

KACC-0205 Basic Electricity

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Competencies and Learning Objectives

1. Explain the electricity safety rules and practices as they apply to the HVAC industry.
 - Describe the electricity safety rules and practices as they apply to the HVAC industry.
2. Obtain correct electric circuit measurements using electrical test equipment.
 - Describe multimeter and megger in evaluating electrical circuits.
 - Evaluate electrical circuits using an electric multimeter and a megger.
3. Determine the electrical characteristics of each component in series and parallel circuits.
 - Describe electron flow and the components that control them.
 - Differentiate between series and parallel circuits.
 - Draw and wire basic series and parallel circuits.
 - Measure voltage, amperage, resistance, and wattage using a multimeter.
 - Calculate the voltage, amperage, resistance, and wattage using Ohm's Law.
 - Describe AC Current and its' power distribution and voltage system used by HVAC equipment.
4. Interpret and draw wiring diagrams and wire electrical circuits.
 - Identify HVAC electrical components and their respective symbols used in wiring diagrams.
 - Interpret schematic diagrams.
 - Draw wiring diagrams using a sequence of operation.
 - Wire electrical circuits.
5. Wire HVAC equipment control circuits from wiring diagrams.
 - Identify the basic components used in electrical controlling HVAC equipment.
 - Wire basic heating and cooling control circuits.

Orientation to Course

Course Description

Someone once said "**Love makes the world go round**", but in the HVAC world "**It is electricity that makes everything go round**". In this course you will be learning electricity theory and the principles of electricity. You will explore the applications of electricity in HVAC equipment. You will learn how to use a multi-meter to check the electrical characteristics of that equipment. You will be learning how to read, draw and wire up basic HVAC wiring diagrams and circuits.

Competencies

Upon completion of the course, you will be rated as MC (Mastered Competency) or NM (Not-Mastered Competency) based on your demonstrated ability of the course's established competencies. You will:

- Explain the electricity safety rules and practices as they apply to the HVAC industry.
- Obtain correct electric circuit measurements using electrical test equipment.
- Determine the electrical characteristics of each component in series and parallel circuits.
- Interpret and draw wiring diagrams and wire electrical circuits.
- Wire HVAC equipment control circuits from wiring diagrams.

Assessment

You will be given a written progress exam and/or a lab practical to see if you are on track in progressing toward the required competencies at the end of each module. You must pass these progress exams with a score of at least 80% before you can move on to the next module.

At the end of the course you will again be given a written exam and final lab practical that you must pass with at least a score of 80% before you will be rated with an MC as your grade for the course.

Syllabus and Textbook *(Note: Books and materials required for this course are listed below.*

Instructor uses instructional materials from the publisher, including presentations, videos, and other learning materials.)

Read the syllabus to understand the expectations for this course. The instructor will go through the syllabus and review the textbook with you on your first day of class.

Course work

All DVDs in the course need to be viewed in the classroom. This is only in the first module. You will need to ask your instructor for the DVD.

Labs

You will have 14 labs as a part of this course. There is a schedule for labs and other opportunities to work with instructors. Sign up ahead of time for labs, about a week before you want to work on a lab. Make sure you come at that time or reschedule it.



Course Navigation

In the left navigation bar is a Course Tools menu. It provides information about what tools you need for the course, and how to navigate in Canvas. Start the course with the first module below. You can also click on the **Modules** link in the left navigation bar to navigate through the course.

Modules

Module 1: Electrical Safety

Electrical Safety Overview

No matter what piece of HVAC equipment you are going to work on in the field, you will always be dealing with electricity. To properly check over a HVAC system you will need to do it with the power turned on. So understanding basic electrical safety rules and practices is a must.

When you have completed this module, you will know how to:

- Explain the electricity safety rules and practices as they apply to the HVAC industry. Explore the online information sites and/or watch the optional YouTube videos to further your knowledge.

[National Electrical Code](#)

[OSHA Electrical Safety Student Handbook](#)

[Controlling Electrical Hazards](#)

There are several videos that you will need to watch. Click the Next button to view the videos.

Electrical Safety Overview Continued

Click on the button below to load the video you want to view. Click the play button to watch the video.

