وزارة التعليم العالي والبحث العلمي
الجامعة التقنية الشمالية
المعهد التقني كركوك

الحقيبة التعليمية

القسم العلمي: التقنيات الميكانيك/ انتاج

اسم المقرر: تكنولوجيا كهرباء

المرحلة / المستوى: الاول

الفصل الدراسي: الاول

السنة الدراسية:2025/2024

معلومات عامة

اسم المقرر:	**تكنولوجيا كهرباء**
القسم:	التقنيات الميكانيك/ انتاج
المعهد	التقني كركوك
المرحلة / المستوى	الاول
الفصل الدراسي:	الاول
عدد الساعات الاسبوعية:	نظري 1 عملي 2
عدد الوحدات الدراسية:	3
الرمز:	METP129
نوع المادة	نظري 1 عملي 2 كلهما 3
هل يتوفر نظير للمقرر في الاقسام الاخرى	كلا
اسم المقرر النظير	/
القسم	/
رمز المقرر النظير	/
معلومات تدريسي المادة	
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اللقب العلمي:	**استاذ مساعد**
سنة الحصول على اللقب	2018
الشهادة :	**دكتوراه**
سنة الحصول على الشهادة	**2013**
عدد سنوات الخبرة (تدريس)	**20 سنة**

الوصف العام للمقرر

يركز على تعليم الأساسيات الضرورية في مجال الكهرباء. يشمل المقرر دراسة المفاهيم الأساسية مثل الجهد، التيار، والمقاومة، وتحليل وتصميم الدارات الكهربائية. يتناول أيضًا التعرف على المكونات الكهربائية الأساسية، مثل المقاومات والمكثفات، ويغطي تكنولوجيا الطاقة، بما في ذلك مصادر الطاقة المتجددة. ويشدد على مبادئ السلامة والأمان في التعامل مع الكهرباء.

الاهداف العامة

- سيتعلم الطالب أساسيات الكهرباء، بما في ذلك الجهد، التيار، والمقاومة، وكيفية تطبيقها في الدارات الكهربائية.
- سيتمكن الطالب من تحليل وتصميم الدارات الكهربائية، وفهم كيفية عمل المكونات الأساسية مثل المقاومات والمكثفات.
- سيتعلم الطالب تكنولوجيا الطاقة، بما في ذلك مصادر الطاقة المتجددة وكيفية استخدامها في التطبيقات العملية.
- سيتعلم الطالب مبادئ السلامة والأمان في التعامل مع الأجهزة الكهربائية وضمان بيئة عمل آمنة.

الأهداف الخاصة

- اكساب المتعلم مهارات اختيار المكونات الكهربائية المناسبة للتطبيقات الهندسية المختلفة بناءً على خصائصها الكهربائية.
- إلمام المتعلم بكيفية تحليل وتفسير سلوك الدارات الكهربائية تحت ظروف مختلفة، مثل التغيرات في الجهد والتيار، وبالتالي فهم كيفية تأثير هذه العوامل على أداء الدارات، مما يساعد في التنبؤ بكفاءتها واستدامتها في تطبيقات متعدد

الأهداف السلوكية او نواتج التعلم

- سيكون الطالب على معرفة بأساسيات تكنولوجيا الكهرباء والمكونات الكهربائية.
- سيتمكن من التميز بين أنواع مختلفة من المكونات الكهربائية مثل المقاومات والمكثفات والترانزستورات.
- سيستطيع إجراء اختبارات وتقييم أداء المكونات الكهربائية في الدارات.
- سيتمكن من التميز بين الأنظمة الكهربائية المختلفة مثل الأنظمة التناظرية والرقمية

المتطلبات السابقة

يحتاج الطالب بعض المفاهيم الاساسية مثل قانون اوم ووحدات التيار والفولطية والمقاومة

الأهداف السلوكية او مخرجات التعليم الأساسية		
ت	تفصيل الهدف السلوكي او مخرج التعليم	آلية التقييم
1	أن يقارن الطالب بين خصائص المكونات الكهربائية المختلفة مثل المقاومات والمكثفات والترانزستورات (مهارة المقارنة والتحليل)**.**	إعداد تقرير مقارن يتناول خصائص المقاومات والمكثفات والترانزستورات، موضحين الفروقات الرئيسية بين هذه المكونات من حيث الأداء والاستخدام.
2	أن ينقد الطالب الأساليب المستخدمة في اختبار أداء الدارات الكهربائية وكفاءتها	تقديم دراسة حالة حول اختبار أداء دائرة كهربائية معينة، وطلب من الطلاب تقديم نقد مفصل للأساليب المستخدمة في اختبار الأداء والكفاءة.
3	أن يشرح الطالب الفرق بين الخصائص الكهربائية والميكانيكية للمكونات المختلفة	تقديم عرض تقديمي أو تقرير يشرح الفرق بين الخصائص الكهربائية والميكانيكية للمكونات المختلفة، مع أمثلة توضيحية.
4	أن يرسم الطالب مخططًا يوضح العلاقة بين أداء الدارات الكهربائية والعوامل المؤثرة مثل الجهد والتيار (مهارة الربط بين المفاهيم)	رسم مخطط يوضح العلاقة بين أداء الدارات الكهربائية والعوامل المؤثرة مثل الجهد والتيار، مع تفسير كيف تؤثر هذه العوامل على الأداء

أساليب التدريس (حدد مجموعة متنوعة من أساليب التدريس لتناسب احتياجات الطلاب ومحتوى المقرر)

الاسلوب او الطريقة	مبررات الاختيار
1. تقديم المحاضرات النظرية:	إلقاء محاضرات تركز على الجوانب النظرية للمادة، مع شرح مفصل للمفاهيم الأساسية
2. .استعمال جهاز العرض (DATA SHOW) استخدام.	جهاز العرض لعرض محتوى تعليمي وشرح المعلومات بشكل بصري
3. . استخدام الفيديوهات التعليمية	عرض مقاطع فيديو توضيحية لتقديم أمثلة عملية وتعزيز الفهم.
4. تطبيق طريقة البحث وإعداد التقارير	تشجيع الطلاب على البحث عن موضوع معين وإعداد تقارير حوله، ثم مناقشة النتائج في الفصل
5. طرح المشكلات وتقديم الحلول	عرض مشكلة معينة على الطلاب ومطالبتهم بتقديم حلول مناسبة ومبنية على تحليل دقيق

الوحدة النمطية الاولى

١- النظرة الشاملة (Over View):

أ- الفئة المستهدفة (Target Population):-

طلبة المرحلة الاولى في قسم الميكانيك

ب- مبررات الوحدة (Rationale):-

الحاجة التعلم الوحدات والرموز الكهربائية وتحليل الدائرة الكهربائية وقانون اوم وتطبيقاته وقانون كيرشوف .

ت- الفكرة المركزية (Central Ideas):-

- الوحدات والرموز الكهربائية
- شدة التيار
- الفولتية
- قانون اوم
- قانوني كيرشوف

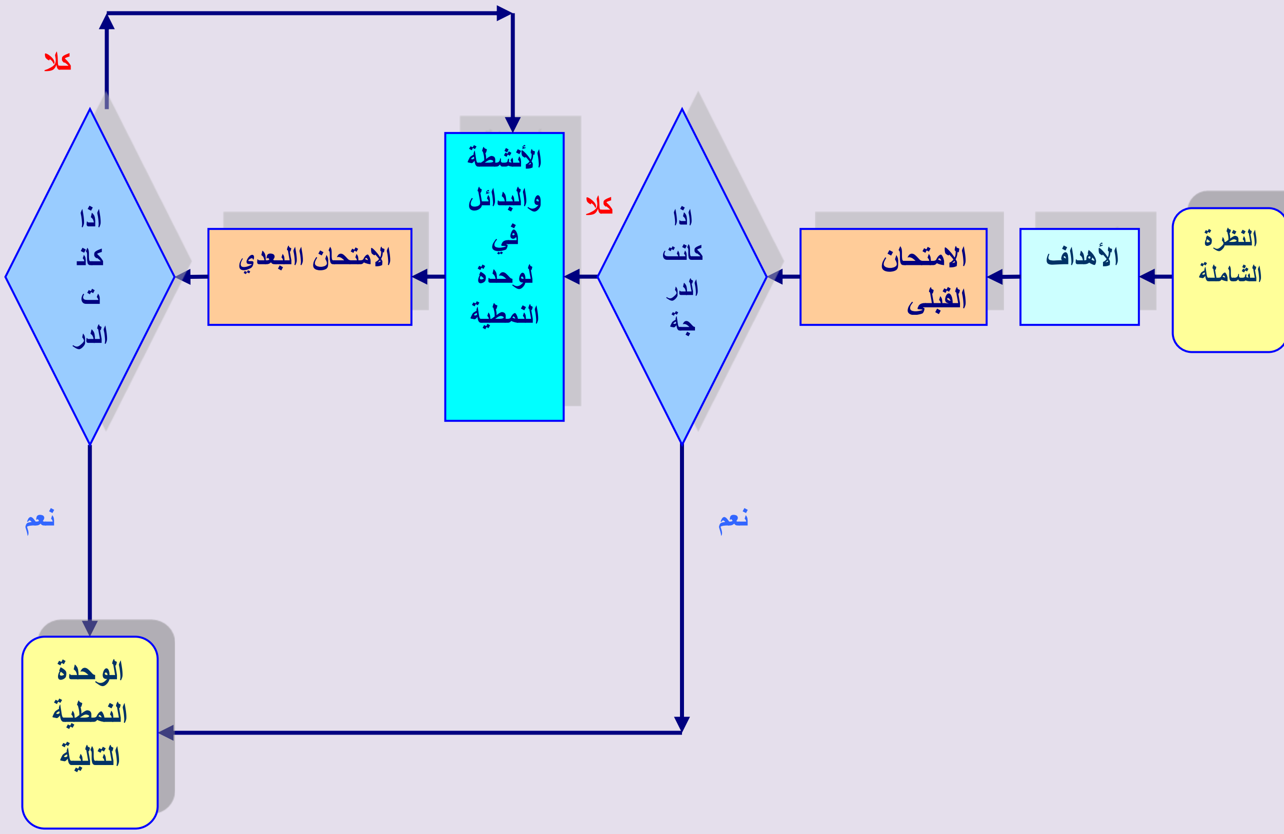
ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

- يتعرف على الوحدات والرموز الكهربائية ودوائر DC
- يطبق قانون اوم
- يطبق طرق توصيل المقاومات (التوالي ،التوازي ،المركب)

- يستخدم قانوني كيرشوف للفولتية والتيار.

جـ - المخطط الانسيابي:



مخطط انسيابي للتدرب بواسطة الوحدة النمطية.

٢- الاختبار القبلي (Pre – Test):

Put a circle around the letter that precedes the correct answer for each of the following

1- Unit of resistance is:

a- joul

b- Amper

c- Ohm

d- Letter

2- Ohms law is:

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

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

C- $I = \frac{Q}{t}$

d- $V = \frac{W}{Q}$

3- In series connecting is:

a- current variable and fixed voltages

b- constant current and constant voltage)

c- the current variable and variable voltages)

d- Constant current and voltage variable

4- In the parallel connecting be:

a- Variable voltages and current variable

b- Variable voltage and constant current

c - The current variable and fixed voltages

d- Constant current and constant voltage

5- What is the voltage across an electric heater of resistance 5 Ω through which passes a current of

22 A?

a-220 v

b-110 v

c- 121v

d-80v

٣-عرض الوحدة النمطية

Electrical Current:

The continuous flow of free electronic constitutes an electric current. The unit of current is ampere (A) and is measured by Ammeter. It is denoted by the letter "I".

Ampere:

If one coulomb charge cross over the area of cross section of the conductor per one second then the value of current flows through the conductor is called 'one Ampere'.

One Coulomb:

$2\pi \times 10^{18}$ Number of electrons is mention as one coulomb.

Voltage: To create the current flow in a conductor; the electrical pressure which is used to move the electrons is called voltage. It is denoted by the letter 'V'. The unit of voltage is 'volt' and is measured by voltmeter.

One Volt:

One volt means the force to move one coulomb of electrons in one second.

Resistance:

The property of conductor which opposes the flow of current through it is called resistance. It is denoted by the letter 'R'. The unit of resistance is ohms (Ω) and it is measured by Ohm meter.

Ohm:

When a conductor having 1V potential between the two end points; one ampere current will flowing through the conductor and the resistance value of the conductor is 1 Ohm (Ω).

Electric Power:

Power is defined as the product of voltage and current. Unit of power is watts and denoted by the letter "P".

$$P = V \times I \quad watts$$

The electrical unit:

Quantity	Symbol	Unit	Abbreviation
Current	I	Ampere	A
Voltage	V	volt	V
Resistance	R	Ohm	Ω
Charge	Q	Coulomb	C
Power	P	watt	W

Engineering prefix:

Power of 10	Prefix	Symbol
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p

<u>Example</u>-1 Express the following in engineering prefix:

a) 10×10^4 volt. b) 0.1×10^{-3} watts. C) 250×10^{-7} ampere.

Solution:

a) 10×10^4 Volt $=100 \times 10^3$ V $=100\ k$V.

b) 0.1×10^{-3} watts $=0.1 milli$watts = 0.1 mW .

c) 250×10^{-7} Ampere = 25×10^{-6} A =25µA.

<u>Example-2</u> Convert 0.1MV to kV

Solution:

$$0.1MV = 0.1 \times 10^6\ V = (0.1 \times 10^3) \times 10^3 = 100kV$$

<u>Homework</u> : Convert 1800kV to MV

<u>Law of resistance</u>:

The resistance of a conductor in a circuit depends upon the following states:

- It depends upon the material.
- Directly proportional to the length of the conductor.
- Inversely proportional to the area of the cross-section of the conductor.
- It also depends upon the temperature of the conductor.

Resistance calculation:

$$R = \rho \frac{L}{A}$$

Where:

R is the resistance (ohms)

ρ is specific resistance (resistivity) in (ohm. Meter).

L is length of the conductor (meter).

A is area of the cross section of a conductor (Sq.m).

Specific resistance:

The resistance that is offered by one cubic cm material is called specific resistance. The following table shows the specific resistance of material:

Materials		Specific resistance is ohm - meter
Gold	-	2.42×10^{-8}
Silver	-	1.63×10^{-8}
Copper	-	1.724×10^{-8}
Aluminium	-	2.83×10^{-8}
Rubber	-	8×10^{7}
Glass	-	10×10^{11}

Example-3: $1cm^2$ cross section 50m long copper conductor has specific resistance $1.72*10^{-8}$ Ω.cm find the resistance.

Solution:

$$L = 50m = 50 \times 100cm = 5000cm$$

$$A = 1\ cm^2$$

$$specific\ resistance = 1.72 \times 10^{-8} \Omega.cm$$

$$R = \rho \frac{L}{A} = 1.72 \times 10^{-8} \times \frac{5000}{1} = 0.0086\ \Omega$$

Ohm's Law

A relationship was derived by the scientist Ohm; between the current; voltage and resistance of the circuit. It says;

"At a constant temperature; the current flowing through the circuit is directly proportional to the voltage and inversely proortional to the resistance".

$$\text{Current} = \frac{\text{Voltage}}{\text{Resistance}}$$

$i.e.\ \ I = \frac{V}{R}$

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

$V = I \times R$

When the resistance of a circuit is constnt; if the voltage increases the current increases and the voltage degreases the current decreases. If any two of the three values (I; V; R) are known the third value can be easily calculated.

Example-4 The supply voltage of the circuit is 240V and the resistance value is 12 Ω. Calculate the current flowing through this circuit.

Solution:

Voltage (V) = 240V

Resistance (R) = 12Ω

Current (I) = ?

According to Ohm's law

$$I = \frac{V}{R} = \frac{240}{12} = 20A$$

Example-5 The supply voltage of the circuit is 230V. if 10A current is flowing through this circuit. Calculate the resistance value of the circuit.

Solution:

Voltage (V) = 230v

Current (I) = 10A

Resistance (R) = ?

According to Ohm's law

$$\mathrm{R} = \frac{\mathrm{V}}{\mathrm{I}} = \frac{230}{10} = 23\Omega$$

Homework: Find out the voltage of the circuit when 6A current is flowing through the circuit. Resistance of the circuit is 40Ω.

