## U.S. ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL

 FORT SAM HOUSTON, TEXAS 78234-6100

## DEVELOPMENT

This subcourse is approved for resident and correspondence course instruction. It reflects the current thought of the Academy of Health Sciences and conforms to printed Department of the Army doctrine as closely as currently possible. Development and progress render such doctrine continuously subject to change.

## ADMINISTRATION

For comments or questions regarding enrollment, student records, or shipments, contact the Nonresident Instruction Section at DSN 471-5877, commercial (210) 2215877, toll-free 1-800-344-2380; fax: 210-221-4012 or DSN 471-4012, e-mail accp@amedd.army.mil, or write to:

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Be sure your social security number is on all correspondence sent to the Academy of Health Sciences.

## CLARIFICATION OF TRAINING LITERATURE TERMINOLOGY

When used in this publication, words such as "he," "him," "his," and "men" are intended to include both the masculine and feminine genders, unless specifically stated otherwise or when obvious in context.

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# CORRESPONDENCE COURSE OF <br> THE US ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL <br> <br> SUBCOURSE MDO903 <br> <br> SUBCOURSE MDO903 <br> <br> BASIC ELECTRICAL CIRCUITS <br> <br> BASIC ELECTRICAL CIRCUITS <br> <br> INTRODUCTION 

 <br> <br> INTRODUCTION}

This subcourse is designed to give you a basic knowledge of simple circuits that carry electricity from a power source to some kind of electrical equipment. With a knowledge of these fundamentals, you will be able to make better use of electrical equipment and to better understand future textual materials that mention electrical factors in the function of equipment.

## Subcourse Components:

This subcourse consists of programmed text.
Lesson 1. Basic Electrical Circuits

## Study Suggestions:

Here are some suggestions that may be helpful to you in completing this subcourse:
--Read and study each lesson carefully.
--Complete the subcourse lesson.

## Credit Awarded:

To receive credit hours, you must be officially enrolled and complete an examination furnished by the Nonresident Instruction Section at Fort Sam Houston, Texas. Upon successful completion of the examination for this subcourse, you will be awarded 3 credit hours.

You can enroll by going to the web site http://atrrs.army.mil and enrolling under "Self Development" (School Code 555).

A listing of correspondence courses and subcourses available through the Nonresident Instruction Section is found in Chapter 4 of DA Pamphlet 350-59, Army Correspondence Course Program Catalog. The DA PAM is available at the following website: http://www.usapa.army.mil/pdffiles/p350-59.pdf.

## SUBCOURSE MD0903

## LESSON 1

## ASSIGNMENT

OBJECTIVE

## INSTRUCTIONS

## SUGGESTIONS

Basic Electrical Circuits.
Frames 1 through 100.
After completing the programmed text, you should be able to choose correct answers to questions about basic electrical circuits, current, resistance, amperes, volts, and equivalent.

This text is set up differently from most subcourses It is a workbook that utilizes programmed instruction. The numbered "frames" present information and/or a question about presented information. You should work through the frames in the order presented.
Answer each question that is presented. To check your answers, go to the shaded box of the NEXT frame. For example. the solution to the question presented in Frame 2 is found in the shaded box of Frame 3.

Read Subcourse MD0902, Basic Electricity, before taking this subourse.

After going through the programmed text at a relatively slow pace, go back through it several times as rapidly as you can. This will not take long and will help you feel more knowledgeable as you study. The purpose of the programmed text is memorization as well as understanding.

| FRAME 1 <br> The diagram below will help you to recall that current is a flow of $\qquad$ through a conductor. |  |
| :---: | :---: |
| FRAME 2 <br> Below are several series circuits. Study the carefully. <br> In a series circuit, there (is only one/are more than one) path for the current to flow. | Solution to Frame 1 electrons |
| FRAME 3 <br> The above is a series circuit because | Solution to Frame 2 is only one |
| FRAME 4 <br> Label each circuit as either "Series" or "Not Series." | Solution to Frame 3 <br> it has only one path for current to flow |


| FRAME 5 | Solution to Frame 4 |
| :---: | :---: |
| What would be the reading on the ammeter in the series circuit below? | a. Series <br> b. Not Series <br> c. Not Series <br> d. Series |
| FRAME 6 <br> No matter where you measure the current in the series circuit below, the current readings would all be the | Solution to Frame 5 $\frac{12 \mathrm{v}}{2 \Omega}=6 \mathrm{amp}$ |
|  |  |
| FRAME 7 <br> In any part of a series circuit, the current is the $\qquad$ as long as the circuit is not changed. | Solution to Frame 6 <br> same (6 amp) |
| FRAME 8 <br> Write in the current reading of each ammeter connected in the series circuit below. | Solution to Frame 7 <br> same |