[National Electrical Code Handbook](#)

[Personal Electrical Safety Equipment - Gloves](#)

[Unsafe Wiring Examples](#)

[NFPA 70E Introduction](#)

[NFPA 70E Lockout/Tagout](#)

[NFPA 70E Arc Flash](#)

[NFPA 70E & Arc Flash Discussion](#)

Electrical Safety Assignments

In this module you will view a PowerPoint presentation, watch a video, and take a safety quiz. You will also start using the Electricity for Refrigeration, Heating and Air Conditioning textbook, beginning with chapter 1.

Work on the following assignments. You will need to go to class to watch the DVD.



General Electrical Safety

1. Read chapter 1 “Electrical Safety” in the *Electricity for Refrigeration, Heating and Air Conditioning* textbook.
2. Check your knowledge: Take the chapter review quiz.
3. Go to class to watch the Electrical Safety DVD.
4. Take the DVD Quiz on the Electrical Safety DVD.

Check Your Knowledge: Chapter 1 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook. (Note that the questions listed will not be in the same order as the textbook.)

To take a quiz:

1. Click **Take this Quiz** link.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Electrical Safety Quiz

Take this quiz to make sure you understand electrical safety. You must get 80% or higher to move to the next assignment. This quiz will help you and your instructor determine your progress toward competency.

Electrical Safety Assignments Part 2

Lockout/Tagout

1. Go to class to watch the Lockout/Tagout Safety DVD. Ask the instructor for the DVD and use one of the classroom computers and your earphones to watch the video.
2. Take the DVD Quiz on Lockout/Tagout Safety DVD.

Lockout/Tagout Safety DVD Quiz

Take this quiz to make sure you understand lockout/tagout safety. You must get 80% or higher. This quiz will help you and your instructor determine your progress toward competency.

Module 2: Using Meters

Using Meters Overview

Of all the tools you will be using in the field, none will get used as much as your multimeter. Taking electrical measurements on HVAC equipment is a must to properly troubleshoot any piece of equipment. This module will help give you the experience you need to properly use your meter.

Another useful meter you will be using is a megohm meter or megger. This meter is used to check the winding insulation for shorts in motors. You will have a lab where you will be using the megger.

Competency:

Obtain correct electric circuit measurements using electrical test equipment.

To obtain this competency, you will learn the following:

- Describe multimeter and megger in evaluating electrical circuits.
- Evaluate electrical circuits using an electric multimeter and a megger.

To begin this module, watch **Electric Meters and Measurements** video.

Explore the online information sites and/or watch the optional YouTube videos to further your knowledge.

[Fluke Training Video](#)

[Fluke Training Program](#)

Using Meters Assignments

Read the chapter to learn about how to use meters on the job. When you have completed the assignments, go to class and work on Lab 1 and Lab 2.

1. Read chapter 4 “Electric Meters” in your textbook.
2. Take the Check Your Knowledge: Chapter 4 Quiz.
3. Complete your Lab Projects for this module.

Check Your Knowledge: Chapter 4 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Lab 4-1: Reading Electric Meters

You will need your Electricity lab manual and your multimeter for this lab.

In this lab you will be using your multimeter to take different electrical measurements on equipment in the lab. Remember to sign up for your labs. Make sure you print off the checklist before you go to class.

1. Work with your instructor on this lab to help show you where to take your readings.
2. You will need to remove the lab sheets for Lab 4-1 from your lab manual.
3. Print your name and the date on the top of the first lab sheet.
4. Print out the Lab 4-1 Worksheet Instructions. (*Note: The instructor uses a series of worksheets from a publisher's workbook for this course.*)
5. Use the lab manual sheets and the worksheet instructions for the lab.
6. Have your instructor sign off in the comments section under your name that you have completed the lab.
7. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab Project: Using a Megger

For this lab you will be using a megohmmeter (megger) to check both open motors and refrigeration compressors for shorts to ground. You will complete this lab in class. You

may want to make an appointment with the instructor before you go. Make sure you print off the checklist before you go.

1. Print out the Lab Worksheet to be used with the lab.
2. Using the lab worksheet follow the instructions for the lab.
3. Have your instructor sign your worksheet that you have completed the lab.
4. Scan the lab worksheet and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Using Meters Progress Written Exam

This exam will help you and your instructor see how you are progressing in the course. You need to achieve 80% or higher to move to the next module.

Using Meters Lab Practical

As was stated at the beginning of this module the competency for this module is to be able to "Obtain correct electric circuit measurements using electrical test equipment."

