v=30\sin(377t+20^{o})$

$i=I_m\sin(377t+20^{o})$

$I_m=V_m/R=30/5=6A$

$\therefore I=6\sin(377t+20^{o})$





2

Pure Inductance

$i_L = I_m .\sin\omega t$,$v = L\, di/dt = L.d(I_m \sin \omega t)/dt$

$V = L\, I_m\, d(\sin\omega t)/dt = I_m.L(\cos\omega t).\omega$

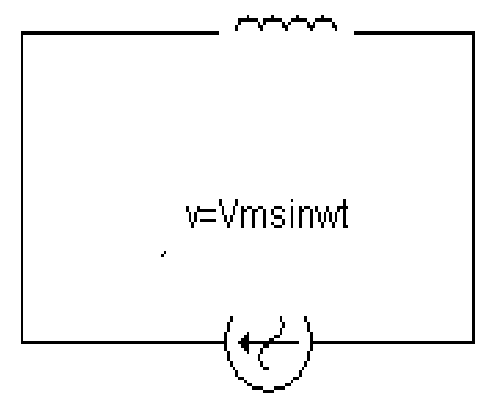
$= I_m.\omega L.(\cos\omega t) = I_m.X_L .\sin(\omega t + \pi/2)$

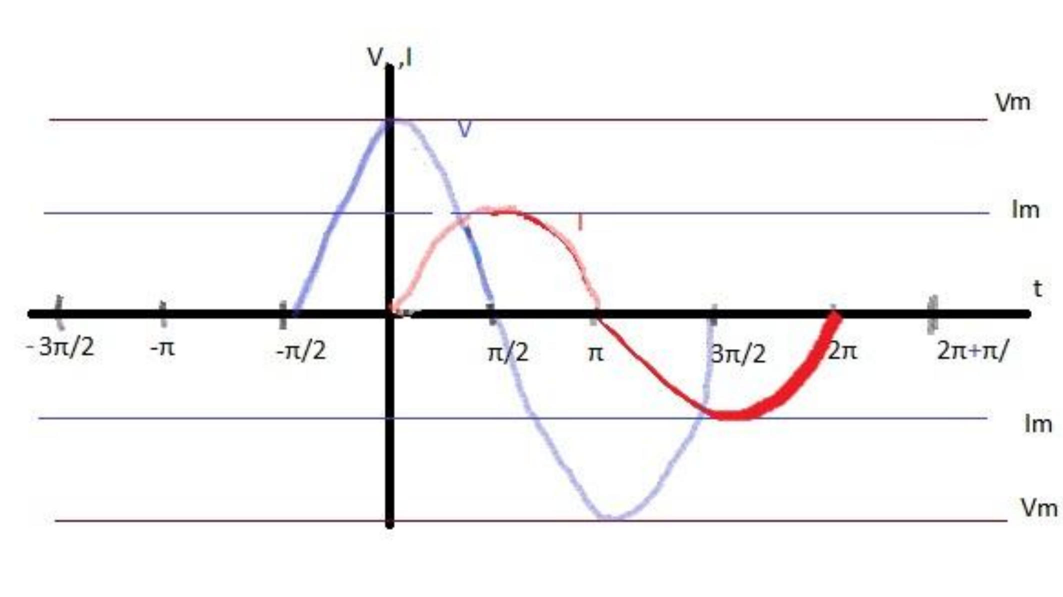
$= V_m \sin(\omega t + \pi/2)$

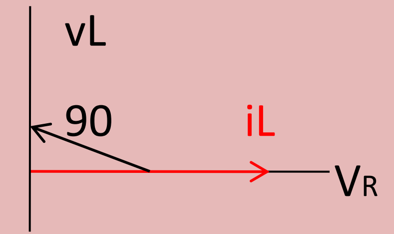
$:. V_L = V_m \sin(\omega t + \pi/2)$ because :- $\cos \text{Ø} = \sin(\text{Ø} + \pi/2)$

$X_L = \omega.L = 2\pi f.L$ (ohm)=inductance reactance in(Ω)

L=inductance(Henery) –H-







Phaser diagram :. The voltage is Leading at the current with 90 º

Wave form

الفولتية متقدمة عن التيار 90 درجة v_L leads i_L by 90 º

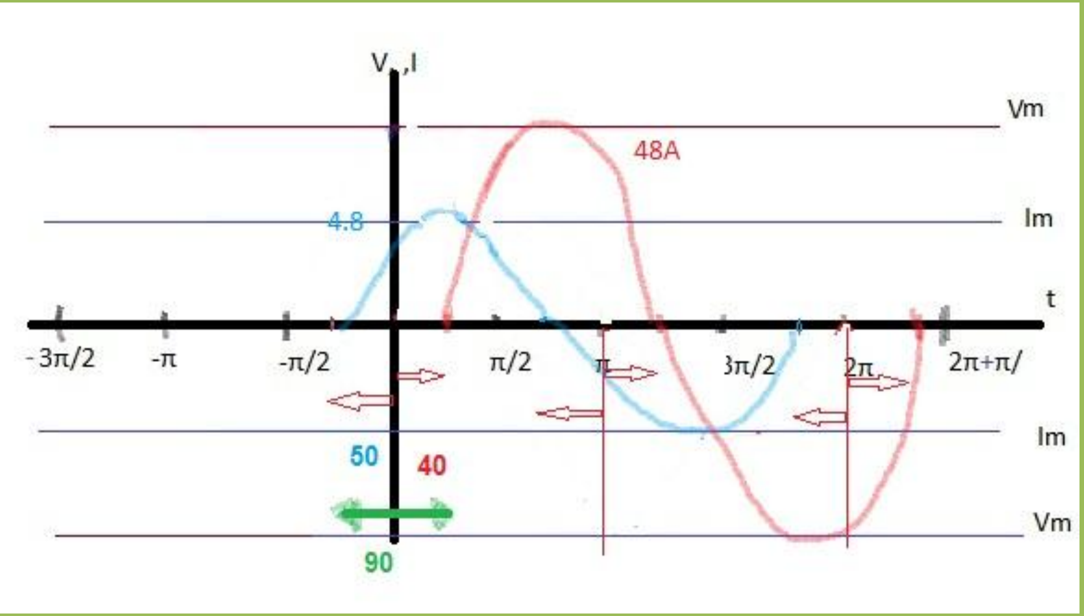
Ex(2): The voltage across an 0.2 H coil v=4.8 sin(0.05t +50 °) , find the equation of the current ,draw the wave form and phaser diagram.

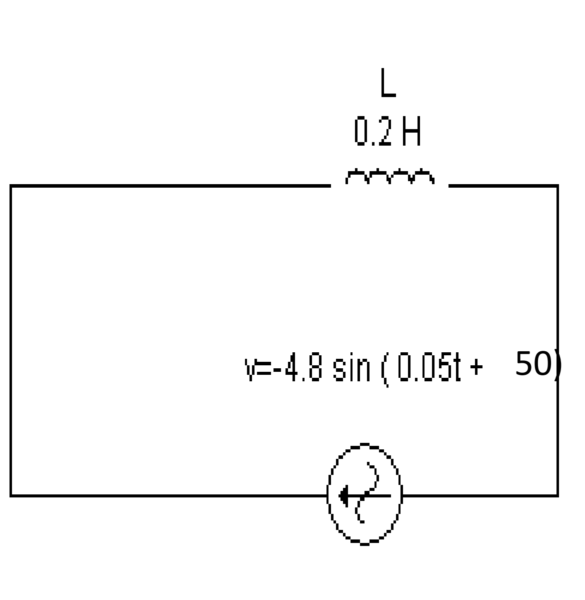
Solution : v= -4.8 sin (0.05 t + 50 °)

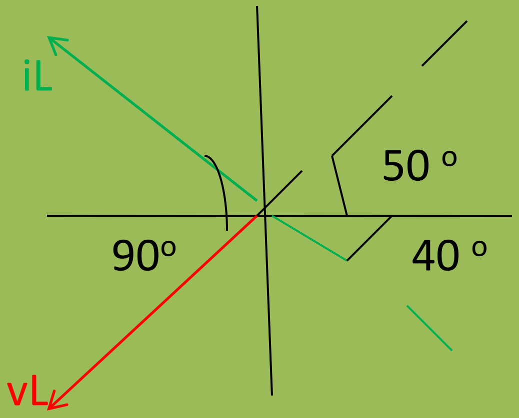
i= I_m sin(0.05t + 50° - 90°)= I_m sin(0.05t -40 °)

$I_m = V_m / X_L$ = -4.8/ω.L =-4.8/(0.05x0.2)= -48A

:. i= -48sin(0.05t-40)A.







Wave form :- V_L Leads i_L by 90 °

$I_m = V_m / X_L$

Phaser diagram

3

Pure capcitance

$V_c = V_m .\sin \omega t$

C= capacitance (farad)

$C = c.dv/dt = c . d(v_m \sin\omega t)/dt$

$I = c. V_m (\cos \omega t).\omega = \omega.c.V_m (\sin (\omega t + \pi/2))$

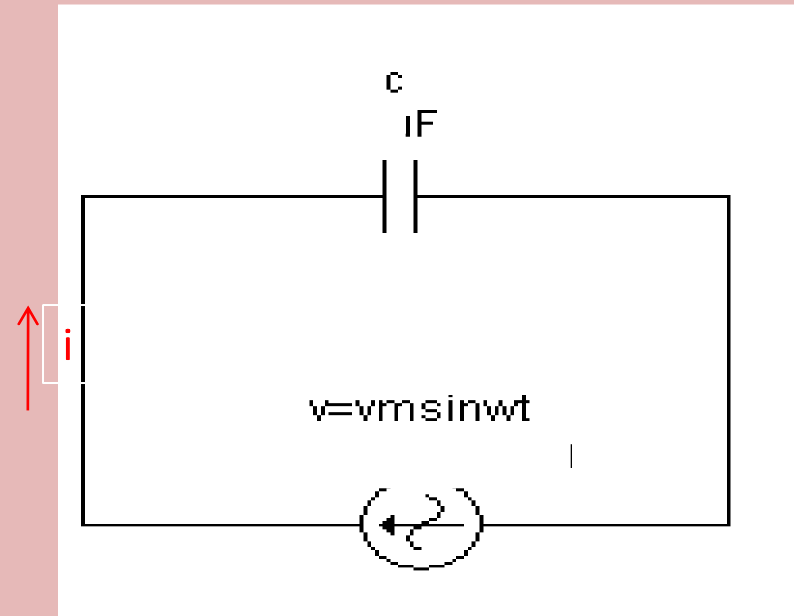
$= V_m \sin(\omega t + \pi/2)/(1/\omega.c)$

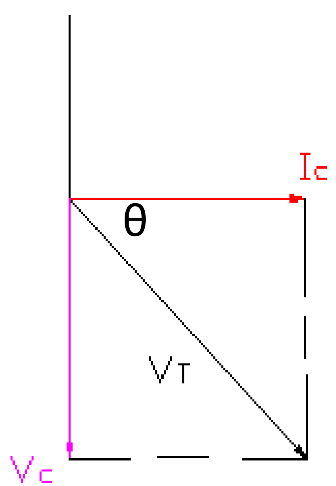
$= V_m \sin (\omega t + \pi/2)/X_c$

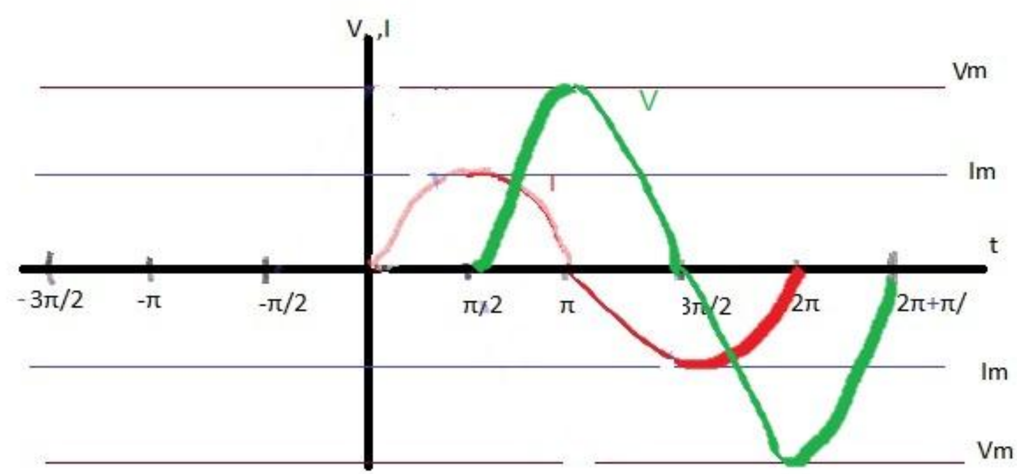
$i_c = I_m \sin (\omega t + \pi/2)$:. I_c Leads V_c by 90 °

when $X_c = 1/\omega.c = 1/2\pi f.c$

X_c= capacitive reactance(Ω)







Vc lags ic by 90 الفولتية متاخرة عن التيار

Ex (3): For the cct. Shown find (f) then what are the value of (R) that connected with (C) to reduce the current to (0.5A) with the same frequency

