Radio Mechanics
Fourth Year

Module 5
Show Me If You Can
(Circuit Analysis)

What this module is about

Congratulations, you did well in the previous modules. How do you feel going through this module? Do you think you are already equipped with the necessary knowledge and skills? I hope so.

This module dwells on the application of basic electrical quantities in the computation and analysis of electrical and electronic circuits. As the end-user of this module, you need depth of understanding of its content and be able to apply it in solving simple electrical problems. It also enables you to understand the characteristics of the different electronic components when they are connected in different ways.

After going through this module, you should be able to do these:

1. Compute resistance in series, parallel and series-parallel.
2. Compute capacitance and voltage rating of capacitors in series and parallel connections.
3. Compute inductance in series and parallel connections.
4. Explain transformer ratio.

How to learn from this module

For maximum benefit from this module, here are some tips to guide you in learning the different lessons.

1. Work through this module in proper sequence as the contents are presented.
2. After reading and understanding the objectives, answer all the questions in the pretest.
3. Check your answers by comparing these with the key to answers in the last part of this module.
4. Read and understand each lesson well. Perform the activities and answer the self-check to determine the extent of your learning.
5. Answer the posttest and compare your answers with the key to answers. You must get a score of at least 80% in order to move on to the next module.

PRETEST

Directions: Read each statement carefully. Write **on** if the statement is correct, and **off** if it is wrong. Write your answers on the blank before each number.

________ 1. Current is the same in all points of series- connected resistors.
________ 2. Voltage drop across each resistor increases when they are connected in series.
________ 3. Total resistance rises when resistors are connected in parallel.
________ 4. When one of the resistors connected in series becomes defective, it affects the whole circuit.
________ 5. Each resistor serves as current divider when connected in parallel.
________ 6. Current has only one path to flow in parallel-connected resistors.
________ 7. When four resistors are connected in series, current flowing at R_1 is the same as that at R_3.
________ 8. If three 10-ohm resistors are connected in series, total resistance will be 30 ohms.
________ 9. Only three resistors can be connected parallel to one another.
________ 10. Each resistor in a series circuit acts as voltage divider.
________ 11. Connecting capacitors in series means increasing capacitance.
________ 12. The working voltage of capacitors add when they are connected in series.
________ 13. Capacitance values of capacitors rise when they are connected in parallel.
________ 14. Connecting inductors in series results in a higher inductance.
________ 15. The secondary voltage of a transformer is reduced when primary winding has more turns than the secondary.
________ 16. A step-up transformer produces more voltage at its secondary compared to what is applied across its primary winding.
________ 17. Total inductance increases when the mutual inductance between two coils is series-opposing.
________ 18. Parallel inductors provide higher inductance.
________ 19. More turns of wire in the secondary means higher secondary voltage.
________ 20. Secondary current in a transformer is inversely proportional to the turns ratio.

Lesson 1

Resistance in Series, Parallel and Series Parallel Connections

Resistors can be connected in series, parallel and series-parallel combination. Each connection has its own characteristic as to voltage, current and resistance.

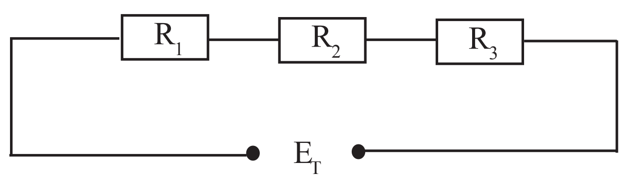
Resistance in Series

When resistors are connected in series, they come up with the following characteristics:

1. The same current will follow through the components in the circuit. Thus, current total (IT) is;
   $I_T = I_1 = I_2 = I_3$, etc.