So for this Lab Practical you will: "Perform proper multimeter and Megger reading on HVAC Lab equipment."

This lab practical must be performed in the presence of your instructor and will help you and your instructor see how you are progressing in the course. You will need a score of 80% higher to show that you have mastered the competency.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

Module 3: Electrical Theory and Circuits

Electrical Theory and Circuits Overview

Before you can start working on HVAC equipment and their wiring circuits, you need to understand how electricity is created and how it works. You will learn the difference between Alternating current (AC) and Direct current (DC). You also need to understand the difference between voltage, current, resistance and power. You will also get a look at Ohm's Law and how to use it when working with electrical circuits. In this module you will be exploring the topic of electricity theory and circuits makeup.

Competency:

Determine the electrical characteristics of each component in series and parallel circuits.

To obtain this competency, you will learn the following:

- Describe electron flow and the components that control them.
- Differentiate between series and parallel circuits.
- Draw and wire basic series and parallel circuits.
- Measure voltage, amperage, resistance, and wattage using a multimeter.
- Calculate the voltage, amperage, resistance, and wattage using Ohm's Law.

- Describe AC Current and its' power distribution and voltage system used by HVAC equipment.

Before you begin this module please watch the following videos: *(Note: The instructor uses a series of DVDs that he has received permission to stream through the learning management system)*

Energy, Atoms, and Electricity

Energy Flow and Current

Magnetism

Electrical Theory and Circuits Assignments

Read the chapters to learn about electrical theory and circuits. For this section of the module, you will read two textbook chapters, view presentations, watch videos, and complete two labs. When you have completed the assignments and taken the quiz, go to class and work on the labs. Print the lab worksheets before you go to class.

1. Read Chapter 2 "Basic Electricity" in the textbook.
2. Review and study the PowerPoint presentation on Atoms and Electrons, Ohms Law, Resistance.
3. Study the PowerPoint presentation on AC and DC Current.
4. Check your knowledge: Take the chapter review quiz.

Check Your Knowledge: Chapter 2 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Electric Circuits Assignments

Now that you know how electricity is produced and the difference between AC and DC current, you are ready to start looking at the characteristics of series and parallel circuits.

First let's take a look at a couple of videos.

1. Watch: **Basic Circuits**.
2. Now watch this video on [Series vs Parallel Circuits](#).
3. Read chapter 3 "Electric Circuits" in the textbook.
4. Take the Check Your Knowledge: Chapter 3 Quiz.

Check Your Knowledge: Chapter 3

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

NOTE: If a question asks you to draw something, draw it on a piece of paper and type the words "On Paper" in the answer box, then compare your drawing to the answer given by the computer.

Ohm's Law Overview

It is time to now dig deeper into Ohm's Law. As you have read, Ohm's Law is the relationship between volts, amps, ohms and watts. In the next assignments you will be working on your first

lab project using Ohm's Law to figure the characteristics of series and parallel circuits. The Ohm's Law wheel shown here can be very useful when you are figuring Ohm's Law Problems.

Ohm's Law Videos

Before we begin, let's take a look at four videos.

1. Electrical Resistance and Ohm's Law *(Note: The instructor uses a series of DVDs that he has received permission to stream through the learning management system)*
2. Electrical Power
3. [MAKE presents: Ohm's Law](#)
4. [Ohm's Law, The Basics](#)

Ohm's Law Assignments

Work on the assignments and complete the labs in class. Remember to print off the lab worksheets before going to class. You may need to schedule with your instructor a time to work with him.

1. Please review and study the PowerPoint Presentation on Meters, Circuits, Loads & Switches.ppsx. *(Note: Instructor uses publisher's presentations for this course.)*
2. Complete the Ohms Law Problems worksheet and using Ohm's Law answer the questions.
3. After you have answered the questions, take the Ohm's Law quiz. Use the worksheet and fill in the answers to each question.
4. Complete the Ohms Law Matrix's worksheets.
5. Complete your Lab Project for this module.

Ohms Law Problems Worksheet

For this assignment you will use the Ohms Law Problems worksheet that you printed out and filled out using Ohm's Law to answer the questions.

After you have answered the questions, take the quiz and using the worksheet fill in the answers to each question.