Solution

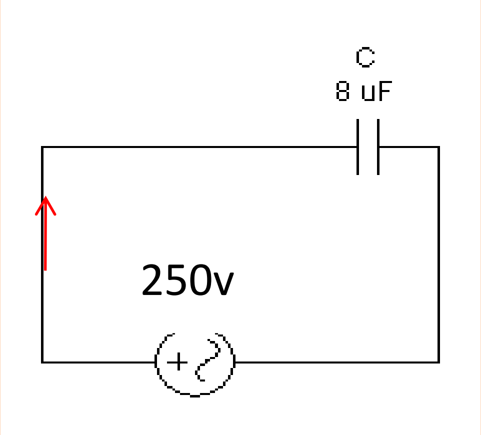
$X_c = 250/1 = 250\ \Omega$

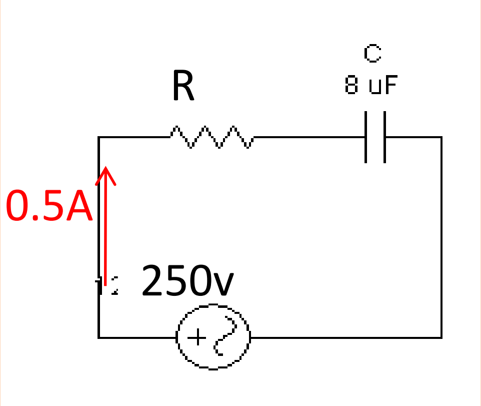
$X_c = 1/\omega.c = 1/2\pi fc \therefore F = 1/2\pi.X_c.c$

$F = 1/(2 \times 3.14 \times 250 \times 8 \times 10^{-6}) = 79.5\ HZ$

$Z = \sqrt{R^2 + X_c^2} = \sqrt{R^2 + 250^2}$, $Z = 250/0.5 = 500\ \Omega$

$\therefore 500^2 = R^2 + 250^2 \therefore R^2 = 500^2 - 250^2 \therefore R = 433\ \Omega$

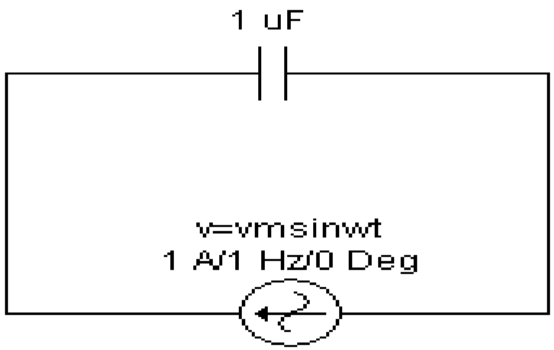




Post test

Ex(4) : for the cct. shown find the sinusoidal expression for the current , draw the wave form, the phaser diagram

V=70sin(800t -20)



Solution : V_c=70sin(800t-20) ,i_c=$I_m$sin(800t-20 +90 ^{o})

=I_m sin (800t + 70) , I_m= V_m/X_c =70/(1/ω.c) =70 x ω . C

=70x 800 x1 x 10 $^{-6}$ = 56 mA :. I_c=56sin(800t + 70) mA

الأسبوع الحادي عشر
تأثير التيار المتناوب على الدوائر الكهربائية في حالات التوالي

Aim of lecture   To make the student should be able to determine the impact of AC circuits linking respectively, and to learn to find the relationship between the current and voltages in connecting respectively, and finding phase angle and total defiance of the electrical circuit.

over view النظرة الشاملة -

A- Population target

الفئة المستهدفة

 Student of first year
of
Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

Pretest

Define : Phase shift , Phase diagram ,Phase angle(ϕ) , inductance(L), Capacitance (c), Inductive reactance (XL), Capacitive reactance (xc),Impedance(Z)

Solution: Phase shift:الفرق بالطور بين موجة التيار والفولتية

Phase diagram: مخطط اتجاهي يمثل اتجاه وزاوية كلا من التيار والفولتية

Phase angle(ϕ): مقدار الزاوية التي تشكل فرق الطور بين التيار والفولتية

inductance(L):مقدار الحث الذي ينتجه الملف الكهربائي عند مرور التيارالكهربائي ويقاس بوحدة الهنري

Capacitance (c) سعة المتسعة وتقاس بوحدة الفاراد إلا ان الفاراد وحدة كبيرة جدا فعادة تعطى بوحدة المايكرو فراد أو الملي فاراد لذا يجب تحويل الوحدات إلى الفراد

Inductive reactance (XL) :كمية المعاوقة التي يبديها الحث من الملف للتيار الكهربائي وتقاس بوحدة (الاوم) ويتناسب مقدارها طرديا مع الحث

Capacitive reactance (xc), كمية المعاوقة التي تبديها المتسعة للتيار الكهربائي المار خلالها وتقاس بوحدة (ألاوم)

Impedance(Z) كمية الممانعة الكلية التي تبديها عناصر متنوعة (مقاومة مع ملف , مقاومة مع متسعة, جميع العناصر مشتركة) للتيار الكهربائي المار خلالها بغض النظر عن نوع الربط للعناصر المذكورة – (توالي أو توازي أو مختلط أونجمي أومثلثي ... ألخ)

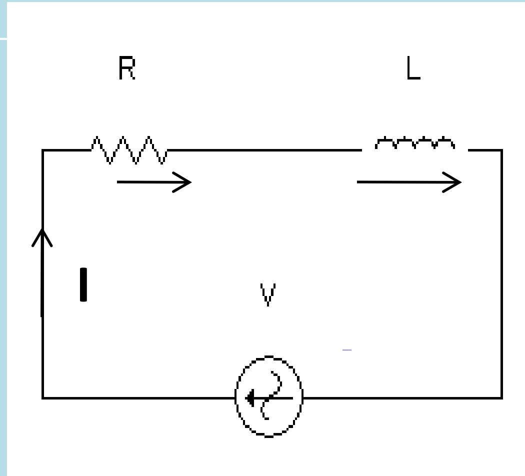
R- L in series

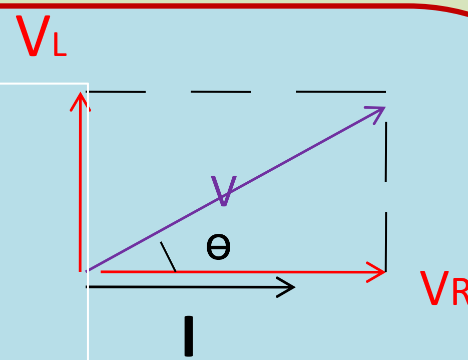
$V_R = I.R$, $V_L = I. X_L$

$V = \sqrt{V_R^{\,2} + V_L^{\,2}}$

$= \sqrt{(I.R)^2 + (I.X_L)^2}$

$V = I\sqrt{(R^2 + X_L^2)}$



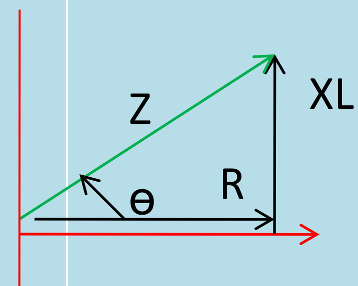


$\therefore Z = V/I = \sqrt{(R^2 + X_L^2)}$

(Ω) Impedance of the cct. ,

$\tan\theta = V_L/V_R = I.X_L / I.R = X_L / R$

$\therefore \tan\theta = V_L/V_R \therefore \theta = \tan^{-1} V_L/V_R$



Triangle of Impedance

$\tan\theta = X_L / R \therefore \theta = \tan^{-1} X_L / R$

ϴ =phase angle between V and I

قيمة الزاوية تتراوح اكبر من الصفر واصغر من 90 درجة (موجبة)مثل +30 او +45او +60 = ϴ

(قيمة الزاوية الفولتية – قيمةϴ)مثل -30 او -45او -60 = زاوية التيار) في حال زاوية الفولتية =0

Ex(1) :- For the cct. Shown find the value and direction the current

$Z=\sqrt{R^2+X_L{}^2}$, $X_L=\omega.L=314\times0.1=31.4\ \Omega$

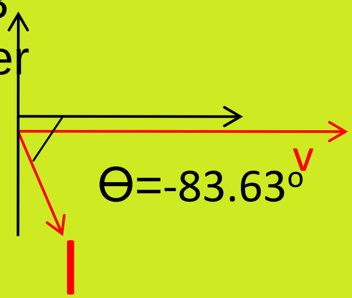
$Z=\sqrt{(3.5)^2+(31.4)^2}=31.6\Omega$

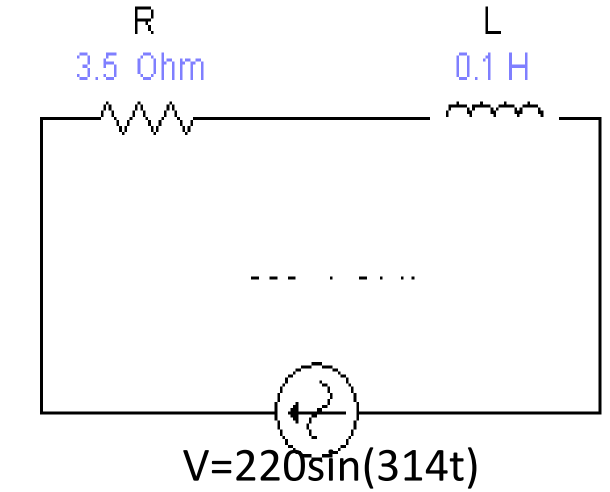
$I=v/Z=220/31.6=6.96\ A$

$\Theta=\tan^{-1}X_L/R=\tan^{-1}31.4/3.5=\tan^{-1}8.97$

$\therefore\Theta=83.63^o$ $\therefore i=6.96<-83.63$

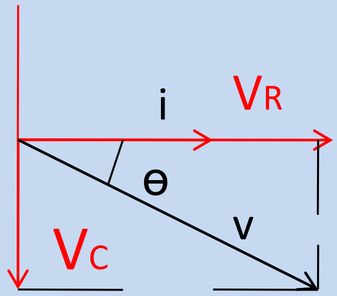
$\therefore i=6.96\sin(314t-83.63)$Amer

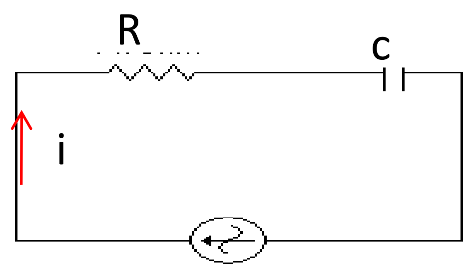




R-c in series

$V_R=I.R$, $V_C=I.X_C$





$V=\sqrt{V_R{}^2+V_C{}^2}=\sqrt{(I.R)^2+(I.X_c)^2}$

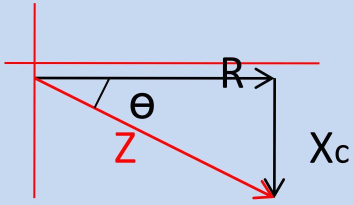
$V=I\sqrt{(R^2+X_c{}^2}$

$\therefore Z=V/I=\sqrt{(R^2+X_c{}^2}$, $X_c=1/\omega.c$

$\tan\theta=V_c/V_R=I.X_c/I.R=X_c/R$

$\therefore\theta=\tan^{-1}V_c/V_R$ Or

$\tan\theta=X_c/R$ $\therefore\theta=\tan^{-1}X_c/R$

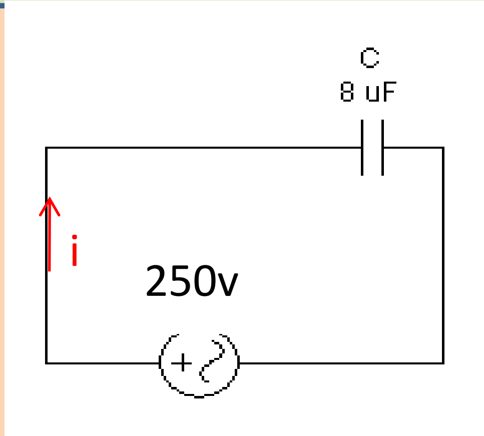


Ex(2) : For the cct. Shown if(I=1A) find (f), then what are the value of (R) that connected with (C) to reduce قلل the current to (0.5A) with the same frequency .