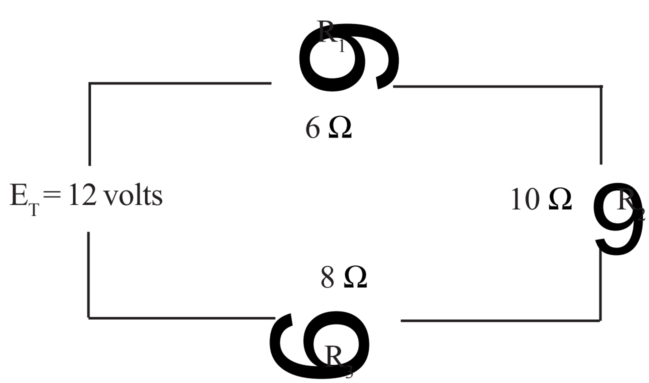
2. Total voltage (ET) of the circuit is equal to the sum of the voltage drop of each component. Thus:
   $E_T = E_1 + E_2 + E_3 ...$

3. Total resistance (RT) of the circuit is equal to the sum of all the resistances connected in the circuit. Thus;
   $R_T = R_1 + R_2 + R_3 ...$



Block Diagram of Resistors Connected in Series

Sample Problem:



$R_T = R_1 + R_2 + R_3$
$= 6\ \Omega + 10\ \Omega + 8\ \Omega$
$= 24\ \Omega$

$I_T = \frac{E_T}{R_T}$ (from Ohm's law)

$= \frac{12 \text{ volts}}{24\ \Omega}$

$= 0.5$ A

$E_1 = I_1 \times R_1$ (from Ohm's law)
$= .5\text{A} \times 6\ \Omega$
$= 3$ volts

$E_2 = I_2 \times R_2$

$= .5\text{ A} \times 10\ \Omega$
$= 5$ volts

$E_3 = I_3 \times R_3$
$= .5\text{ A} \times 8\ \Omega$
$= 4$ volts

Checking:

$E_T = E_1 + E_2 + E_3$
$= 3\text{ V} + 5\text{V} + 4\text{V}$
$= 12$ V - total applied voltage

Parallel Resistance

In a parallel circuit, components are connected across the voltage source. The current has more than one path to flow in.

Characteristics:

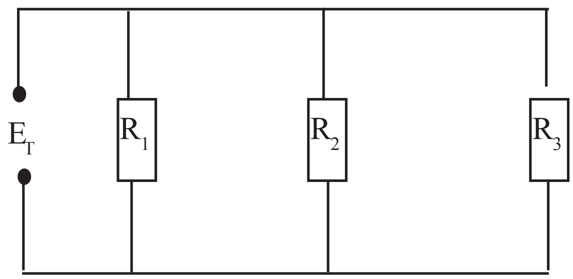
1. Each component receives the same voltage, or voltage is common to all connected components.
$E_T = E_1 = E_2 = E_3 ..$

2. Total current is equal to the sum of individual current in each branch.
$I_T = I_1 + I_2 + I_3 ....$

3. Total resistance is equal to the reciprocal of individual resistance. Hence, total resistance is lower than the lowest resistance connected.

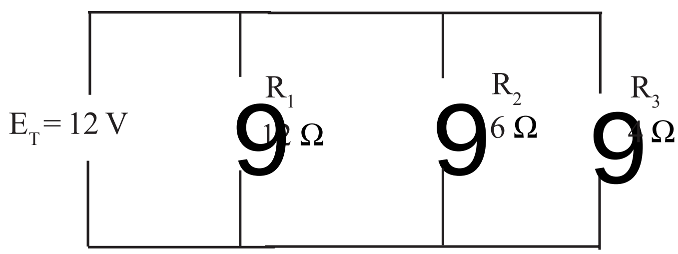
$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} ......}$$

we can also use this formula, $R_T = \frac{R_1 \times R_2}{R_1 + R_2}$; for determining R_T of two resistors connected in parallel.



Block Diagram of Resistors Connected in Parallel

Sample Problem:



$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$, Substitute the values of R_1, R_2 and R_3.

$$= \frac{1}{\frac{1}{12} + \frac{1}{6} + \frac{1}{4}}$$ (Find the least common denominator, LCD)