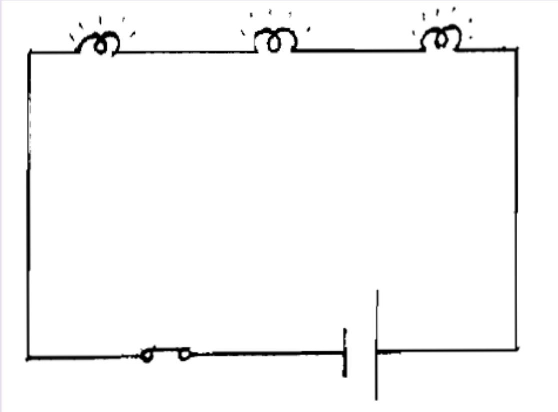
Electrical Circuits:

The circuit is defined as; the current flows from the supply points through the load to complete path. The type of electrical circuit are:

1) Closed circuit. 2) Open circuit. 3) Short circuit.

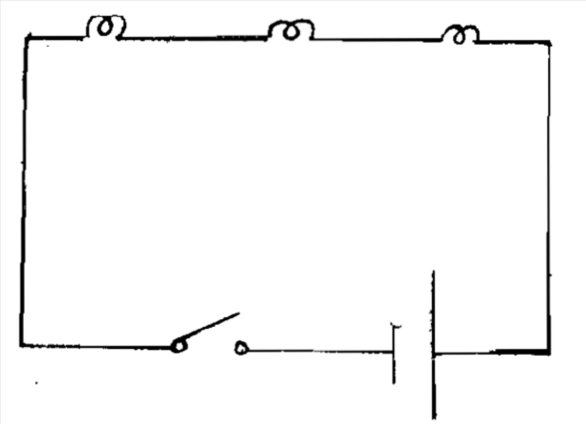
1. Closed circuit

When a load is connected between two terminals of an electrical supply in such away; that the current should pass through the load is said to be closed circuit.



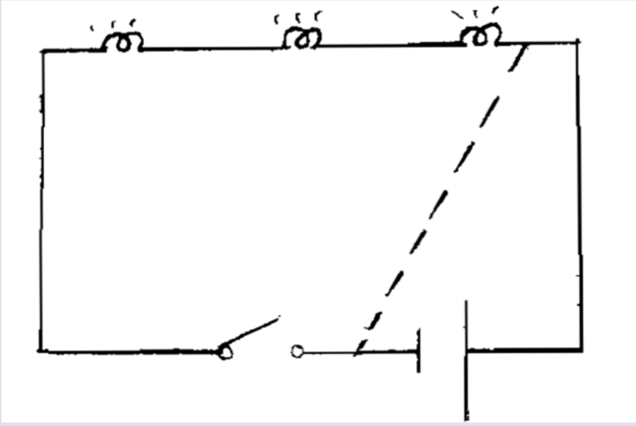
2. Open circuit

In a circuit if there is no way to the flow of current due to disconnection of wire or if the switch is off state; then the circuit is said to be open circuit.



3. Short Circuit:

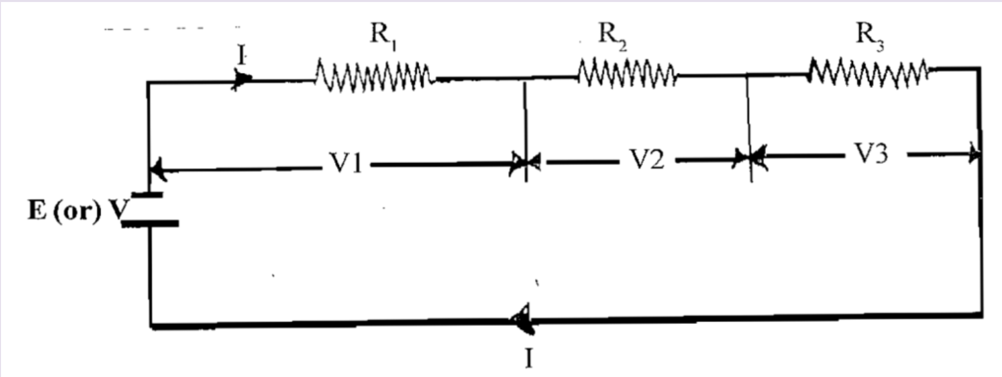
The wires contact each other when there are connected in supply; the short circuit will occurs when two terminals of the supply is connected directly without the load the current flow of the circuit is infinite because it has no resistance.



Classification of electric circuits

1. Series Circuit.
2. Parallel Circuit.
3. Series Parallel Circuit.
4. Mesh or Network Circuit.

1. Series Circuit:



"I" ampere current flows in all three resistors"

Each resistor has a voltage drop across it as given by Ohm's law. Thus

$$V_1 = IR_1;\ V_2 = IR_2;\ V_3 = IR_3$$

The total drop in three resistors put together is:

$$V = V_1 + V_2 + V_3$$

$$= IR_1 + IR_2 + IR_3$$

$$= I(R_1 + R_2 + R_3)$$

$$\frac{V}{I} = R_1 + R_2 + R_3 \left[\frac{V}{I} = R\right]$$

$where\ R = R_1 + R_2 + R_3$

Voltage divider rule:

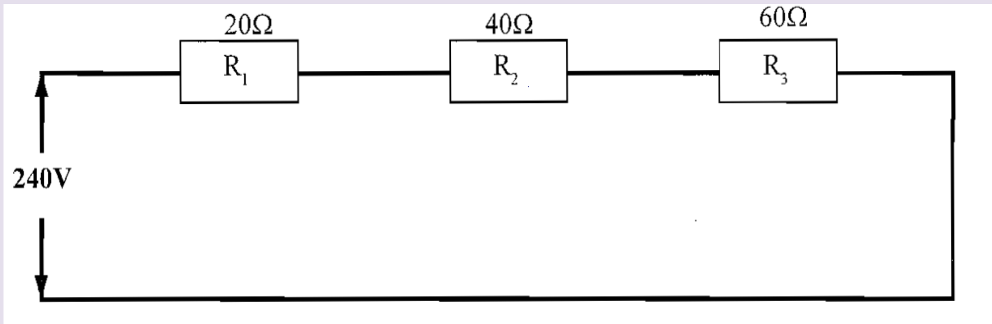
$$V_1 = \mathrm{V} \times \frac{\mathrm{R_1}}{\mathrm{R_1} + \mathrm{R_2} + \mathrm{R_3}}$$

$$V_2 = \mathrm{V} \times \frac{\mathrm{R_2}}{\mathrm{R_1} + \mathrm{R_2} + \mathrm{R_3}}$$

$$V_3 = \mathrm{V} \times \frac{\mathrm{R_3}}{\mathrm{R_1} + \mathrm{R_2} + \mathrm{R_3}}$$

Example-6: the 20Ω; 40Ω and 60Ω resistors are connected in series across a 240v supply. Find out the total resistance of the circuit and current that flows through the circuit.

Solution:



$$R_1 = 20\;;\; R_2 = 40;\; R_3 = 60$$

$$E = 240v$$

$$R_T = ?\;;\; I = ?$$

According to Ohm's law:

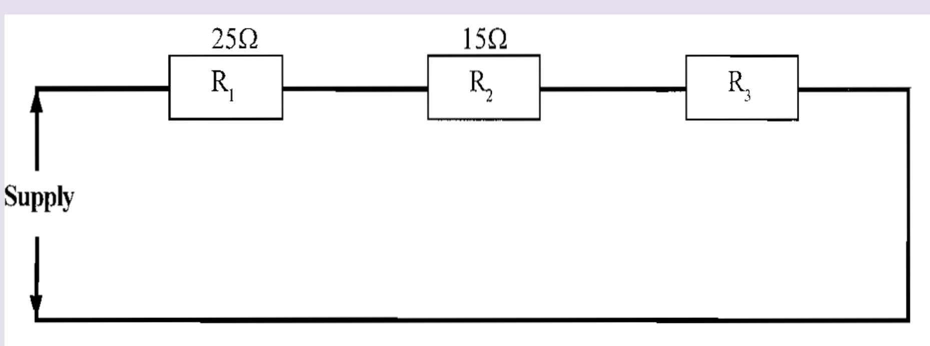
$$I = \frac{V}{R_T}$$

$$where\ R_T = R_1 + R_2 + R_3 = 20 + 40 + 60 = 120\Omega$$

$$I = \frac{V}{R_T} = \frac{240}{120} = 2A$$

<u>Example-7:</u> Three resistors are connected in series. The total resistance (R_T) of the circuit is 60Ω. The first two resistors are 25Ω and 15Ω find out the third one.

Solution:

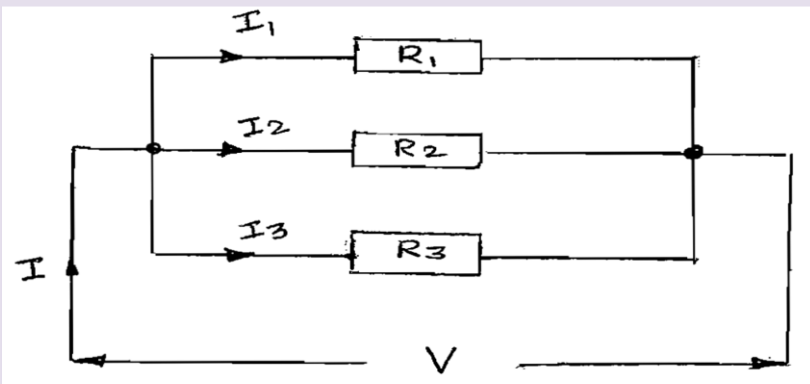


$$R_T = R_1 + R_2 + R_3 \qquad\qquad 60 = 25 + 15 + R_3$$

$$R_3 = 60 - 40 = 20\Omega$$

2. Resistance in parallel Circuit:

When resistors are connected across one another so that the same voltage is applied between the end points of each; then they are said to be in parallel. The current in each resistor is different and the current I taken from the supply is divided among the resistors.



In parallel circuit total current (I) is equal to some of the current I_1; I_2 and I_3.

$$I = I_1 + I_2 + I_3$$

According to Ohm's law we can find the total resistance (R_T) as given below:

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

$$I_1 = \frac{V}{R_1}$$

$$I_2 = \frac{V}{R_2}$$

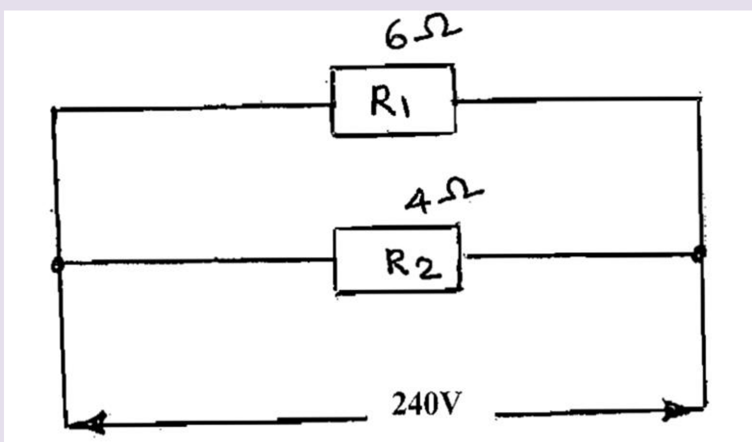
$$I_3 = \frac{V}{R_3}$$

$$R_T = \frac{R_1 R_2 R_3}{R_2 R_3 + R_1 R_3 + R_1 R_2}$$

$$V = V_1 = V_2 = V_3$$

<u>Example-8</u>: 6Ω and 4Ω resistors are connected in parallel through 240v supply. Find out the total resistance and current flows in it.

Solution:



$$R_1 = 6\Omega \qquad R_2 = 4\Omega \qquad V = 240v$$

$$R_T = ?$$

In parallel circuit

$$R_T = \frac{R_1 R_2}{R_1 + R_2} = \frac{6 \times 4}{6 + 4} = \frac{24}{10} = 2.4\Omega$$

According to Ohm's law

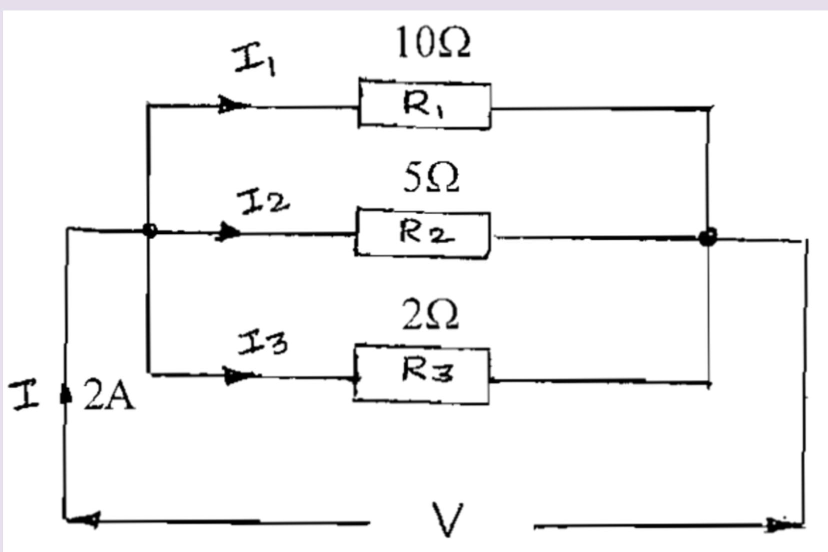
$$I = \frac{V}{R_T} = \frac{240}{2.4} = 100A$$

Example-9: Three resistors 10Ω; 5Ω and 2Ω are connected in parallel. The total current flowing in the circuit is 2A. find out the total resistnce and supply voltage of the circuit.

Solution:

$$R_1 = 100\Omega \qquad R_2 = 5\Omega \qquad R_3 = 2\Omega$$

$$R_T = ? \qquad I = 2A \qquad V = ?$$

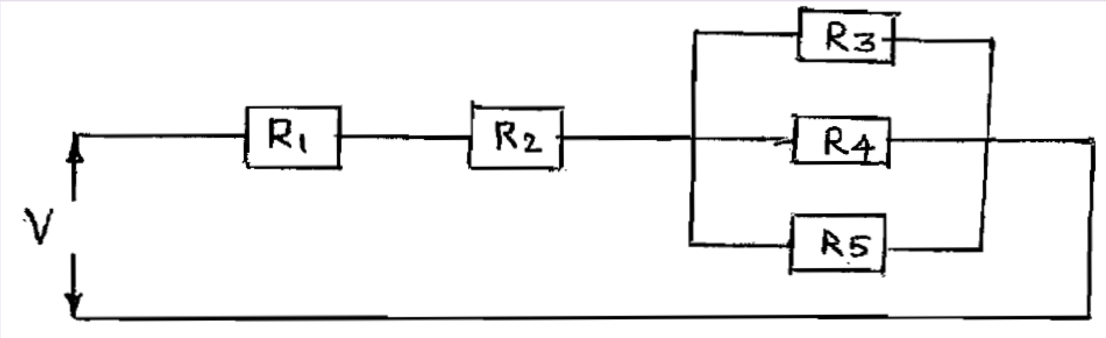


$$R_T = \frac{R_1R_2R_3}{R_2R_3 + R_1R_3 + R_1R_3} = \frac{10 \times 5 \times 2}{(5 \times 2) + (2 \times 10) + (10 \times 5)}$$

$$= \frac{100}{10 + 20 + 50} = \frac{100}{80} = 1.25\Omega$$

$$V = I \times R_T = 2 \times 1.25 = 2.5v$$

Resistance in series parallel circuit: In this circuit one and more resistors connected in series with one more resistors connected in parallel. It is a combination of series and parallel circuit.