Solution

$X_c = V_c / I_c = 250/1 = 250\ \Omega$

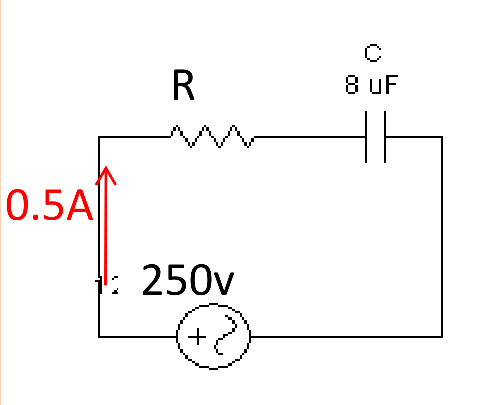
$X_c = 1/\omega.c = 1/2\pi fc \quad \therefore f = 1/(2\pi.c.X_c)$



$f = 1/(2\text{x}3.14\text{x}8\text{x}10^{-6}\text{x}250) = 79.5\ HZ$

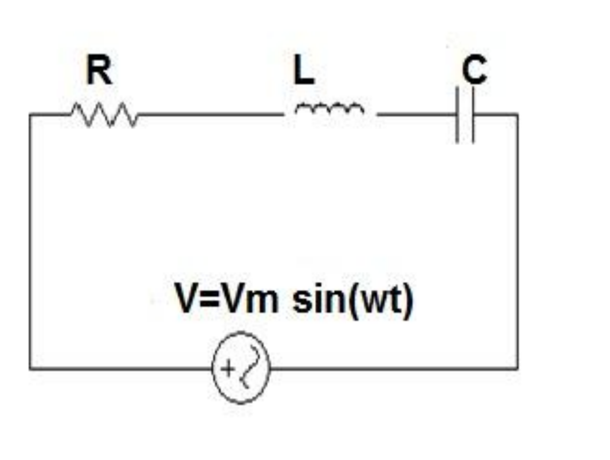
$Z = \sqrt{(R^2 + X_c^2} = \sqrt{(R^2 + 250^2}, \qquad Z = 250/0.5 = 500\ \Omega$

$\therefore 500^2 = R^2 + 250^2 \quad \therefore R^2 = 500^2 - 250^2 \therefore R = 433\ \Omega$



R-L-C in series

1- If $X_L > X_C$ ∴ $V_L > V_C$



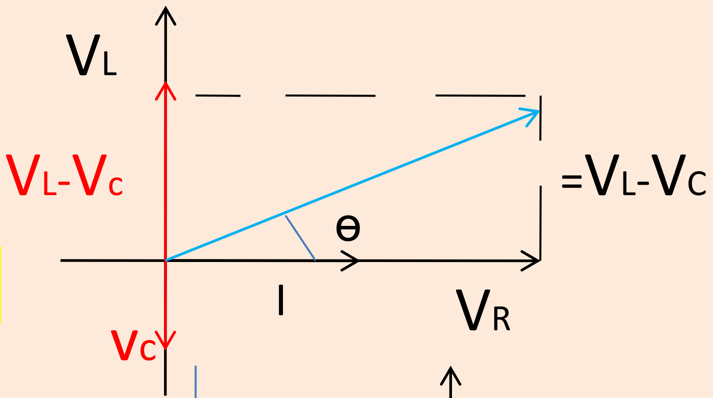
$V_R = I.R$, $V_L = I.X_L$, $V_C = I.X_C$, $V = \sqrt{V_R^2 + (V_L - V_C)^2}$

$V = I . \sqrt{R^2 + (X_L - X_C)^2}$

∴ $Z = V/I = \sqrt{R^2 + (X_L - X_C)^2}$ {The impedance of the cct.}

$\theta = \tan^{-1} (V_L - V_C) / V_R$

$\theta = \tan^{-1} (X_L - X_C) / R$

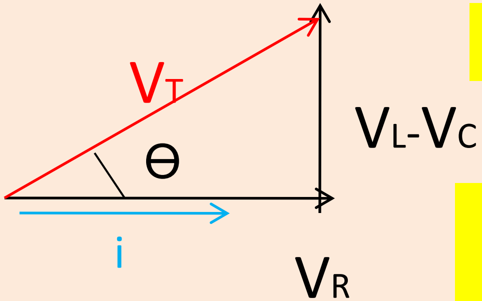


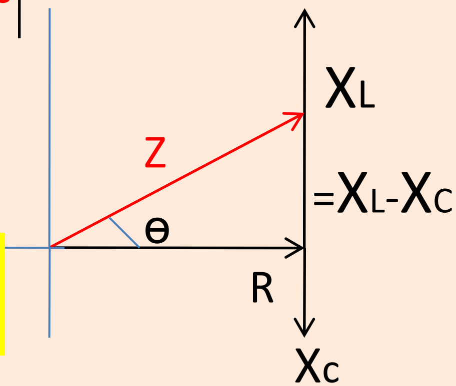
Also : $X_L > X_C$:

1/the cc.t is inductive

2/ϴ is positive

3/ V_T lead يتقدم i_T by ϴ





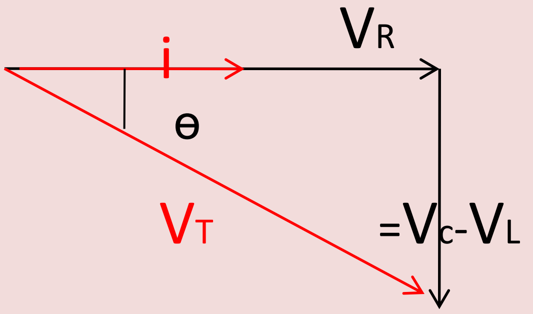
2/ If $X_C > X_L$:. $V_C > V_L$

When $X_L < X_C$

1/ The cct. Is capacitive

2/ө is negative

3/ i_T leads يتقدم V_T by ө



3/ If $X_L=X_C$;. $V_L=V_C$

When $X_L= X_C$

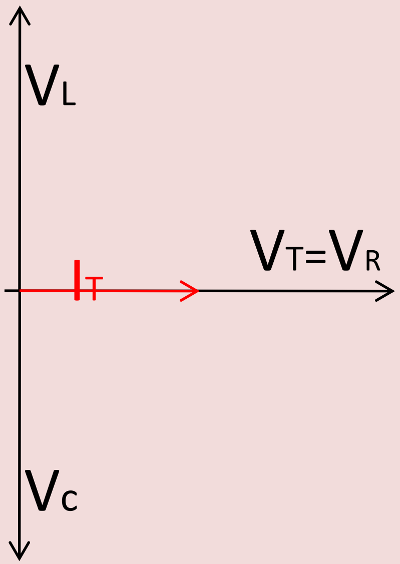
1/ We have **resonance case**

2/ ϴ =0

3/Z =R

4/ $V_L=V_C$

5/ $V_T=V_R$



Resonance series frequancy

$X_L=X_C$:.$2\pi f_o.L=(1/2\pi f_o.C)$

:.$f_o^2=(1/4\pi^2 L.C)$

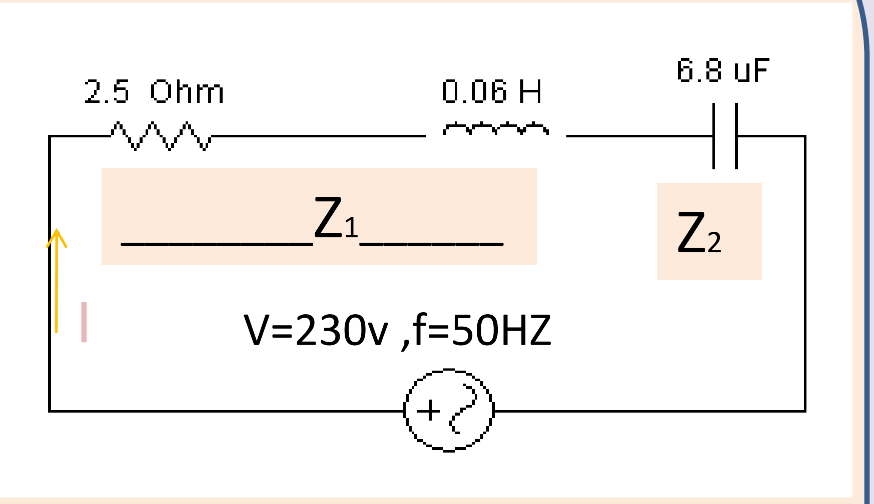
$f_r=f_o= 1/(2.\pi.\sqrt{L.C})$ HZ

The energy stord in the coil(w,e)

$W=(1/2) L.I_m^2$ joule

EX(3) : For the cct. Shown Find (Z_T, I, ϴ, V_{Z1} ,V_{Z2}) draw the phaser diagram .

$Z_T = \sqrt{R^2 + (X_L - X_C)^2}$



$X_L = 2\pi f.L = 2x3.14x50x0.06 = 18.8\Omega$

$X_C = 1/2\pi f.c = 1/(2x3.14x50x6.8x10^{-6}) = 468.1\Omega$

$Z_T = \sqrt{2.5^2 + (18.8 - 468.1)^2} = 449.3\ \Omega$

$I = V/Z = 230/449.3 = 0.5\ A$

$\theta = \tan^{-1}\ (X_L - X_C)/R = \tan^{-1}(-449.3)/2.5$

:. $\theta = -89.68^o$

:. $V = 230 < -89.68^o$ v

$i = 0.5 < 0$ A

$Z_1 = \sqrt{(2.52\ + (18.8)^2}$

$= 18.965\Omega$

Z2 $= XC = 468.1\ \Omega$

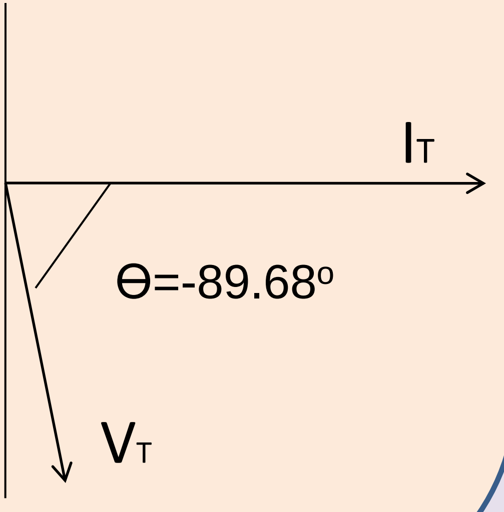
:.$V_{Z1} = I.Z1 = 0.5x\ 18.965$

$= 9.48$ v

:.$V_{Z2} = I.Z_2 = I.XC$

$= 0.5x468.1$

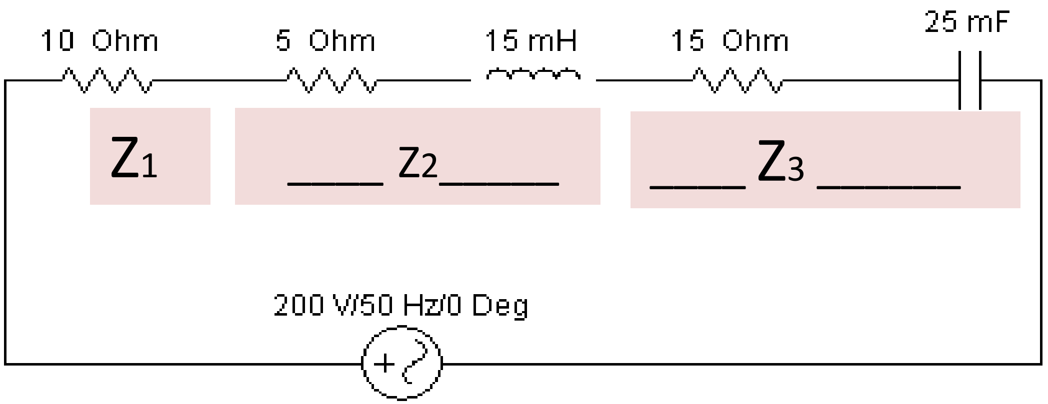
$= 234v$



Post test

Ex(a) : For the cct. Shown Find (Z_T, I, ɵ ,V_{Z1},V_{Z2} , V_{Z3})then draw the phaser diagram .

H .W



solution

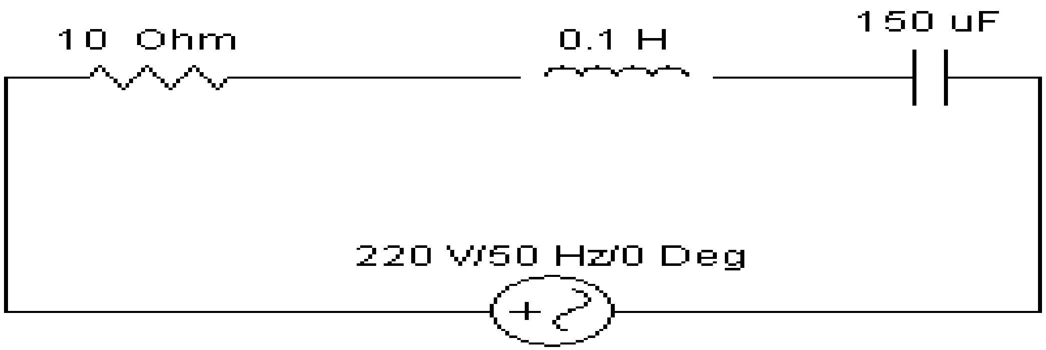
Z_T=31.6 Ω ,
I=6.329A A

ϴ =18.43°

V_{Z1}= 63.29v
V_{Z2}= 99.998v
V_{Z3}=184.49v

EX(b): For the cct. Shown Find: I, ɵ ,VR,Vc , VL and draw the phaser diagram.

H.W



solution

I= 14 A

ϴ =45.55°

V_R= 140v
V_C =297v
V_L= 439.81v

over view النظرة الشاملة -

A- Population target

الفئة المستهدفة

 Student of first year

of

Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

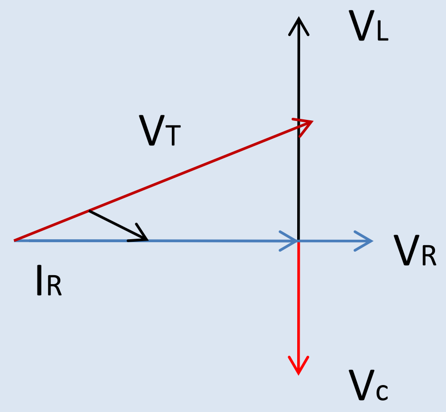
Aim of lecture : To make the student should be able to decipher complex electrical networks linking parallel and current knowledge of the relationship Balvoltaip in this case, and how to find a phase angle and the reluctance of the circle and permittivity

Tribal test

الاختبار القبلي

Ex: Drawing the phase diagram for the cct contain (L,C)in series .If xL > xc

Solution :-



R-L in parallel

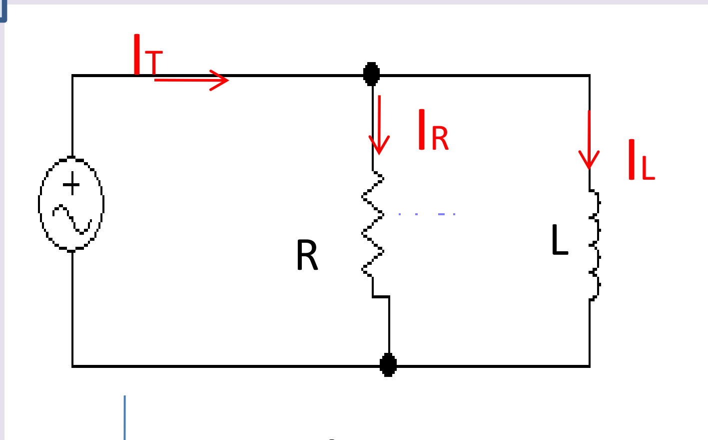
في حالات التوازي

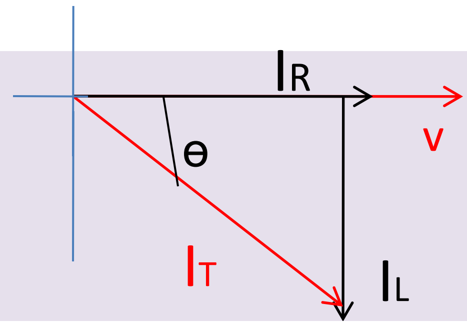
$I_R = V/R$, $I_L = V/X_L$, $I_T = \sqrt{I_R^2 + I_L^2}$