Testing Procedures:

1. Click **Take this Quiz**.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Ohms Law Matrix Assignment

For this assignment you will need to print out the Ohms Law Matrix worksheets. In this assignment you will be using the given values in the matrix to find the missing values.

1. After you have completed the worksheet ask the instructor for the answer sheet so you can see how you did.
2. Have your instructor sign off that you have completed the assignment.
3. Scan the matrix worksheets and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Lab 3-1: Series and Parallel Circuits

For this lab you will be wiring both series and parallel circuits using Controls Lab Station #1. Have your instructor inspect your wiring, then turn on the power to the trainer and answer the questions in the lab manual.

1. You will need to remove the lab sheets for Lab 3-1 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. For this lab you will not need to build the trainer shown in your lab sheet. You will be using the trainer marked Controls Lab Station #1
4. Have your instructor sign off in the comments section under your name that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

!!! Remember your lock-out/tag-out procedures!!!

Lab Project: Light Globe Trainer

For this assignment you will be working on Controls Lab Station #2, the Lennox Basic Electricity Trainer (Light Globe Trainer). You will be wiring more series and parallel circuits and using your meter and Ohm's Law.

Please print out the Light Globe Trainer worksheets. Get with your instructor so they can show you the trainer and help to explain the Lab.

!!! Don't forget your lock-out/tag-out procedures!!!

Have your instructor sign off that you have completed the lab.

Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Power Distribution Assignments

Before we get any farther we want to take a look at how this power that we use is distributed to our homes and businesses. We also want to look at the different types of voltage systems that you will encounter in the field as you work on HVAC equipment.

To begin with let's take a look at this video **Electricity Transmission and Wiring**

Work on the assignments listed below and complete the lab in class.

1. Read chapter 7 "Alternating Current, Power Distribution, and Voltage Systems" in the textbook.
2. Take the Check Your Knowledge: Chapter 7 Quiz.
3. Take the Electricity and Circuits Written Progress Exam.

Check Your Knowledge: Chapter 7 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Electricity Theory and Circuits Progress Exam

This exam covers chapters 2, 3 and 7 in the Smith Electricity Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Electrical Circuits Lab Practical

As was stated at the beginning of this module the competency for this module is to be able to: "Determine the electrical characteristics of each component in series and parallel circuits"

So for this Lab Practical you will: "Draw series and parallel circuits; Wire up these circuits; Using multimeter and Ohms Law, figure out the electrical characteristics of each component."

This lab practical is designed to show whether you have mastered this competency or not. You must pass this competency before you will be allowed to move on to the next module.

This lab practical must be performed in the presence of your instructor.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

You will need a score of 80% or higher to show that you have mastered the outcome.

Module 4: Wiring Diagrams

Wiring Diagrams Overview

No matter what piece of HVAC equipment you are working on, it will have a wiring diagram that shows how the unit is wired and controlled. Understanding these wiring diagrams and also understanding the sequence of operation of the unit is vital to serving HVAC equipment.

Competency:

Interpret and draw wiring diagrams and wire electrical circuits.

To obtain this competency, you will learn the following:

- Identify HVAC electrical components and their respective symbols used in wiring diagrams.
- Interpret schematic diagrams.
- Draw wiring diagrams using a sequence operation.
- Wire electrical circuits.

Before you begin this module please watch these videos:

Basic Electrical Components *(Note: The instructor uses a series of DVDs that he has received permission to stream through the learning management system)*

Wiring Diagrams

Wiring Diagrams Assignments

Read the chapter to learn about how to read and understand wiring diagrams used in HVAC equipment. When you have completed the steps below, go to class and work on the labs.



1. Read chapter 5 “Components, Symbols, and Circuitry of Air-Conditioning Wiring Diagrams” in your textbook.
2. Take the Check Your Knowledge: Chapter 5 Quiz.

Check Your Knowledge: Chapter 5 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Wiring Symbols Overview

To be able to drive you need to understand what the road signs mean. The same goes for reading wiring diagrams. You need to understand what symbols mean in a diagram.

1. To help with understanding symbols let's take a look at a couple of videos:
 - [Electric symbols for HVAC](#)
 - [Schematic Reading HVAC Training Solutions](#)
2. Read and review PowerPoint presentation on Symbols and Wiring Diagrams.

