ITT Technical Institute

ET3480T

Power Systems

Onsite Course

SYLLABUS

Credit hours: 4.5

Contact/Instructional hours: 67 (41 Theory Hours, 26 Lab Hours)

Prerequisite(s) and/or Corequisite(s):

Prerequisites: ET3380T Power Electronics or equivalent

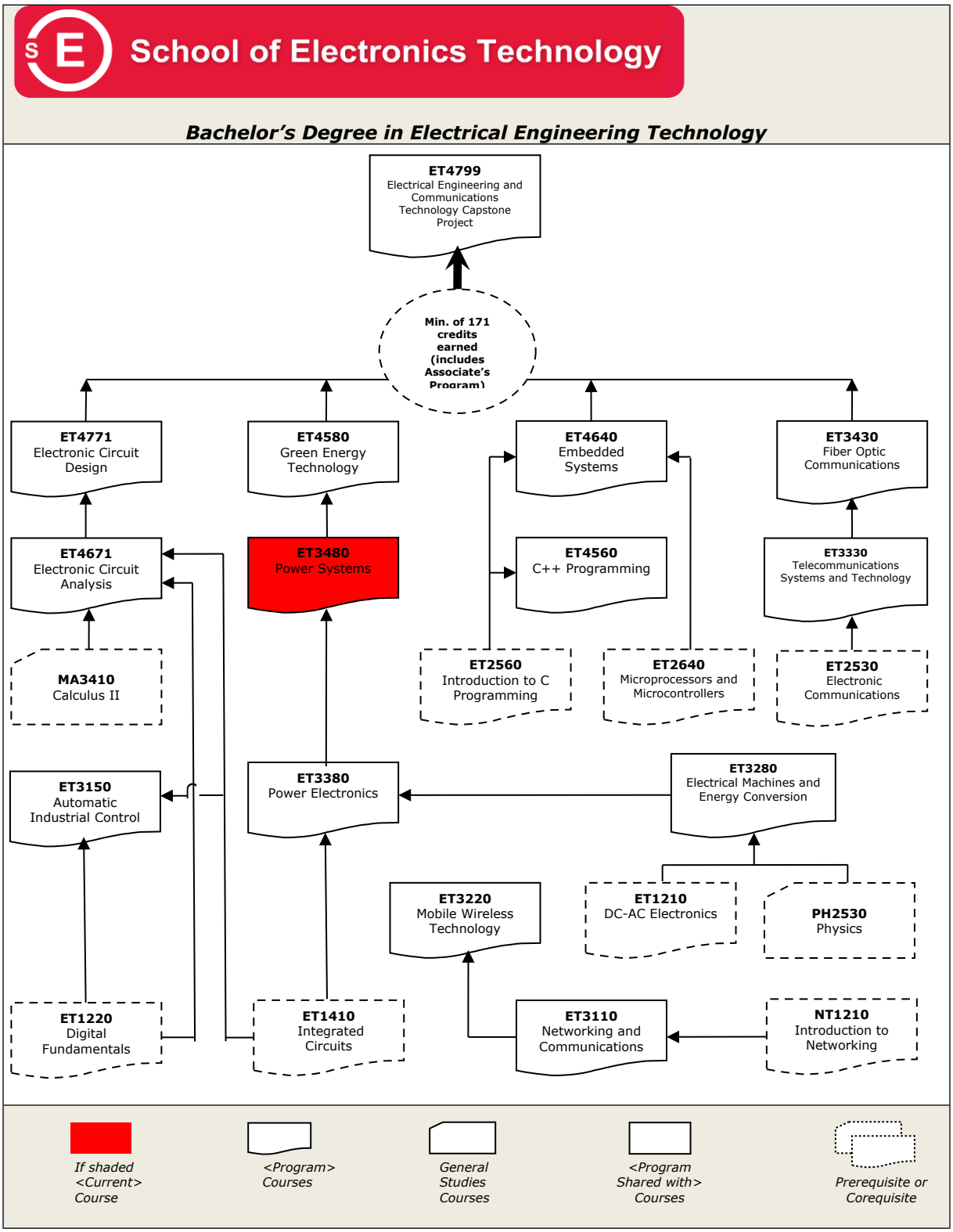
Course Description:

In this course, students study energy conversion, elements and the structure and operation of electric power systems. Topics include generators, transformers, load flow and power distribution, and the operation and analysis of power systems.