$I_T = \sqrt{(V/R)^2 + (V/X_L)^2} = \sqrt{V^2 / R^2 + V^2 / X_L^2}$

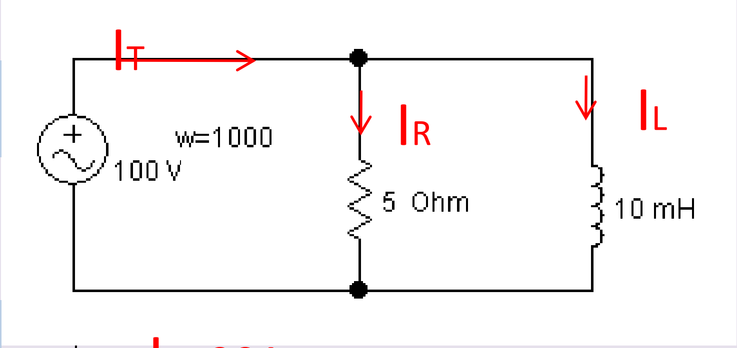
$I_T = V\sqrt{1/R^2 + 1/X_L^2} = I/V = Y = \sqrt{1/R^2 + 1/X_L^2}$ (Moh) , $1/\Omega$,(Siemens) ,(admittance of the cct.) , $Y = 1/Z$, $Z = 1/Y$

$\Theta = \tan^{-1}$ **(-IL / IR)**





EX(1): **for the cct. Shown find YT, ZT, IR ,IL , IT ,ɵ**
Drawing the phaser diagram.



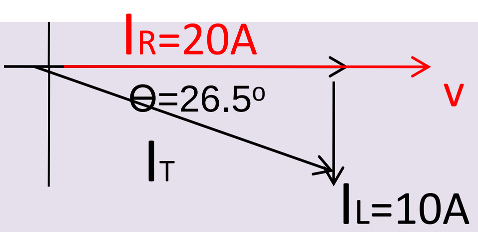
$I_R = v/R = 100/5 = 20A$, $I_L = V/X_L = 100/(1000*0.01)) = 10A$

$I_T = \sqrt{I_R^2 + I_L^2} = \sqrt{20^2 + 102} = 22A$

$\Theta = \tan^{-1}$ $-I_L / I_R = \tan\text{-}1\ (-10/20) = -26.5$

$Z_T = V/I_T = 100/22 = 4.545\Omega$

$Y_T = 1/Z_T = 0.22$ moh



R-C in Parallel

$I_R = V/R$, $I_C = V/X_c$

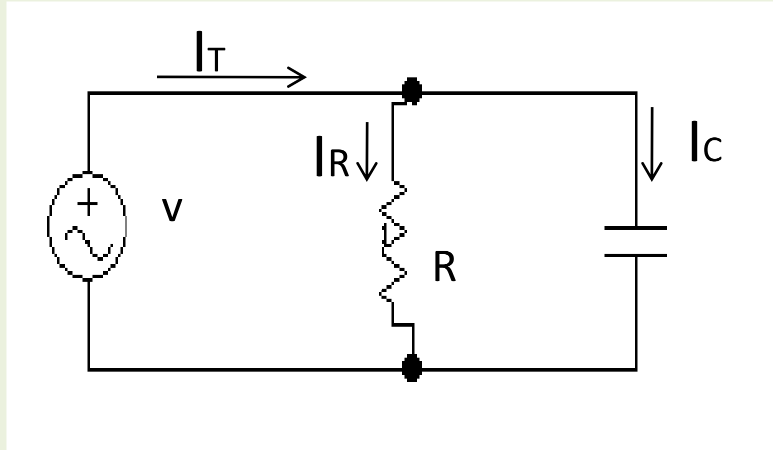
$I_T = \sqrt{I_R^2 + I_c^2}$

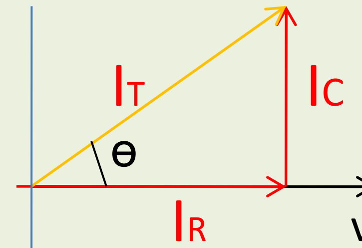
$= \sqrt{(V/R)^2 + (V/X_c)^2}$

$I = V\sqrt{(1/R^2) + (1/X_c^2)}$

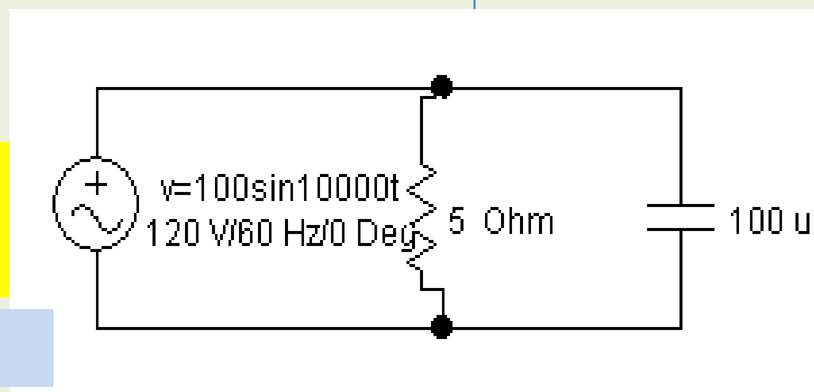
$I/v = Y = \sqrt{(1/R^2) + (1/X_c^2)}$

$\Theta = \tan^{-1}(I_C / I_R)$





EX(2) : for the cct. Shown find Y_T, Z_T, I_R ,I_c , I_T ,ɵ Drawing the phaser diagram.



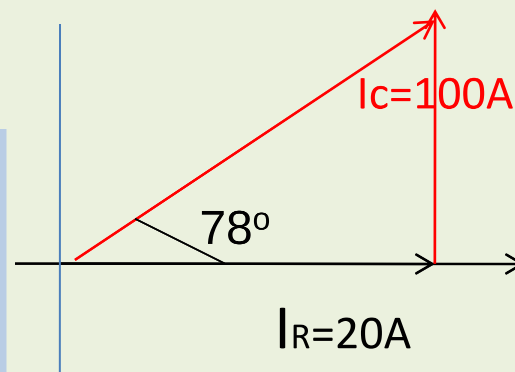
Solution :$X_c = 1/\omega.C = 1/(10000 \times 100 \times 10^{-6}) = 1\Omega$

$Y = \sqrt{1/R^2 + 1/Xc^2} = \sqrt{1/52 + 1/12} = 1.01$moh ,

$Z = 1/Y = 0.98\ \Omega$, or $Z = V/I = 100/101 = 0.98\ \Omega$, $IR = V/R = 100/5 = 20A$

$Ic = V/Xc = 100/1 = 100A$, $IT = \sqrt{IR^2 + Ic^2} = \sqrt{20^2 + 1002} = 101A$

$ɵ = \tan^{-1} Ic/IR = \tan^{-1} 5 = 78^o$



The general Parallel case

1

If $X_L > X_c$:. $I_c > I_L$:. $I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$

$Z_T = 1/\sqrt{(1/R)^2 + (1/X_c - 1/X_L)^2}$ OR $Z = V/I_T$

$\theta = \tan^{-1} (I_c - I_L) / I_R$

2

If $X_c > X_L$:. $I_L > I_c$:. $I_T = \sqrt{I_R^2 + (I_c - I_L)^2}$

$Z_T = 1/\sqrt{(1/R)^2 + (1/X_L - 1/X_c)^2}$ OR $Z = V/I_T$

$\theta = \tan^{-1} (I_c - I_L) / I_R$

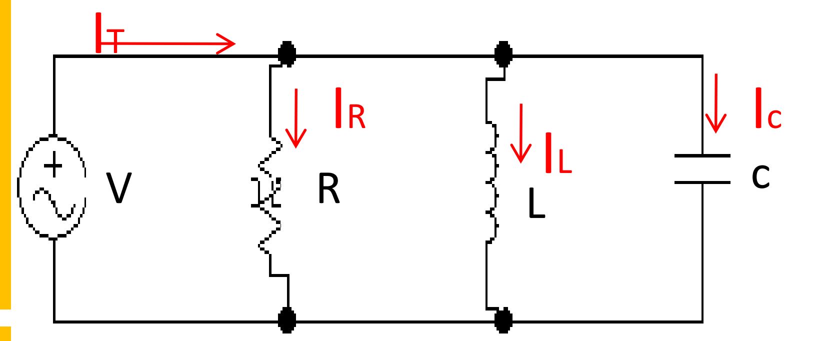
3

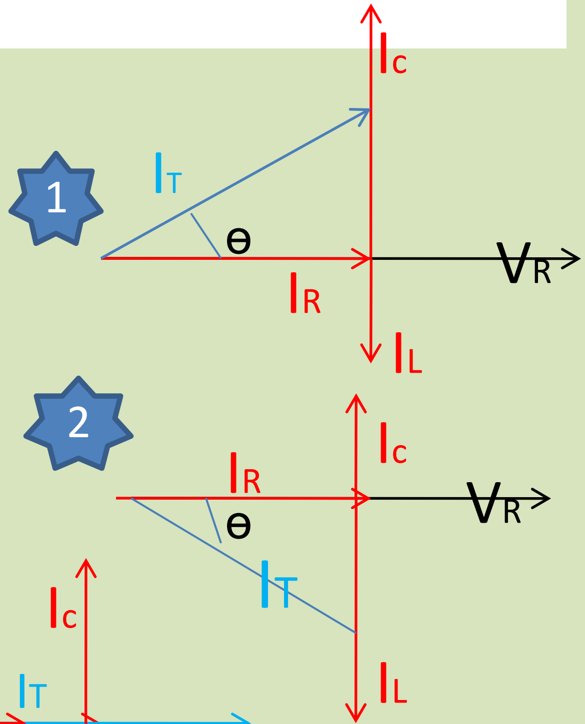
If $X_C = X_L$ (Resonance Parallel case) :. $I_c = I_L$:. $I_T = I_R$

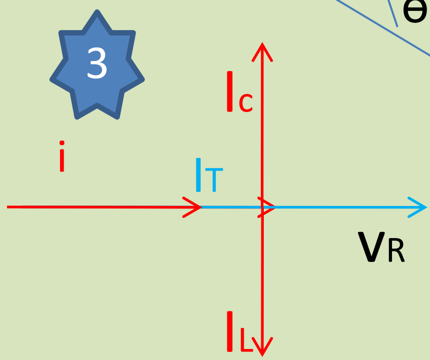
$Z_T = 1/\sqrt{(1/R)^2}$:. $Z_T = R$, $V_T = I_T . Z_T$, $\theta = 0$

$f_r = 1/ 2.\pi . \sqrt{L . C}$ HZ

f_r: (Resonance Parallel frequancy)

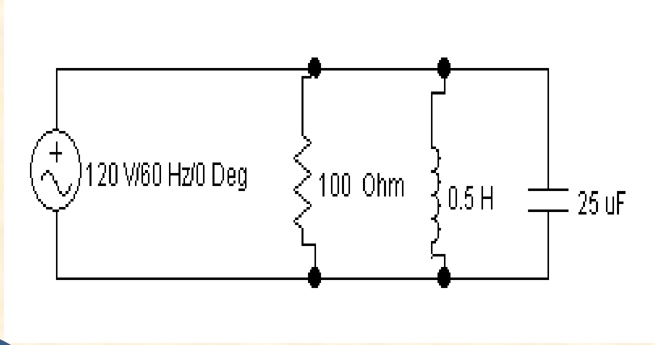






Example(3):

For the parallel cct. Shown in figer find : 1/ The total current 2/ phase angle 3/ Impedance of the cct. 4/ phase diagram .



solution

$I_R = V/R = 120/100 = 1.2A$, $X_c = 1/2\pi f.c = 1/2\ \pi\ x60x25x10^{-6}$

:. $X_c = 100\Omega$, $I_c = V/X_c = 120/100 = 1.2A$, $X_L = 2\ \pi f.L = 2\ \pi x60x0.5$

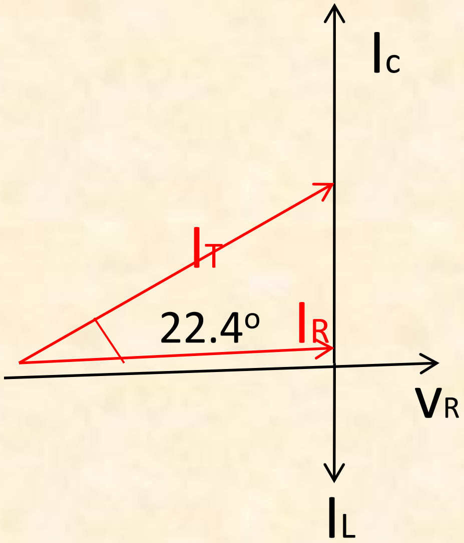
:.$X_L = 188.4\Omega$, $I_L = V/X_L = 120/188.4 = 0.63A$