$$= \frac{1}{\frac{1 + 2 + 3}{12}}$$

$$= \frac{1}{\frac{6}{12}}$$

$$I_1 = \frac{E_1}{R_1}$$

$$= \frac{12\ V}{12\ \Omega}$$

$$= 1 A$$

$$I_2 = \frac{E_2}{R_2}$$

$$= \frac{12\ V}{6\ \Omega}$$

$$= 2 A$$

$= \frac{1 \times 12}{6}$

= 2 ohms

$IT = \frac{E_T}{R_T}$

$= \frac{12\ V}{2\ \Omega}$

= 6 A

$I_2 = \frac{E_3}{R_3}$

$= \frac{12\ V}{4\ \Omega}$

= 3 A

Checking: $IT = I_1 + I_2 + I_3$

$= 1A + 2A + 3A$

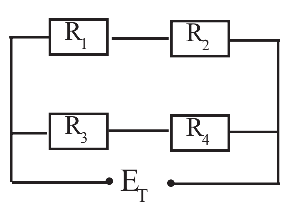
$= 6\ A$

Resistance in Series Parallel

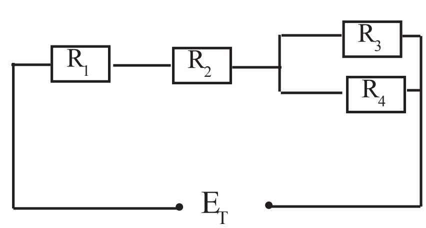
In computing resistance in series-parallel circuits, the easiest way is to simplify the circuit. One way of simplifying a series-parallel circuit is to redraw it in order to identify easily which are connected in series and which are connected in parallel.

Characteristics of Series Parallel Connections

1. The current in series-parallel connected resistor divides in a parallel path and comes together in the series portion.
2. In series-parallel connected resistors, voltage is the same in the parallel part, and divides in the series portion.
3. Resistance in the series portion increases while in parallel portion, it decreases.



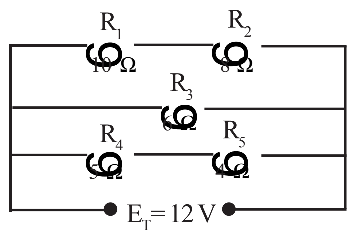
R_1 and R_2 are connected in series and are parallel to R_3



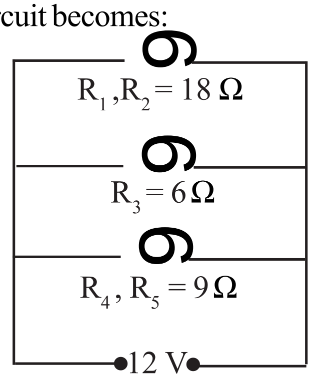
R_1 and R_2 are connected in series. They are also connected in series and R_4 which are also connected in series.

with R_3 and R_4 which are connected in parallel.

Sample Problem



From the original circuit, you can combine R_1 and R_2, then R_3 and R_4. Take note that in their connections, both are in series. Thus, the circuit becomes:



For the combined resistance of R_1 and R_2, R_4 and R_5.

$$R_{1,2} = R_1 + R_2 = 10\ \Omega + 8\ \Omega = 18\ \Omega$$

$$R_{3,4} = R_4 + R_5 = 5\ \Omega + 4\ \Omega = 9\ \Omega$$

From the redrawn circuit above, the resistors are now connected in parallel; thus:

$$R_T = \frac{1}{\frac{1}{R_{1,2}} + \frac{1}{R_3} + \frac{1}{R_{4,5}}}$$

$$= \frac{1}{\frac{1}{18} + \frac{1}{6} + \frac{1}{9}} \text{ (finding the lcd)}$$

$$= \frac{1}{\frac{1 + 3 + 2}{18}}$$

$$= \frac{1}{\frac{6}{18}}$$

$$= 1 \times \frac{18}{16}$$

R_T = 3 ohms

$IT = \frac{ET}{PT}$

$= \frac{12\ V}{3\ \Omega}$

= 4 amperes

Since R_1 and R_2 are in series and are connected in parallel with other resistors, the same amount of current flows through them and receive a voltage supply of 12 volts.