Here the total resistance (R_T) of the circuit is:

$$R_T = R_1 + R_2 + \frac{R_3 \times R_4 \times R_5}{R_4R_5 + R_5R_3 + R_3R_4}$$

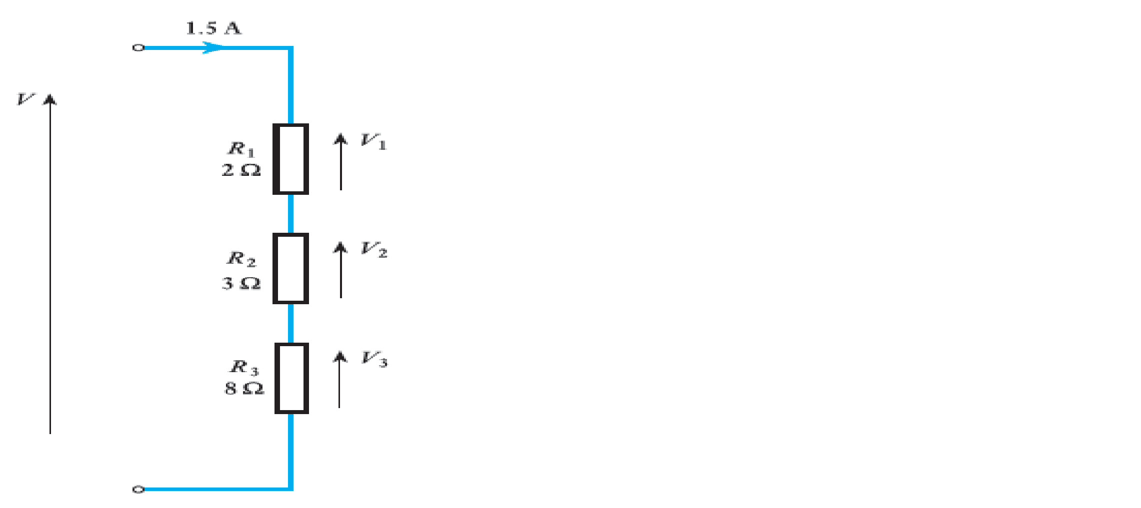
اختبار ذاتي:

Q.1 what mean by:

Current, voltage, resistance, ohms law

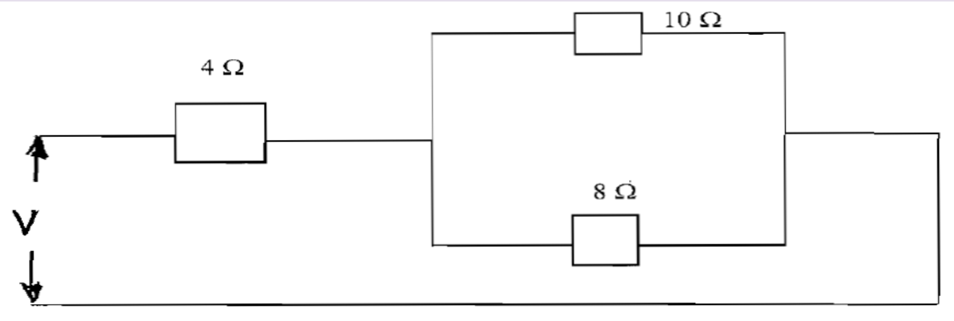
Q.2

Calculate the voltage across each of the resistors shown in Fig. and hence calculate the supply voltage V.



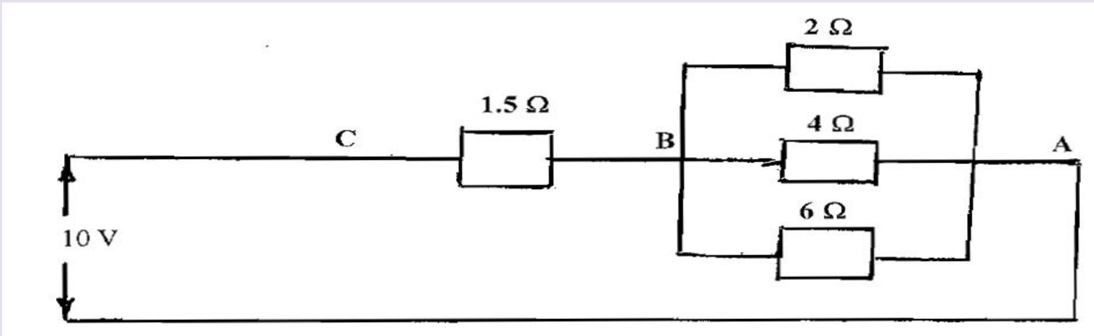
Example-7: 10Ω and 8Ω resistors are connected in parallel with a 4Ω resistor is sries. Find out the total resistance of the series parallel circuit.

Solution:



$$R_T = 4 + \frac{10 \times 8}{10 + 8} = \frac{80}{18} = 8.44\Omega$$

Example-10: Three resistors 2Ω; 4Ω and 6Ω are connected in parallel. This parallel combination is connected in series with a resistor of 1.5Ω . Find the current through each resistor when the applied voltage is 10v



Solution:

$$R_P = \frac{R_1R_2R_3}{R_2R_3 + R_1R_3 + R_1R_3} = \frac{2 \times 4 \times 6}{(2 \times 4) + (4 \times 6) + (6 \times 2)}$$

$$= \frac{48}{8 + 24 + 12} = \frac{48}{44} = 1.09\Omega$$

$$R_{\mathrm{T}} = \mathrm{R_P} + \mathrm{R_4} = 1.09 + 1.5 = 2.59\Omega$$

Total current in circuit is:

$$I = \frac{V}{R_T} = \frac{10}{2.59} = 3.86A$$

Voltage drop across AB is:

$$V_{AB} = I \times R_P = 3.89 \times 1.09 = 4.24v$$

(Voltage is constant in parallel circuit)

Current in 2Ω resistor $= \frac{\mathrm{V_{AB}}}{\mathrm{R_1}} = \frac{4.24}{2} = 2.12\mathrm{A}$

Current in 4Ω resistor $= \frac{\mathrm{V_{AB}}}{\mathrm{R_2}} = \frac{4.24}{4} = 1.06\mathrm{A}$

Current in 6Ω resistor $= \frac{\mathrm{V_{AB}}}{\mathrm{R_3}} = \frac{4.24}{6} = 0.706\mathrm{A}$

٤-الاختبار البعدي (Post – Test):

1-circuit containing resistances connected to the value of each respectively (2, 4) Ω and source voltage value (10) volts find total current, resistance and voltage on all resistance

2. - circuit containing resistances connected in parallel value each one (4, 8) Ω and source voltage value (100) volts find total current and resistance college and stream all resistance?

3- What is the charge transferred in a period of 8 s by current flowing at the rate of 2.5 A?

4- A 960 Ω lamp is connected to a 240 V supply. Calculate the current in the lamp?

5- A voltage of 20 V is required to cause a current of 2 A to flow in a resistor of resistance 10 Ω. What voltage would be required to make the same current flow if the resistance were 40 Ω?

مفاتيح الاجابة على الاختبارات

<table>
<tr><th colspan="2">الاختبار البعدي</th><th>الاختبارات الذاتية</th><th colspan="2">الاختبار القبلي</th></tr>
<tr><td rowspan="2">Rt=6Ω
I_T=0.16A
V1=3.3v
V2=6.6v</td><td rowspan="2">1</td><td rowspan="6">

Q.1

Electrical Current:

The continuous flow of free electronic constitutes an electric current. The unit of current is ampere (A) and is measured by Ammeter. It is denoted by the letter "I".

Voltage: To create the current flow in a conductor; the electrical pressure which is used to move the electrons is called voltage. It is denoted by the letter 'V'. The unit of voltage is 'volt' and is measured by voltmeter.

Resistance:

The property of conductor which opposes the flow of current through it is called resistance. It is denoted by the letter 'R'. The unit of resistance is ohms (Ω) and it is measured by Ohm meter.

Ohms law:

"At a constant temperature; the current flowing through the circuit is directly proportional to the voltage and inversely proortional to the resistance".

Q.2

$$V_1 = IR_1 = 1.5 \times 2 = 3.0 \text{ V}$$
$$V_2 = IR_2 = 1.5 \times 3 = 4.5 \text{ V}$$
$$V_3 = IR_3 = 1.5 \times 8 = 12.0 \text{ V}$$
$$V = V_1 + V_2 + V_3 = 3.0 + 4.5 + 12.0 = 19.5 \text{ V}$$

</td><td>C</td><td>1</td></tr>
<tr><td>B</td><td>2</td></tr>
<tr><td>R_T=2.6Ω
I_T=37.5A
I1=25A
I2=12.5A</td><td>2</td><td>d</td><td>3</td></tr>
<tr><td>20c</td><td>3</td><td>c</td><td>4</td></tr>
<tr><td>0.25A</td><td>4</td><td rowspan="2">b</td><td rowspan="2">5</td></tr>
<tr><td>5-80v</td><td></td></tr>
</table>

References

1-Electrical Technology by – Theraga

2- Electrical Technology by – Hughes

3- Electrical Technology by – Erick

الوحدة النمطية الثانية

١- النظرة الشاملة (Over View):

١- النظرة الشاملة (Over View):

أ- الفئة المستهدفة (Target Population):-

طلبة المرحلة الاولى في قسم الميكانيك

ب- مبررات الوحدة (Rationale):-

الحاجة الى التعرف على التيار المتناوب وكيف يتولد هذا التيار و معرفة انواع محطات توليد الطاقة الكهربائية .

ت- الفكرة المركزية (Central Ideas):-

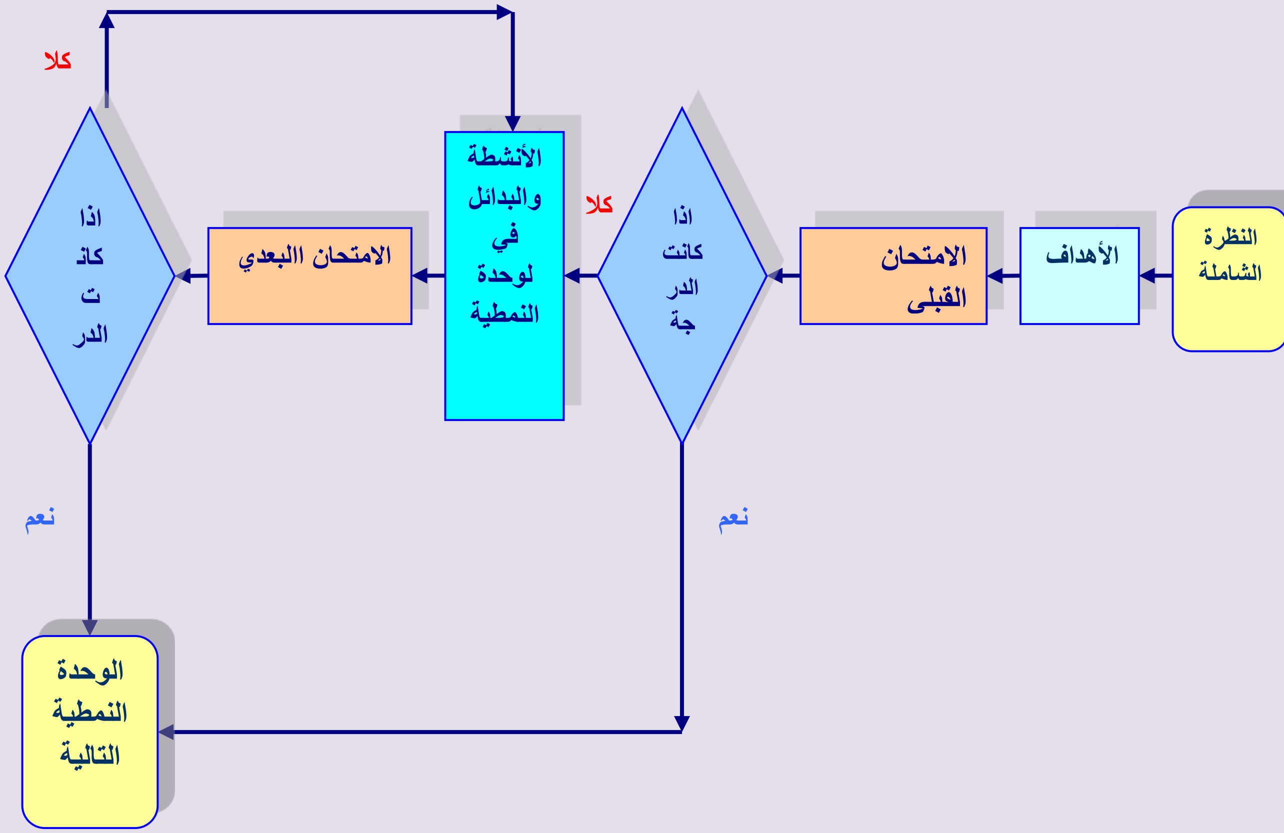
- طرق الحصول على التيار المتناوب
- انواع محطات توليد الطاقة الكهربائية
- الموجة الجيبية
- القيمة الفعالة للتيار والجهد المتناوب

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

- يتعرف على دوائر التيار المتناوب
- يتعرف انواع محطات توليد الطاقة الكهربائية
- يدرس خصائص الموجة الجيبية
- يستخرج القيمة الفعالة للتيار والجهد المتناوب

جـ - المخطط الانسيابى:



مخطط انسيابي للتدرب بواسطة الوحدة النمطية.

٢- الاختبار القبلي (Pre – Test):

Put a circle around the letter that precedes the correct answer for each of the following

1- AC current is:

a- Fixed intensity and direction variable

b - Intensity variable and fixed direction

c- Constant intensity and direction

d- Intensity and direction variable

2- The highest value of the alternating current when the angle:

a- 30

b- 90

c- 0

d- 45

3- Phase difference between voltage and current in the case of pregnancy resistance

a- The same phase

b- Current lead over voltages

c- The current later than voltages

4- The unit of frequency is:

a- pa

b- Weber

c- Farad

d- Hz

5- The rms value is equal to:

a- $\frac{I_{max}}{\sqrt{2}}$

b- $BLv\sin\theta$

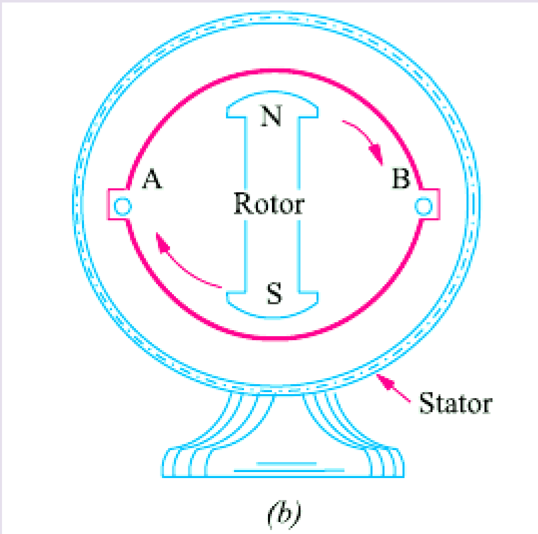
c- $I_{max}\sin\omega t$

d- $\frac{2I_{max}}{\pi}$

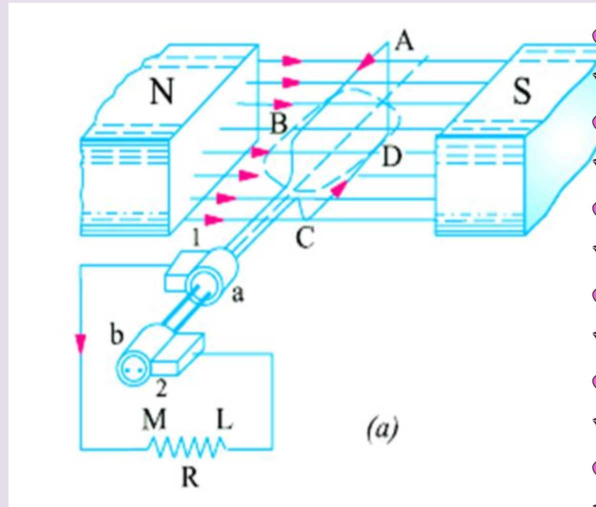
٣-عرض الوحدة النمطية

Alternating Current:

Alternating current may be generated by rotating a coil in a magnetic field as shown in figure (a) or by rotating a magnetic field within a stationary coil as shown in figure (b).

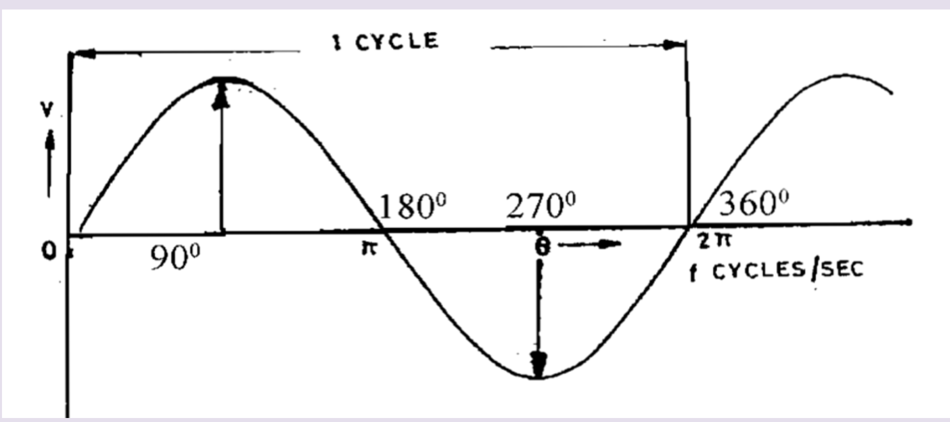


(b)



(a)

Alternating current flows in one direction one time and later its changes its direction of flows. And the magnitude changes at every time. The magnitude depends upon the position of the coil.