$I_c - I_L = 1.2 - 0.63 = 0.57A$:. $I_T = \sqrt{I_R^2 + (I_c - I_L)^2}$

:.$I_T = \sqrt{(1.2)^2 + (0.57)^2}$:. $I_T = 1.3A$,

$\theta = \tan^{-1} I_c - I_L / I_R = \tan^{-1} 0.57/1.2 = 22.4^o$

$Z = V/I_T = 120/1.3 = 92\Omega$



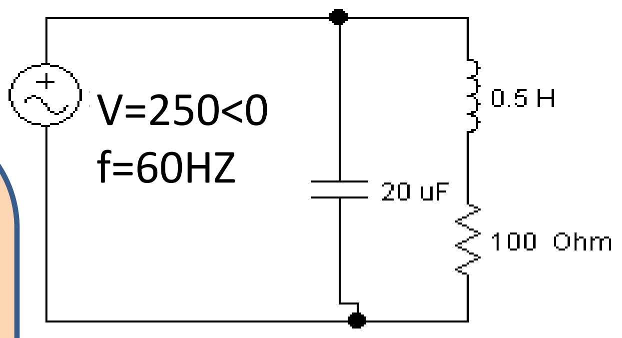
Posttest

Ex: For the cct. Shown in figer find 1) the source current I_T .
2) Active and reactive power and apparent power

Solution

$X_L=2\pi x60x0.5=188\Omega$

$X_c=1/2\ \pi x60x20x10^{-6}\ =132.6\Omega$



$Z_L=\sqrt{(1002+188^2)}=213\,\Omega$, $\theta=\tan^{-1} 188/100=62^o$

$Z_L=213<62^o\ \Omega$, $Z_C=132.6<-90^o$

$I_L=V/Z_L=250/213<62=1.17<-62$ A

$I_C=V/Z_C=250/132.6<-90^o=1.88<90A$, $I_T=I_L+I_C$

:. $I_T=1.88<90+1.17<-62$

:. $I\cos\theta=1.17x\cos -62+1.88x\cos 90=0.423A$

$I\sin\theta=1.17x\sin -62+1.88x\sin 90=0.79A$

:. $I_T=\sqrt{(0.423)^2+(0.79)^2}=0.896A$

$\theta=\tan^{-1}\ 0.79/0.423\ =61.8^o$:. $I=0.896<61.8A$

P=I.Vcos ɵ =250x0.896xcos61.8=105.73 watt (Active power)
Q=I.Vsinɵ =250x0.896 xsin61.8 =197.4 var (Reactive power)
S=V.I =250x0.896=224 V.A (Apparent power)

ألأسبوع الثالث عشر

استخدام التوصيف (J- operator) لحساب العناصر الكهربائية

- النظرة الشاملة over view

A- Population target

الفئة المستهدفة

 Student of first year

of

Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

Aim of lecture:

To make students able to use the (J-operator) to find total impedance college and college permittivity and the current and voltage and phase angle of circuits linking oppositions series and parallel.

pretest

Define :

Impedance , admittance .

And what the units them

Solution :- (Impedance) is obstruction shown by the circuit the Tar passing through and measured in Ohms.

(Permittivity or – admittance) is portability circuit to allow electrical current to pass through them and measured in semens (S) .

السماحية أو المسايرة

تعرف السماحية او المسايرة بانها النسبة بين التيار والفولتية ورمزها Y ووحدة قياسها هي السيمنس s

$Y = I / v$, $Y = 1/Z$

$B = 1/X$ mho , $G = 1/R$ mho

G= (مو) التوصيلية,B = الموصلية(مو)

$Z = R + jX$ (Ω)

$Y = 1/(R+jX) = G + JB$ (s)

In series connection : $Y = 1/Y_1 + 1/Y_2 + 1/Y_3 + \ldots\ldots. 1/Y_n$ (if n = any number)

In parallel connection : $Y = Y_1 + Y_2 + Y_3 + \ldots\ldots + Y_n$

Ex(1) : Find the equivalent impedance for impedances(4+j3) , (3 – j4) , (5 – j5) when connected sometimes in parallel and the other in series .

Solution:

أولا :لحساب الممانعة في حالة ربط التوازي نقول :

$1/Z_T = 1/Z_1 + 1/Z_2 + 1/Z_3$

:. 1/ZT = 1/ (4+j3) + 1/ (3 – j4) + 1/ (5 – j5)

بالضرب في مرافقات المقامات للبسط و المقام ينتج

$$\frac{1}{Z_T} = \frac{4-J3}{4^2-3^2} + \frac{3+J4}{3^2+4^2} + \frac{5+J5}{5^2+5^2} = \frac{4-J3}{25} + \frac{3+J4}{25} + \frac{5+J5}{50} = \frac{8-J6+6+J8+5+J5}{50}$$

$$= \frac{19+J7}{50} \qquad \therefore z_t = \frac{50}{19+J7}$$

وبضرب هذه المعادلة بالمرافق نحصل على :

$$z_t = \frac{50(19-J7)}{19^2+7^2} = 0.122(19-J7)$$

=0.122 X 20.24<-20.22Ω

=2.469<-20.22Ω

ثانيا : في حالة ربط التوالي لحساب الممانعة نقول :

$Z_T = Z_1 + Z_2 + Z_3 \;\; = 4+j3+3-j4+5-j5 \;\; = 12-j6\Omega$

ثالثا : لحساب السماحية الكلية في حالة التوازي نقول :

$Y = 1/Z$ mho $\quad$:. $Y = 4+j3+3-j4+5-j5 = 12-j6$ mho

رابعا : لحساب السماحية الكلية في حالة التوالي نقول :

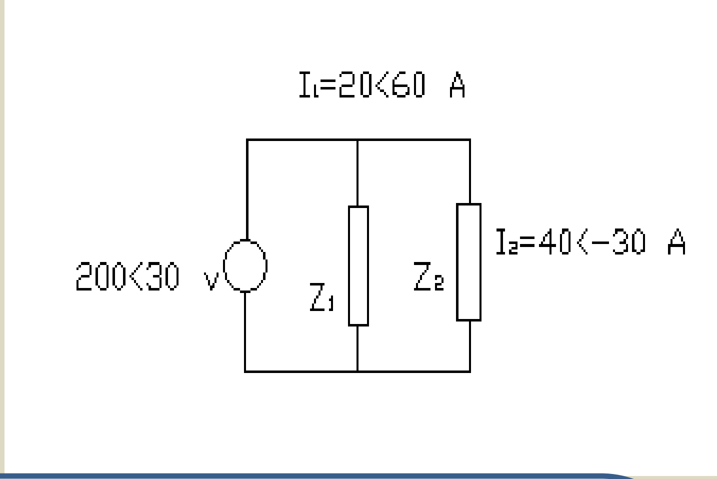
$Y_1 = 1/Z_1 \;,\; Y_2 = 1/Z_2 \;,\; Y_3 = 1/Z_3$

$1/Y = 1/Y_1 + 1/Y_2 + 1/Y_3$

Or: $Y_T = 1/Z_T$ $\quad$:. $Y_T = 1/(12-j6) = (12+j6)/\{(12-j6)(12+j6)\}$

:. $Y_T = (12+j6)/(144+36) = (12+j6)/180 = 0.066 + j0.033$ mho

Ex(2) : Two impedance connected in parallel . The currents flow at each branch is 20<60 A , 40< -30 A , if the voltage 200<30 v , Find the Total impedance and the admittance of the cct .



solution

$Z_T = V / I$, $I = I_1 + I_2$

$I_1 = 20\angle 60 = 20\cos 60 + j20\sin 60 = (10+j17.3)A$

$I_2 = 40\angle -30 = 40\cos(-30) + j40\sin(-30) = 34.6 - j20A$

$I = I1 + I2 = 10 + j17.3 + 34.6 - j20 = (44.68\angle -3.46A)$

$Z = V/I = 200\angle 30 / 44.68\angle -3.46 = 4.47\angle 33.46 = (3.72 + j2.46)\Omega$

$Y = 1/Z = 1/4.47\angle 33.46$

$Y = 0.223\angle -33.46$

$Y = 0.18 - j0.123$ moh

Posttest

Ex(3) : Find the impedance to the cct when the voltage supply equal to (100+j50 v) , and the current is flow in it equal to (4.5+j12 A) .

solution

V=100+j50 ,

:. V = 111.8<26.56 v

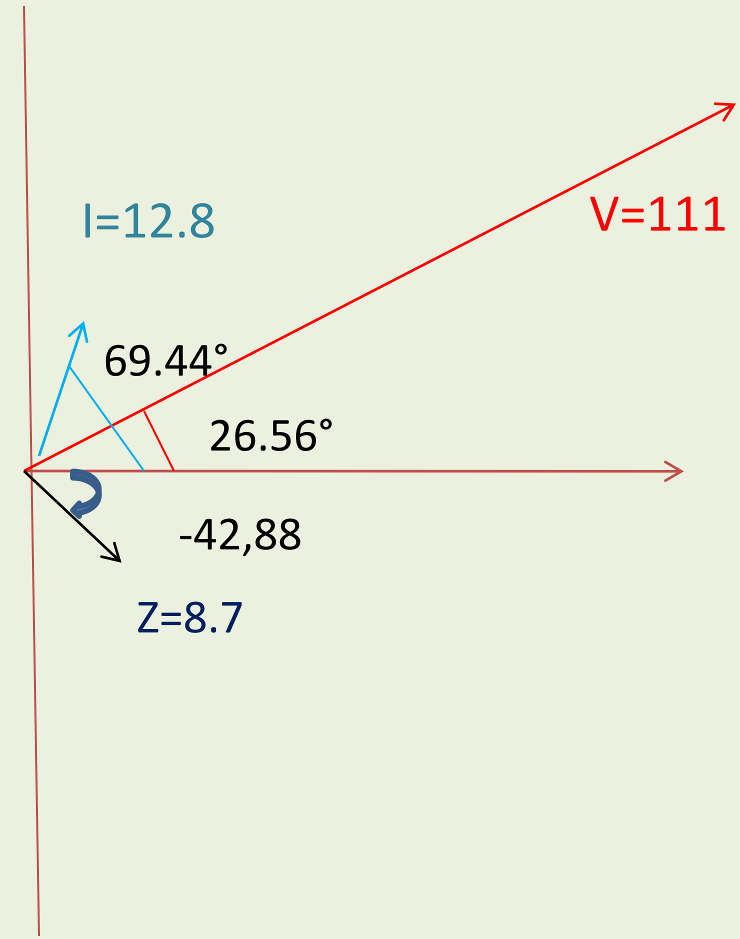
I=4.5+j12 A ,

:. I =12.8 <69.44 A

Z=V/ I =111.8<26.56/12.8<69.44

=8.7 <-42.88Ω

= (6.37 – j5.92)Ω



الأسبوع الرابع عشر
رنين التوالي
series resonance

- النظرة الشاملة over view

A- Population target

الفئة المستهدفة

 Student of first year
of
Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

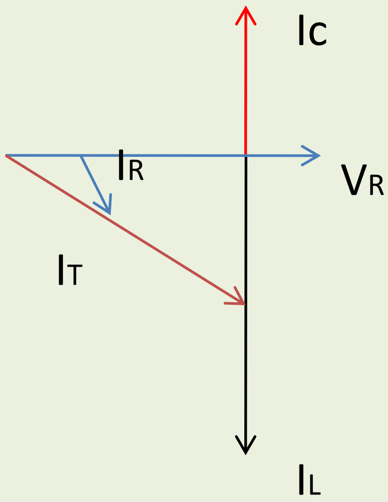
Aim of lecture

To make students able to learn circuits respectively ringing and how to access them, and calculate the current and voltage and impedance at resonance condition, as well as finding the bandwidth and find a quality factor and how to draw a relationship between the inductive reactance and capacitive reactance with frequency.

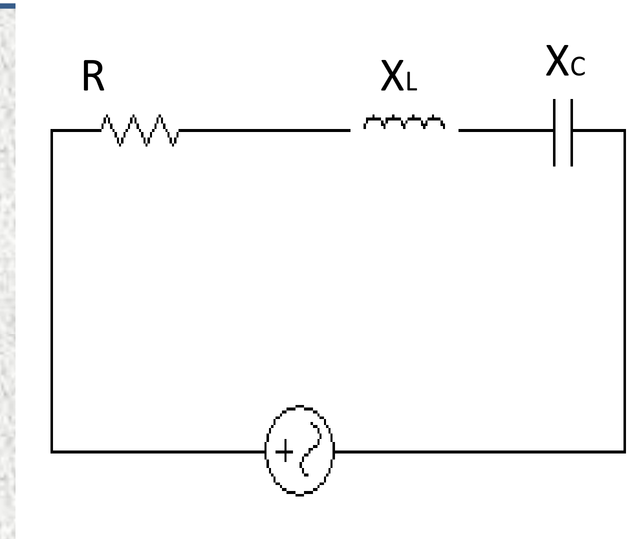
pretest

Ex: Draw the phaiser diagram at parallel circuit contain (L,c) If $X_L > X_C$

solution



If $X_L=X_C$;. $V_L=V_C$



When $X_L= X_C$

Resonance series frequency

XL=XC

:.2∏fo.L=(1/2∏fo.C)

:.fo^2 =(1/4$∏^2$ L.C)

fr=fo=1/ 2.π. $\sqrt{L . C}$ HZ

The energy stord in the coil(w,e)