$I_{1,2} = \frac{E_T}{R_{1,2}}$

$= \frac{12\ V}{18\ \Omega}$

= 0.667 A

$E_1 = I_1 \times R_1$
$= 0.667\ A \times 10\ \Omega$
$= 6.67\ V$

$E_2 = I_2 \times R_2$
$= 0.667\ A \times 8\ \Omega$
$= 5.336\ V$

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

$= \frac{12\ V}{6\ \Omega}$

= 2A

Checking:

$E_{1,2} = E_1 + E_2 = 6.67 + 5.336\ V$
$= 12.006\ V$ or $12\ V$

$E_3 = I_3 \times R_3 = 2A \times 6\ \Omega = 12\ V$
$E_4 = I_4 \times R_4 = 1.33\ A \times 5\Omega = 6.65\ V$
$E_5 = I_5 \times R_5 = 1.33\ A \times 4\ \Omega = 5.32\ V$

$I_{4,5} = \frac{E_T}{R\ 4,5}$

$= \frac{12\ V}{9\ \Omega}$

= 1.33 A

Checking:

$E_{4,5} = E_4 + E_5$
$= 6.65V + 5.32\ V$
$= 11.97\ V$ or $12\ V$

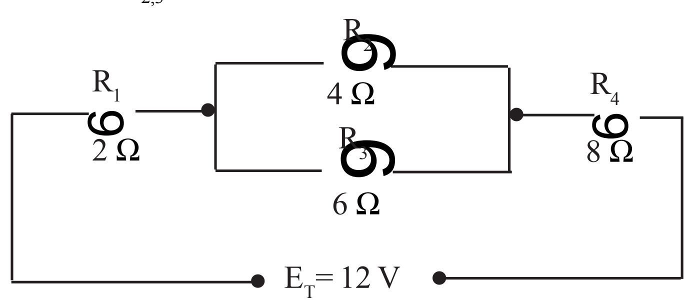
Checking:

$I_T = I_{1,2} + I_3 + I_{4,5}$
$= 0.667\ A + 2A + 1.33\ A$
$I_T = 3.997\ A$ or $4A$

Activity 1

Study and anlyze the given circuit below and compute the following:

1. R_T
2. I_T
3. I_1
4. I_2
5. I_3
6. I_4
7. E_1
8. E_4
9. $E_{2,3}$



Self-check

Directions: Read each statement carefully. Write **on** on the blank if the statement is correct, and **off** if it is wrong.

___________ 1. In a circuit with five resistors in series, current at R_1 is the same as at R_4.

___________ 2. Total resistance in a parallel connected resistor circuit is lower than the lowest resistance value connected.

___________ 3. Each resistor acts as voltage divider if they are connected in parallel.

___________ 4. The current in series-parallel connected resistor divides in the parallel path and comes together in the series portion.

___________ 5. A defective component in a series-connected resistor circuit disables the whole circuit.

Lesson 2

Capacitance in Series and Parallel Connections

Generally, all capacitors store charges in their dielectrics. The ability of these capacitors to store electric energy is known as **capacitance or capacity** (c), the basic unit used is the **Farad** (F). Farad is a unit that is too large for a capacitor for ordinary purposes. Usually, microfarad (uf) and picofarad (pf) are used.

1F	= 1,000,000 uf		1 uf	= 0.000001 F
1F	= 1,000,000,000,000 pf	or	1 pf	= 0.000000000001 F
1 uf	= 1,000,000 pf		1 pf	= 0.000001 uf

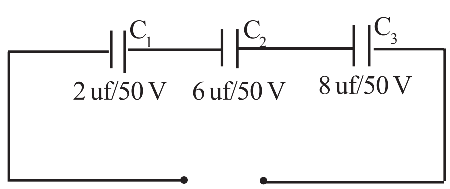
Series Capacitors

There are two factors to be considered before connecting capacitors in a circuit. One is their capacitance value (c), and the other their working voltage or voltage rating. You can solve these, using the following formula:

$$\text{Capacitance total (CT)} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

$$\text{Working voltage (WV)} = CV_1 + CV_2 + CV_3 ...$$

Sample Problem:



Solution:

$$C_T = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}} = \frac{1}{\frac{19}{24}}$$

$$= \frac{1}{\frac{1}{2} + \frac{1}{6} + \frac{1}{8}}$$ find the lcd

$$= \frac{1}{\frac{12 + 4 + 3}{24}}$$

$$= 1 \times \frac{24}{19}$$

$$C_T = 1.263 \text{ uf}$$

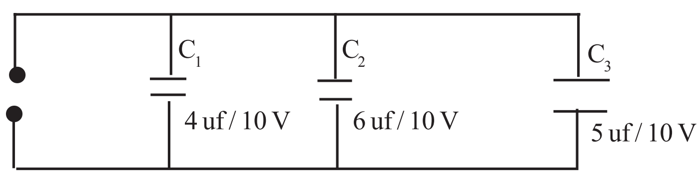
$$WV = CV_1 + CV_2 + CV_3$$
$$= 50 \text{ V} + 50 \text{ V} + 50 \text{ V}$$
$$WV = 150 \text{ volts}$$