| FRAME 15 <br> In a series circuit with only one resistor, $R_{1}$ and $R_{t}$ must be the same. In the series circuit below, there is only one resistor. This means the $\mathrm{R}_{1}$ and $\mathrm{R}_{\mathrm{t}}$ (are/are not) the same. They are both equal to $\qquad$ -. | Solution to Frame 14 $30$ |
| :---: | :---: |
| FRAME 16 <br> To find the current in the circuit below, you would substitute the number ( $4 / \underline{6} / \underline{10} / \underline{24})$ for $R_{t}$ in the formula $I_{t}=\frac{E_{t}}{R_{t}}$. | Solution to Frame 15 are $2 \Omega$ |
| FRAME 17 <br> In the circuit below, $\mathrm{E}_{\mathrm{t}}=$ $\qquad$ . $R_{t}=$ $\qquad$ <br> Find the current $I_{t}=$ $\qquad$ . | Solution to Frame 16 $10$ |


| FRAME 18 <br> If you calculated current (I) in the circuit below and used this formula: <br> a. $\quad \mathrm{I}_{\mathrm{t}}=\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{1}, \text { your answer would be (right/wrong). }}$ <br> b. $\quad \mathrm{I}_{\mathrm{t}}=\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{2},}$ your answer would be (right/ $\underline{\text { wrong }) .}$ <br> c. $\quad \mathrm{I}_{\mathrm{t}}=\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}}$, your answer would be (right/wrong). | Solution to Frame 17 <br> 90 v <br> $30 \Omega$ <br> 3 amp $I_{t}=\frac{E_{t}}{R_{t}}=\frac{90 v}{30 \Omega}=3 \mathrm{amp}$ |
| :---: | :---: |
| FRAME 19 <br> In the circuit below, find I. <br> Example: : $I_{t}=\frac{E_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}^{-}}=\frac{10 \mathrm{v}}{(2+3) \Omega}=\frac{10 \mathrm{v}}{5 \Omega}=2 \mathrm{amps}$ <br> You do this one: $=$ | Solution to Frame 18 <br> a. wrong <br> b. wrong <br> c. right |


| FRAME 20 <br> In the circuit below, $\mathrm{I}_{\mathrm{t}}=$ $\qquad$ | Solution to Frame 19 $\mathrm{I}_{\mathrm{t}}=\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}}=\frac{12 \mathrm{v}}{6 \Omega}=2 \mathrm{amps}$ |
| :---: | :---: |
| FRAME 21 <br> So far, you have learned that in series circuits: <br> a. There is/are (only one/more than one) path for the current to flow. <br> b. Current has the (same/different) value everywhere in the circuit. <br> c. To get $R_{t}$, we (sum/subtract) all individual resistances. <br> d. To find $I_{t}$, you must use ( $\left.\underline{R}_{1} / \underline{R}_{t}\right)$ $\qquad$ in the formula $\mathrm{I}_{\mathrm{t}}=\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}}$. | Solution to Frame 20 $3 \mathrm{amp} \quad \begin{aligned} \mathrm{I}_{\mathrm{t}} & =\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}} \\ & =\frac{90 \mathrm{v}}{30 \Omega} \\ & =3 \mathrm{amp} \end{aligned}$ |
| FRAME 22 <br> The voltage applied by a battery is called the applied voltage ( $E_{a}$ ). <br> This battery will apply a voltage called the | Solution to Frame 21 <br> a. only one <br> b. same <br> c. sum <br> d. $R_{t}$ |
| FRAME 23 <br> In the circuit below, the $\mathrm{E}_{\mathrm{a}}$ (applied voltage) is $\qquad$ volts. | Solution to Frame 22 applied voltage $\left(\mathrm{E}_{\mathrm{a}}\right)$ |


| FRAME 24 |
| :--- | :--- | :--- |
| To move a wagon uphill, you must apply a force. To move |
| electrons through a resistor, a battery must also apply |$\quad$ Solution to Frame 23