Where Does This Course Belong?

This is a fourth-quarter course in the Electrical Engineering and Communications Technology bachelor's degree program in the School of Electronics Technology.

The following table demonstrates how this course fits in the program:



NOTE: Refer to the catalog for the state-specific course information, if applicable.

Course Summary

Major Instructional Areas

1. Structure and elements of electrical power systems
2. Fundamental principles of power system operation and control
3. Load flow and power distribution
4. Operation and analysis of power systems
5. Power generation, transmission, and distribution and the Smart Grid

Course Objectives

1. Analyze the overall function of a typical residential and commercial electrical power distribution system.
2. Use phasor representations and complex algebra techniques to calculate electrical quantities and loads.
3. Analyze the use of various types of devices, such as wiring and overcurrent protection devices, used in typical residential and commercial electrical power distribution systems.
4. Design a branch circuit using various devices and branch circuit apparatus to safely provide and control the delivery of electrical power for a given occupancy.
5. Discuss the characteristics of various conduit and raceway systems and grounding techniques.
6. Analyze the role of service entrance apparatus needed to safely provide and control the delivery of electrical power.
7. Examine the operations of motors, transformers, and capacitors in an electrical power distribution system.
8. Calculate voltage drops and short-circuit currents in a power system.
9. Determine various techniques used to protect equipment in the power distribution system in case of a short circuit or any other fault.
10. Describe the advantages and features of the Smart Grid.
11. Describe the history of U.S. electricity, the essential components of the power grid, and the role of FERC in purchased power.

Learning Materials and References

Required Resources

Textbook Package	New to This Course	Carried over from Previous Course(s)	Required for Subsequent Course(s)
Bosela, T.R. (2012). *Electrical systems design.* (Custom ed.). Upper Saddle River, NJ: Prentice Hall.	■		
Other Items	**New to this Course**	**Carried over from Previous Course(s)**	**Required for Subsequent Course(s)**
Multisim software		■	
Current Student Toolkit		■	

Recommended Resources

Books, Professional Journals

- National Fire Protection Association (NFPA) Journal http://www.nfpa.org/archivedjournalhome.asp?categoryID=2206 (accessed 07/11/12)
- Transmission and Distribution World Magazine

http://tdworld.com/ (accessed 07/11/12)

- Ugly's Electrical References

http://www.uglys.net/ (accessed 07/11/12)

Professional Associations

- American Public Power Association (APPA)

http://www.publicpower.org/ (accessed 07/11/12)

- Edison Electric Institute (EEI)

http://www.eei.org/Pages/default.aspx (accessed 07/11/12)

- Institute of Electrical and Electronics Engineers (IEEE) http://www.ieee.org (accessed 07/11/12)
- National Fire Protection Association (NFPA)

http://www.nfpa.org/ (accessed 07/11/12)

- National Rural Electric Cooperative Association (NRECA) http://www.nreca.coop/Pages/default.aspx (accessed 07/11/12)

ITT Tech Virtual Library (accessed via Student Portal | https://studentportal.itt-tech.edu)

- School of Electronics Technology > Professional Organizations > NEMA: The Association of Electrical & Medical Imaging Equipment Manufacturers
- School of Electronics Technology > Professional Organizations > Electrical Safety Foundation International

Other References

- PowerWorld Demo Software

http://www.powerworld.com/downloads/demosoftware.asp (accessed 07/11/12)

- Smart Grid News

http://www.smartgridnews.com (accessed 07/11/12)

NOTE: All links are subject to change without prior notice.

