NEW COURSE DEVELOPMENT OR EXISTING COURSE ASSESSMENT REPORT

PREPARED BY: Ken Hovda
DATE: 8/29/2012
COURSE TITLE: Electronics for Renewable Energy Systems
New course: **X** or Existing course:____ Department: **Computers, Electronics, and Networking**
Credit Hours: **5** Lecture Hours Per Week: **2.5** Lab Hours Per Week: **2.5**
Is this course required for a Degree or Certificate? **Not currently, but it will be required for the Associates degree in Electronics and Robotics Technology if adopted.**

COURSE DESCRIPTION:

Course will cover concepts in linear electronics used in power electronics systems, such as linear and switching power supplies, charge controllers, and power inverters. Basic overview of photovoltaic, wind, and microhydro power generation systems will be included.

PREREQUISITES:

Required:

- CEN 151 DC Electronics
- CEN 162 AC & Linear Electronics

Recommended:

- N/A

RESOURCES USED TO PREPARE THIS COURSE:

Material and concepts from:

- Floyd, T.: Electronics Fundamentals: Circuits, Devices, and Applications, 2007
- Pressman, A.: *Switching and Linear Power Supply, Power Converter Design*, Hayden, 1977.
- Coughlin, R. & Driscoll, F.: *Operational & Linear Integrated Circuits, 4th Ed.,* Prentice Hall, 1991.
- Scherz, P.: Practical Electronics for Inventors, 2007.
- Kemp, W.: *The Renewable Energy Handbook: A guide to Rural Independence, Off-grid and Sustainable Living,* 2005.
- Chiras, D.: Solar Electricity Basics, 2010.
- Sullivan, G.: *Wind Power for your Home*, 1978.
- Davis, S.: *Microhydro: Clean Power from Water*, 2003.

TEXTBOOKS USED BY STUDENTS

- Vanek & Albright: *Energy Systems Engineering: Evaluation & Implementation,*
- Scherz, P.: Practical Electronics for Inventors, 2007.

GENERAL COURSE GOAL:

Provide students with a general understanding of renewable energy technology and introduce them to some common renewable energy sources as well as the electronics circuits commonly used in monitoring, distributing, and controlling renewable energy systems.

COURSE OUTCOMES:

At the conclusion of this course, students will be able to:

- **identify the major components which are used in renewable energy production.**
- **discuss the pros and cons of selecting any of a variety of energy sources.**
- **describe the functional components of a linear power supply.**
- **describe the functional components of a switching power supply.**
- **explain pulse-width modulation and state an application.**
- **construct a simple charge controller.**

METHODS OF ASSESSMENT:

- **Inquiry and discussion**
- **Quizzes (written and lab)**
- **Exam (written and lab)**
- **Group Projects**

METHODS OF INSTRUCTION MAY INCLUDE:

- **Lecture**
- **Demonstration**
- **Lab Experiments**

TOPICAL OUTLINE:

INSTRUCTIONS: In the spaces below, develop instructional units and show the topics that support each unit. Note: For each topic, indicate which industry-derived skills are addressed by the topic. To do this, you must first choose which skill set you are using. The choices are below. Please place an "x" by the skill set you will use. (Choose only one.)

___ Energy Project/Program Management

_X_ Commercial Building Analyst

Cite the code number for each skill from the Skill sheet. Put it AFTER each topic description.

Unit 1: Course Introduction and Review of Fundamentals (2 weeks)

1. Learning Objectives.

   At the conclusion of this unit, students will be able to:

   - analyze simple AC and DC circuits in series and parallel configurations. (B10)
   - briefly explain what sustainability is and why it is important. (A10)
   - outline safety procedures necessary when working with high energy electrical circuits. (B14)

2. Introduction.

   The purpose of the first unit is two-fold. First, I want to share what I have learned in the past year about the abundant employment opportunities which are soon going to be available to technicians who have prepared themselves to work in sustainable technologies. The Smart Grid will require the design, manufacture, installation, and maintenance of a myriad of new devices and many systems in operation today will need to be replaced or upgraded/modified.