| FRAME 29 | Solution to Frame 28 |
| :---: | :---: |
| You have learned that the symbol for voltage is $E$. | $\left(\mathrm{R}_{1}\right) 5 \mathrm{v}$ |
| For voltage drop across $\mathrm{R}_{1}$, you will use the symbol $\mathrm{E}_{1}$. | $\left(R_{2}\right) 20 \mathrm{v}$ |
| For voltage drop across $R_{2}$, you will use the symbol $E_{2}$. <br> For voltage drop across $\mathrm{R}_{3}$, you will use the symbol |  |
|  |  |
| FRAME 30 | Solution to Frame 29 |
| Total voltage drop $\left(\mathrm{E}_{\mathrm{t}}\right)$ is the sum of all individual voltage drops. In the circuit below, $E_{t}$ is the $\qquad$ of $E_{1}$ and $E_{2} . E_{t}=$ $\qquad$ . | $E_{3}$ |
|  |  |
| FRAME 31 <br> $E_{t}$ (total voltage drop) in this circuit is $\qquad$ volts. | Solution to Frame 30 total (or sum) |
|  | 15 v |


| FRAME 32 <br> $E_{t}$ in the circuit below is $\qquad$ | Solution to Frame 31 $30$ |
| :---: | :---: |
| FRAME 33 <br> $E_{t}$ (total voltage drop) in the circuit below is $\qquad$ <br> $E_{t}$ (applied voltage) is also $\qquad$ | Solution to Frame 32 $15 v$ |
| FRAME 34 <br> In the series circuit below, the $\mathrm{E}_{\mathrm{a}}$ (applied voltage) is $\qquad$ and the $E_{t}$ (total voltage) is $\qquad$ . $E_{t}$ and $E_{a}$ are (the same/different) in any series circuit. | Solution to Frame 33 10 v $10 \mathrm{v}$ |


| FRAME 35 <br> $E_{t}$ in the circuit below is $\qquad$ ; $\mathrm{E}_{\mathrm{a}}$ is $\qquad$ . | Solution to Frame 34 18 v <br> 18 v <br> the same |
| :---: | :---: |
| FRAME 36 <br> If $E_{t}=24 v$, then $E_{a}=$ $\qquad$ <br> If $E_{a}=6 v$ then $E_{t}=$ $\qquad$ <br> If any series circuit, $E_{t}$ and $E_{a}$ are $\qquad$ | Solution to Frame 356v <br> $6 v$ <br> 6 v |
| FRAME 37 <br> One way to find I (current) in a series circuit is to use $E_{t}$ in the formula $I_{t}=\frac{E_{t}}{R_{t}^{t}}$ <br> To find $I_{t}$ in the circuit above, use $\qquad$ in the formula | Solution to Frame 36 <br> $24 v$ <br> $6 v$ <br> the same (equal) |


| FRAME 38 |  | Solution to Frame 37 |
| :---: | :---: | :---: |
| Find I in the circuit below. |  |  |
| Example: | You work this problem. | $l_{t}=\frac{E_{t}}{R_{t}}$ |
|  |  |  |
| $\mathrm{I}_{\mathrm{t}}=\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}}=$ | $I_{t}=$ |  |
| $=\frac{20 v}{10 \Omega}$ |  |  |
| $\mathrm{I}_{\mathrm{t}}=2 \mathrm{amps}$ | $I_{t}=$ |  |
| FRAME 39 |  | Solution to Frame 38 |
| Find $I$ in the circuit below. |  |  |
| Example: | You do this: |  |
|  |  | $\frac{24 v}{12 \Omega}$ <br> 2 amp |
| $\mathrm{I}_{\mathrm{t}}=\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}^{-}}=$ | $I_{t}=$ |  |
| $=\frac{27 v}{9 \Omega}$ | $=$ |  |
| $=3 \mathrm{mps}$ | $I_{t}=$ |  |


| FRAME 40 <br> I (current) in the series circuit below is . $\qquad$ | Solution to Frame 39 $\begin{aligned} \mathrm{I}_{\mathrm{t}} & =\frac{\mathrm{E}_{\mathrm{t}}}{\mathrm{R}_{\mathrm{t}}} \\ & =\frac{5 \mathrm{v}}{5 \Omega} \\ & =1 \mathrm{amp} \end{aligned}$ |
| :---: | :---: |
| FRAME 41 <br> You just learned that to find I in a series circuit, you use the formula: $I_{t}=\frac{E_{t}}{R_{t}}$. <br> Since $E_{a}=E_{t}$, you (may/may not)also use the formula $I_{t}=\frac{E_{a}}{R_{t}}$ | Solution to Frame 40 <br> 3 amp $\frac{9 v}{3 \Omega}=3 a m p$ |
| FRAME 42 <br> In the circuit below I = $\qquad$ | Solution to Frame 41 may |