Advantage and disadvantage of AC current:

Advantage:

- It easy to conduct AC to one place to another place.
- In AC current easy to develop high voltage.
- AC equipment is low cost.
- Possible to convert to DC.
- Easy to step down of setup the voltage by transformer.

- AC motors are cheapest.

Disadvantage:

- Cannot able to store in battery.
- Because of high starting current in AC the voltage drop is occurred.
- The speed of the AC motors is depending up on the frequency.
- According to the induction load; power factor gets low.

If coil rotate in magnetic field or magnetic field rotate inside the coil there is an alternating e. m. f. generate in the coil. The generated emf is proportional to the number of turns of coil, magnetic field strength, and the angle between the coil and magnetic field.

$$e = BLv \sin\theta$$

From this:

$$L = Length\ of\ the\ conductor.$$

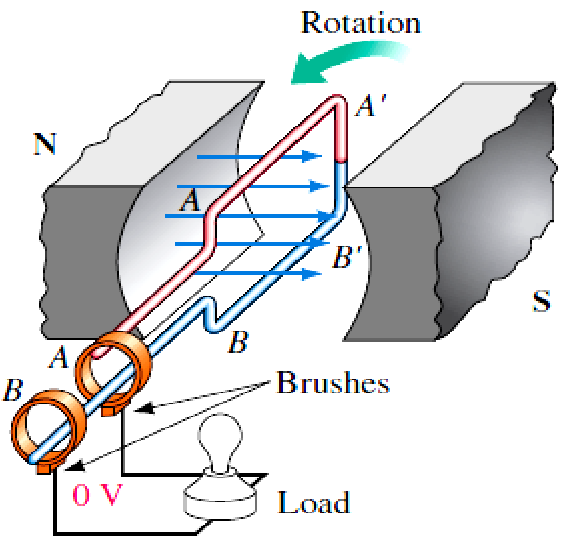
$$v = Velocity\ of\ conductor.$$

$$B = Flux\ density.$$

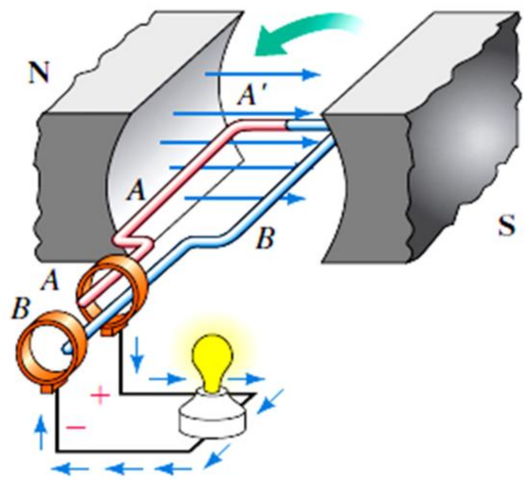
$$\theta = angle\ between\ field\ to\ conductor.$$

$$e = generated\ AC\ emf$$

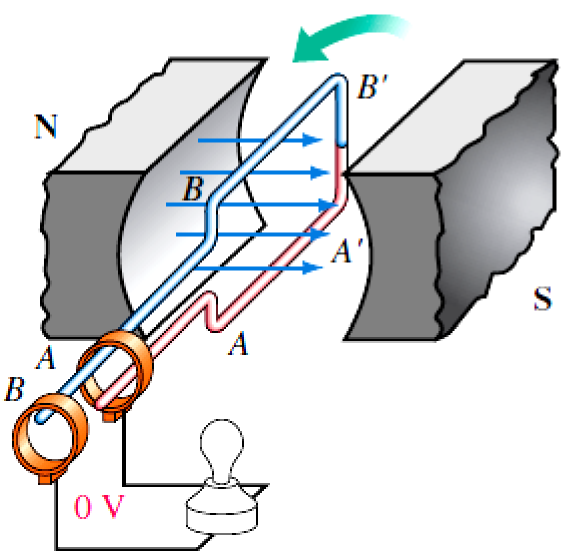
The generated AC emf value is depending upon the sine value of the angle between the magnetic field and conductor.



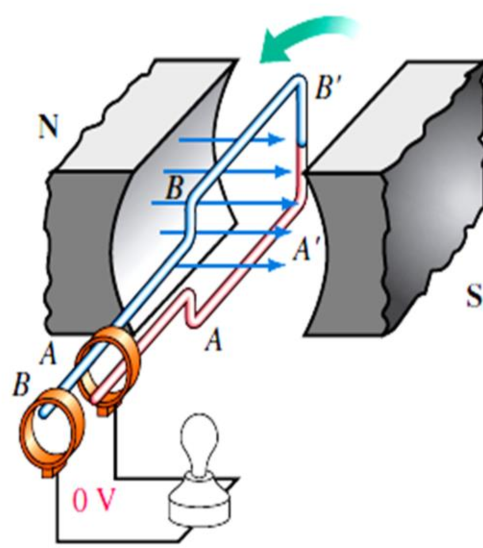
(a) 0° Position: Coil sides move parallel to flux lines. Since no flux is being cut, induced voltage is zero.



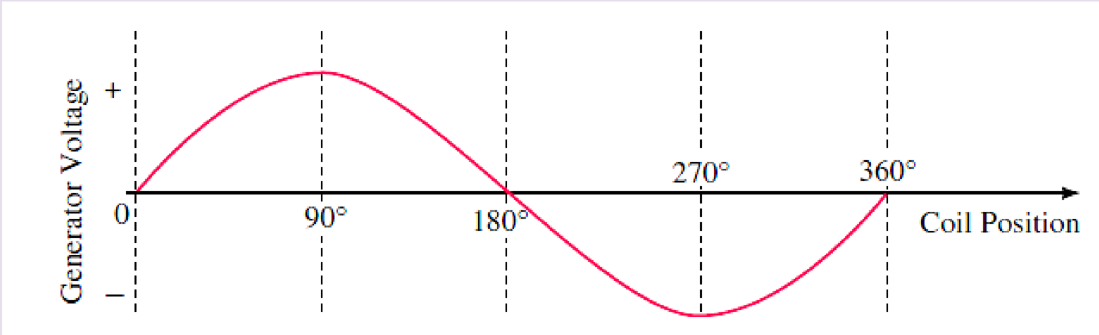
(b) 90° Position: Coil end *A* is positive with respect to *B*. Current direction is out of slip ring *A*.



(c) 180° Position: Coil again cutting no flux. Induced voltage is zero.



(c) 180° Position: Coil again cutting no flux. Induced voltage is zero.



Cycle:

An alternating current complete set of one positive half cycle and one negative half cycle is called one cycle.

Time period:

The time taken by an alternating quantity to complete one cycle is called time period. It is denoted by the letter "T".

Frequency:

The number of cycle per second is called the frequency of the alternating quantity. The unit is hertz (Hz).

Instantaneous value:

The alternating quantity changes at every time.

$$v = V_{max} \sin \omega t \quad or \quad i = I_{max} \sin \omega t$$

Maximum value:

The maximum value positive or negative of an alternating quantity is known as its maximum value. Denoted by "I_{max} or V_{max}".

الاختبار الذاتي:

What is different between AC and DC current?

Effective value and RMS value:

The effective value of an alternating current is given by that DC current which when flowing through a given circuit for a given time produces the same heat as produced by the alternating current when flowing through the same circuit for the same time also is called root mean square value RMS. The voltmeter and ammeter are read the effective value only.

$$RMS\ value = \frac{I_{max}}{\sqrt{2}} \quad or \quad \frac{V_{max}}{\sqrt{2}}$$

Average value:

The average value is calculated by the averages of the maximum value of alternating quantity at different instances.

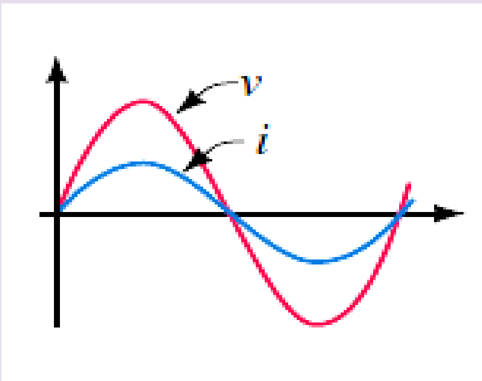
$$Average\ value = \frac{2I_{max}}{\pi} \quad or \quad \frac{2V_{max}}{\pi}$$

اختبار ذاتي 2 :

An alternating current has the following equation $i = 10\sin(40\pi t)$ find: 1) average current. 2) The frequency. 3) The current after $\left(\frac{1}{110}\right)$ second. 4) The time to reach the current 9A.

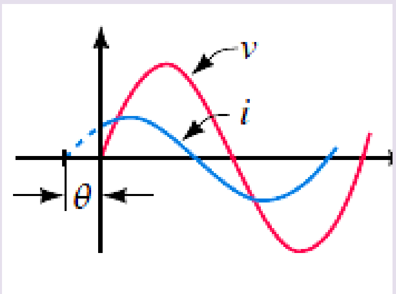
In phase:

If waveform of two AC quantities (voltage or current) gets the maximum and zero at same time then they are said to be in phase.

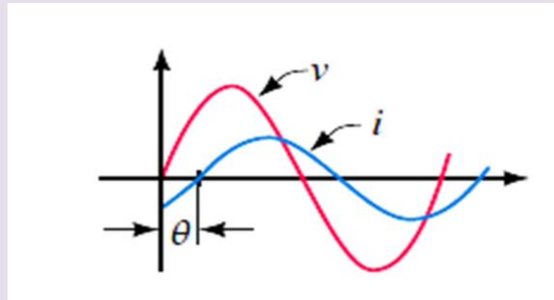


Out of phase:

If in AC circuit two quantities namely voltage or current waves get the maximum and zero at different value then they are said to be out of phase.



Current leads



Current lags

٤-الاختبار البعدى (Post – Test):

1- What type of electrical power plant?

2- What are the factors that depend on electrical driving force during file rotation within a magnetic field or magnetic pole rotation within a file?

3- An alternating current of sinusoidal waveform has an r.m.s. value of 10.0 A. What are the peak values of this current over one cycle?

4- An alternating voltage has the equation $v = 141.4 \sin 377t$; what are

The values of:

(a) r.m.s. voltage;

(b) frequency;

(c) The instantaneous voltage when $t = 3$ ms?

5- A moving-coil ammeter, a thermal* ammeter and a rectifier are connected in series with a resistor across a 110 V sinusoidal a.c. supply. The circuit has a resistance of 50 Ω to current in one direction and, due to the rectifier, an infinite resistance to current in the reverse direction. Calculate:

(a) The readings on the ammeters;

مفاتيح الاجابة على الاختبارات

الاختبار البعدي		الاختبارات الذاتية	الاختبار القبلي	
Thermal power plant, hydroelectric, solar ,wind ,energy wave of the sea ,nuclear plant	**1**	**1-The defernt between ac current and dc current is the frequency** **2-** $i_{Av} = \frac{2i_{max}}{\pi} = \frac{2*10}{\pi} = 6.3A$ .1 $w = 2\pi f = 40\pi \qquad f = \frac{40\pi}{2\pi} =$ .2 $20\ Hz$ $i = 10\sin(40\pi t) = 10 \times$ .3 $\sin\left(40\pi \times \frac{1}{110}\right) = 0.19A$ $9 = 10\sin(40\pi t)\ \sin(40\pi t) =$ .4 $\frac{9}{10}$ $40\pi t = 0.35\pi$	**d**	1
			b	2
The number of turns of coil, magnetic field strength, and the angle between the coil and magnetic field.	**2**		**a**	3
14 .14A	**3**		**D**	4
100 V 60 Hz 127.8 V	**4**		**a**	5
1.56 A.	5			

References:

1-Electrical Technology by – Theraga

2- Electrical Technology by – Hughes

3- Electrical Technology by – Erick

الوحدة النمطية الثالثة

١- النظرة الشاملة (Over View):

١- النظرة الشاملة (Over View):

أ- الفئة المستهدفة (Target Population):-

طلبة المرحلة الاولى في قسم الميكانيك

ب- مبررات الوحدة (Rationale):-

الحاجة الى التعرف على دوائر التيار المتناوب ثلاثي الاوجه وطرق ربط هذه الدوائر الكهربائية واستخداماتها .

ت- الفكرة المركزية (Central Ideas):-

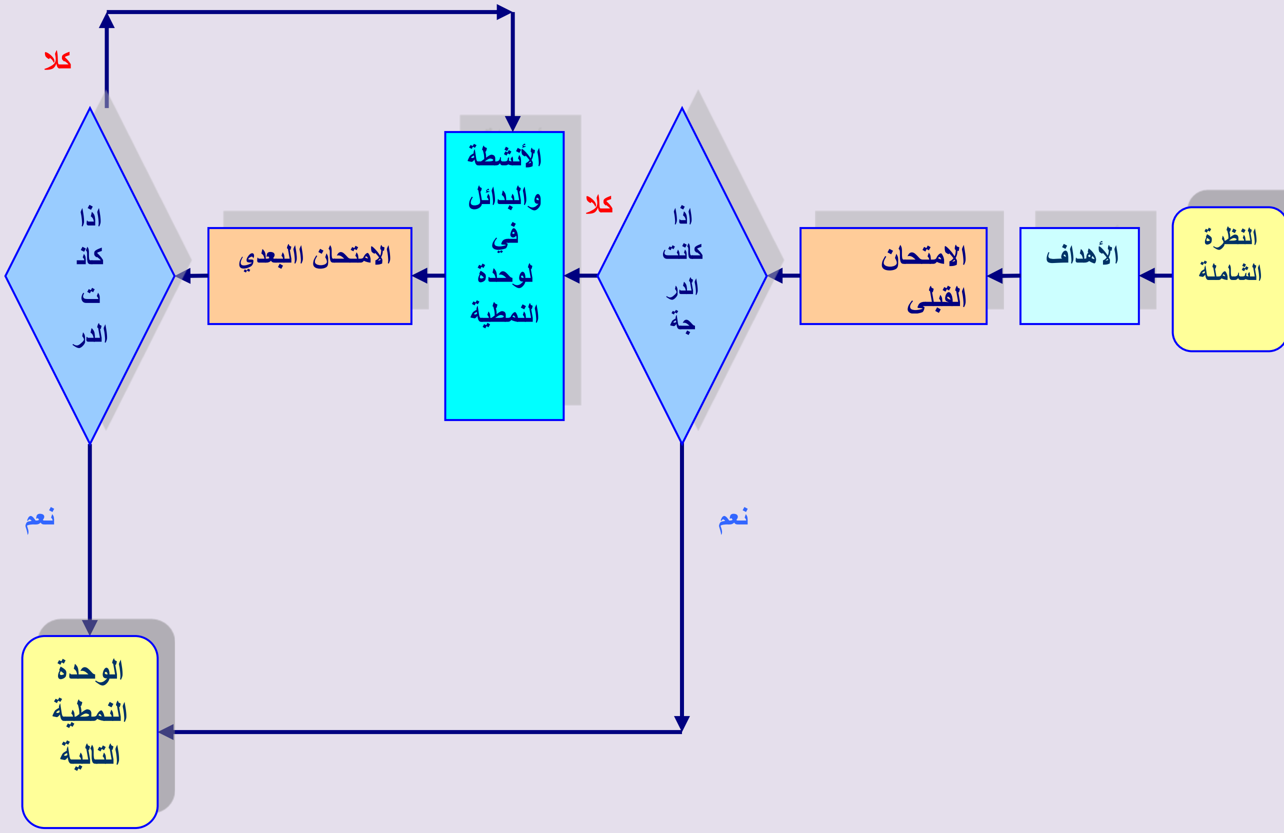
- مولدات التيار المتناوب ثلاثي الاوجه
- طريقة تمييز الاوجه
- طرق الربط (شكل نجمة Y،شكل دلتا Δ)
- امثلة تطبيقية على طرق الربط

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

- يتعرف على دوائر التيار المتناوب ثلاثي الاوجه .
- يتعرف على طرق ربط دوائر التيار المتناوب ثلاثي الاوجه .
- يطبق طرق الربط على امثلة تطبيقية .

جـ - المخطط الانسيابى:



مخطط انسيابي للتدرب بواسطة الوحدة النمطية.