Second, we will review some basic concepts from DC and AC Electronics to make sure that everyone in the class has the proper background to work through the later units which will be more technically challenging.

3. Topics covered.
    - Review fundamentals of DC and AC Electronics.
    - Introduction to Sustainability.
    - Electrical safety.

4. Assessments.
    - Written Quiz.
    - Lab Quiz.
    - Book Report (due at end of quarter).

5. Major Activities.
    - Conduct experiments with protoboard.
    - Participate in discussions on a variety of topics related to sustainability.
    - Choose a book from Suggested Reading List (included).

6. Necessary Equipment.
    - Protoboard and Parts Kit.

Unit 2: Energy Generation and Distribution (1 week)

1. Learning Objectives.

    At the conclusion of this unit, students will be able to:
    - explain what Smart Grid technology is and how it will affect an individual's ability to control their energy use and cost. (C3)
    - discuss the difference between grid-tied and off-grid systems. (C3)
    - compare and contrast renewable and nonrenewable energy sources and list benefits and/or drawbacks of each source. (A10)

2. Introduction.

    This unit will begin with a discussion of the different sources of energy we use for large-scale commercial production, medium-scale distributed generation, and small-scale home generation, of electricity. After the initial discussion, most of our focus for this unit will be on small-scale systems. These will include both grid-tied and off-grid systems.

3. Topics covered.
    - Smart Grid technology.
    - Renewable and nonrenewable energy sources.
    - grid-tied and off-grid systems.

4. Assessments.
    - Written Quiz.
    - Lab Quiz.

5. Major Activities.
    - Participate in discussions on a variety of topics related to renewable energy.
    - Begin research into possible project ideas.

6. Necessary Equipment.
    - N/A

Unit 3: Linear Devices (2 weeks)

1. Learning Objectives.

    At the conclusion of this unit, students will be able to:
    - identify three applications for an operational amplifier (Op-Amp). (B10)
    - identify the two main reasons why voltage regulation is desirable. (B10)
    - explain pulse-width modulation and state an application. (B10)
    - construct a simple sine-wave generator. (B10)

2. Introduction.

    In this unit, we will lay the groundwork for the next unit on power supplies. We will discuss the various linear components and ICs which are commonly used in power supplies and converters. We will also cover several applications for each type of device.

3. Topics covered.
    - Operational amplifiers.
    - Voltage Regulators.
    - Pulse-width modulation.
    - Signal Generation (Sine/Square/Triangle).

4. Assessments.
    - Written Quiz.
    - Lab Quiz.

5. Major Activities.
    - Conduct experiments with protoboard.
    - Participate in discussions to help students choose a project to research.

6. Necessary Equipment.
    - Protoboard and Parts Kit.

Unit 4: Power Supplies (1 week)

1. Learning Objectives.

    At the conclusion of this unit, students will be able to:
    - draw a functional diagram of a linear power supply and describe the purpose of each section. (B10)
    - compare and contrast the advantages and disadvantages of linear and switching power supplies. (B10)
    - describe how voltage regulation works and why it is important. (B10)

2. Introduction.

   This unit will start with a simple unregulated DC power supply and then it will be improved by adding filtering, a voltage regulator, and over-current protection. Then we will talk about switching power supplies, how they function, and how they differ from linear supplies

3. Topics covered.
   - Linear power supplies and their operational characteristics.
   - Switching power supplies and how they differ from linear supplies.
   - Integrated Circuit Voltage Regulators.

4. Assessments.
   - Written Quiz.
   - Lab Quiz.

5. Major Activities.
   - Examine typical examples of linear and switching power supplies.
   - Experiment with voltage regulators and filters to limit variations of voltage with changing load conditions and ac ripple.