| FRAME 46 <br> To calculate $E$ (voltage drop across $R_{1}$ ) exactly, you use the formula $E_{1}=I_{1} \times R_{1}$ : <br> To calculate $E_{1}$ in the circuit above, you use the formula | Solution to Frame 45 <br> calculate the exact voltage drop |
| :---: | :---: |
| FRAME 47 | Solution to Frame 46 |
| Find $\mathrm{E}_{1}$ in the circuits below: <br> Example: <br> You do this one | $\mathrm{E}_{1}=\mathrm{I}_{1} \times \mathrm{R}_{1}$ |
|  |  |
| $\begin{array}{rlrl} \mathrm{E}_{1} & =1 \times \mathrm{R}_{1} & \mathrm{E}_{1} & = \\ & =3 \mathrm{amp} \times 2 \Omega & = \\ & =6 \mathrm{v} & = \end{array}$ |  |


| FRAME 48 | Solution to Frame 47 |
| :---: | :---: |
| Example: $\begin{aligned} E_{2} & =I \times R_{2} \\ & =3 \mathrm{amp} \times 4 \Omega \\ & =12 \mathrm{v} \end{aligned}$ <br> $\mathrm{I}=3 \mathrm{amp}$ <br> You do this one: $\begin{aligned} \mathrm{E}_{2} & = \\ & = \\ & = \end{aligned}$ $\qquad$ $\qquad$ $\qquad$ <br> $\mathrm{I}=3 \mathrm{amp}$ | $\begin{aligned} E_{1} & =I_{1} \times R_{1} \\ & =4 \mathrm{amp} \times 6 \Omega \\ & =24 \mathrm{v} \end{aligned}$ |
| FRAME 49 <br> In the circuit below $\mathrm{I}=2 \mathrm{amp}$. Find $\mathrm{E}_{2}$ (voltage drop across $\mathrm{R}_{2}$ ). | Solution to Frame 48 $\begin{aligned} E_{2} & =I \times R_{2} \\ & =3 \mathrm{amp} \times 5 \Omega \\ & =15 \mathrm{v} \end{aligned}$ |
| FRAME 50 <br> Compute $\mathrm{E}_{2}$ in the circuit below: $\mathrm{E}_{2}=$ $\qquad$ | Solution to Frame 49 $\begin{aligned} & 24 \mathrm{v} \\ & E_{2}=I \times R_{2} \\ &=2 \mathrm{amp} \times 12 \Omega \\ &=24 \mathrm{v} \end{aligned}$ |


| FRAME 51 <br> To check the total voltage drops, you can sum the individual voltage drops to get $E_{t}$. This should equal $E_{a}$. <br> The voltage drops calculated above (do/do not) check. | Solution to Frame 50 $\begin{aligned} \mathrm{E}_{2} & =I \times \mathrm{R}_{2} \\ & =4 \mathrm{amp} \times 10 \Omega \\ & =40 \mathrm{v} \end{aligned}$ |
| :---: | :---: |
| FRAME 52 <br> In the circuit below, find $\mathrm{E}_{1}, \mathrm{E}_{2}, \mathrm{E}_{3}$. $E_{1}=$ $\qquad$ $\mathrm{E}_{2}=$ $\qquad$ <br> $E_{3}=$ $\qquad$ $E_{t}=$ $\qquad$ | Solution to Frame 51 do |
| FRAME 53 <br> Sometimes you will not be told the value of I (current). Therefore, before you can compute $\mathrm{E}_{1}$, or $\mathrm{E}_{2}$, or $\mathrm{E}_{3}$, you must find the value of $\qquad$ to use in the formulas: $\begin{aligned} & \mathrm{E}_{1}=\mathrm{I}_{1} \times \mathrm{R}_{2} \\ & \mathrm{E}_{2}= \\ & \mathrm{E}_{3}= \\ & \end{aligned}$ | Solution to Frame 52 $\begin{aligned} & E_{1}=20 v \\ & E_{2}=24 v \\ & E_{3}=14 v \\ & E_{t}=58 v \end{aligned}$ |