$W=(1/2)\ L.I^2_m$ joule

We have **resonance case when**

1/ $X_L=X_C$

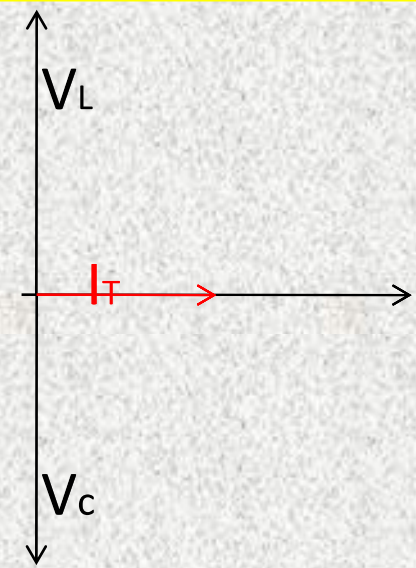
2/Z =R

3/ $V_L=V_c$

4/ $V_T=V_R$

5/ Ɵ =0

6/ Imax is flow



Quality factor (Q operator) : - It is the relation between reactive and active power at Resonance case

1) $Q = I^2 . X_L / I^2 . R$ **$:. Q = X_L/R$** 2) $Q = 2\pi f_r.L / R = 2\pi (1/2\pi \sqrt{L.c}) .L / R$

$:. Q = \omega_r.L/R = 2\pi f_r.L / R$ { When resonance case :. $X_L = X_c$ $:. \omega_r.L = 1/\omega_r.c$ }

$:. Q = (1/R) . \sqrt{L.c}$

$:. Q = 1/\omega_r.R.C = \omega_r.L/R = (1/R) \sqrt{L.c}$

Band width (B.w) OR Pass Band

$B.w = f_2 - f_1$

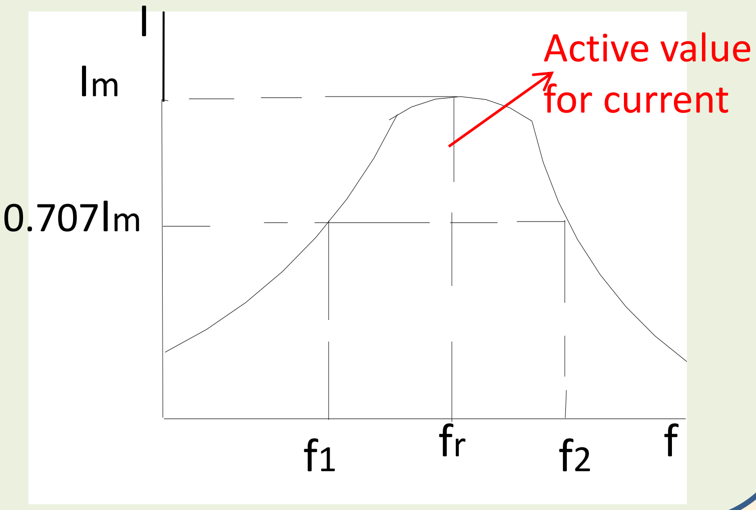
$I_{r.m.s} = I_m / \sqrt{2} = 0.707\, I_m$

$f_r = \sqrt{f_1 \times f_2}$, $Q = f_r / B.w$

For the cct. Have $Q \geq 10$

$\{f_2 = f_r + B.w/2$, $f_1 = f_r - B.w/2\}$ because :

$F_r = 1/2\pi \sqrt{L.c}$



Q factor of a series resonant cct. Reconsider the equations for I, VL and Vc at resonance

$V_L = I.X_L$, $I = V/R$, $V_L = (V/R).X_L$, Or :

$V_L/V = X_L/R$ .....(1)

similarly ; $Vc/V = Xc/R$

The ratio (capacitor voltage ,voltage, or inductor voltage at resonancy/ (supply voltage)is a measure of the quality of a resonance cct.

This is termed the (Q) factor of the cct and it is also known as the voltage magnification factor .

From equ. (1);

$Q = \omega.L/R$ ...(2) and $Q = X_c/R$ giving $Q = 1/\omega.C.R$

Since the coil resistance is often the only resistance in a series resonance cct, the (Q) is some times referred to as the (Q) factor of the coil, Rewriting equation....(2)

$Q = (2\Pi.f_r.L)/R$ and substituting for fr from equation : $f_r = 1/(2\Pi\sqrt{L.c})$

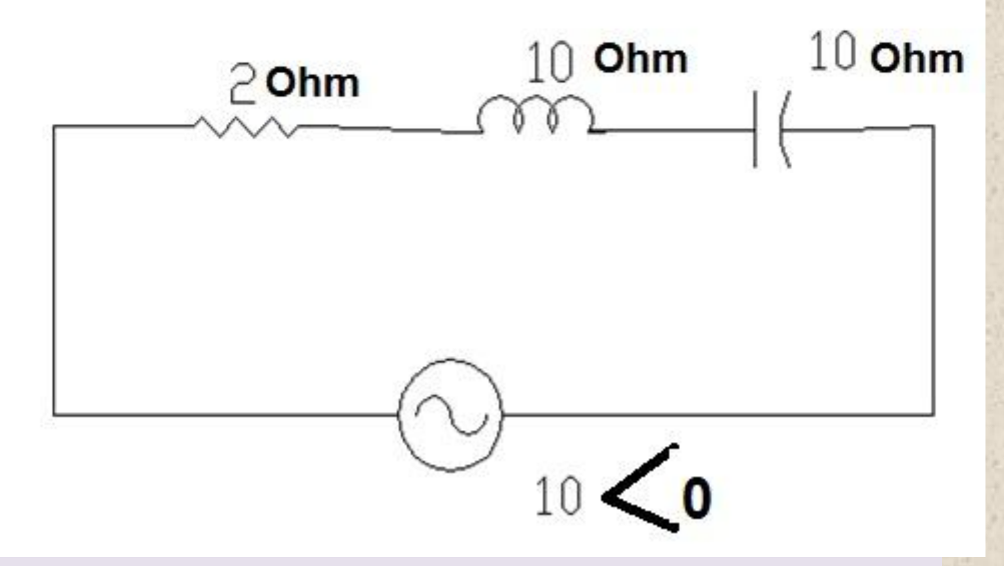
$\therefore Q = [2\Pi.L(1/2\Pi\sqrt{L.c})]/R$ which reduces to ; $Q = 1/R(\sqrt{L}/C)$

It is seen that the Q factor of a series resonance cct. May be increased either by reducing (R)
Or by increasing the L/C ratio .

The Q factor can also be defined in terms of the ratio of the reactive power to the power dissipated in the cct. Resistance. Using this the equations for Q come out exactly as derived above .

Ex.1 For the resonance cct. Shown below find :

1) I,VR,VL,Vc , in polar form . 2) The quality factor .
3) The band width B.W if the resonance frequency (5000)HZ .
4) The Band width (B.W) if the resonance frequency (500) HZ.



Solution :

1) $X_L=X_C$ (resonance case) , Z_T= R=2 , I= V/Z= 10 <0/2<0= 5<0 A
V_R= I.R=5<0x2<0=10<0 V. , V_L= I.X_L= 5<0x10<90=50<90 v
V_c= I.X_c= 5<0x10<-90=50<-90 v , **2)** Q= X_L/R= 10/2=5
3)B.W=f_r/Q=5000/5=1000Hz , **4)** B.W=f_r/Q=500/5=100Hz

Ex2;The band width of a series resonance cct. Is (400Hz), R=10Ω Find : Q , XL , L , C

solution :

Q = fr/B.W =4000/400 =10 , $Q=X_L/R$

:. $X_L=$ Q.R=10.10=100Ω

$X_L=2\prod.f.L$, $L = X_L/2\prod.f = 100/(2(3.14)4000) = 0.0039$ H

in resonance case : $X_L=X_c$

:. $X_C= 1/(2\prod f.c)$, :. $C= 1/ (X_c(2\prod)f)$

$C= 1/(100(2)(3.14)\ 4000)=0.39x10^{-6}$ F

Ex 3:. A series L-c-R cct. Which resonates at (fr) =500kHZ , has L=100 μH, R=25Ω ,and C=1000P.f . Deter mine the (Q) factor of the cct. Also , determine the new value of (C) required for resonance at (500 KHz) when the value of (L) is doubled (تضاعف) and calculate the new (Q) factor .

Solution : $Q=1/R(\sqrt{L/C})$,$Q = (1/25\Omega) (\sqrt{100\ \mu H/1000 p.F}) =12.6$

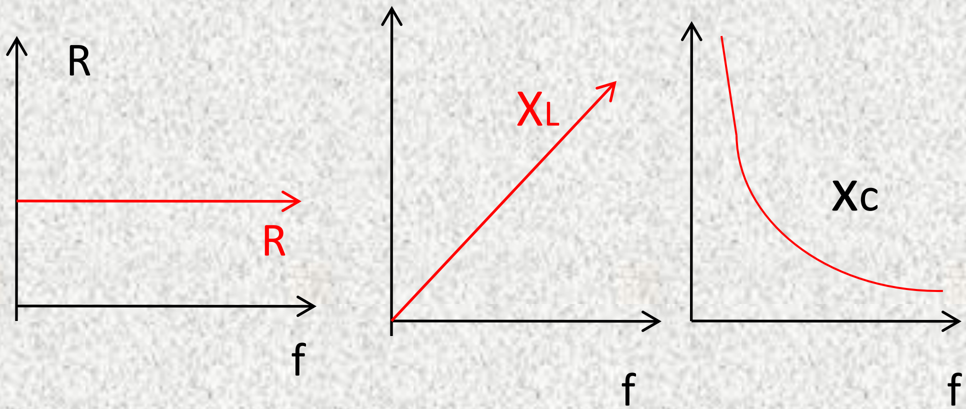
When : L is doubled:

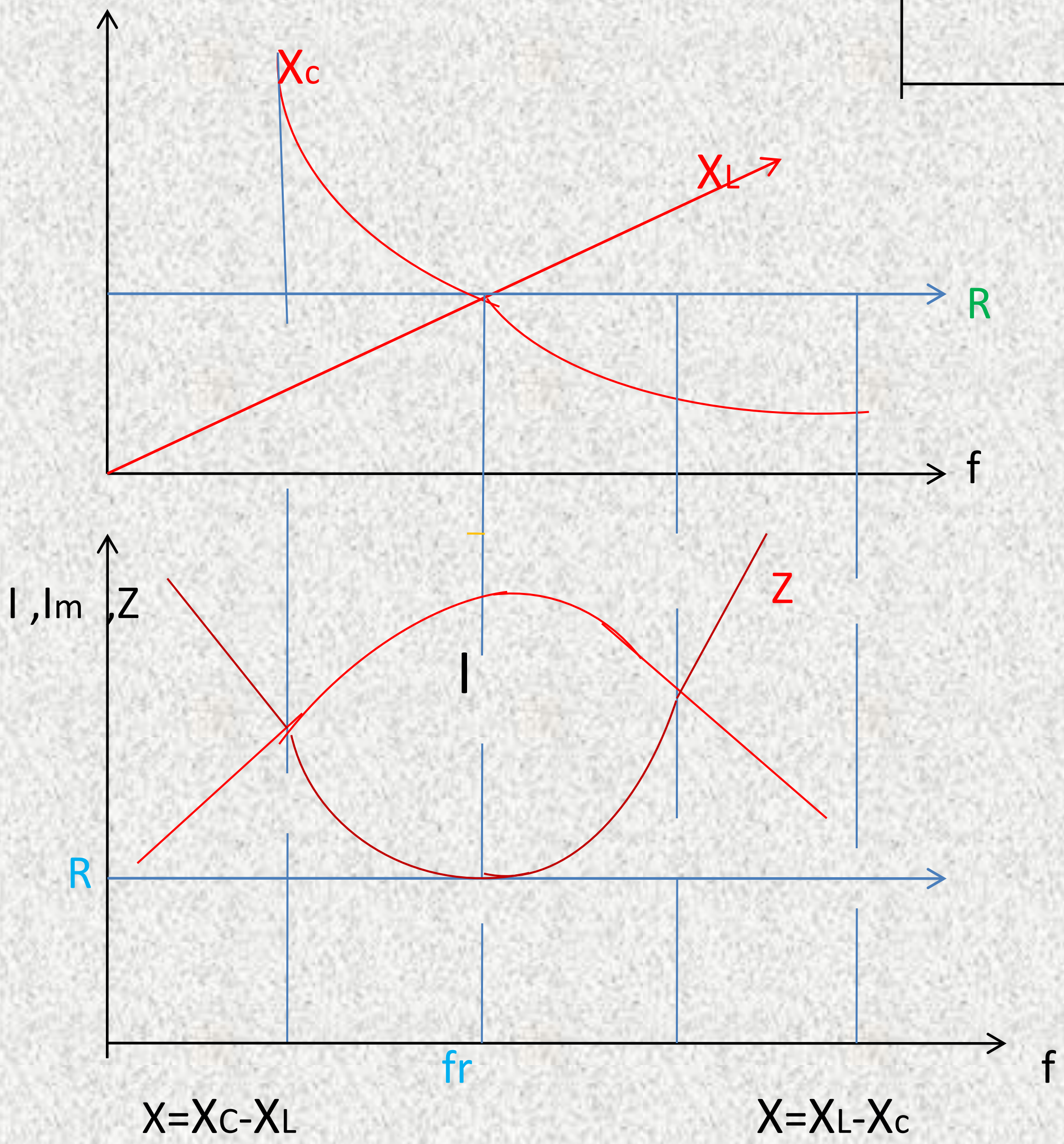
$f_r = (1/2\pi)(\sqrt{L.C})$, :. $C= 1/(4\pi^2 x\ f_r^2 x L) = 1/[4\pi^2 x(500kHz)^2 x200\mu F]$