٢- الاختبار القبلي (Pre – Test):

(Pre – Test) الاختبار القبلي

Put a circle around the letter that precedes the correct answer for each of the following

1- the angle between each phase in three phase system is:

a- 240

b- 120

c- 90

d- 150

2- In star connection the line voltage is equal to:

a- $V_L=\sqrt{3}\ V_{PH}$

b- $V_L=\frac{VPH}{\sqrt{3}}$

c- $V_L= V_{PH}$

d- $V_L=\sqrt{2}\ V_{PH}$

3- In Delta connection the line voltage is equal to:

a- $V_L=\sqrt{3}\ V_{PH}$

b- $V_L=\frac{VPH}{\sqrt{3}}$

c- $V_L= V_{PH}$

d- $V_L=\sqrt{2}\ V_{PH}$

4- In star connection the line current is equal to:

a- $I_L=\sqrt{3}\ I_{PH}$

b- $I_L=\frac{IPH}{\sqrt{3}}$

c- $I_L= I_{PH}$

d- $I_L=\sqrt{2}\ I_{PH}$

5- In Delta connection the line current is equal to:

a- $I_L=\sqrt{3}\ I_{PH}$

b- $I_L=\frac{IPH}{\sqrt{3}}$

c- $I_L= I_{PH}$

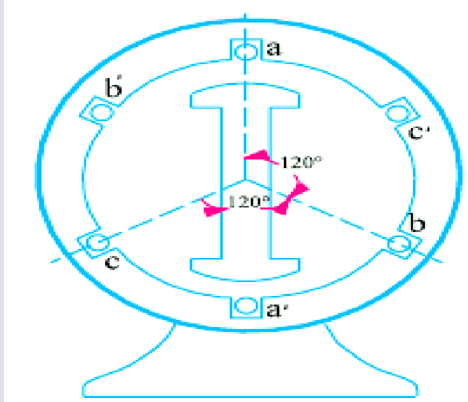
d- $I_L=\sqrt{2}\ I_{PH}$

٣-عرض الوحدة النمطية

Three phase system

Three phase generator:

Large scale generation of power is achieved by generating three phase e.m.f. using three separate windings insulated from each other. They are placed on the rotor of the alternator. The windings are displaced at angle of 120^o with each other as shown in figure (a). When the rotor is rotated e.m.f. will be induced in the three coils (phases).



'*a*'

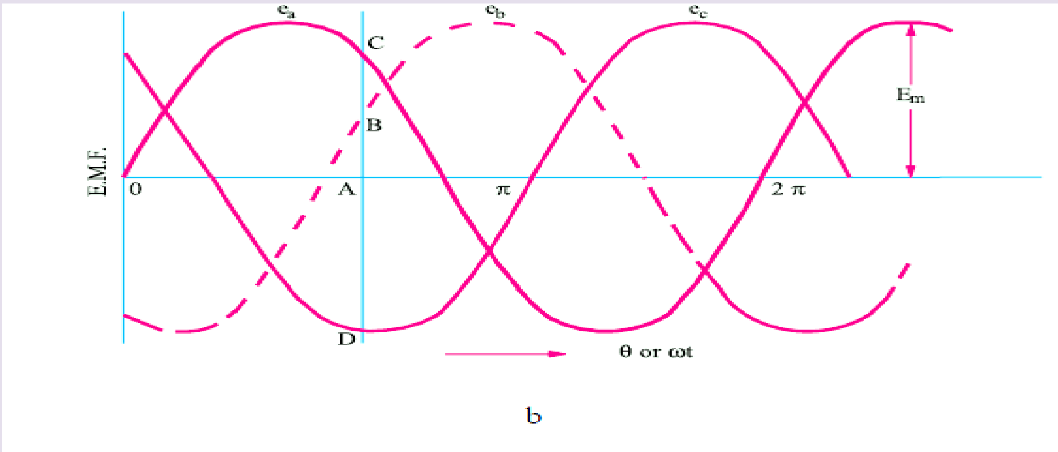
The instantaneous values of the three e.m.f. will be given by curves of figure (b):

$$e_a = E_m \sin \omega t$$

$$e_b = E_m \sin(\omega t - 120^o)$$

$$e_c = E_m \sin(\omega t - 240^o)$$

$$e_a + e_b + e_c = 0$$



Numbering of phase

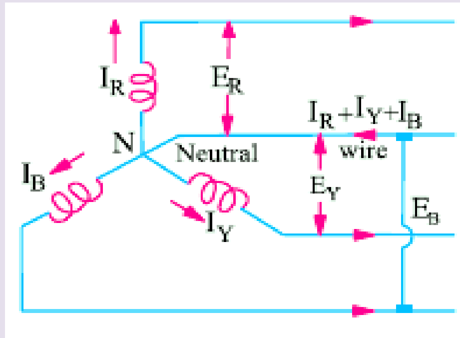
The three phases may be numbered 1; 2; 3 or a; b; c or as is customary they may be given three color. The colors used commercially are red; yellow and blue. In this case the sequence is RYB.

Interconnection of three phases:

a) Star or Wye (Y) connection.
b) Mesh or Delta (Δ) connection.

Star or Wye (Y) connection

The three coils are joined together at point N as shown in figure this point is known as star point or neutral point. The three conductors meeting at point N are replaced by a single conductor known as neutral conductor.



The line voltage is equal to:

$$V_L = \sqrt{3}V_{phase}$$

Where V_L is the line voltage and V_{phase} is the phase voltage

Current in phase 1 = I_R ; Current in phase 2 = I_Y ; Current in phase 3 = I_B

$$since \;\; I_R = I_Y = I_B = I_{phase}$$

$$the\ line\ current \quad I_L = I_{phase}$$

Total active power is:

$$P = \sqrt{3}.V_L.I_L.\cos\varphi$$

Total reactive power is:

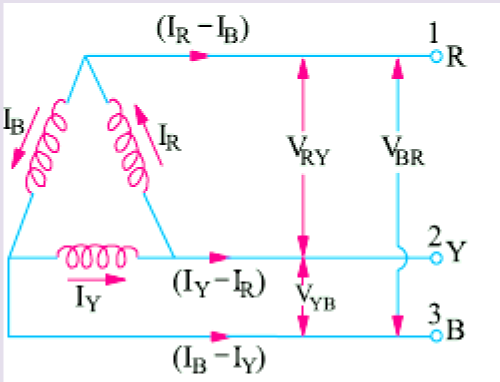
$$Q = \sqrt{3}.V_L.I_L.\sin\varphi$$

Total apparent power is:

$$S = \sqrt{3}.V_L.I_L \quad Obviously \quad S = \sqrt{P^2 + Q^2}$$

Mesh or Delta connection:

In this form of interconnection the dissimilar ends of the three phase winding are joined together as shown in figure. If the system is balanced then sum of the three voltages round the closed mesh is zero.



The line voltage is equal to:

$$V_L = V_{phase}$$

Where V_L is the line voltage and V_{phase} is the phase voltage

Where V_L is the line voltage and V_{phase} is the phase voltage

$$the\ line\ current \quad I_L = \sqrt{3}.I_{phase}$$

Total active power is:

$$P = \sqrt{3}.V_L.I_L.\cos\varphi$$

Total reactive power is:

$$Q = \sqrt{3}.V_L.I_L.\sin\varphi$$

Total apparent power is:

$$S = \sqrt{3}.V_L.I_L \quad Obviously \quad S = \sqrt{P^2 + Q^2}$$

اختبار ذاتي:

1-Why connecting power generators AC three-phase at startup on the shape of a star and then turned to Delta?

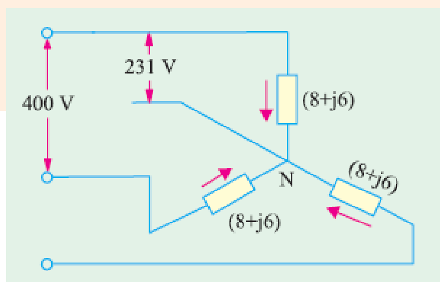
2-

Example 19.12. *A star-connected alternator supplies a delta connected load. The impedance of the load branch is (8 + j6) ohm/phase. The line voltage is 230 V. Determine (a) current in the load branch, (b) power consumed by the load, (c) power factor of load, (d) reactive power of the load.* **(Elect. Engg. A.M.Ae. S.I. June 1991)**

٤-الاختبار البعدي (Post – Test):

1-

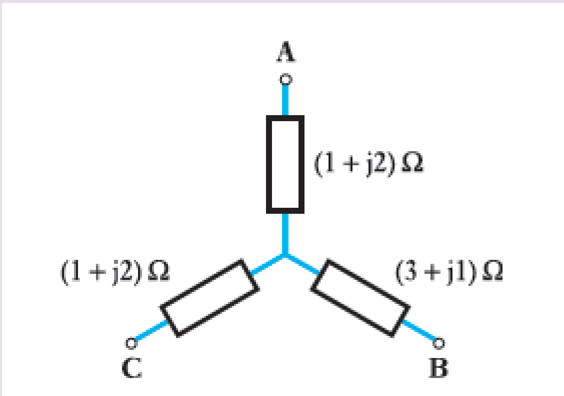
Example 19.1. *A balanced star-connected load of (8 + j6) Ω per phase is connected to a balanced 3-phase 400-V supply. Find the line current, power factor, power and total volt-amperes.*



2-

Example 19.10. *A three pahse 400-V, 50 Hz, a.c. supply is feeding a three phase delta-connected load with each phase having a resistance of 25 ohms, an inductance of 0.15 H, and a capacitor of 120 microfarads in series. Determine the line current, volt-amp, active power and reactive volt-amp.* **[Nagpur University, November 1999]**

3- Determine the delta equivalent circuit for the star circuit shown in fig.



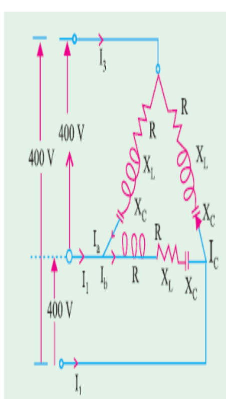
4-

Example 19.4. *Given a balanced 3 − ϕ, 3-wire system with Y-connected load for which line voltage is 230 V and impedance of each phase is (6 + J8) ohm. Find the line current and power absorbed by each phase.* **(Elect. Engg - II Pune Univ. 1991)**

5-

Example 19.6 *Calculate the active and reactive components in each phase of Y-connected 10,000 V, 3-phase alternator supplying 5,000 kW at 0.8 p.f. If the total current remains the same when the load p.f is raised to 0.9, find the new output.*

مفاتيح الاجابة على الاختبارات

الاختبار البعدي		الاختبارات الذاتية	الاختبار القبلي	
Solution. $Z_{ph} = \sqrt{8^2+6^2} = 10\Omega$ $V_{ph} = 400/\sqrt{3} = 231\text{ V}$ $I_{ph} = V_{ph}/Z_{ph} = 231/10 = 23.1\text{ A}$ (i) $I_L = I_{ph} = 23.1\text{ A}$ (ii) p.f. $= \cos\phi = R_{ph}/Z_{ph} = 8/10 = 0.8$ (lag) (iii) Power $P\ \sqrt{3}V_L I_L \cos$ $= \sqrt{3}\times 400\times 23.1\times 0.8 = 12{,}800\text{ W}$ [Also, $P = 3I^2_{ph}\,R_{ph} = 3(23.1)^2\times 8 = 12{,}800\ W$] (iv) Total volt-amperes, $S = \sqrt{3}\,V_L I_L = \sqrt{3}\times 400\times 23.1 = 16{,}000\text{ VA}$	1	1- This connection used to protect the engine from starting higher current value, which may range from 6 to 8 times the value of the rated current of the motor 2- I_{PH}=23A P=12684 W P.F=0.8 Q=9513 VAR	b	1
			a	2
Solution. Impedance per phase $r + jX_L - jX_C$ $X_L = 2\pi\times 50\times 0.15 = 47.1\ \Omega$ $X_C = \dfrac{10^6}{32\cdot 37} = 26.54\ \Omega$ $\cos\phi = \dfrac{25}{32.37}$ Lagging, since inductive reactance is dominating. Phase Current $= \dfrac{400}{25+j20.56} = 12.357$ Line Current $= \sqrt{3}\times 12.357 = 21.4$ amp Since the power factor is 0.772 lagging,  Fig. 19.22	2		C	3
Z1=(7 + j4) Ω Z2=(1.5 + j5.5) Ω	3		C	4

Z3=(7 + j4) Ω				
I_L=13.3A P=1061W	**4**		**a**	5
I_{ACTIVE}=288.8A $I_{reactive}$=216.6A P=5625 KW	5			

References:

1-Electrical Technology by – Theraga
2- Electrical Technology by – Hughes
3- Electrical Technology by – Erick

الوحدة النمطية الرابعة

١- النظرة الشاملة (Over View):

النظرة الشاملة (Over View):-

أ- الفئة المستهدفة (Target Population):-

طلبة المرحلة الاولى في قسم الميكانيك

ب- مبررات الوحدة (Rationale):-

الحاجة الى معرفة انواع المواد المغناطيسية والمجال المغناطيسي وشدة المجال المغناطيسي والفيض المغناطيسي وقوانين فراداي للكهرومغناطيسية والقوة الدافعة المغناطيسية .

ت- الفكرة المركزية (Central Ideas):-

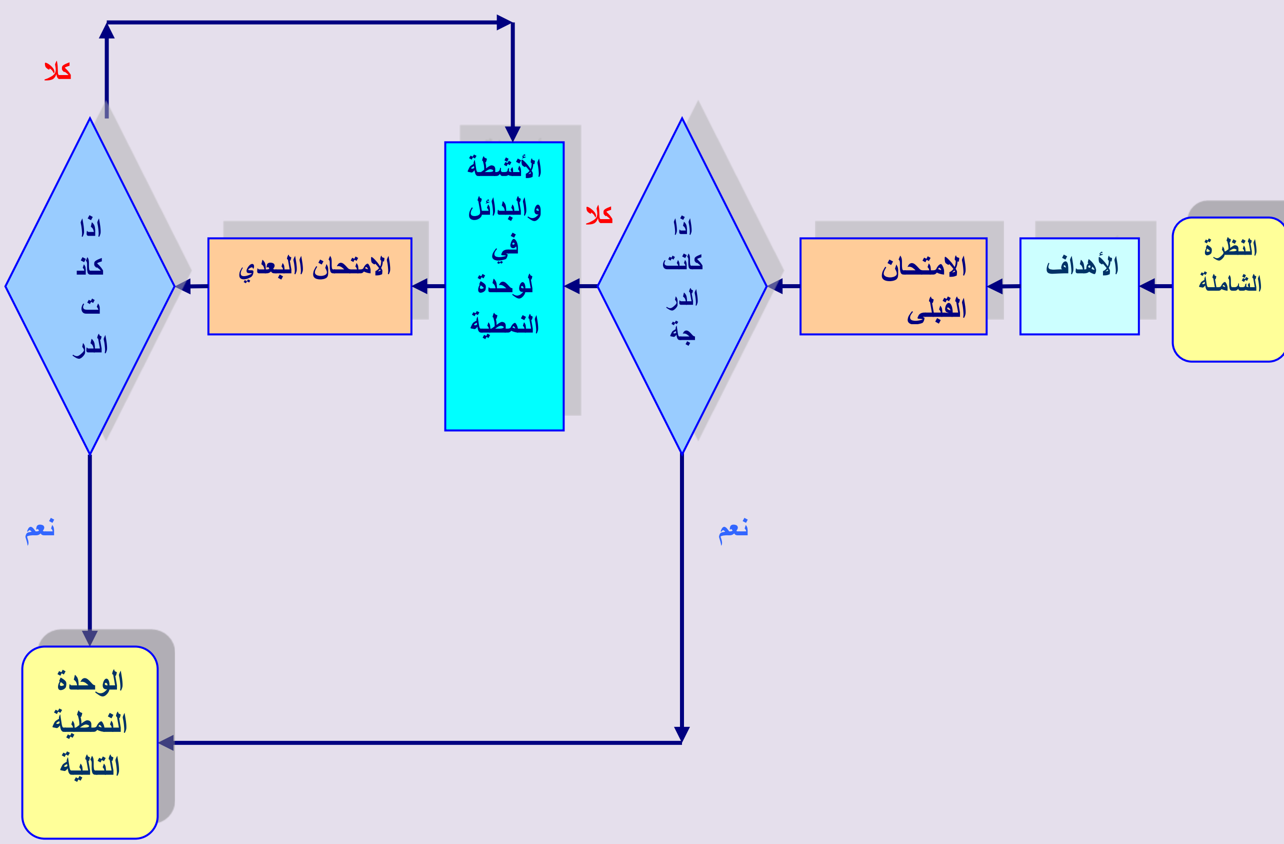
- **المجال المغناطيسي**
- **خصائص المجال المغناطيسي**
- **انواع المواد المغناطيسية**
- **تعريف (كثافة المجال ، شدة المجال ، القوة الدافعة المغناطيسية)**

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

- يتعرف على انواع المواد المغناطيسية وشدة المجال المغناطيسي .
- يطبق قوانين فراداي للكهرومغناطيسية .
- يفهم مبدا القوة الدافعة المغناطيسية .