|  |  |
| :---: | :---: |
| To find $E_{1}$ in the circuit below, you must first find $\qquad$ . You find I now. I = $\qquad$ amp. | $\begin{aligned} & 1 \\ & I_{2} \\ & I_{3} \times R_{3} \end{aligned}$ |
| FRAME 55 <br> In the circuit below, find I and then $\mathrm{E}_{2}$. $\begin{aligned} & \mathrm{I}=\quad \mathrm{amp} \\ & \mathrm{E}_{2}=\quad \mathrm{v} \end{aligned}$ | Solution to Frame 54 <br> Total resistance $\frac{\mathrm{E}_{\mathrm{a}}}{\mathrm{R}_{\mathrm{t}}}=\frac{18 \mathrm{v}}{6 \Omega}=3 \mathrm{amp}$ |
| FRAME 56 <br> In the circuit below, find $\mathrm{I}, \mathrm{E}_{1}, \mathrm{E}_{2}$, and $\mathrm{E}_{3}$. $\mathrm{I}=$ $\qquad$ $\begin{aligned} & \mathrm{E}_{1}= \\ & \mathrm{E}_{2}= \\ & \mathrm{E}_{3}= \\ & \hline \end{aligned}$ | Solution to Frame 55 $\begin{aligned} & I=\frac{E_{a}=24 v}{R_{t}}=2 \mathrm{amp} \\ & E_{2}=I \times R_{2} \\ & \quad=2 \mathrm{amp} \times 4 \Omega \\ & \quad=8 \mathrm{v} \end{aligned}$ |


| FRAME 57 <br> In the circuit below, find: $E_{1}=$ $\qquad$ ; $\mathrm{E}_{2}=$ $\qquad$ ; $\mathrm{E}_{3}=$ $\qquad$ Check: $\qquad$ | Solution to Frame 56 $\begin{gathered} 2 \mathrm{amps}\left(R_{t}=7+4+3\right. \\ =14 \Omega \\ 1=\frac{\mathrm{E}_{\mathrm{a}}}{}=\frac{28}{R_{\mathrm{t}}}=2 \mathrm{amps} \\ 14 \\ \mathrm{E}_{1}=1 \times \mathrm{R}_{1}=2 \mathrm{amp} \mathrm{x} \\ 7 \Omega=14 \mathrm{v} \\ \mathrm{E}_{2}=1 \times \mathrm{R}_{2}=2 \mathrm{amp} \mathrm{x} \\ 4 \Omega=8 \mathrm{v} \\ \mathrm{E}_{3}=1 \times R_{3}=2 \mathrm{amp} \mathrm{x} \\ 3 \Omega=6 \mathrm{v} \end{gathered}$ <br> Yes, 28v = 28v |
| :---: | :---: |
| FRAME 58 <br> To summarize what you have learned about series circuits, complete the statements below: <br> a. There is/are (only one/more than one) path for current to flow. <br> b. I (current) has (the same/a different) value(s) everywhere in the circuit. <br> c. To get $R_{t}$, you (sum/subtract) the individual resistances. <br> d. To get $E_{t}$, you (sum/subtract) the individual voltage drops. <br> e. $\mathrm{E}_{\mathrm{t}}$ and $\mathrm{E}_{\mathrm{a}}$ (are/are not) the same. <br> f. To find $I$, you (must/must not) use $R_{t}$. <br> g. To find $I$, you (must/must not) use $E_{t}$ or $E_{a}$. <br> h. To find $\mathrm{E}_{1}$, use the formula $\qquad$ <br> i. To find $\mathrm{E}_{3}$, use the formula $\qquad$ | Solution to Frame 57 $\begin{aligned} & E_{1}=20 v \\ & E_{2}=12 v \\ & E_{3}=8 v \end{aligned}$ <br> Check: $\begin{aligned} & E_{a}=E_{t} \\ & 40 v=40 v \end{aligned}$ |


| FRAME 59 |
| :--- | :--- |
| This is one way of placing |
| resistors in parallel. | | Solution to Frame 58 |
| :--- |
| aralle only one |