Reading Schematic Diagrams Overview

Now you are ready to dig deeper into reading, interpreting and drawing wiring schematics or drawing.

1. Watch [HVAC Training - Schematic diagrams.](#)
2. Read chapter 6 “Reading Schematic Diagrams” in your textbook.
3. Check your knowledge: Take the chapter review quiz.
4. Complete your Lab Projects for this module.

Check Your Knowledge: Chapter 6 Review Quiz

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Lab 5-1: Electrical Symbols

For this lab you will be identifying and drawing basic wiring symbols used in HVAC wiring diagrams.

1. You will need to remove the lab sheets for Lab 5-1 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Follow the instructions on your lab sheets.
4. Have your instructor sign off in the comments section under your name that you have completed the lab.
5. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab 6-1: Reading Basic Schematic Diagrams

This lab will be done in Canvas, so you do not need to come to the college to perform this lab. For this lab you will be working with wiring diagrams, answering questions where the answers will be found in these diagrams.



1. You will need to use the Lab 6-1 sheets from your lab manual to find the answers for this lab.
2. Fill out your lab sheets first and then you will record your answers from your worksheet into the quiz after they have been answered.
3. When you are ready click on Take the Quiz to start your lab.

Lab 6-2: Reading Advanced Schematic Diagrams

This lab will be done in Canvas, so you do not need to come to the college to perform this lab. For this lab you will be working with more advanced wiring diagrams, answering questions where the answers will be found in these diagrams.

1. You will need to use the Lab 6-2 sheets from your lab manual to find the answers for this lab.
2. Fill out your lab sheets first and then you will record your answers from your worksheet into the quiz after they have been answered.
3. When you are ready click on Take the Quiz to start your lab.

Lab 6-3: Drawing Basic Diagrams

For this lab you will be drawing and the wiring basic control circuits. You will be using Controls Lab Station #6 for this lab. You will have your instructor inspect your wiring, then turning on the power to the trainer.

1. You will need to remove the lab sheets for Lab 6-3 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Print out the Lab 6-3 Worksheet Instructions.
4. Follow the instructions on your lab sheets and lab worksheet instructions.
5. Have your instructor sign off in the comments section under your name that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Wiring Diagrams Progress Written Exam

This exam covers chapters 5 and 6 in the Smith Electricity Textbook. This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

Wiring Diagrams Lab Practical

As was stated at the beginning of this module the competency for this module is to be able to: "Interpret and draw wiring diagrams and wire electrical circuits."

So for this Lab Practical you will: "Wire up different wiring circuits using wiring diagrams already created and by wiring diagrams drawn to match the required sequence of operation. "

This lab practical is designed to show whether you have mastered this competency or not. You must pass this competency before you will be allowed to move on to the next module. This lab practical must be performed in the presence of your instructor.

Schedule time with your instructor when you are ready for your lab practical.

1. Your instructor will provide you with the worksheets for this lab.
2. Here is the checklist that will be used to grade you on your lab.
3. After the lab your instructor will enter your score into Canvas.

You will need a score of 80% or higher to show that you have mastered the outcome.

Module 5: Electrical Controls Systems

Electrical Controls Systems Overview

Now that you have an understanding of basic control circuits can move on to more complex controls used in HVAC equipment. A top-notch HVAC service tech is one who has a good working knowledge of the sequence of operation of HVAC equipment and can read and understand the wiring diagram for that piece of equipment.

Competency:

Wire HVAC equipment control circuits from wiring diagrams.

To obtain this competency, you will learn the following:

- Identify the basic components used in electrical controlling HVAC equipment.
- Wire basic heating and cooling control circuits.

Electrical Controls Systems Assignment

Read the chapters to learn about wiring different kinds of HVAC equipment control circuits. For this module, you will read textbook chapters, view presentations, and complete 6 labs. When you have completed the assignments and taken the quiz, go to class and work on the labs. Make sure you print out the lab worksheets before class.

HVAC Electrical Equipment Controls

1. Read chapter 11 “Contactors, Relays, and Overloads” in the Smith Electricity textbook.
2. Take the Check Your Knowledge: Chapter 11 Quiz.
3. Read chapter 12 “Thermostats, Pressure Switches, and Other Electric Control Devices” in the Smith Electricity textbook.
4. Read and review the presentation on Thermostats and Heating Controls.
5. Take the Check Your Knowledge: Chapter 12 Quiz.
6. Read chapter 14 “Heating Control Devices” in the textbook.
7. Take the Check Your Knowledge: Chapter 14 Quiz
8. Complete your Lab Projects for this module.