جـ - المخطط الانسيابى:



مخطط انسيابي للتدرب بواسطة الوحدة النمطية.

٢- الاختبار القبلي (Pre – Test):

Put a circle around the letter that precedes the correct answer for each of the following

1- The unit of MMF is:

a- amper-turn

b- volt

c- amper-volt

d- amper-m

2- Reluctance is equal to:

a- $S=\frac{\mu}{LA}$

b- $S=\frac{L}{\mu A}$

c- $S=\frac{A}{\mu L}$

d- S=$\rho \frac{L}{A}$

3- Electromagnetic waves generated when

a-Continuous flow of current in a wire

b- Electric charges in movement at a constant speed wire

c- Accelerated movement electrical charges in the wire

d- The presence of static electrical charges in the wire

4- That could hasten the electric charge in the connector when it affects

a- Static electric field

b- Electric field oscillating

c- Electrical and magnetic field constants

d- Static magnetic field

5- B is symbol of:

a- the flux density

b- The magnetic force

c- Total flux

d- number of turns

٣.عرض الوحدة النمطية

Electromagnetism

Magnetism plays an important role in electricity. Electrical appliances like Generator; Motor; Measuring instruments and Transformer are based on the electromagnetic princible and also the important components of Television; Radio and Aeroplane are working on the same princible.

Magnetic Material

Magnetic materials are classified based on the property called permeability as:

1. Dia Magnetic Material.
2. Para Magnetic Material.
3. Ferro Magnetic Material.

Dia Magnetic Materials

The materials whose permeability is below unity are called Dia magnetic material. Example Lead; Copper; Class and mercury.

Para Magnetic Material:

The materials whose permeability is above unity are called Dia magnetic material. Example Lead; Copper Sulphate; Oxygen and Aluminium.

Ferro Magnetic Material:

The materials with permeability thousands of times more than that of para magnetic materials. Example Iron; Cobalt; Nickel.

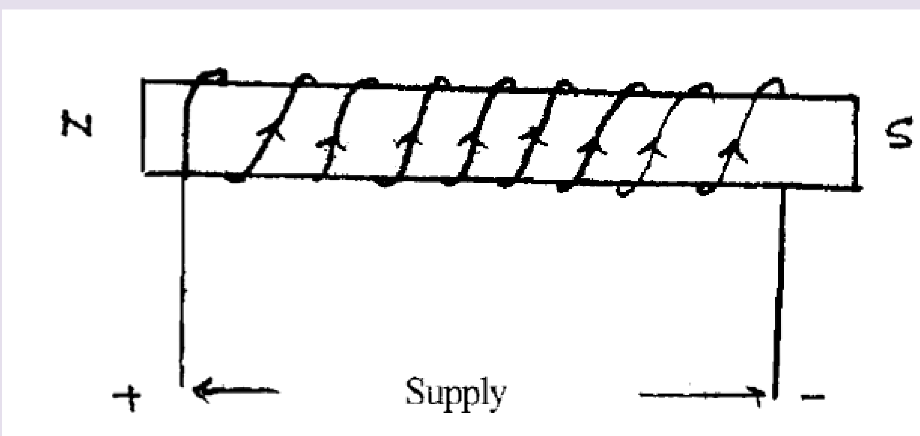
Permanent Magnet

Permanent magnet means the magnetic materials which will retain the magnetic property at all times permanently. This type of magnets manufactured by aluminum; nickel; Iron; cobalt steel (ALNICO).

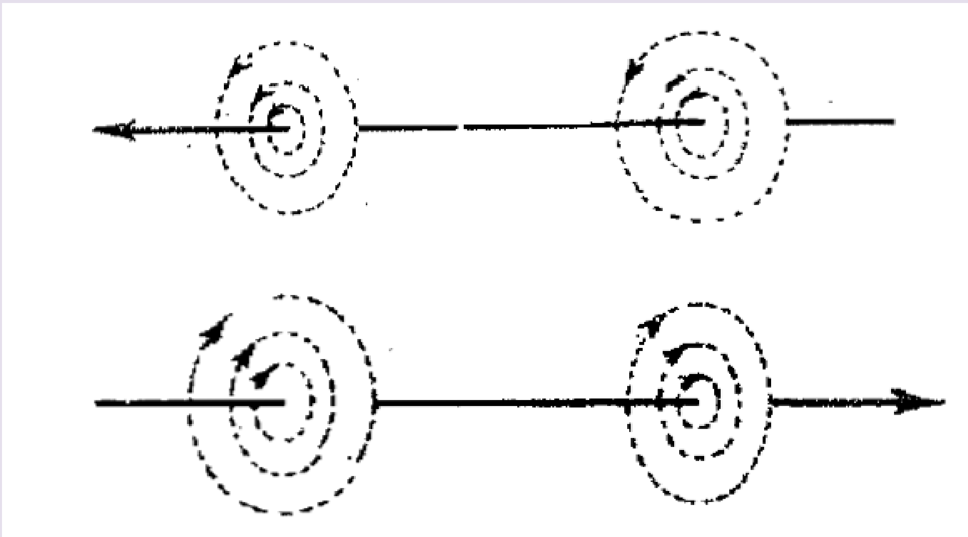
To make a permanent magnet a coil is wound over a magnetic material and DC supply is passed through the coil.

Electromagnet:

Insulated wire wound on a bobbin in many turns and layers in which current is flowing and a soft iron piece placed in the bobbin is called electromagnet.



Magnetic Effect by electric current



If current passes through a conductor magnetic field is setup around the conductor. The quantity of the magnetic field is proportional to the current.

Permeability

The permeability of a magnetic material is defined as the ratio of flux created in that material to the flux created in air. Its symbol is μ and

$$\mu = \frac{B}{H}$$

B is the flux density

H is the magnetic force

Magnetic field

The space around a magnet in which the influence of the magnet can be detected is called the magnetic field.

Magnetic lines

Magnetic lines of force (flux) are assumed to be continuous loops; the flux lines continuing on through the magnet. They do not at the poles

Magnetic Flux

The magnetic flux in a magnetic circuit is equal to the total number of lines existing on the cross section of the magnetic core at right angle to the direction of the flux. Its symbol is φ and the SI unit is Weber.

$$\varphi = \frac{N.I}{S} = \frac{N.I.a.\mu_o \mu_r}{l}$$

Where φ totals flux

N number of turns

S reluctance

I current in amperes

μ_o permeability of free space

μ_r relative permeability

l $lengh\ of\ the\ magnetic\ path\ in\ m$

a magnetic path across sectional area in m^2

Magnetic field strength

This is also known as field intensity or magnetic intensity and is represented by the letter H. its unit is ampere turns per meter.

$$H = \frac{MMF}{Length\ of\ coil\ in\ meters} = \frac{NI}{l}$$

Flux density

The total number of lines of force per square meter of the cross-sectional area of the magnetic core is called flux density and is represented by the symbol B. its unit is tesla.

$$B = \frac{\varphi}{A}$$

Example-13: Calculate flux density at a distance of 5cm from a long straight circular conductor carrying a current of 250A and placed in air.

Solution.

$$B = \frac{\mu_0 I}{2\pi r}$$

Now, at the conductor surface, $r = 1 \text{ mm} = 10^{-3} \text{ m}$

$$\therefore \quad B = \frac{4\pi \times 10^{-7} \times 250}{2\pi \times 10^{-3}} = \mathbf{0.05 \ Wb/m^2}$$

Magnetomotive force

The amount of flux density setup in the core is dependent upon five factors: number of turns; material of magnetic core; length of the core and the cross sectional area of the core.

$$MMF = N.I$$

Magnetic Reluctance

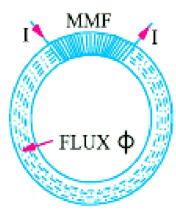
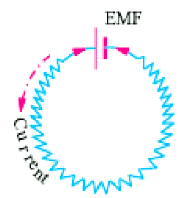
In the magnetic circuit there is something analogues to electrical resistance and is called reluctance. Its symbol is S.

$$S = \frac{l}{\mu_o \mu_r a}$$

اختبار ذاتي: 1

Example 6.2. *Calculate the magnetising force and flux density at a distance of 5 cm from a long straight circular conductor carrying a current of 250 A and placed in air. Draw a curve showing the variation of B from the conductor surface outwards if its diameter is 2 mm.*

Comparing between magnetic and electric circuit

Magnetic Circuit	Electric Circuit
 Fig. 6.27	 Fig. 6.28
1. Flux = $\frac{\text{m.m.f.}}{\text{reluctance}}$	Current = $\frac{\text{e.m.f.}}{\text{resistance}}$
2. M.M.F. (ampere-turns)	E.M.F. (volts)
3. Flux Φ (webers)	Current I (amperes)
4. Flux density B (Wb/m^2)	Current density (A/m^2)
5. Reluctance $S = \frac{l}{\mu A} \left(= \frac{l}{\mu_0 \mu_r A}\right)$	resistance $R = \rho \frac{l}{A} = \frac{l}{\rho A}$
6. Permeance (= 1/reluctance)	Conductance (= 1/resistance)
7. Reluctivity	Resistivity
8. Permeability (= 1/reluctivity)	Conductivity (= 1/resistivity)
9. Total m.m.f. = $\Phi S_1 + \Phi S_2 + \Phi S_3 + ...$	9. Total e.m.f. = $IR_1 + IR_2 + IR_3 + ...$

Electromagnetic induction

Electromagnetic induction means the electricity induced by the magnetic field.

Faraday's laws of Electromagnetic induction

There are two laws of Faraday's laws of electromagnetic induction. They are:

1) First Law.   2) Second law.

First law

Whenever a conductor cuts the magnetic flux lines an emf is induced in the conductor.

Second law

The magnitude of the induced emf is equal to the rate of change of flux-linkage.

Induced electromotive force

Induced electromotive force is of two types: they are

i) Dynamically induced emf.
ii) Statically induced emf.

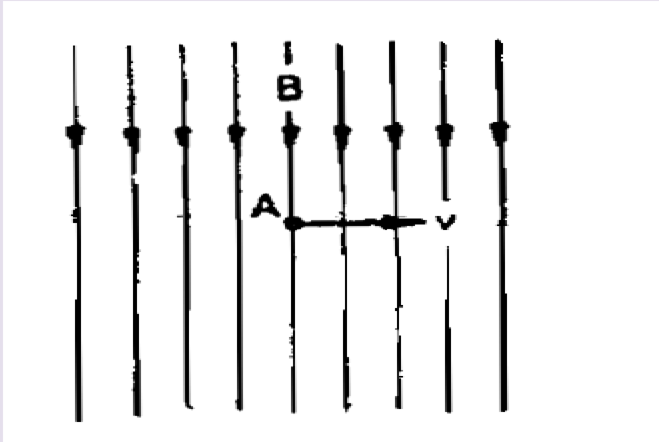
Dynamically induced emf

Dynamically induced emf means an emf induced in a conductor when the conductor moves across a magnetic field. The figure shows when a conductor "A" with the length "L" moves across a "B" wb/m^2 flux density with "v" velocity. Then the dynamically induced emf is induced in the conductor. This induced emf is utilised in the generator.

$$emf = B.l.v$$

اختبار ذاتي:2

A magnetic flux of 400 μWb passing through a coil of 1200 turns is reversed in 0.1 s. Calculate the average value of the e.m.f. induced in the coil.



٤-الاختبار البعدى (Post – Test):

٤-الاختبار البعدي (Post – Test):

1- What faraday laws of electromagnetic induction?

2- What types of induced electromotive force?

3-

Example 6.1. *The magnetic susceptibility of oxygen gas at 20°C is 167×10^{-11} H/m. Calculate its absolute and relative permeabilities.*

4-

Example 6.2. *Calculate the magnetising force and flux density at a distance of 5 cm from a long straight circular conductor carrying a current of 250 A and placed in air. Draw a curve showing the variation of B from the conductor surface outwards if its diameter is 2 mm.*

5-

Example 6.3. *A wire 2.5 m long is bent (i) into a square and (ii) into a circle. If the current flowing through the wire is 100 A, find the magnetising force at the centre of the square and the centre of the circle.* **(Elec. Measurements; Nagpur Univ. 1992)**

مفاتيح الاجابة على الاختبارات

الاختبار القبلي	
1	a
2	b
3	c
4	b
5	a

الاختبارات الذاتية

1-

$$E = \frac{N\Phi}{t}$$

average e.m.f. induced in coil is

$$\frac{1200 \times (800 \times 10^{-6})}{0.1} = 9.6 \text{ V}$$

2-

Solution. As seen from Art. 6.15 (*i*),

$$H = \frac{I}{2\pi r} = \frac{250}{2\pi \times 0.05} = 795.6 \text{ AT/m}$$

$$B = \mu_0 H = 4\pi \times 10^{-7} \times 795.6 = 10^{-3} \text{ Wb/m}^2$$

In general, $B = \frac{\mu_0 I}{2\pi r}$

Now, at the conductor surface, $r = 1 \text{ mm} = 10^{-3}$ m

$$\therefore \quad B = \frac{4\pi \times 10^{-7} \times 250}{2\pi \times 10^{-3}} = 0.05 \text{ Wb/m}^2$$

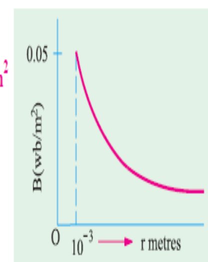


Fig. 6.22

الاختبار البعدي	
Faraday's laws of Electromagnetic induction **There are two laws of Faraday's laws of electromagnetic induction. They are:** **1) First Law. 2) Second law.** First law **Whenever a conductor cuts the magnetic flux lines an emf is induced in the conductor.** Second law **The magnitude of the induced emf is equal to the rate of change of flux-linkage.**	**1**
Induced electromotive force are of two types: they are **i) Dynamically induced emf.** **ii) Statically induced emf.**	**2**
μ_r=1.00133 μ=12.59*10^-7 H/m	**3**
H=795.6 AT/m B=0.05wb/m^2	**4**
H=144AT/m H=125.6 AT/m	5

References:

1-Electrical Technology by – Theraga

2- Electrical Technology by – Hughes

3- Electrical Technology by – Erick

الوحدة النمطية الخامسة

١- النظرة الشاملة (Over View):

١- النظرة الشاملة (Over View)

أ- الفئة المستهدفة (Target Population):-

طلبة المرحلة الاولى في قسم الميكانيك

ب- مبررات الوحدة (Rationale):-

معرفة نظرية عمل المحول الكهربائي وتركيبه وطريقة ترتيب الملفات واستنتاج معادلة القوة الدافعة الكهربائية ونسبة التحويل .