| FRAME 63 | Solution to Frame 62 |
| :---: | :---: |
| Now let us look at resistance. In the parallel circuit below, resistance $1\left(R_{1}\right)$ is $15 \Omega$; $R_{2}$ is $\qquad$ $\Omega$; and $R_{3}$ is $\qquad$ $\Omega$. | a. Series <br> b. Parallel <br> c. Series <br> d. Parallel |
| FRAME 64 <br> In any parallel circuit, $R_{t}$ (total resistance) is less than the smallest resistance. In the circuit below, $R_{t}$ is less than $\qquad$ $\Omega$. | Solution to Frame 63 $10$ $20$ |
| FRAME 65 <br> $R_{t}$ will be less than $10 \Omega$ in the circuit below. $R_{t}$ is always (more/less) than the smallest resistance. | Solution to Frame 64 <br> 5 |
| FRAME 66 <br> So far you have learned that: <br> a. A parallel circuit has (only one/more than one) path for current flow. <br> b. $R_{t}$ is (more/less) than the (largest/smallest) resistance in a parallel circuit. | Solution to Frame 65 less |


| FRAME 67 | Solution to Frame 66 |
| :---: | :---: |
| To determine the value of $R_{t}$ in a parallel circuit, use the formula: | a. more than one <br> b. less; smallest |
| $\mathrm{R}_{\mathrm{t}}=\frac{1}{\frac{1}{\mathrm{R}_{1}}+\frac{1}{\mathrm{R}_{2}}+\frac{1}{\mathrm{R}_{3}}} \text {, etc. }$ <br> In the circuit above, you use the formula $R_{t}=$ $\qquad$ |  |
| FRAME 68 | Solution to Frame 67 |
| Find $R_{t}$ <br> Example <br> Problem | $R_{t}=\frac{1}{\frac{1}{R_{1}}+\frac{1}{R_{2}}+\frac{1}{R_{3}}}$ |
|  |  |
| $\begin{array}{rlrl} \mathrm{R}_{\mathrm{t}} & =\frac{1}{\frac{1}{\mathrm{R}_{1}}+\frac{1}{\mathrm{R}_{2}}+\frac{1}{\mathrm{R}_{3}}} & \mathrm{R}=\frac{1}{\frac{1}{\mathrm{R}_{1}+\frac{1}{R_{2}}+\frac{1}{R_{3}}}} \\ & =\frac{1}{\frac{1}{3}+\frac{1}{6}+\frac{1}{12}} & & \\ & =\frac{1}{\frac{4}{12}+\frac{2}{12}+\frac{1}{12}}=\frac{1}{\frac{7}{12}}=\frac{12}{7} & = \\ & =1.714 \Omega & \end{array}$ |  |


| FRAME 69 <br> a. In the parallel circuit below, $R_{t}$ equals $\qquad$ <br> b. $R_{t}$ (is/is not) less than the smallest resistor. | Solution to Frame 68 $R_{t}=\frac{1}{\frac{1}{2}+\frac{1}{4}+\frac{1}{8}}$ $\begin{aligned} & \frac{1}{\frac{4}{8}+\frac{2}{8}+\frac{1}{8}}=\frac{1}{\frac{7}{8}}=\frac{8}{7} \\ & =1.14 \Omega \end{aligned}$ |
| :---: | :---: |
| FRAME 70 <br> So far you have learned that: <br> a. A parallel circuit has (only one/more than one) path for current to flow. <br> b. To find $R_{t}$, you use the formula $\qquad$ . <br> c. You can check on any $R_{t}$ you compute because the $R_{t}$ in a parallel circuit must be (more/less) than the (largest/smallest) resistance. | Solution to Frame 69 <br> a. $\frac{1}{\frac{4}{40}+\frac{2}{40}+\frac{1}{40}}=\frac{1}{\frac{7}{40}}=\frac{40}{7}$ $R_{t}=5.71 \Omega$ <br> b. is |
| FRAME 71 <br> To help prevent confusion between finding $R_{t}$ in series circuits and finding $R_{t}$ in parallel circuits, answer the questions below: <br> a. To find $R_{t}$ in the SERIES CIRCUIT above, use this formula: <br> b. To find $R_{t}$ in the PARALLEL CIRCUIT above, use this formula: | Solution to Frame 70 <br> a. more than one <br> b. $R_{t}=\frac{1}{\frac{1}{R_{1}}+\frac{1}{R_{2}}+\frac{1}{R_{3}}}$ <br> c. less, smallest |




