## Course Syllabus

## ELCT 554 – Integration of Photovoltaics in Modern Power Systems

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|---|---|
| **Course Coordinator:** | Dr. Andrea Benigni |
| **Catalog Description:** | Analysis and design of power systems in presence of photovoltaic generation with focus on protection systems, control, power quality. |
| *Credit Hours* | 3 |
| *Prerequisite(s) by course* | ELCT 551:Power System Design and Analysis |
| *Prerequisite by topics* | Power System Design and Analysis, techniques for sinusoidal steady-state analysis of three phase systems, power-flow and short-circuit analysis |
| *Required Textbook* | Math H. Bollen, Fainan Hassan *"Integration of Distributed Generation in the Power System"* |
| *Other Materials* | Class notes posted on Blackboard |

**Learning Outcomes:**

Undergraduate students who successfully complete this course will be able to:

1. Analyze the impact of photovoltaics generators on power system performance including:
    - Voltage and frequency control
    - Power quality
    - Protection.
2. Describe the economic challenges and the role of policy in the integration of PV generation

Graduate students who successfully complete this course will be able to:

3. Use simulation for the design of control and protection systems for power systems in presence of photovoltaic generation

**Course Topics:**

- Photovoltaics plant structure and fundamental components
- Generation vs. load variability and forecasting problem
- Role of energy storage
- Power quality issues
- Voltage and frequency control
- Protection systems
- Introduction to the IEEE 1547 standard for interconnecting distributed resources with electric power systems
- Market and policies role

**Course Contribution to Program Outcomes:**

ELCT 554 contributes to an achievement of:

- Outcome A – an ability to apply knowledge of mathematics, science and engineering
- Outcome E -- an ability to identify, formulate, and solve engineering problems
- Outcome J – knowledge of contemporary issues
- Outcome K -- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

## General Course Policies

**Academic Integrity**

Unless otherwise stated, assignments and examination work are expected to be the sole effort of the student submitting the work. Students are expected to follow the University of South Carolina Honor Code and they should expect that every instance of a suspected violation will be reported. Students found responsible for violations of the Code will be subject to academic penalties under the Code in addition to whatever disciplinary sanctions are applied.

**Accommodating Disabilities**

Reasonable accommodations are available for students with a documented disability. If you have a disability and may need accommodations to fully participate in this class, contact the Office of Student Disability Services: 777-6142, TDD 777-6744, email sasds@mailbox.sc.edu, or stop by LeConte College Room 112A. All accommodations must be approved through the Office of Student Disability Services.

**Diversity**

When scheduling exams, I have attempted to avoid conflicts with major religious holidays. If, however, I have inadvertently scheduled an exam or major deadline that creates a conflict with your religious observances, please let me know as soon as possible so that we can make other arrangements.

**Deviations**

Minor deviations from the syllabus are a normal part of any adaptive teaching and learning process.

## Instructor's Addendum for Spring 2017

**Instructor:** Dr. Andrea Benigni

**Office:** Swearingen 3A19

**E-mail:** benignia@cec.sc.edu

**Class Location**: Swearingen 2A15

**Phone:** 803.777.3390

**Office hours:** anytime I am in the office or by appointment

### Weekly Schedule

| | |
|---|---|
| **Week 1** | Photovoltaics plant structure and fundamental components |
| **Week 2** | Photovoltaics plant structure and fundamental components |
| **Week 3** | Generation vs. load variability and forecasting problem |
| **Week 4** | Generation vs. load variability and forecasting problem |
| **Week 5** | Role of energy storage |
| **Week 6** | Power quality issues |
| **Week 7** | Power quality issues |
| **Week 8** | Voltage and frequency control |
| **Week 9** | Voltage and frequency control |
| **Week 10** | Protection systems |
| **Week 11** | Protection systems |
| **Week 12** | Protection systems |
| **Week 13** | Introduction to IEEE 1547 |
| **Week 14** | Market and policies role |
| **Week 15** | Final Exam |

### Grading:

There will be three exams. The final exam will be cumulative. Failure to take an exam will result in a grade of zero for that test.

Homework will be assigned almost every week. Problem solutions must show a clear systematic method for arriving at the correct solution for full credit. Points will be taken off for incorrect solutions or work that is difficult to follow.

A project will be assigned around the middle of the semester. The project assignment will be different for graduate and undergraduate students. Projects for undergraduate students will focus on analysis of power systems with high penetration of photovoltaics systems. Projects for graduate students will focus on higher-level design or synthesis skills such as design of protection and control systems.

Students will be graded according to the following table:

| | **Undergraduate** | **Graduate** |
|---|---|---|
| Homework | 15 | 10 |
| Test1 | 20 | 15 |
| Test2 | 20 | 15 |
| Final Exam | 35 | 35 |
| Project | 10 | 25 |

| Final Grade | Semester Average |
|---|---|
| A | 100 ≥ S.A. ≥ 91 |
| B+ | 90 ≥ S.A. ≥ 86 |
| B | 85 ≥ S.A. ≥ 81 |
| C+ | 80 ≥ S.A. ≥ 76 |
| C | 75 ≥ S.A. ≥ 71 |
| D+ | 70 ≥ S.A. ≥ 66 |
| D | 65 ≥ S.A. ≥ 61 |
| F | 60 ≥ S.A. ≥ 00 |

## Instructor Policies

**Attendance Policy**
Students are expected to attend each scheduled class meeting, to be on time, and to be prepared for each class session.

When you miss class, you miss important information. If you are absent, you are responsible for learning material covered in class. If you are absent when an assignment is due, you must have submitted the assignment prior to the due date to receive credit. If you miss more than 10% of the classes, whether excused or unexcused, your grade may be dropped one letter grade.

**Expectations for Classroom Behavior**
Please be respectful of each other, the instructor, and any guest presenters while in class. We are all here to learn! Any disrespectful or disruptive behavior may result in your referral to the Office of Student Judicial Programs.

**Assignment Submission**
Assignments are always due before class starts on the day noted. Late assignments will be accepted only in cases of emergency.

**Midterm and Final Exams**
Makeup exams will be allowed only with pre-approval of the instructor or with an acceptable, documented reason. Acceptable reasons for makeup exams include severe illness, family emergencies or other unavoidable events including dangerous weather conditions and car accidents. Exam format for makeup exams may be different than the original exam.

**Expectations of the Instructor**
I understand that students expect me to facilitate their learning, to answer their questions appropriately, to be fair and objective in grading, to provide timely and useful feedback on assignments, to maintain adequate office hours, and to treat them as I would like to be treated in their place.