Check Your Knowledge: Chapter 11

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

1. Click **Take this Quiz**.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Check Your Knowledge: Chapter 12

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

4. Click **Take this Quiz**.
5. Read each question and choose the best answer(s).
6. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Check Your Knowledge: Chapter 14

After you have read the textbook chapter, take this open book chapter review quiz. This quiz is designed to help you know what you have learned from the textbook.

Testing Procedures:

7. Click **Take this Quiz**.
8. Read each question and choose the best answer(s).
9. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Lab 11-1: Contractors and Relay

For this lab you will be wiring control circuits that contain relays or contactors or both using Controls Lab Station #8.

1. You will need to remove the lab sheets for Lab 11-1 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Print out the Lab 11-1 Worksheet Instructions.
4. Follow the instructions on your lab sheets and lab worksheet instructions.
5. Have your instructor sign off in the comments section under your name that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab 12-2: Low-Voltage Thermostats

For this lab you will be wiring control circuits that deal with using low voltage thermostats using Controls Lab Station #8.

1. You will need to remove the lab sheets for Lab 12-2 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Print out the Lab 12-2 Worksheet Instructions.
4. Follow the instructions on your lab sheets and lab worksheet instructions.
5. Have your instructor sign off in the comments section under your name that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab 12-3: Line-Voltage Thermostats

For this lab you will be wiring control circuits that deal with using high voltage thermostats using Motor Controls Lab Station #2 and Controls Station #10.

1. You will need to remove the lab sheets for Lab 12-3 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. Print out the Lab 12-3 Worksheet Instructions.
4. Follow the instructions on your lab sheets and lab worksheet instructions.
5. Have your instructor sign off in the comments section under your name that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab Project: Wiring White Board Furnace Controls

For this lab you will be wiring a mock furnace control circuit, using Controls Lab Station #9.

1. Print out the Lab Worksheet to be used with the lab.
2. Using the lab worksheet/checklist follow the instructions for the lab.
3. Have your instructor sign off that you have completed the lab.
4. Scan the Lab worksheet/checklist and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab 14-1: Electric Heating Controls

For this lab you will be wiring control circuits that deal with electric heaters using Controls Station #6 and additional Lab 14-1 board.

1. You will need to remove the lab sheets for Lab 14-1 from your lab manual.
2. Print your name and the date on the top of the first lab sheet.
3. For this lab you will only be doing Section A. Electric Resistance Heating Circuitry and the Questions at the end of the lab.
4. Follow the instructions on your lab sheets and lab worksheet instructions.
5. Have your instructor sign off in the comments section under your name that you have completed the lab.
6. Scan this page of the lab sheets and submit your scan into Canvas to complete your lab, so you can move on to the next assignment.

Lab Project Electric Heater Control Wiring

For this lab you will be wiring up an electric heat control circuit on the Hampden Electric Heat Furnace System trainer (Controls Lab Station #10).

1. Print out the Lab Worksheet to be used with the lab.
2. As your Instructor for the copy of Lab Project: Electric Heater Control Wiring folder.
3. Using the lab folder and the worksheet/checklist follow the instructions for the lab.
4. Have your instructor sign off that you have completed the lab.
5. Scan the Lab worksheet/checklist and submit your scan into canvas to complete your lab, so you can move on to the next assignment.

Electrical Controls System Progress Exam

This exam covers chapters 11, 12 and 14 in the Smith Electricity Textbook. This exam will help you and your instructor see how you are progressing in the course. You need to achieve 80% or higher to move to the next module.

Electrical Controls Systems Lab Practical

As was stated at the beginning of this module the Learning Outcome for this module is to be able to: "Wire HVAC equipment control circuits from wiring diagrams."

So for this Lab Practical you will: "Draw wiring diagrams from and then wire up wiring circuits using these wiring diagrams. "

This lab practical is designed to show whether you have mastered this competency or not. You must pass this competency before you will be allowed to move on to the next module.

This lab practical must be performed in the presence of your instructor.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the checklist that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

You will need a score of 80% or higher to show that you have mastered the outcome.