:. C=500P.F

$Q^2=(1/25)(\sqrt{200\mu H/500p.f})$, :. Q =25

Impedance and frequency Relation ship

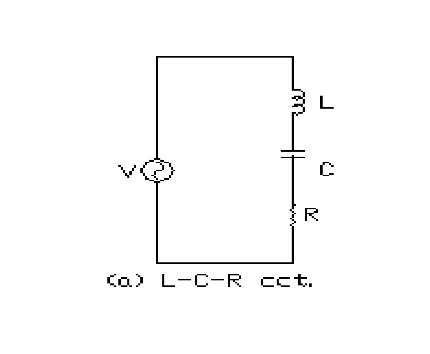


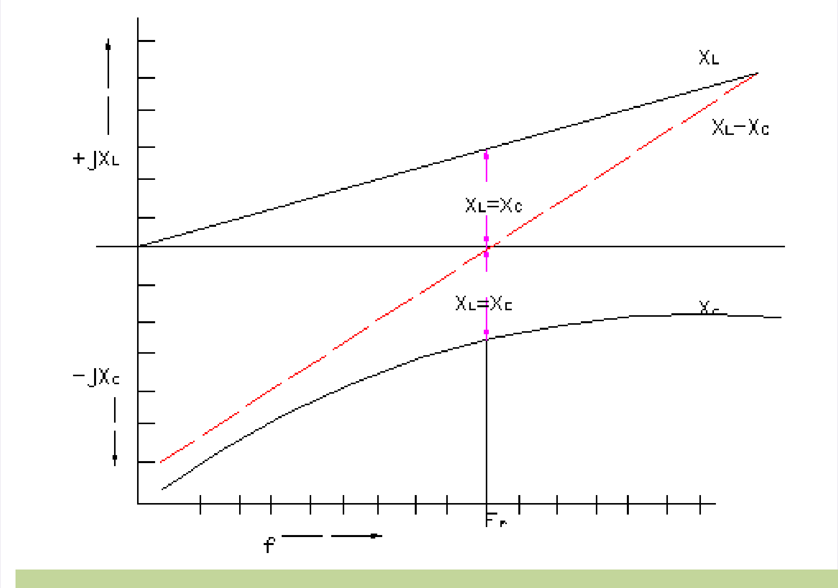


The relation ship between (Z, I , θ) with frequency (f) For (L-C-R)ccts.
ألعلاقة بين (الممانعة , ألتيار, زاوية ألطور) مع التردد في دوائر (ملف - متسعة – مقاومة)التوالي

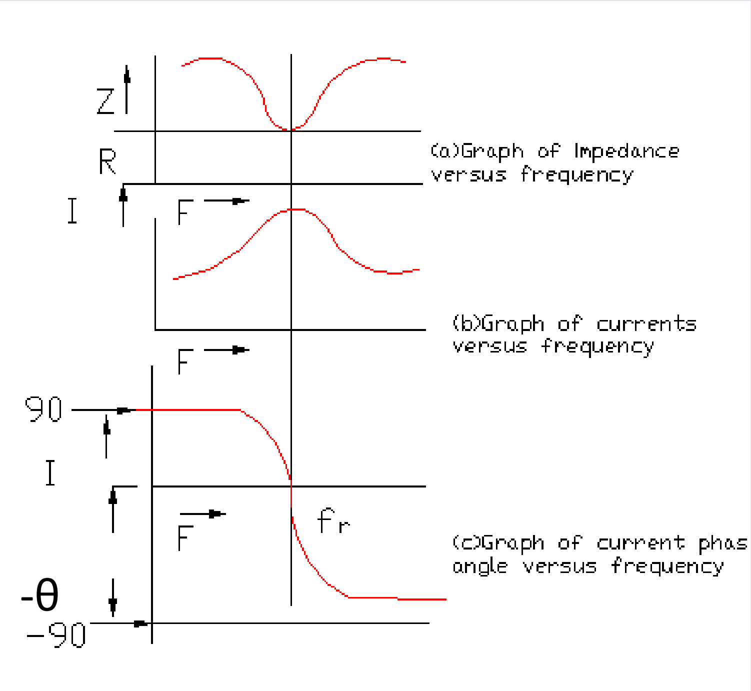
A series L-C-R cct has a minimum Impedance at thr resonance frequency.

$I= V/[R+j(X_L-X_c)]$





X_L,X_C and (X_L _ X_C) Plotted versus frequency



ألمنحنيات تمثل ألعلاقة بين كلا من الممانعة , ألتيار ,وزاوية ألطور مع ألتردد

Because $Z= R+J(X_L - X_c)$,The Impedance dips to (R) at Fr and

the current peaks . (I_{max})

$\theta=0$ at fr θ Leading below fr, and is lagging above fr ,

When θ =The current phase angle.

$|I| = V/\sqrt{R^2 + (X_L - X_C)^2}$, with out reference to its phase angle .

Thus at resonance when XL=Xc ,the current equation becomes , $I = V/R$

من ألمنحني (b) ألذي يبين علاقة التيار بالتردد . أن ألتيار أقل مايمكن عند الترددات أعلاه وأقل عند ألرنين لكن قيمة ألتيار تحصل عندما ألممانعة أقل مايمكن (أعلى قيمة للتيار عندما تكون ألممانعة أقل قيمة لها) .

As already noted from (b) the impedance of the series L-C-R cct. Is largely capacitive at frequencies well be low resonance. This means that the cct. Current leads the applied voltage by a phase angle of approximately 90 ^{o}. Conversely, because the impedance is largely inductive at frequencies much greater than the resonance frequency, the phase angle of the current above resonance is approximately -90^o

The graph of phase angle versus frequency for the series L-C-R cct (C) shows the 90o leading phase angle at low frequencies, changing to 0 o at the resonance frequency, and moving to a lagging phase angle above (fr)

$X_L=2\prod f_r.L$, $Xc=1/(2.\prod.f_r .C)$, $2.\prod f_r.L=1/2\prod.f_r.C$

:. $Fr^2= 1/(2\prod)^2.L.C$

and $fr = 1/(2\prod.\sqrt{L.C})$ HZ When L and C are in henrys and farad, respectively, Equation gives fr, in hertz .

واعتياديا اذا لاحظنا الشكلb , ممانعة التوالي L-C-R
تكون اكبر من ألمتسعة في الترددات بينما ألرنين أقل مايمكن

EX(4) . A series L-c-R cct. Which resonates at (fr) =500kHZ , has L=100 μH, R=25Ω ,and C=1000P.f . Deter mine the (Q) factor of the cct. Also , determine the new value of (C) required for resonance at (500 KHz) when the value of (L) is doubled (تضاعف) and calculate the new (Q) factor .

Solution :

$Q=1/R(\sqrt{L/C})$, $Q = (1/25\Omega)(\sqrt{100\ \mu H/1000p.F}) = 12.6$

When L is doubled:

$f_r = (1/2\pi)(\sqrt{L.C})$, $\therefore C = 1/(4\pi^2 x\ f_r^2 x L) = 1/[4\pi^2 x (500kHz)^2 x 200\mu F]$

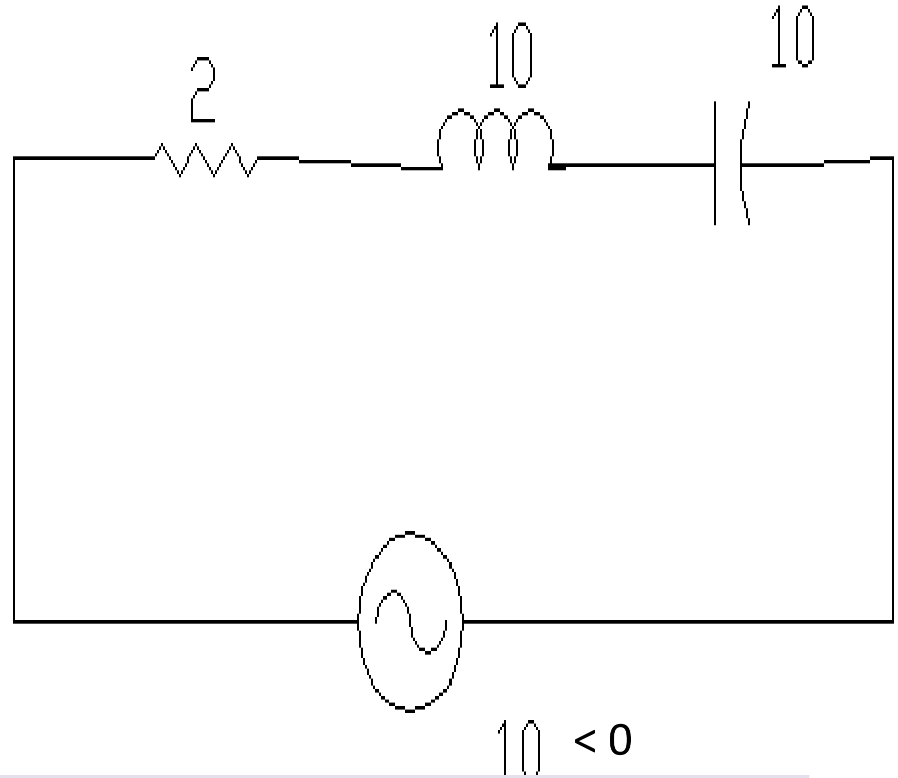
$\therefore C=500P.F$

$Q^2=(1/25)(\sqrt{200\mu H/500p.f})$, $\therefore Q = 25$

Posttest

Ex.5 For the resonance cct. Shown below find :

1) I,VR,VL,Vc , in polar form .
2) The quality factor .
3) The band width B.W if the resonance frequency .
4) The Band width (B.W) if the resonance frequency (500 HZ)



Solution :

$X_L = X_C$ (resonance case) , Z_T= R=2 , I= V/Z= 10 <0/2<0= 5<0 A

V_R= I.R=5<0x2<0=10<0 V. , V_L= I.X_L= 5<0x10<90=50<90 v

V_c= I.X_c= 5<0x10<-90=50<-90 v , Q= X_L/R= 10/2=5

B.W=F_r/Q=5000/5=1000Hz

Ex6;The band width of a series resonance cct. Is (400Hz), R=10Ω Find : Q , XL , L , C

solution : Q= fr/B.W =4000/400 =10 , $Q=X_L/R$

:. X_L= QxR=10x10=100Ω

X_L=2∏.F.L , :. L =X_L/2∏.f.L =100/(2x3.14x4000)

= 0.0039 Hz

in resonance $X_L=X_c$

:. X_C= 1/(2∏f.c) , :. C= 1/ (X_cx2x∏xf)

= 1/(100x2x3.14x 4000)=0.39x1o-6 F

الأسبوع الخامس عشر
رنين التوازي

- النظرة الشاملة over view

A- Population target

الفئة المستهدفة

- Student of first year
of
Electrical Techniques Department

طلبة قسم التقنيات الكهربائية – السنة الأولى

Aim of lecture

Student to be able to tell the parallel ringing and how to calculate the voltage and current impedance and phase angle and the resonant frequency and bandwidth with the knowledge of drawing graphs relations with the frequency and find the quality factor.

.

pretest

Explain cases that get then resonance series case , and drawing the phaser diagram at this case .

Solution

We have **resonance case when**

1/ $x_L = x_c$

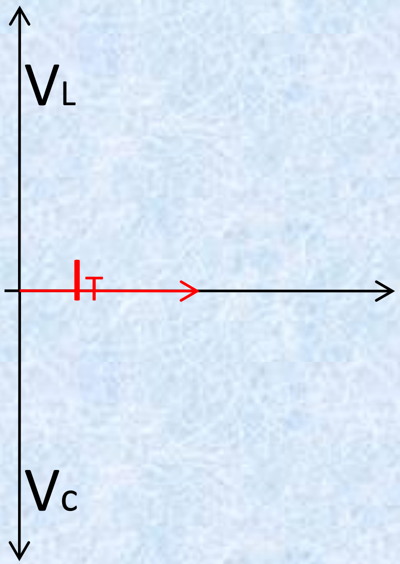
2/Z =R

3/ $V_L = V_c$

4/ $V_T = V_R$

5/ ϴ =0

6/ Imax is flow



رنين التوازي Resonance Parallel case

If XC=XL :. (Resonance Parallel case)

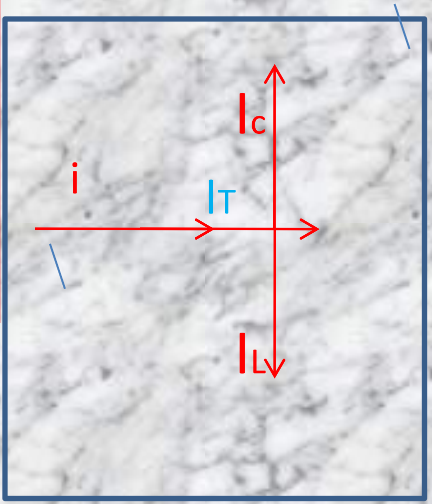
:. $I_c=I_L$:. $I_T= I_R$

$Z_T= 1/\sqrt{(1/R)^2}$:. $Z_T= R$, $V_T= I_T.Z_T$, VT=IT.R , θ=0

$f_{r}= 1/\ 2.\pi.\sqrt{L.C}$ HZ

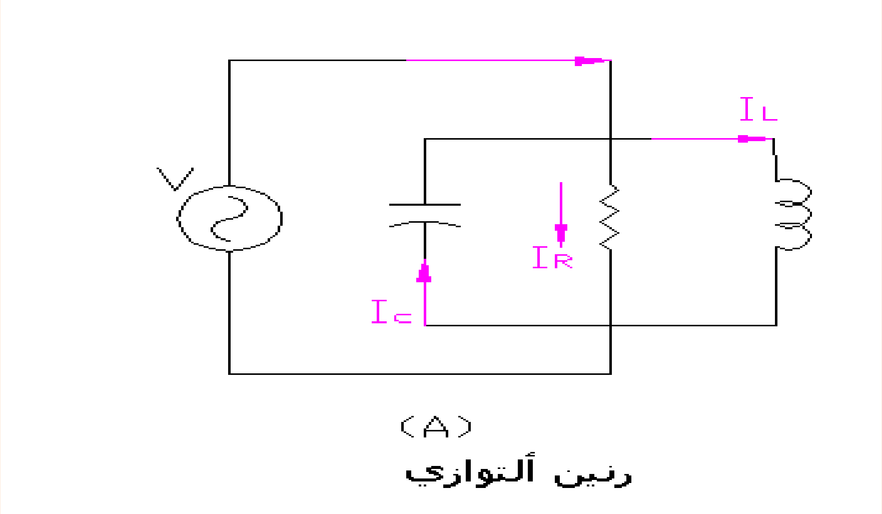
f_r: (Resonance Parallel frequency)