ت- الفكرة المركزية (Central Ideas):-

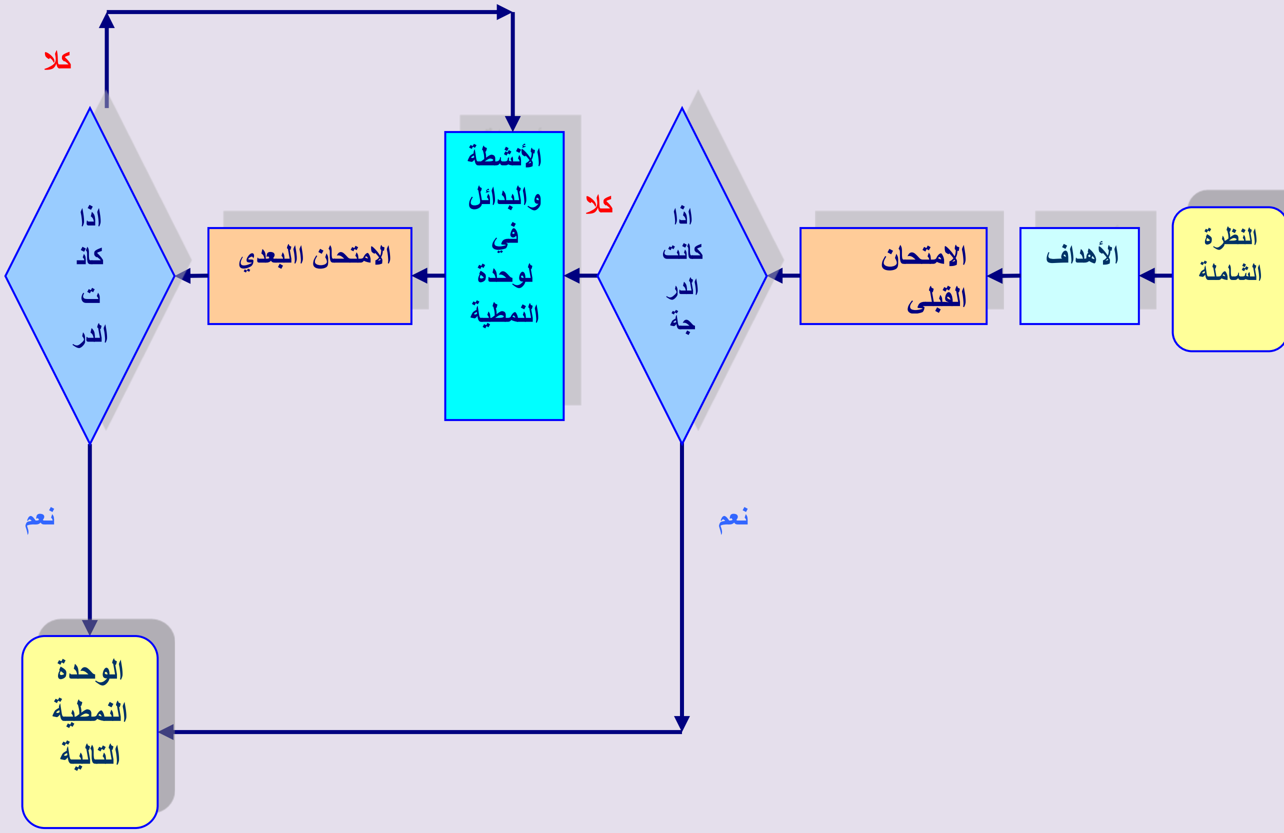
- **المحولات الكهربائية**
- **قانون فاراداي**
- **انواع المحولات (خافظة ، رافعة)**
- **امثلة تطبيقية**

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

- **يتعرف على اجزاء المحولات الكهربائية .**
- **يستنتج قانون القوة الدافعة الكهربائية .**
- **يعرف الفرق بين المحولات (خافظة ، رافعة) .**

جـ - المخطط الانسيابى:



مخطط انسيابى للتدرب بواسطة الوحدة النمطية.

٢- الاختبار القبلي (Pre – Test):

٢- الاختبار القبلي (Pre – Test):

1- What types of electrical transformers in terms of ?

structure?

2- What are the uses of electrical transformers?

3- What is the transformer construction?

4- What is working principle of transformer?

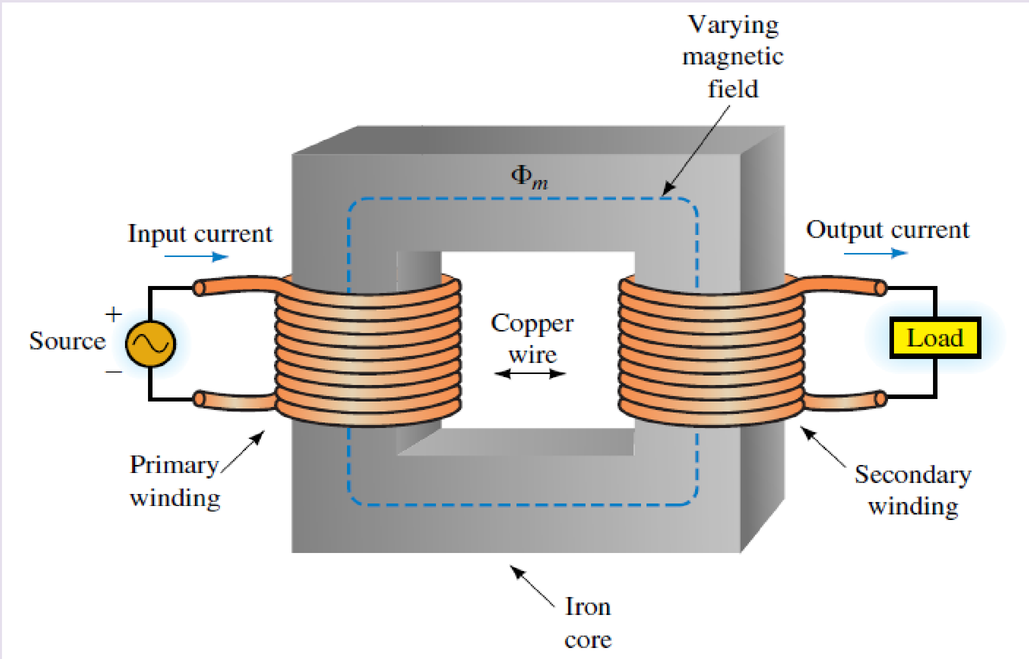
5- At no load what are type of losses in transformer?

٣-عرض الوحدة النمطية

٣-عرض الوحدة النمطية

The transformer

A transformer is a magnetically **coupled circuit,** i.e., a circuit in which the magnetic field produced by time-varying current inone circuits induces voltage in another. To illustrate, a basic iron-core transformer is shown in Figure. It consists of two coils wound on a common core. Alternating current in one winding establishes a flux which links the other winding and induces voltage in it. Power thus flows from one circuit to the other via the medium of the magnetic field, with no electrical connection between the two sides. The winding to which we supply power is called the **primary,** while the winding from which we take power is called the **secondary.** Power can flow either direction, as either winding can be used as the primary or the secondary.



Faraday's Law

All transformer operation is described by Faraday's law. Faraday's law (in SI units) states that the voltage induced in a circuit by a changing magnetic field is equal to the rate at which the flux linking the circuit is changing. When Faraday's law is applied to iron-core and air-core transformers, however, the results that emerge are quite different: Iron-core transformers are found to be characterized by their turn's ratios, while air-core transformers are characterized by self- and mutual inductances.

Voltage Ratio

Now apply Faraday's law. Since the flux linkage equals $N\Phi$ and since N is constant, the induced voltage is equal to N times the rate of change of Φ, i.e., $e = Nd\Phi/dt$. Thus, for the primary,

$$e_p = N_p \frac{d\Phi_m}{dt}$$

while for the secondary

$$e_s = N_s \frac{d\Phi_m}{dt}$$

Dividing Equation 24–1 by Equation 24–2 and cancelling $d\Phi_m/dt$ yields

$$\frac{e_p}{e_s} = \frac{N_p}{N_s}$$

The ratio of primary voltage to secondary voltage is equal to the ratio of primary turns to secondary turns. This ratio is called the **transformation ratio** (or **turns ratio**) and is given the symbol a.

$$a = N_p/N_s$$

Step-Up and Step-Down Transformers

A **step-up** transformer is one in which the secondary voltage is higher than the primary voltage, while a **step-down** transformer is one in which the secondary voltage is lower. Since $a = Ep/Es$, a step-up transformer has $a<1$, while for a step-down transformer, $a > 1$. If $a = 1$, the transformer's turns ratio is **unity** and the secondary voltage is equal to the primary voltage.

اختبار ذاتي:1

What is the difference between the actual and the ideal transformers?

2-

Example 32.3. *A single-phase transformer has 400 primary and 1000 secondary turns. The net cross-sectional area of the core is 60 cm^2. If the primary winding be connected to a 50-Hz supply at 520 V, calculate (i) the peak value of flux density in the core (ii) the voltage induced in the secondary winding.* **(Elect. Engg-I, Pune Univ. 1989)**

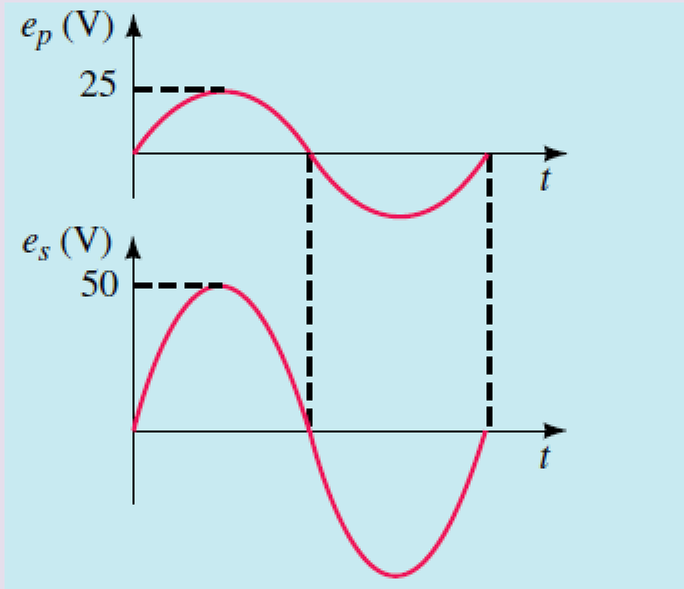
EXAMPLE-14 Suppose the transformer has 500 turns on its primary and 1000 turns on its secondary.a. Determine its turn's ratio. Is it step-up or step-down?b. If its primary voltage is e_p=25 sin wtV, what is its secondary voltage?c. Sketch the waveforms.

Solution

a. The turns ratio is $a = N_p/N_s$= 500/1000 =0.5. This is a step-up transformer.

b. $e_s = e_p/a$ = (25 sin wt)/0.5 = 50 sin wtV.

c. Primary and secondary voltages are in phase as noted earlier.



H.WIf the transformers have 600 turns on their primary and 120 turns on their secondary, and $\mathbf{E}_p$= 120 V, what is $\mathbf{E}_s$

٤-الاختبار البعدي (Post – Test):

1-

Example 32.1. *The maximum flux density in the core of a 250/3000-volts, 50-Hz single-phase transformer is 1.2 Wb/m^2. If the e.m.f. per turn is 8 volt, determine*

(i) primary and secondary turns (ii) area of the core.

2-

Example 32.2. *The core of a 100-kVA, 11000/550 V, 50-Hz, 1-ph, core type transformer has a cross-section of 20 cm × 20 cm. Find (i) the number of H.V. and L.V. turns per phase and (ii) the e.m.f. per turn if the maximum core density is not to exceed 1.3 Tesla. Assume a stacking factor of 0.9.*

What will happen if its primary voltage is increased by 10% on no-load ?

3-

Example 32.4. *A 25-kVA transformer has 500 turns on the primary and 50 turns on the secondary winding. The primary is connected to 3000-V, 50-Hz supply. Find the full-load primary and secondary currents, the secondary e.m.f. and the maximum flux in the core. Neglect leakage drops and no-load primary current.* (Elect. & Electronic Engg., Madras Univ. 1985)

4-

Example 32.6. *A single phase transformer has 500 turns in the primary and 1200 turns in the secondary. The cross-sectional area of the core is 80 sq. cm. If the primary winding is connected to a 50 Hz supply at 500 V, calculate (i) Peak flux-density, and (ii) Voltage induced in the secondary.*

(Bharathiar University November 1997)

5-

Example 32.7. *A 25 kVA, single-phase transformer has 250 turns on the primary and 40 turns on the secondary winding. The primary is connected to 1500-volt, 50 Hz mains. Calculate (i) Primary and Secondary currents on full-load, (ii) Secondary e.m.f., (iii) maximum flux in the core.*

مفاتيح الاجابة على الاختبارات

	الاختبار القبلي	الاختبارات الذاتية		الاختبار البعدي
1	**Step-Up and Step-Down Transformers**	**1-The working principle of the electrical transformer on Faraday's law of electromagnetic to induce which states that the value of the electrical driving force (voltage) is proportional to the magnetic flux change rate and for this reason, the converter does not work in DC power systems because the constant current creates a magnetic field constant amount of change is equal to zero cannot create voltage timely manner Induction and this is one of the main reasons for the .preference AC DC**	**1**	N1=32 N2=375 A=0.03m^2
2	**Transformers are used in practical life, electrical appliances and gauges**		**2**	N1=1060 N2=53 E=10.4v
3	**The simple element of transformer consist of two coil having mutual inductance and a laminated steel core**		**3**	I_1=8.33A I_2=83.3A E_2=300v Φ=27mWb
4	**Transfers electrical power from one circuit to another; it does without change of frequency**		**4**	Bm=0.563Wb/m^2 V_2=1200v
5	Copper losses and eddy current		5	V_2=240v I_1=16.67A I_2=104.2A

References:

1-Electrical Technology By – Theraga

2- Electrical Technology by – Hughes

3- Electrical Technology by – Erick

الوحدة النمطية السادسة

١- النظرة الشاملة (Over View):

النظرة الشاملة (Over View)

أ- الفئة المستهدفة (Target Population):-

طلبة المرحلة الاولى في قسم الميكانيك

ب- مبررات الوحدة (Rationale):-

الالمام الشامل بتركيب واساسيات تشغيل واداء المحركات الحثية.

ت- الفكرة المركزية (Central Ideas):-

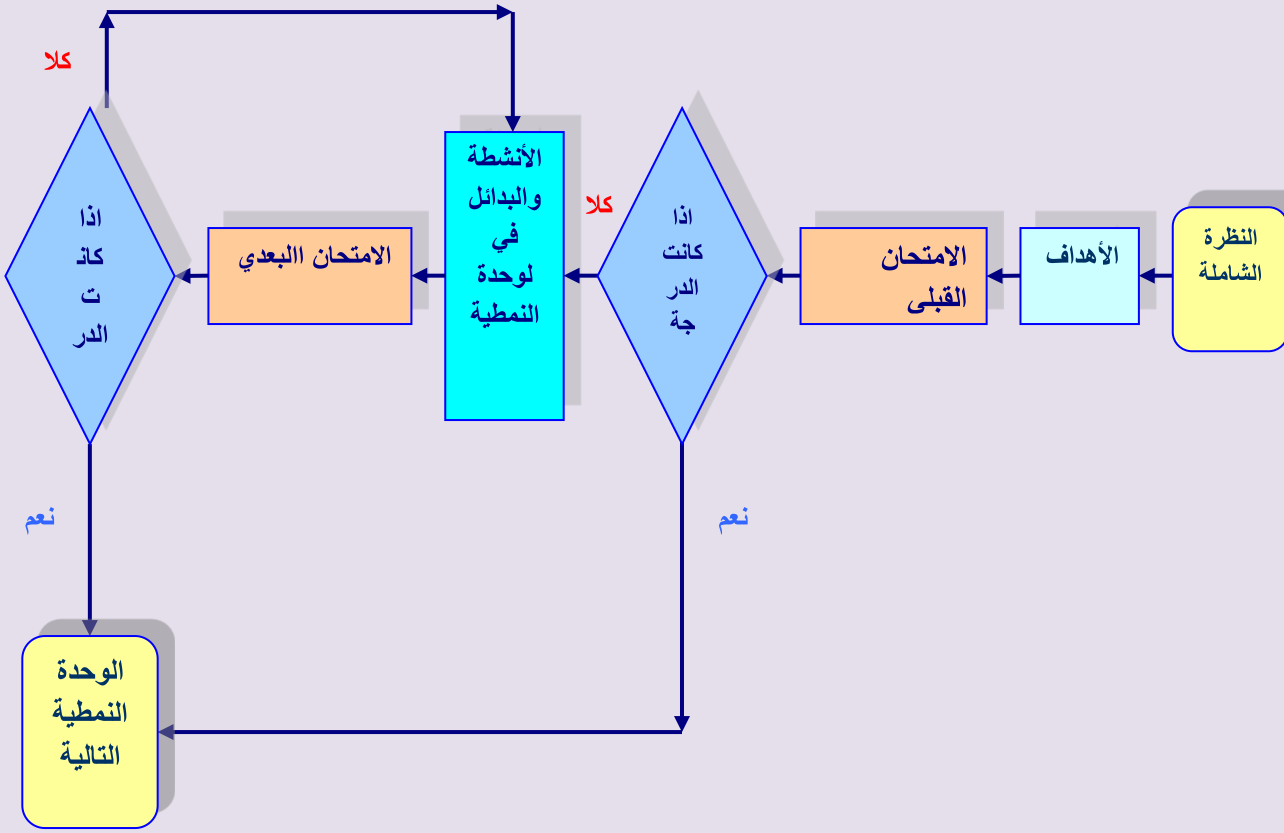
- اصناف الات التيار المتناوب
- تطبيق المحركات في الحياة العملية
- المحركات الحثية ثلاثية الاوجه
- مبدا عمل المحركات الحثية
- المفاتيح الكهربائية

ث- أهداف الوحدة (Objectives):-

سيكون الطالب بعد دراستهِ لهذه الوحدة قادراً على أن:

- يفهم نظرية عمل المحركات الحثية .
- يلم بخواص المحركات الحثية .
- يلم بكيفية توليد المجال المغناطيسي الدوار في المحركات الحثية .