Final Competency Exam and Practical Assessment

Final Competency Exam and Practical Assessment

As was stated at the beginning of this course the Competencies for this course, are to be able to:

- Explain the electricity safety rules and practices as they apply to the HVAC industry.
- Obtain correct electric circuit measurements using electrical test equipment.
- Determine the electrical characteristics of each component in series and parallel circuits.
- Interpret and draw wiring diagrams and wire electrical circuits.
- Wire HVAC equipment control circuits from wiring diagrams.

At the end of each module you showed that you had mastered the competency for that module. This Written Exam and Lab Practical are going to again make sure that you can still master this course's competencies.

Written Exam Form A *(There is a Form B in case the student does not pass Form A)*

This written exam covers all chapters that was in this module. That being:

- Chapter 1: Electrical Safety
- Chapter 2: Basic Electricity
- Chapter 3: Electric Circuits
- Chapter 4: Electric Meters
- Chapter 5: Components, Symbols, and Circuitry of Air-Conditioning Wiring Diagrams
- Chapter 6: Reading Schematic Diagrams
- Chapter 7: Alternating Current, Power Distribution, and Voltage Systems
- Chapter 11: Contactors, Relays, and Overloads

- Chapter 12: Thermostats, Pressure Switches, and Other Electric Control Devices
- Chapter 14: Heating Control Devices

This exam must be taken in the classroom. You must get a score of 80% or better to move on to the next assignment.

This assessment will measure your knowledge in basic electricity. The assessment consists of 48 questions. To pass this assessment, you will need a score of 80% (38 out of 48 points).

If you do not pass on the first attempt, you will have the opportunity to meet with your instructor, study and practice the content further, and retake a different version of the assessment.

Testing Procedures:

1. Click **Take this Quiz**.
2. Read each question and choose the best answer(s).
3. When you have answered all the questions, click the **Submit** button. You will be shown your score.

Basic Electricity for HVAC Lab Practical A *(There is a Form B in case the student does not pass Form A)*

This Lab Practical is going to again make sure that you can still master this course's learning outcomes.

So for this Lab Practical you will be asked to perform some of the same items you had to master before.

Note: You are going to be tested on these learning outcomes (and others you will master) at different times as you go through the program. This is to make sure that you don't forget and can continue to master the required learning outcomes even after you have passed a course.

You must pass this lab before you will be allowed to move on to the next course.

This lab practical must be performed in the presence of your instructor.

You will need a score of 80% or 59 points to show that you have mastered the outcome.

1. Schedule time with your instructor when you are ready for your lab practical.
2. Your instructor will provide you with the worksheets for this lab.
3. Here is the **Checklist** that will be used to grade you on your lab.
4. After the lab your instructor will enter your score into Canvas.

Lab Practical 1: Using Meters Checklist for Evaluation

Aspect	Meets Expectations (Proficient) 1 Point	Compressor	Evaporator fan motor	Condenser fan motor	Transformer input	Transformer output	Contractor coil	Comments
		Score (0-1)						
Voltage	a. Meter is set to the proper mode.							
	b. Test leads are placed in proper location.							
	c. Record the correct reading for voltage.							
Ohms	a. Multimeter is set to the proper mode.							
	b. Test leads are placed in proper location.							
	c. Record the correct reading for Ohms.							

Aspect	Meets Expectations (Proficient) 1 Point	Compressor	Evaporator fan motor	Condenser fan motor	Transformer input	Transformer output	Contractor coil	Comments
		Score (0-1)						
Amperage	a. Multimeter is set to the proper mode.							
	b. The multimeter is clamped in proper location.							
	c. Record the correct reading for amperage.							
Megger	a. Megger is set to the proper mode.							
	b. Test leads are placed in proper location.							
	c. Record the correct reading for megger.							

Lab Practical 2: Electrical Circuits Checklist for Evaluation

Aspect	Meets Expectations (Proficient) 1 Point	Series Circuit 1	Series Circuit 2	Parallel circuit 1	Parallel circuit 2	Series-Parallel circuit	Comments
		Score (0-1)					
Draw diagram	Diagram was drawn correctly.						
Wire Diagram	Diagram was wired correctly.						
Voltage	a. Correctly measured total circuit voltage.						
	b. Correctly calculated voltage drop across each load.						
	c. Correctly measured voltage drop across each load.						