Parallel Capacitors

When capacitors are connected in parallel, their capacitance value adds, but their working voltage remains constant. Hence, the working voltage of capacitors to be connected in parallel must be equal.

$$C_T = C_1 + C_2 + C_3 ...$$

Sample Problem



Solution:

$$C_T = C_1 + C_2 + C_3$$
$$= 4 \text{ uf} + 6 \text{ uf} + 5 \text{ uf}$$
$$= 15 \text{ uf}$$

Working voltage should be the same for the three capacitors. Hence, working voltage in the above circuit is 10 V.

Self-check

Directions: Match Column A with Column B. Write the letter corresponding to your answer in the blank before the number.

Column A	Column B
1. 1 uf	a. 1000 F
2. capacitance in parallel	b. $WV = CV_1 + CV_2 + CV_3$
3. capacitance in series	c. $C_T = C_1 + C_2 + C_3$

4. working voltage in series
5. working voltage in parallel

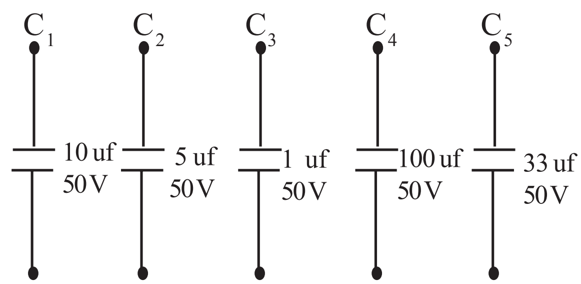
d. 1,000,000 pf

e. $WV = CV_1 = CV_2 = CV_3 ...$

f. $C_T = \dfrac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$

Activity 2

Below are capacitors drawn in schematic symbols. Connect them in parallel, and compute their total capacitance and working voltage or voltage rating.



Lesson 3

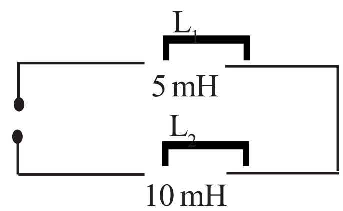
Inductance in Series and Parallel Connections

Inductance is the property of an inductor or coil and any circuit to oppose change in current flowing through it when voltage is applied. Inductance is measured in terms of henry which is symbolized by letter H. Its symbol is L. Like resistors, inductors can also be connected in series, parallel and series-parallel.

Inductance in Series

The total inductance of coils or inductors in series is the sum of the individual inductance L values. Since the series coils have the same current, total induced voltage is a result of the total number of turns. Hence, in series,

$L_T = L_1 + L_2 + L_3 ....$ This formula assumes mutual inductance between the coils.



Example 1

In the diagram above, L_1 is 5 mH and L_2 is 10 mH. How much is the total inductance L_T?

Solution:

$$L_T = L_1 + L_2 \quad = 5\text{ mH} + 10\text{ mH}$$
$$= 15\text{ mH or } 0.015\text{ H}$$

Note:

To convert mH to H, divide the value of mH by 1000.

Series Coils with Mutual Inductance LM

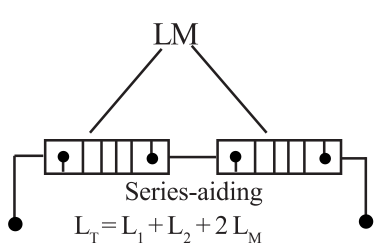
This case depends on the amount of mutual coupling and on whether the coils are connected series-aiding or series-opposing.

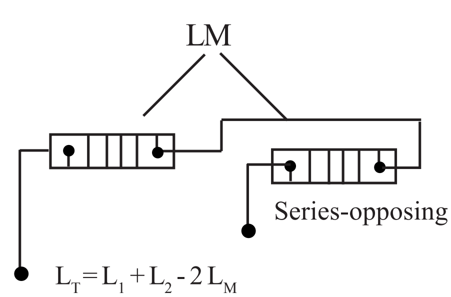
Series-aiding means that the common current produces the same direction of magnetic field for the coils.