6. Necessary Equipment.
   - Protoboard and Parts Kit.

Unit 5: Charge Controllers and Power Inverters (1 week)

1. Learning Objectives.

   At the conclusion of this unit, students will be able to:
   - draw a functional diagram of a charge controller and describe the purpose of each section. (B10)
   - explain the purpose of a charge controller as it might be used in a home-based renewable energy system either grid-tied or off-grid. (B10)
   - describe how a power inverter works and why it is important. (B10)
   - Specify an appropriate charge controller and/or power inverter for a given application. (C5)

2. Introduction.

   Charge controllers and power inverters are key components in a renewable energy system. They provide for the safe and efficient transfer of energy from one part of the system to another. Understanding how they work and how to select an appropriate device for each application are extremely important if we hope for the system to provide dependable energy production for a long time.

3. Topics covered.
   - Functional breakdown of charge controllers and AC power inverters.
   - Formulas and calculations necessary to call out a specific device for a given application.

4. Assessments.
    - Written Quiz.
    - Lab Quiz.

5. Major Activities.
    - Connect a PV panel to a battery with a charge controller while monitoring current and battery state of charge (voltage).
    - apply a DC voltage to a power inverter and see the shape of the waveform using an oscilloscope. Watch for changes in the waveform as the load condition changes.

6. Necessary Equipment.
    - Protoboard and Parts Kit.
    - Small inverter and charge controller.

Unit 6: Renewable Energy Sources (2 weeks)

1. Learning Objectives.

    At the conclusion of this unit, students will be able to:
    - explain the difference between renewable and nonrenewable energy sources. (A10)
    - discuss the pros and cons of selecting any of a variety of energy sources. (C3)
    - perform calculations necessary to specify components required for a small, off-grid photovoltaic system, including panels, batteries, charge controller, and inverter. (C5)

2. Introduction.

    During this unit, we will learn to distinguish between renewable and nonrenewable energy sources. We will identify several renewable sources which are well-suited to small-scale generation, such as photovoltaic (PV), wind, and micro-hydro. The primary focus will be on PV (DC) and wind (AC) so that we can compare the requirements for each type of power produced.

3. Topics covered.
    - Renewable vs. nonrenewable energy sources.
    - Photovoltaic (PV), wind, and micro-hydro systems.
    - Formulas for calculating power and current requirements for a proposed system.

4. Assessments.
    - Written Quiz.
    - Lab Quiz.

5. Major Activities.
    - Discuss advantages and disadvantages of various renewable energy sources.
    - Perform calculations to determine appropriate sizing of components for a hypothetical PV system.

- PV demonstration.
- Wind turbine demonstration.

6. Necessary Equipment.
    - Small PV panel and battery (for demonstration).
    - Small wind turbine and battery (for demonstration).
    - Small inverter and charge controller.

Unit 7: Research Projects & Presentations

1. Learning Objectives.

    At the conclusion of this unit, students will be able to:
    - conduct an effective inquiry process. (F11)
    - plan, schedule, and execute a project. (F12)
    - effectively collaborate with peers. (G2)

2. Introduction.

    This is the unit where everything comes together. During the last week, each student will present what they learned from reading the book they chose from the Suggested Reading List. If students chose to build a project, they will have an opportunity to demonstrate what they have found. There will be lots of time for discussion and peer review.

3. Topics covered.
    - Review of all course material.
    - Preparing to make a presentation.
    - Constructive peer review.
4. Assessments.
    - Written Final.
    - Lab Final project.
    - Book Report presentation.

5. Major Activities.
    - Finish work on projects.
    - Present Book Report.
    - Review for written final exam.

6. Necessary Equipment.
    - Materials used for projects.
    - Display board, powerpoint, or other appropriate medium for presentation.

Notes: I may merge Units 4 and 5 into a single 2-week long unit. The material is closely related and I think the course would flow more smoothly if that was the case.

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