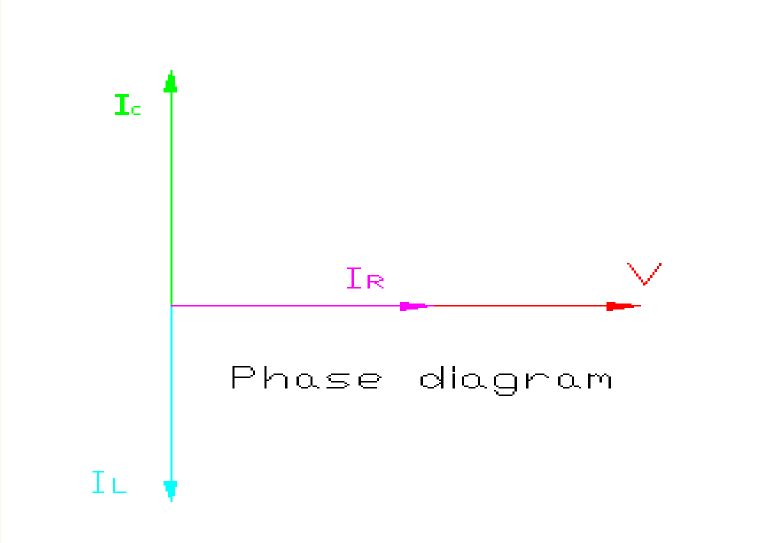
i

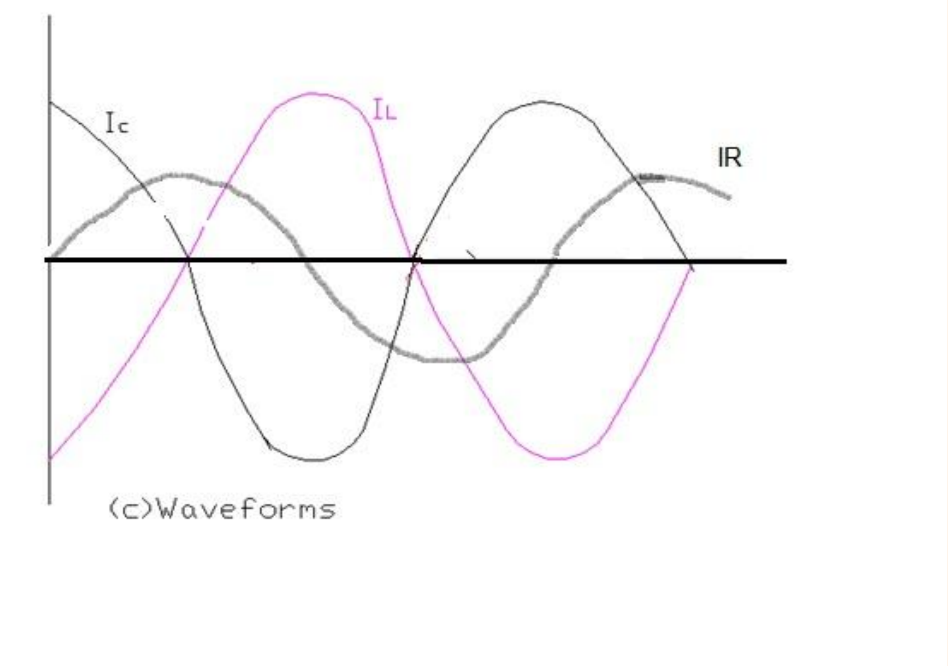


Parallel resonance :

$Y=(1/R) - j(1/X_L) + j(1/X_c)$





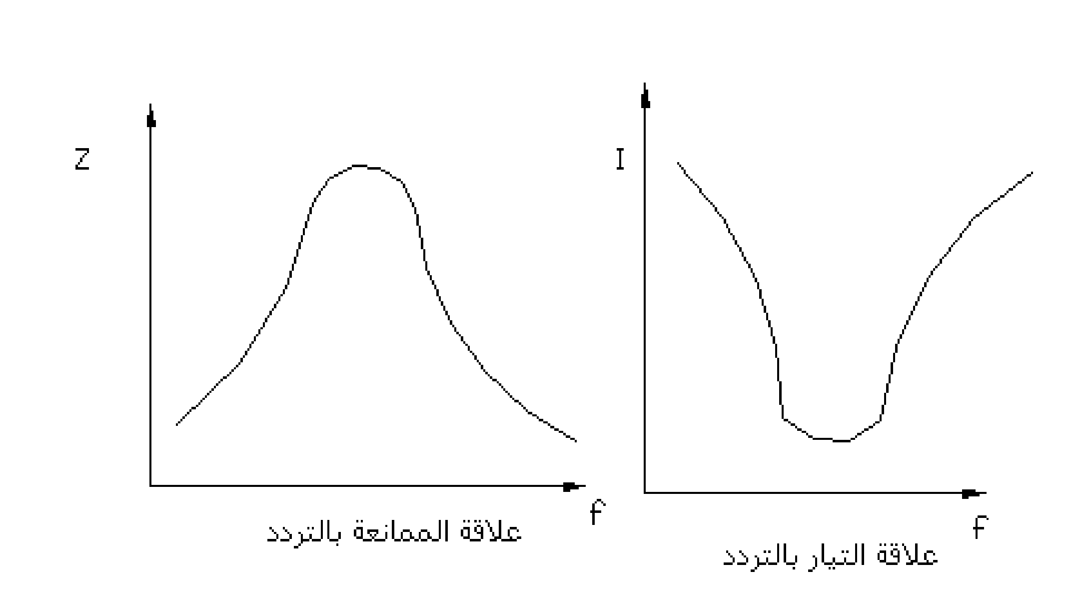


I_R with the same phase with (v) , If the supply frequency is adjusted until X_L and X_c are equal, the admittance becomes: Y=1/R , and the cct. Impedance, R=Z . Consequently, the current taken from the supply source is I=V/R

The current through (R) is in phase with the supply voltage. The current through (L) lags the supply voltage by 90^o . This is illustrated by the phaser diagram (b), and by the cct. Wave forms in figure (C) .When X_L X_c are equal, the inductive and capacitive currents are equal and opposite, as illustrated in the phaser diagram. Thus, the total current supplied by the voltage source is I_R ,I_c and I_L are the result of the energy stored in the cct. Being continuously transferred from the inductor to the capacitor , and back again .

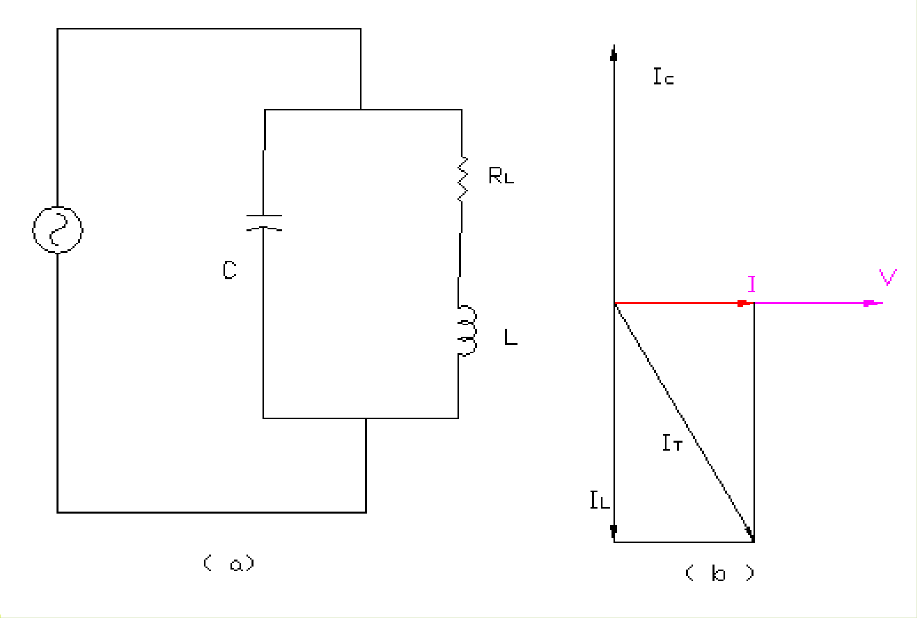
A parallel L- C ccts has a maximum impedance at the resonance frequency

عندما ناقشنا رنين التوالي وجدنا إن الممانعة أقل في حالة التوازي والتيار ألمنحدر ألمأخوذ من المصدر في حالة الرنين كالمبين



Ex(1). L-c cct has R=5.5 Ω , L=68μH , C adjustable from 200 p.f to 1200 pf ,and stray (يشوش) Capacitance of 30 p.f in parallel with C . Determine the maximum cct impedance at resonance.

عند ملاحظة المخطط (b) نلاحظ ان ألتيار ألكلي يرسم من ألمصدر في حالة الرنين هو (I) والذي هو بنفس الطور لفولتية المصدر كذلك ألتيار أقل بكثير من تيار المتسعة وتيار الملف . لذا يكون في حالة رنين التوازي ألتيار أعظم قيمة وهذا مشابه لاعظم قيمة للفولتية في حالة رنين ألتوالي
ألعامل (Q) أو معامل ألتيار ألاعظم لدائرة رنين ألتوازي يمكن تحديدها كنسبة بين تيار الملف أو تيار المكثف ألى ألتيار الكلي



$$I=I_L.\cos\theta = I_L(R_L/X_L) \quad , \quad Q = I_L/I = X_L/R_L \, ,$$
$$Q=\omega.L/R_L \quad ......(3)$$

The eq.(3) is exactly the same as the (Q) factor equation for a series resonant cct. That is the (Q) is

Again the (Q) factor of the inductance.

Resonance frequency

In equation $Xc= (R_L^2+X_L^2)/X_L$ ....(4) IN cct (a) above:
$Y=[1/R_L+jX_L]+ j(1/Xc)$,(نضرب بالمرافق) (R L- jXL)/(RL-jXL):
$Y=[R_L/(R_L^2+X_L^2)] – j[X_L/(R_L^2+X_L^2)] +j\, 1/Xc$, $1/Xc= X_L/(R_L^2+X_L^2)$, Or
$Xc= (R_L^2+X_L^2)/X_L$

When $Q > 10$, $X_L^2 >> R_L^2$ also $X_c=X_L$

This gives the resonance frequency for a parallel L-C cct for Q > 10 :-
$f_r=[1/(2\pi.\sqrt{L.C}$) ....(5) this is the same as in series resonance frequency .

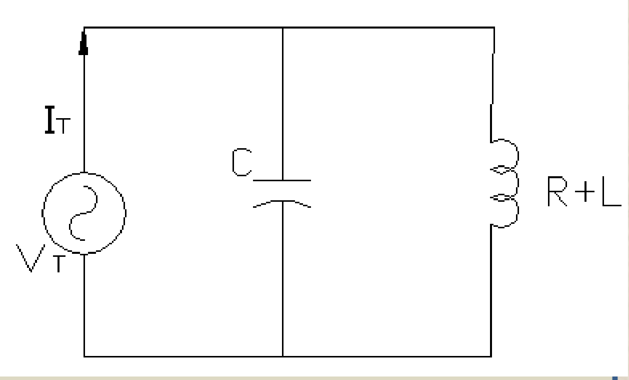
المعادلة (5) لانطبق في حالة ألتوازي عندما (Q) أقل من (10) . وقيمة (f_r) في حالة ألتوازي يمكن أن يكون

$Fr=1/2\pi.\sqrt{L.C}\ x\sqrt{1-(CRL^2/L)}$

The band width of a parallel resonanant cct. Determined in exactly the same way as that for a series resonant cct.

$\Delta f= f_r/Q$

Resonance in parallel cct. s



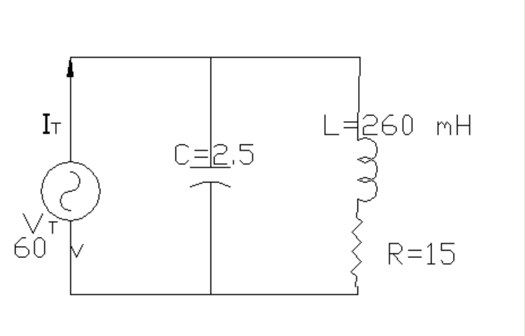
We will consider the practical case of a coil in Parallel with a capacitor as shown

$$Fr = (½∏)\sqrt{(1/L.c) - (R^2/L^2)} \quad .....(1)$$

, If the coil resistance is very small , so the equation of the resonance frequency . Will be :

$$Fr = 1/(2∏\sqrt{L.C}) \quad ....(2)$$

Ex(2) : For the cct shown below find the resonance frequency .



Solution: $F_r = (½∏)x\sqrt{(1/L.c) - (R^2/L^2)}$, = 197 HZ

Post test

Ex(3) : An inductive cct. Of resistance 2Ω and inductance 0.01H is connected to a 250 mho , 50 Hz .
What is the value of the capacitance should be placed in parallel to produce resonance ?

Solution : $F_r = (1/2\pi)[\sqrt{(1/L.C) - (R^2/L^2)}$

, $50 = (1/2\pi) x \sqrt{(1/0.01x\ C) - 4/(0.01)^2}$

:. C=721 μ F