Series-opposing means, the common current produces opposite direction of magnetic field for the coils. To calculate total inductance of two coils that are series-connected and have mutual inductance:

$$L_T = L_1 + L_2 + L_M$$

The LM is plus (+) when the total inductance is increasing, that is the coils are series-aiding. The LM is minus (-) when they are series-opposing, to reduce the total inductance.





Example (Series-aiding)

$L_1 = 4$ H

$L_2 = 5$ H

$L_M = 3$ H

Formula: $L_T = L_1 + L_2 = 2 L_M$

$= 4\text{ H} + 5\text{H} + (2 \times 3\text{ H})$

$= 4\text{ H} + 5\text{ H} + 6\text{ H}$

$= 15\text{ H}$

Example (Series-opposing)

$L_1 = 4$ H

$L_2 = 5$ H

$L_M = 3$ H

Fomula: $L_T = L_1 + L_2 - 2 L_M$

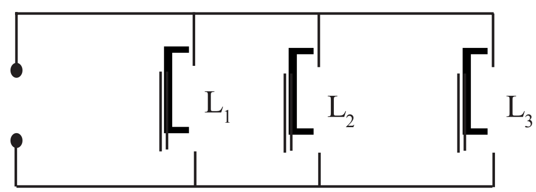
$= 4\text{ H} + 5\text{ H} - (2 \times 3\text{ H})$

$= 4\text{ H} + 5\text{ H} - 6\text{ H}$

$= 3\text{ H}$

Inductance in Parallel

If inductors are connected in parallel, the same principle is applied as in the case of parallel resistors, the reciprocal of the total inductance is equal to the sum of the reciprocal of the individual inductances. There are also three conditions to keep in mind in computing inductance in parallel. These are not mutual inductance, but are series-aiding and series-opposing.



Formula 1 (No mutual inductance)

$$L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}}$$

Example:

$L_1 = 5$ H

$L_2 = 20$ H

$L_3 = 4$ H

$L_T = ?$

Applying the formula: $$L_T = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}}$$ Substituting the values of L_1, L_2, and L_3

$$= \frac{1}{\frac{1}{5} + \frac{1}{20} + \frac{1}{4}}$$ Find the LCD

$$= \frac{1}{\frac{4 + 1 + 5}{20}}$$

$$= \frac{1}{\frac{10}{20}}$$

$$= 1 \times \frac{20}{10}$$

$$= 2\ H$$

Formula 2 (With Mutual Inductance- Series-aiding)

$$L_T = \frac{1}{\frac{1}{L_1 + L_M} + \frac{1}{L_2 + L_M}}$$

Example:

$L_1 = 5\ H$

$L_2 = 2\ H$

$L_M = 3\ H$

$L_T = ?$

Applying the formula: $L_T = \frac{1}{\frac{1}{L_1 + L_M} + \frac{1}{L_2 + L_M}}$

$$= \frac{1}{\frac{1}{5 + 3} + \frac{1}{2 + 3}}$$

$$= \frac{1}{\frac{5 + 8}{40}}$$

$$= \frac{1}{\frac{13}{40}}$$

$$= 1 \times \frac{40}{13}$$

$$= 3.076 \text{ H or } 3.1 \text{ H}$$

Formula 3 (With mutual inductance - series-opposing)

$$L_T = \frac{1}{\frac{1}{L_1 - L_M} + \frac{1}{L_2 - L_M}}$$

Example:

L_1 = 5 H

L_2 = 6 H

L_M = 2 H

L_T = ?