Information Search

Use the following keywords to search for additional online resources that may be used for supporting your work on the course assignments:

- Electrical device
- Electrical service entrance
- Electrical distribution
- Electrical transmission
- Electrical phasors
- Electrical protection
- Electrical grounding
- Electrical raceway
- Electrical wiring
- Electrical transformer

Course Plan

Suggested Learning Approach

In this course, you will be studying individually and within a group of your peers. As you work on the course deliverables, you are encouraged to share ideas with your peers and instructor, work collaboratively on projects and team assignments, raise critical questions, and provide constructive feedback.

Use the following advice to receive maximum learning benefits from your participation in this course:

DO	DON'T
▪ Do take a proactive learning approach. ▪ Do share your thoughts on critical issues and potential problem solutions. ▪ Do plan your course work in advance. ▪ Do explore a variety of learning resources in addition to the textbook. ▪ Do offer relevant examples from your experience. ▪ Do make an effort to understand different points of view. ▪ Do connect concepts explored in this course to real-life professional situations and your own experiences.	▪ Don't assume there is only one correct answer to a question. ▪ Don't be afraid to share your perspective on the issues analyzed in the course. ▪ Don't be negative about the points of view that are different from yours. ▪ Don't underestimate the impact of collaboration on your learning. ▪ Don't limit your course experience to reading the textbook. ▪ Don't postpone your work on the course deliverables—work on small assignment components every day.

Course Outline

Unit 1: INTRODUCTION TO ELECTRICAL SYSTEMS DESIGN

Out-of-class work: *10 hours*

Upon completion of this unit, students are expected to:

- List the basic elements of an electrical power distribution system.
- List the apparatus and safety devices in a typical residential or commercial power riser diagram.
- Label the various phase and line voltages in a typical three-phase electrical service diagram.
- Explain the significance of the National Electrical Code (NEC) in establishing standards for design, safe installation, and maintenance of electrical wiring, apparatus, and equipment.
- Calculate the NEC minimum demand loads for a residential or commercial occupancy using load diversity.
- Determine the monthly power bill using the peak power demand, power usage, and power rate schedule.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapters 1 and 3	Assignments	Unit 1 Assignment 1: Residential Electrical Systems	2.5%
	Lab	Unit 1 Lab 1: Determining Estimated Demand Load	2.5%

Unit 2: ELECTRICAL CIRCUIT CONCEPTS

Out-of-class work: *10 hours*

Upon completion of this unit, students are expected to:

- Apply the phasor analysis method for calculating alternating current in a circuit.
- Explain the concept of complex impedance.
- Apply Ohm's Law to alternating current circuits.
- Explain the concepts of active, reactive, and apparent power.
- Explain the concepts of power factor and reactive factor.
- Apply Kirchhoff's voltage and current laws to simple circuits.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapter 2	Assignments	Unit 2 Assignment 1: Electrical Circuits Basics	2.5%
	Quiz	Unit 2 Quiz 1	5%
	Lab	Unit 2 Lab 1: Electrical Circuits	2.5%

Unit 3: ELECTRICAL WIRING AND PROTECTION

Out-of-class work:

Upon completion of this unit, students are expected to:

- Explain the NEC definition of an electrical switch and specify the required rating and installation per NEC and National Electrical Manufacturers Association (NEMA) standards.
- Explain the NEC definition of an electrical receptacle and specify the required rating and installation per NEC and NEMA standards.
- Explain the time-current characteristics of fuses and circuit breakers.
- Analyze the construction, operation, electrical rating, electrical characteristics, and application of fuses and circuit breakers as overcurrent protection devices.
- Calculate the proper electrical conductor size and identify required installation given the load and environment.