Solution to Frame 77



| FRAME 82 <br> In parallel circuit, the voltage drop across each branch is always (the same/different). | Solution to Frame 81 the same |
| :---: | :---: |
| FRAME 83 <br> In a parallel circuit, the voltage drop across each resistor (regardless of size) is the same. In a series circuit, the voltage drops are (the same/different) according to the size of the resistor. | Solution to Frame 82 the same |
| FRAME 84 <br> Now that you know what happens to resistance and voltage in a parallel circuit, let us look at current. The diagram below shows that in a parallel circuit, the current splits and flows through (only one/each) resistor. | Solution to Frame 83 different |
| FRAME 85 <br> Because the current splits up and flows through each resistor, it is important that you know how to compute the current flowing through $\qquad$ | Solution to Frame 84 each |
| FRAME 86 <br> You have learned that the symbol for current is I. <br> The symbol for the current flowing through $R_{1}$ is $I_{1}$. <br> The symbol for the current flowing through $\mathrm{R}_{2}$ is $\mathrm{I}_{2}$ <br> The symbol for the current flowing through $\mathrm{R}_{3}$ is $\qquad$ | Solution to Frame 86 each resistor |




| FRAME 93 <br> In the circuit below, find $\mathrm{I}_{1}, \mathrm{I}_{2}$, and $\mathrm{I}_{3}$. $\qquad$ | Solution to Frame 92 $\begin{array}{rl} I_{1}= & \frac{E_{a}}{R_{1}}= \\ I_{2}=\frac{E_{a}}{R_{2}} \\ \frac{10 \mathrm{v}}{20 \Omega}= & \frac{10 \mathrm{v}}{5 \Omega}= \\ 0.5 \mathrm{amp} & 2 \mathrm{amp} \end{array}$ |
| :---: | :---: |
| FRAME 94 <br> To find $I_{1}$, you use the formula $I_{1}=\frac{E_{a}}{R_{1}}$ <br> To find $I_{2}$, you use the formula $I_{2}=\frac{E_{a}}{R_{2}}$ <br> To find $I_{3}$, you use the formula $I_{3}=\frac{E_{a}}{R_{3}}$ <br> To find $I_{4}$, you would use the formula $I_{4}=$ $\qquad$ <br> To find $I_{5}$, you would use the formula $I_{5}=$ $\qquad$ | Solution to Frame 93 $\begin{aligned} & I_{1}=\frac{E_{a}}{R_{1}}=\frac{100 \mathrm{v}}{50 \Omega}=2 \mathrm{amp} \\ & \mathrm{I}_{2}=\frac{\mathrm{E}_{\mathrm{a}}}{\mathrm{R}_{2}}=\frac{100 \mathrm{v}}{25 \Omega}=4 \mathrm{amp} \\ & \mathrm{I}_{3}=\frac{\mathrm{E}_{a}}{\mathrm{R}_{3}}=\frac{100 \mathrm{v}}{100 \Omega}=1 \mathrm{amp} \end{aligned}$ |
| FRAME 95 <br> The diagram below shows that $I_{t}$ (total current) flowing into the branches is the (sum/difference) of the current in each branch. | Solution to Frame 94 $\frac{E_{a}}{\mathrm{R}_{4}}$ $\frac{E_{a}}{R_{5}}$ |


| FRAME 96 <br> In the circuit below, $I_{t}$ is $\qquad$ amp. | Solution to Frame 95 sum |
| :---: | :---: |
| FRAME 97 <br> The diagram below shows that $I_{t}$ flowing out of the branches is the (sum/difference) of the current in each branch. | Solution to Frame 96 $2 \mathrm{amp}(0.5+1.5)$ |
| FRAME 98 <br> In the circuit below, $I_{t}$ is the (sum/difference) of $I_{1}$ and $I_{2}$. Thus $\mathrm{I}_{\mathrm{t}}=$ $\qquad$ . | Solution to Frame 97 sum |


| FRAME 99 | Solution to Frame 98 |
| :--- | :--- |
| Fill in the value of $I_{t}$ measured at the two ammeters below: | sum |
| FRAME 100 | $1.5 \mathrm{amp}(1+0.5)$ |
| In a series circuit, current has only one path to follow; |  |
| therefore, it has the same value everywhere in the circuit. | 3 amp (1+0.5+1.5) |
| In a parallel circuit, the current (splits/does not split). | 3 amp (1+0.5+1.5) |
| The current in a parallel circuit (does/does not) have the |  |
| same value everywhere. | Solution to Frame 99 |
| FRAME 101 <br> Congratulations. You have now completed this programmed <br> instruction booklet. <br> It is recommended that you review the lesson material before <br> taking the examination. | splits |

## End of Lesson 1