Applying the formula: $L_T = \frac{1}{\frac{1}{L_1 - L_M} + \frac{1}{L_2 - L_M}}$

$$= \frac{1}{\frac{1}{5 - 2} + \frac{1}{6 - 2}}$$

$$= \frac{1}{\frac{1}{3} + \frac{1}{4}}$$

$$= \frac{1}{\frac{4 + 3}{12}}$$

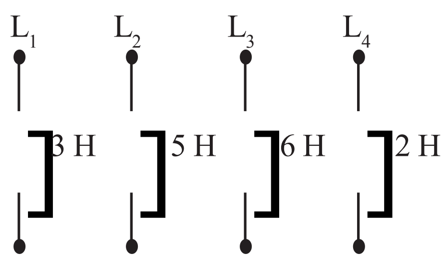
$$= \frac{1}{\frac{7}{12}}$$

$$= 1 \times \frac{12}{7}$$

$$= 1.71 \text{ H}$$

Activity 3

Connect the schematic symbols of inductors below in series, and compute their total inductance in these conditions: a. no mutual inductance b. series-aiding c. series-opposing



NOTE: The inductors have mutual inductance of 4 H if they are in series-aiding or series-opposing.

Self-check

Answer the following questions:

1. What do you mean by series-aiding? series-opposing?
2. What will happen to the total inductance (L_T) if the coils are in series-aiding?
3. What will happen to the total inductance (L_T) if the coils are in series-opposing?
4. What will happen to the total inductance (L_T) if the inductors or coils are connected in parallel?

Lesson 4

Transformer Ratio and Proportion

The transformer is an electrical or electronic device that changes electrical power or energy from one voltage level to another, higher or lower. It basically consists of two coils called windings electrically insulated from each other and wound on a common iron core. The primary winding receives the voltage from the voltage source and the secondary winding delivers the induced voltage. These two windings, through which voltages and currents come in and goes out, have specific relationships with respect to voltage, current and number of turns in the primary and secondary windings. In mathematical forms, these relationships are expressed as follows:

$$\frac{E_P}{E_S} = \frac{N_P}{N_S} \qquad \frac{I_P}{I_S} = \frac{N_S}{N_P} \qquad \frac{I_P}{I_S} = \frac{E_S}{E_P}$$

Where:

E_P = primary voltage
E_S = secondary voltage
N_P = number of turns in the primary coil
N_S = number of turns in secondary coil
I_P = primary current
I_S = secondary current

Turns Ratio

Ratio of the number of turns in the secondary to the number of turns in the primary is the turns ratio of the transformer. It is expressed in the following formula:

$$\text{Turns Ratio} = \frac{N_s}{N_P}$$

For instance, 1000 turns in the primary and 500 turns in the secondary provide a turns ratio of 1000 / 500 or 2:1.

Example 1

$E_P = 220$ volts

$E_S = 50$ volts

$N_P = 1{,}500$ turns

$N_S = ?$

Applying the formula : $\frac{E_P}{E_S} = \frac{N_P}{N_S}$

$\frac{220}{50\ V} = \frac{1{,}500 \text{ turns}}{N_S}$ (by cross multiplication)

$220\ V \times N_S = 50\ V \times 1{,}500\ T$ (by transposition)

$N_S = \frac{50\ V \times 1{,}500 \text{ turns}}{220\ V}$

$= \frac{75{,}000}{220}$

$N_S = 340.90$ turns

Voltage Ratio

The ratio of the primary voltage to the secondary (induced) voltage is equal to the ratio between the number of primary and secondary turns. This relationship is expressed in this formula:

$$\frac{E_P}{E_S} = \frac{N_P}{N_S}$$

The foregoing formula shows that voltage ratio can be varied by changing the ratio between the primary and secondary turns. If primary winding has more turns that the secondary winding, the voltage is reduced. If the primary winding has less turns than the secondary, voltage is increased.

Example 2

A transformer operated from a 220-volt source has a primary winding of 500 turns and a secondary winding of 200 turns. What will be the secondary voltage?

Applying the formula: $\frac{E_P}{E_S} = \frac{N_P}{N_S}$

$$\frac{220\ V}{E_S} = \frac{500\ \text{turns}}{100\ \text{turns}}$$

$$500 \times E_S = 220\ V \times 100\ \text{turns}$$

$$E_S = \frac{220\ V \times 100\ \text{turns}}{500}$$

$$= \frac{22{,}000}{500}$$

$$E_S = 44\ \text{volts}$$

Current Ratio

A step-up transformer may produce more voltage at its seconday than what is applied across its primary winding. However, the secondary current will have to be proportionally less than the primary current. Secondary current is inversely proportional to the turns ratio. This can be expressed in the following formula:

$$\frac{N_P}{N_S} = \frac{I_S}{I_P}$$

Example 3

A power transformer has a primary winding of 150 turns and a secondary of 800 turns. If the current at the primary winding is 2 amperes, how much is the secondary current?