جـ - المخطط الانسيابى:



مخطط انسيابي للتدرب بواسطة الوحدة النمطية.

٢- الإختبار القبلي (Pre – Test):

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Put a circle around the letter that precedes the correct answer for each of the following

1- The motors convert energy from:

a- mechanical to electrical

b- electrical to mechanical

c- Thermal to electrical

2- The generators convert energy from:

a- Thermal to electrical

b- Mechanical to electrical

c- electrical to mechanical

3- What is the construction of induction motor?

4- What is type of rotor?

5- What is the per-phase equivalent circuit of an induction motor?

٣-عرض الوحدة النمطية

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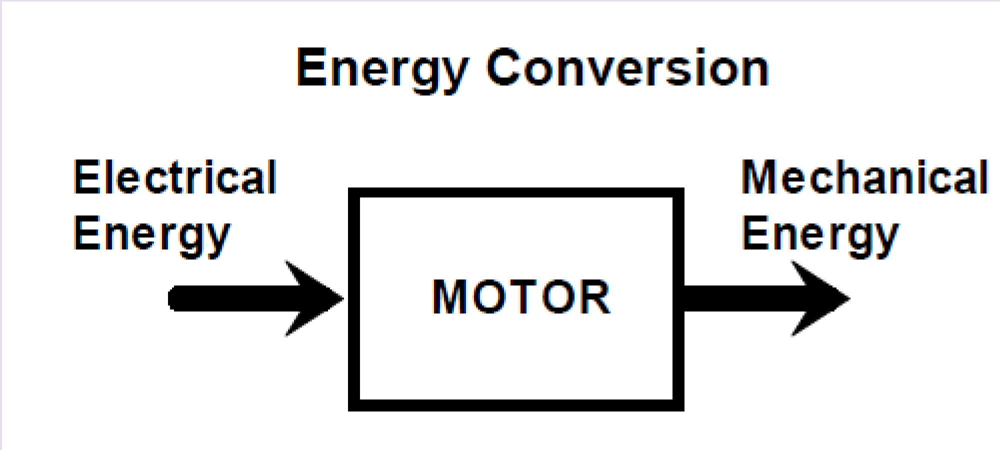
Classification of AC Rotating Machines

•**Synchronous Machines:**
•**<u>Synchronous Generators</u>:** A primary source of electrical energy.
•**<u>Synchronous Motors</u>:** Used as motors as well as power factor compensators (synchronous condensers).
•**Asynchronous (Induction) Machines:**
•**<u>Induction Motors</u>:** Most widely used electrical motors in both domestic and industrial applications.
•**<u>Induction Generators</u>:** Due to lack of a separate field excitation, these machines are rarely used as generators.

Energy Conversion

- Generators convert mechanical energy to electric energy.
- Motors convert electric energy to mechanical energy.



The construction of motors and generators are similar.

• Every generator can operate as a motor and vice versa.

Practical Motor Applications:

1. Refrigerators.
2. Washing machines.
3. Clocks.
4. Drills.
5. Pumps.

Advantages
– Low Initial Cost - $/Hp
– Simple & Efficient Operation
– Compact Size – cubic inches/Hp
– Long Life – 30,000 to 50,000 hours
– Low Noise
– No Exhaust Emissions
– Withstand high temporary overloads
– Automatic/Remote Start & Control

• Disadvantages
– Portability
– Speed Control
– No Demand Charge

Induction motors

The induction motor is the most commonly used AC motor in industrial applications because of its simplicity, rugged construction, and relatively low manufacturing costs. The reason that the induction motor has these characteristics is because the rotor is a self-contained unit, with no external connections. This type of motor derives its name from the fact that AC currents are induced into the rotor by a rotating magnetic field.

Three-phase Induction Motor

The three-phase induction motor the most commonly used type of motor in industrial applications. In particular, the squirrel-cage design is the most widely used electric motor in industrial applications.

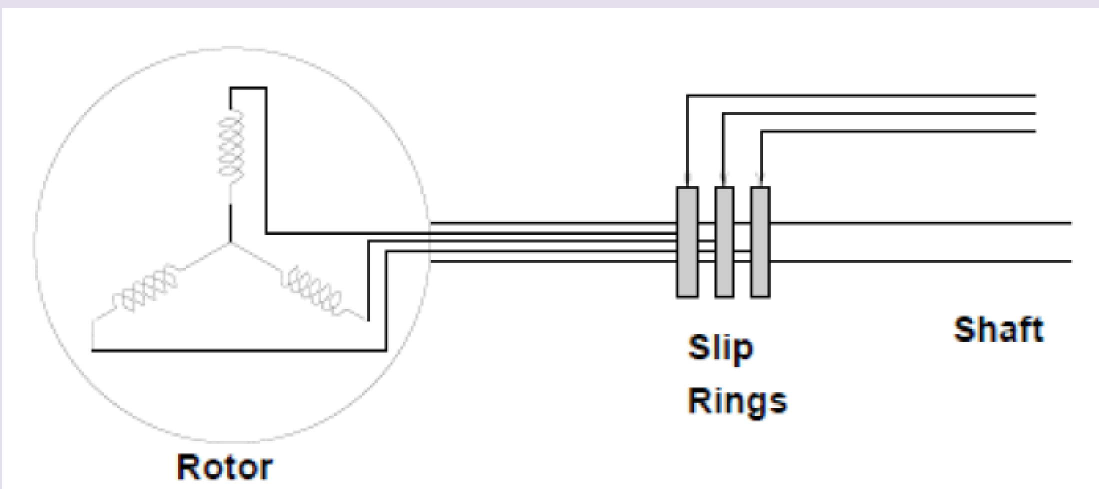
Construction: The main body of the Induction Motor comprises of two major parts:

A. Stator: Stator is made up of number of stampings in which different slots are cut to receive 3 phase winding circuit which is connected to 3 phase AC supply. The three phase windings are arranged in such a manner in the slots that they produce a *rotating magnetic field* after AC supply is given to them. The windings are wound for a definite number of poles depending upon the speed requirement.

B. Rotor: Rotor consists of cylindrical laminated core with parallel slots that carry conductor bars.

Two types of Rotor:

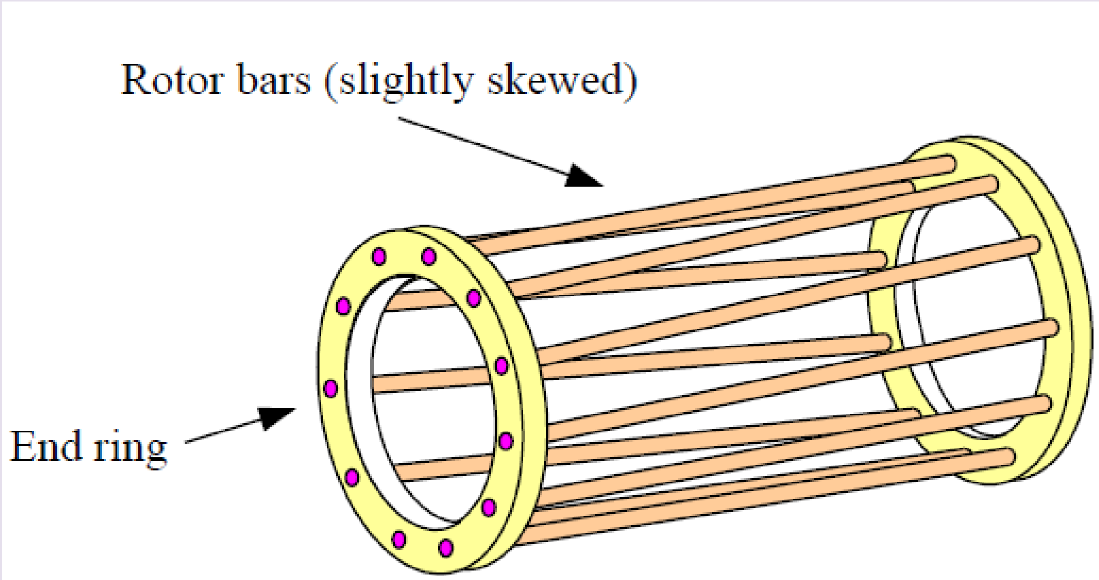
1. Wound Rotor/slip ring: The terminals of the rotor windings are connected to insulated slip rings mounted on the rotor shaft. Carbon brushes bearing on these rings make the rotor terminals available to the circuitry external to the motor. The rotor winding is usually short circuited through external resistances that can be varied.



Wound rotor slip rings and connections

2. Squirrel Cage:

A squirrel cage rotor has a winding consisting of conducting bars (of copper or aluminum) short-circuited at each end by conducting end rings.



اختبار ذاتي:

Why make a stator from sheet metal?

Working Principle:

When balanced 3-phase AC voltages are applied to the stator terminal, stator currents flow through the stator circuits. These currents produce a rotating *mmf*that can be represented as a *rotating magnetic field*. This rotating magnetic field induces voltages in the rotor windings, by Faraday's law. These induced voltages, in turn, cause balanced currents to flow in the short-circuited rotor. These rotor currents then produce a rotor *mmf*, which can also be represented as a *rotating magnetic field*. The interaction of these two rotating magnetic fields produces an electromagnetic torque *Te*, which is used to turn mechanical load *Tm*. At steady state.

The following sequence of events takes place:

- A voltage E = BLv is induced in each conductor while it is being cut by the flux (Faraday's Law)
- The induced voltage produces currents which circulate in a loop around the conductors (through the bars).
- Since the current-carrying conductors lie in a magnetic field, they experience a mechanical force (Lorentz force).
- The force always acts in a direction to drag the conductor along with the magnetic field.

اختبار ذاتي: 1

Why make the stator from iron sheet?

Switchgear

The apparatus used for switching; controlling and protecting the electrical circuits and equipment is known as switchgear. The switchgear equipment is essentially concerned with switching and interrupting currents either under normal or abnormal operating conditions.

Switchgear Equipment:

1. Switches: A switch is a device which is used to open or close an electrical circuit in a convenient way. It can be used under full load or no load conditions but it cannot interrupt the fault currents. When the contacts of a switch are opened an arc is

produced in the air between the contacts. This is particularly true for circuits of high voltage and large current capacity.

2. Fuse: A fuse is a short piece of wire or thin strip which melts when excessive current flows through it for sufficient time. It is inserted in series with the circuit to be protected. Under normal operating conditions the fuse element it at a temperature below its melting point. Therefore it carries the normal load current without overheating. However when a short circuit or overload occurs the current through the fuse element increases beyond its rated capacity. This raises the temperature and the fuse element melts.
3. Circuit breakers:

   A circuit breaker works as a switching device as well as a current interrupting device. It does this by performing the following two functions:

   1. Switching operating during normal working of operation and maintenance.
   2. Switching operation during abnormal conditions that may arise such as over current; short circuit etc.

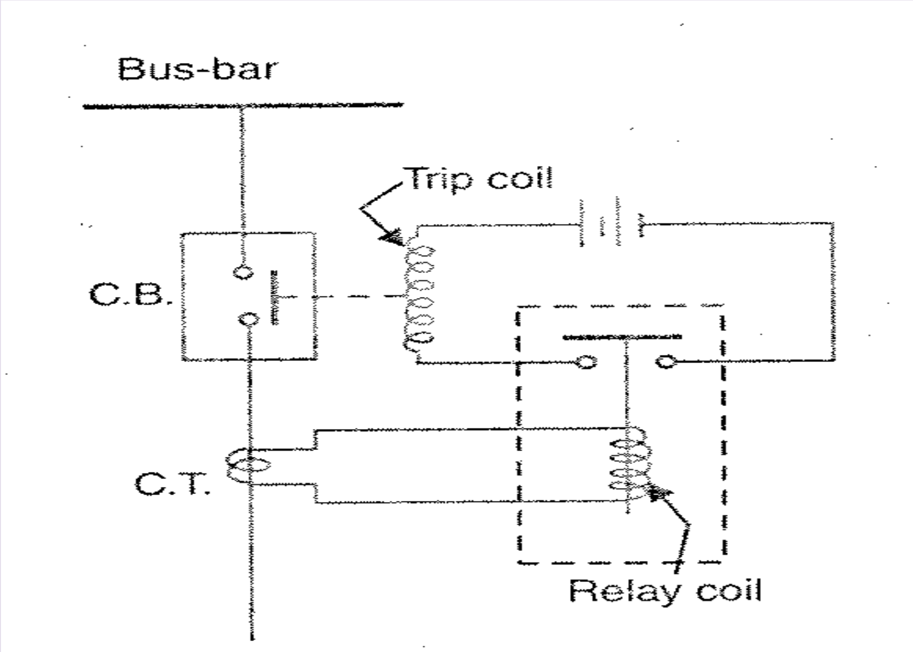


Figure shows the circuit breaker

When any high voltage circuit is interrupted there is a tendency towards an arc formation between the two separating contacts. Therefore the major aim in a circuit breaker design is to quench the arc rapidly enough to keep the contacts in normal state by one of the following methods;

1. High resistance interruption: in this method arc resistance is increased. This method is generally used in DC circuit breakers and low medium voltage AC circuit breakers.
2. In this method: the arc is interrupted at a current zero instance. At that instance. The air between the separating contacts is anodized by introducing fresh air sf6 gas or for an AC are interruptions.

اختبار ذاتي :2

A three-phase induction motor is wound for four poles and is supplied from a 50 Hz system. Calculate:

(a) The synchronous speed;

(b) The speed of the rotor when the slip is 4 per cent;

(c) The rotor frequency when the speed of the rotor is 600 r/min.

٤-الاختبار البعدي (Post – Test):

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1- what are the classification of ac rotating machines?

2- what are the switchgear equipment?

3-

Example 34.1. *A slip-ring induction motor runs at 290 r.p.m. at full load, when connected to 50-Hz supply. Determine the number of poles and slip.*

4-

Example 34.2. *The stator of a 3-φ induction motor has 3 slots per pole per phase. If supply frequency is 50 Hz, calculate*

(i) number of stator poles produced and total number of slots on the stator

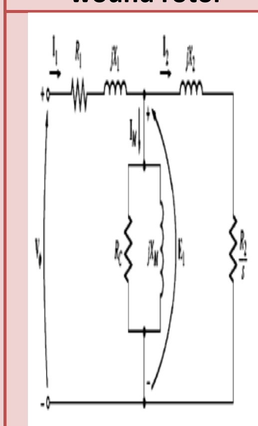
(ii) speed of the rotating stator flux (or magnetic field).

5-

Example 34.4. *A 3-ϕ induction motor is wound for 4 poles and is supplied from 50-Hz system. Calculate (i) the synchronous speed (ii) the rotor speed, when slip is 4% and (iii) rotor frequency when rotor runs at 600 rpm.* (Electrical Engineering-I, Pune Univ. 1991)

مفاتيح الاجابة على الاختبارات

الاختبار القبلي

1	b
2	c
3	Stator and rotor
4	Squiral cage rotor ;phase wound or wound rotor
5	

الاختبارات الذاتية

1 **To minimize the eddy currents created due to exposure iron magnetic field variable that heat**

Q.2

(a) From Equation [36.1]:

$$\text{Synchronous speed} = \frac{60f}{p} = \frac{60 \times 50}{2}$$

$$= 1500 \text{ r/min}$$

(b) From equation [38.1]:

$$0.04 = \frac{1500 - \text{rotor speed}}{1500}$$

$$\therefore \quad \text{Rotor speed} = 1440 \text{ r/min}$$

(c) Also from equation [38.1]:

$$\text{Per-unit slip} = \frac{1500 - 600}{1500} = 0.6$$

Hence, from equation [38.2]:

$$\text{Rotor frequency} = 0.6 \times 50 = 30 \text{ Hz}$$

الاختبار البعدي

1	<u>Classification of AC Rotating Machines</u> •Synchronous Machines: •<u>Synchronous Generators</u>: **A primary source of electrical energy.** •<u>Synchronous Motors</u>: **Used as motors as well as power factor compensators (synchronous condensers).** •Asynchronous (Induction) Machines: •<u>Induction Motors</u>: **Most widely used electrical motors in both domestic and industrial applications.** •<u>Induction Generators</u>: **Due to lack of a separate field excitation, these machines are rarely used as generators.**
2	**Switches , fuse , circuit breaker**
3	P=20 pole ، Slip=3.33%
4	P=6، NS=1000 r.p.m، NO. OF slot=54
5	Nr=1440 r.p.m ، Fr=30 Hz S=0.6 ،

References:
1-Electrical Technology by – Theraga
2- Electrical Technology by – Hughes
3- Electrical Technology by – Erick