

Please outline the following for each lesson

# Course Title

## Lesson Title

Electrical Integration

### Background

### Lesson Stage

Introductory/Instructional/or Culminating

This is an instructional level module in developing content and skills.

### Intended Audience

Who is the intended audience?

What skills and prior educational experience is required to participate in this lesson?

Grades 9-14

### Designer's Name & Contact Email

Include this information so instructors have a resource to contact when implementing the lesson.

Leo E. Remillard e-mail [remillard@tri-county.tc](mailto:remillard@tri-county.tc) or [lremi@comcast.net](mailto:lremi@comcast.net)

Nancy Sibilila e-mail [sibilila@tri-county.tc](mailto:sibilila@tri-county.tc)

### Goals & Focus

### General Topic

For example: Wind Energy or Photovoltaic

Photovoltaic

### Central Questions/Overall Purpose/Key Content Ideas Taught in this Lesson

What is a general or central question that the lesson asks?

- 1) What factors affect conductor ampacity?

Please outline the following for each lesson

- 2) Can you list ways in which voltage drop in the PV output circuit can be reduced?
- 3) Which PV-system circuits require overcurrent protection and which conductors must be protected?
- 4) Is Article 690 of the NEC the only article that covers the installation of PV systems?

Provide an overall summary of the lesson objectives
---

Identify the electrical codes, regulations and recommendations applicable to PV systems.

Calculate the voltage and current limits for various circuits of a PV system.

Determine appropriate conductor ampacities and overcurrent protection ratings for various circuits.

Identify the appropriate types of conductors for PV system circuits based on application and environment.

Describe the required types of disconnects and their installation.

Differentiate between acceptable PV system grounding methods.

Describe the functions and requirements of electrical balance-of-system (BOS) components.

<b>Lesson Duration</b>
------------------------

How long will it take to complete the lesson?
---

6 hours

<b>Related Learning Standards (if applicable)</b>
---

Please refer to any work-based and/or academic learning standards that may apply to this lesson/course.
---

2.C.0.5 Explain how voltage, current, and resistance are related to each other.

2.C.0.6 Using the formula for Ohm's law, calculate an unknown value.

2.C.0.7 Explain the different types of meters and equipment used to measure voltage, current, resistance and power.

2.C.0.8 Using the power formula, calculate the amount of power used by a circuit.

2.D.0.1 Explain the basic characteristics of a series, parallel and combination circuits.

2.D.0.2 Calculate, using Kirchoff's voltage law, the voltage drop in series, parallel, and combination circuits.

2.E.0.1 Perform measurement of current using the ammeter/ clamp-on.

2.E.0.2 Perform measurement of voltage using the voltmeter.

Please outline the following for each lesson

### **Intended Learning Outcomes**

Outcomes should be "SMART"

Specific – Objectives should specify what they want to achieve.

Measurable – You should be able to measure whether you are meeting the objectives or not.

Achievable - Are the objectives you set, achievable and attainable?

Realistic – Can you realistically achieve the objectives with the resources you have?

Time – When do you want to achieve the set objectives?

- a) Explain the function of the National Electrical Code (NEC) in terms of PV installation.
- b) Identify voltage and current limits set by the NEC.
- c) Explain voltage drop in PV systems is an important factor to address.
- d) Describe conductor size and define ampacity..
- e) Explain the function of insulation and list common conductor insulation types.
- f) Identify and describe the types of wiring connections used in PV systems.
- g) Define junction box and identify different types of junction boxes.
- h) Describe the difference between a blocking diode and a bypass diode.
- i) Describe common overcurrent protection devices and the rating systems used for these devices.
- j) Describe the function and required locations of disconnects.
- k) Describe common grounding techniques and identify common types of surge arrestors.

### **KNOW**

By the end of this lesson students will know...

This may include facts, names, dates, places, information, vocabulary.

By the end of this lesson students will be able to identify how to properly install a PV system in accordance with the Nat'l. Electrical Code (NEC). Students will be able to check input and output voltages throughout the system. Students will know various vocabulary words that apply to this module, direct mount, rack mount pole mount design load, live load, wind load, snow load, resonance, galvanic corrosion.

### **UNDERSTAND**

By the end of this lesson students will understand....

This may include big ideas, generalizations, principles, ideas that transfer across situations.

Student will understand that all different types of mechanical loads have to be taken into consideration in order to safely install an PV system on a roof.

### **DO**

By the end of this lesson students will be able to....

This may include skills of the discipline, social skills, production skills, and processes.

By the end of this lesson students will be able to install all necessary wiring in accordance to NEC and MEC.

Please outline the following for each lesson

### *Implementation*

#### ***Pre-Assessment***

How will you determine students' prior knowledge and understanding for this unit?

What data will you collect?

How will you survey prerequisite learning?

Prior to this lesson an oral quiz will be given to the students to find out at level of basic electricity they are at.

#### ***Resources & Materials***

Attach copies of handouts, slides or visuals required

What equipment is needed to conduct the activities in the lesson?

What do the students need to be able to participate in the lesson?

Photovoltaic Systems Textbook (American Technical Publisher, Inc.) ISBN 978-0-8269-1287-9 and related Power point Presentation

Photovoltaics Design and Installation Manual Textbook, (Solar Energy International) ISBN 978-0-86571-520-2N

#### ***Activities Plan (Optional)***

Provide as much detail as possible so that an instructor/trainer could use this plan to teach the course.

This may include a step by step action plan, teaching methodologies or types of activities (e.g. group work, lecture, case study, etc)

Each Lesson may have several activities.

For each activity provide a title and identify the duration of the activity.

For each activity outline the steps the instructor will take to complete the activity.

Students will set up series circuits, parallel circuits, and series/parallel circuits of different values and take and record readings in order to get a better understanding of circuits.

#### ***Assessment/Demonstration of Competencies***

## Clean Energy Workforce Training Capacity Building Curriculum Template

Please outline the following for each lesson

How will the students be assessed on what they have learned?
--

Students will be given a written test which will consist of multiple choice and fill-in blank answers.

Students will have to design different types of circuits and read what value of voltage, resistance and amperage generated by their circuits.