Given : NP = 150 turns
NS = 800 turns
IP = 2 A
IS = ?

Applying the formula: $\frac{NP}{NS} = \frac{IS}{IP}$

$$\frac{150\ \text{turns}}{800\ \text{turns}} = \frac{I_S}{2A} \text{ (by cross multiplication)}$$

$$I_S \times 800\ \text{turns} = 2\ A \times 150\ \text{turns}$$

$$I_S = \frac{2\text{ A} \times 150\text{ turns}}{800\text{ turns}}$$

$$= \frac{300}{800}$$

$$I_S = 0.375\text{ A}$$

Self-check

Answer the following questions:

1. What formula is used to express the turns ratio of a transformer? voltage ratio of transformer? current ratio of transformer?
2. What are the basic parts of a transformer?

Activity 4

Solve for the unknown data in the given sets of transformer ratio and proportion.

1. N_P = 5,000 turns
   N_S = 1,000 turns
   I_S = 3 amperes
   I_P = ?

2. E_P = 220 volts
   E_S = 50 volts
   N_S = 300 turns
   N_P = ?

LET'S SUMMARIZE

- Resistors can be connected in series-parallel and series-parallel combinations.
- In series connections, there is only one path for current to flow in and voltage supply is divided among the connected resistors.
- In parallel connections, voltage source is common to all connected components. Current has two or more paths to flow in and the total resistance becomes lower than the lowest resistance value connected.

- In series-parallel connections, current divides in the parallel path and comes together in the series portion.
- Capacitors can also be connected in series and parallel.
- Connecting capacitors in series means decreasing the total capacitance, while connecting them in parallel means increasing total capacitance.
- Like resistors and capacitors, inductors can also be connected in series and parallel. Connecting inductors in series, increases inductance, connecting them in parallel, decreases inductance.

POSTTEST

Directions: Read each statement carefully. Place a check mark on the blank before the number if the statement is correct; a cross, if wrong.

__ 1. Each resistor in a series circuit serves as a voltage divider.
__ 2. Only three resistors can be connected in parallel.
__ 3. If three 20-ohm resistors are connected in series, total resistance will be 60 ohms.
__ 4. If five resistors are connected in series, current at R_1 is the same at R_5.
__ 5. Current has only one path to flow in parallel-connected resistors.
__ 6. Each resistor acts as current divider if connected in parallel.
__ 7. If one of the resistors connected in series becomes defective, it affects the whole circuit.
__ 8. Total resistance grows higher when resistors are connected in parallel.
__ 9. Voltage drop across each resistor adds when they are connected in series.
__ 10. Current is the same in all points of series-connected resistors.
__ 11. The secondary current in a transformer is inversely proportional to the turns ratio.
__ 12. More turns of wire in the secondary means a higher secondary voltage.
__ 13. Parallel inductors provide higher inductance.
__ 14. Total inductance increases when mutual inductance between two coils is series-aiding.
__ 15. A step-up transformer produces more secondary voltage than what is applied across its primary winding.
___ 16. The secondary voltage of a transformer is reduced when the primary winding has more turns than the secondary.
___ 17. Connecting inductors in series means a higher inductance.
___ 18. Capacitance values of capacitors rise when they are connected in parallel.
___ 19. Connecting capacitors in series means increasing capacitance.
___ 20. Working voltage of capacitors add when they are connected in series.

KEY TO ANSWERS

Pretest	Posttest
1. on	1. ✓
2. on	2. ✗
3. off	3. ✓
4. on	4. ✓
5. on	5. ✗
6. off	6. ✓
7. on	7. ✓
8. on	8. ✗
9. off	9. ✓
10. on	10. ✓
11. off	11. ✓
12. on	12. ✓
13. on	13. ✗
14. on	14. ✓
15. on	15. ✓
16. on	16. ✓
17. off	17. ✓
18. off	18. ✓
19. on	19. ✗
20. on	20. ✓