Aspect	Meets Expectations (Proficient) 1 Point	Series Circuit 1	Series Circuit 2	Parallel circuit 1	Parallel circuit 2	Series-Parallel circuit	Comments
		Score (0-1)					
Ohms	a. Correctly measured each loads' resistance.						
	b. Correctly measured total circuit resistance.						
	c. Correctly calculated total circuit resistance.						
Amperage	a. Correctly calculated total circuit amperage.						
	b. Correctly measured total circuit amperage.						

Aspect	Meets Expectations (Proficient) 1 Point	Series Circuit 1	Series Circuit 2	Parallel circuit 1	Parallel circuit 2	Series-Parallel circuit	Comments
		Score (0-1)					
	c. Correctly calculate damp draw of each load.						
	d. Correctly measured amp draw of each load.						
Watts	a. Correctly calculated each loads' wattage rating.						

Lab Practical 3: Wiring Diagrams Checklist for Evaluation

Aspect	Meets Expectations (Proficient) 1 Point	Wiring Diagram 1	Wiring Diagram 2	Wiring Diagram 3	Wiring Diagram 4	Wiring Diagram 5	Comments
		Score (0-1)					
Wire Diagram	a. Correctly wire switch #1						
	b. Correctly wire switch #2						
	c. Correctly wire light bulb #1						
	d. Correctly wire light bulb #2						
	e. Correctly wire light bulb #3						
	f. Correctly wire light bulb #4						

Aspect	Meets Expectations (Proficient) 1 Point	Wiring Diagram 1	Wiring Diagram 2	Wiring Diagram 3	Wiring Diagram 4	Wiring Diagram 5	Comments
		Score (0-1)					
	g. Correctly wire relay coil #1						
	h. Correctly wire relay #1 NC contact						
	i. Correctly wire relay #1 NO contact						
	j. Correctly wire relay coil #2						
	k. Correctly wire relay #2 NC contact						
	l. Correctly wire relay #2 NO contact						
	m. Correctly wire relay coil #3						

Aspect	Meets Expectations (Proficient) 1 Point	Wiring Diagram 1	Wiring Diagram 2	Wiring Diagram 3	Wiring Diagram 4	Wiring Diagram 5	Comments
		Score (0-1)					
	n. Correctly wire relay #3 NC contact						
	o. Correctly wire relay #3 NO contact						
	p. Correctly wire transformer						
	q. Correctly wire thermostat						
Draw diagram	Diagram was drawn correctly.						

Lab Practical 4: Electrical Control Systems Checklist for Evaluation

Aspect	Meets Expectations (Proficient) 1 Point	Wiring Diagram 1	Wiring Diagram 2	Wiring Diagram 3	Wiring Diagram 4	Comments
		Score (0-1)				
Draw diagram	Diagram was drawn correctly.					
Label diagram	Components were labeled correctly					
Wire Diagram	a. Correctly wire switch #1					
	b. Correctly wire light bulb #1					
	c. Correctly wire light bulb #2					
	d. Correctly wire light bulb #3					

Aspect	Meets Expectations (Proficient) 1 Point	Wiring Diagram 1	Wiring Diagram 2	Wiring Diagram 3	Wiring Diagram 4	Comments
		Score (0-1)				
	e. Correctly wire contactor coil #1					
	f. Correctly wire relay #1 NO contacts					
	g. Correctly wire relay coil #1					
	h. Correctly wire relay #1 NC contact					
	i. Correctly wire relay #1 NO contact					
	j. Correctly wire relay coil #2					
	k. Correctly wire relay #2 NC contact					

Aspect	Meets Expectations (Proficient) 1 Point	Wiring Diagram 1	Wiring Diagram 2	Wiring Diagram 3	Wiring Diagram 4	Comments
		Score (0-1)				
	l. Correctly wire relay #2 NO contact					
	m. Correctly wire transformer					
	o. Correctly wire low voltage thermostat					
	p. Correctly wire high voltage thermostat					
	q. Correctly wire motor					
	r. Correctly wire sequencer					
	s. Correctly wire fuses					

Aspect	Meets Expectations (Proficient) 1 Point	Wiring Diagram 1	Wiring Diagram 2	Wiring Diagram 3	Wiring Diagram 4	Comments
		Score (0-1)				
	t. Correctly wire High Temp Limits					