10 hours

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapters 4 and 5 • Bosela, Chapter 6, pp. 102-122	Assignments	Unit 3 Assignment 1: Wiring and Protection Concepts	2.5%
	Lab	Unit 3 Lab 1: Electrical Wiring and Protection	2.5%

Unit 4: BRANCH AND FEEDER CIRCUIT DESIGN AND GROUNDING

Upon completion of this unit, students are expected to:

- Design the layout of required receptacles, lighting outlets, and switching in compliance with the NEC standards.
- Explain the NEC requirements for Ground Fault Circuit Interruption (GFCI) and Arc Fault Circuit Interruption (AFCI) for a given occupancy.
- Size conduits, device boxes, and junction boxes necessary to meet NEC wiring and installation requirements.
- Explain the type of grounding required by the NEC.

Out-of-class work:
10 hours

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapter 7 • Bosela, Chapter 8, pp. 162-192 • Bosela, Chapter 9	Assignments	Unit 4 Assignment 1: Receptacles, Conduits, and Grounding Concepts	2.5%
	Quiz	Unit 4 Quiz 2	5%
	Lab	Unit 4 Lab 1: Branch and Feeder Circuit Design and Protection	2.5%

Unit 5: SERVICE DESIGN, PANELBOARDS, AND LIGHTING

Upon completion of this unit, students are expected to:

- Verify whether the requirements of the NEC have been met in a riser diagram of an electrical service entrance.
- Explain various electrical utility metering types.
- Explain the phase arrangement in panelboards and switchboards, including the overcurrent protection required by the NEC.
- Develop a balanced electrical panel schedule.

Out-of-class work:
10 hours

- Explain main distribution panel (MDP) and medium-voltage switchgear applications.
- Explain the various light sources, including their operations and application.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapters 10 and 11 • Bosela, Chapter 12, pp. 295-305	Assignments	Unit 5 Assignment 1: Service Design, Panelboards, and Lighting Concepts	2.5%
	Lab	Unit 5 Lab 1: Panel Schedule	2.5%

Unit 6: LOW-VOLTAGE MOTORS, TRANSFORMERS, AND CAPACITORS

Out-of-class work: *10 hours*

Upon completion of this unit, students are expected to:

- Explain the operation of single-phase and three-phase motors, including their typical commercial and industrial applications.
- Properly size the motor feeder, short-circuit protection, and branch circuit conductors to meet NEC requirements.
- Explain the basic theory of transformers and the basic design and construction of electrical utility transmission and distribution transformers.
- Properly size a transformer between the electrical utility and the service entrance to meet the requirements of the NEC.
- Properly size a capacitor for power factor improvement.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapter 13 • Bosela, Chapter 14, pp. 366-377 and 386-394 • Bosela, Chapter 15 pp. 410-415	Assignments	Unit 6 Assignment 1: Low-Voltage Motors, Transformers, and Capacitors Concepts	2.5%
	Quiz	Unit 6 Quiz 3	5%
	Lab	Unit 6 Lab 1: Motor Applications and Sizing of Associated Conductors and Protective Equipment	2.5%

Unit 7: VOLTAGE DROP AND SHORT CIRCUIT CALCULATION

Out-of-class work: *10 hours*

Upon completion of this unit, students are expected to:

- Perform a voltage range study.
- Perform a voltage drop study using an electrical riser diagram.
- Perform a short-circuit study using an electrical riser diagram.
- Explain equivalent system impedance.
- Perform peak asymmetrical fault current calculation.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapter 16 • Bosela, Chapter 17,	Assignments	Unit 7 Assignment 1: Voltage Drop and Short Circuit Calculation	2.5%

pp. 447-460	Lab	Unit 7 Lab 1: Voltage Drop Study	2.5%

Unit 8: EQUIPMENT PROTECTION AND POWER HARMONICS

Out-of-class work: *10 hours*

Upon completion of this unit, students are expected to:

- Analyze the importance of overcurrent device coordination.
- Explain the various types of short-circuit protection available for transformers.
- Explain the use of time-overcurrent relays.
- Explain voltage and current harmonics.
- Explain the resonance issues associated with capacitors.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Bosela, Chapter 18, pages 472-500 • Bosela, Chapter 19, pages 507-520	Assignments	Unit 8 Assignment 1: Overcurrent Devices, Harmonics, and Capacitor Resonance Calculation	2.5%
	Quiz	Unit 8 Quiz 4	5%
	Lab	Unit 8 Lab 1: Device Protection	2.5%

Unit 9: SMART GRID TECHNOLOGY

Out-of-class work: *7 hours*

Upon completion of this unit, students are expected to:

- Explain the meaning of the term Smart Grid.
- List the advantages of using the Smart Grid.
- Highlight the features of the Smart Grid.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Search the Internet and read articles using the following key words: Smart Grid, importance of Smart Grid, and features of Smart Grid. • Refer to the following websites to begin your search: o U.S. Department of Energy http://energy.gov/oe/technology-development/smart-grid o NEMA: The Association for Electrical Equipment and Medical Imaging Manufacturers http://www.nema.org/Policy/Energy/Smartgrid/Pages/What-Is-Smart-Grid.aspx o EDF: Environmental Defense Fund http://www.edf.org/energy/smart-grid-	Project	Project Part 1: Design an Electrical System for a Household (PORFOLIO)	10%

overview?s_src=ggad&s_subsrc=smartgrid&gclid=CMf04MDuhK8CFUhjTAodJBwWVg			

Unit 10: ELECTRICAL POWER TRANSMISSION AND DISTRIBUTION IN THE U.S.

Out-of-class work: *10 hours*

Upon completion of this unit, students are expected to:

- Explain the development and history of the electric utility industry in the United States.
- Distinguish among the components associated with various types of generating plants.
- Explain the flow of electricity power from the generator through the transmission systems to the distribution substation and delivery to the customer.
- Explain the role of FERC in purchased power.

READING ASSIGNMENT	GRADED ACTIVITIES/DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Search the Internet and read articles using the following key words and phrases: development and history of the electric utility industry in the United States, types of power generating plants, power purchasing agreements, electric power transmission, and electricity billing processes. • Refer to the following websites to begin your search: ○ Emergence of Electrical Utilities in America http://americanhistory.si.edu/powering/past/h1main.htm ○ Different Types of Power Plants http://www.differentsourcesofelectricity.com/power-plants.html ○ U.S. DOE: Energy Sources http://energy.gov/science-innovation/energy-sources ○ U.S. DOE: Transmission http://energy.gov/transmission ○ U.S. DOE: Energy Efficiency http://energy.gov/science-innovation/energy-efficiency	Project	Project Part 2: Design an Electrical System Based on Voltage Drop and Other Considerations (PORFOLIO)	10%

Unit 11: FINAL EXAM

			Out-of-class work: *11 hours*
READING ASSIGNMENT	**GRADED ACTIVITIES/DELIVERABLES**		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Review all assigned readings.	Exam	Final Exam	20%

NOTE: Your instructor may add a few learning activities that will change the grade allocation for each assignment in a category. The overall category percentages will not change.

Evaluation and Grading

Evaluation Criteria

The graded assignments will be evaluated using the following weighted categories:

Grading Category Table

Category	Weight
Assignments	20%
Labs	20%
Project	20%
Quizzes	20%
Exam	20%
TOTAL	**100%**

Grade Conversion

The final grades will be calculated from the percentages earned in the course, as follows:

Grade	Percentage	Credit
A	90–100%	4.0
B+	85–89%	3.5
B	80–84%	3.0
C+	75–79%	2.5
C	70–74%	2.0
D+	65–69%	1.5
D	60–64%	1.0
F	<60%	0.0

Academic Integrity

All students must comply with the policies that regulate all forms of academic dishonesty, or academic misconduct, including plagiarism, self-plagiarism, fabrication, deception, cheating, and sabotage. For more information on the academic honesty policies, refer to the Student Handbook and the Course Catalog.

(End of Syllabus)