May 2015 Progress Report

Introducing Specialization in "Sustainable Energy Systems" for Under-Graduate Students in Engineering at the University of West Florida

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Project Time Period: Aug 2014 to July 2016

Summary and Progress

The objective of this proposal is to introduce a specialization in "Sustainable Energy Systems" for Undergraduate Engineering students at the University of West Florida that could also be used to educate industry professionals towards workforce development. The courses have been designed from the perspective of energy system planning, a subject that has always been complex and evolving rapidly during the past 10-15 years to accommodate dramatic changes in the industry. These changes include the ongoing transformation of the nation's generation portfolio from being heavily dependent on fossil fuels to one that is heavily dependent on renewables (especially wind and solar) and the need for operating competitive electricity markets.

The courses designed under this specialization will assist professionals in understanding the limits of our present energy systems and lead us to a future in which we can continue to provide reliable and secure energy resources for improved human quality of life. The proposed specialization program focuses on electrical engineering sources and systems that are non-polluting, conserving of energy and natural resources, economically viable and safe for workers, communities and consumers. Coursework takes a systems level and interdisciplinary approach to solving seemingly intractable sustainable energy problems, as opposed to single disciplinary and locally optimized approaches destined to yield marginal positive impacts. Students will be able to create study programs suited to their interests and aspirations through their choice of electives and design projects. The course is electrical engineering-based but also covers a wider range of topics including economics, sustainability and environmental studies.

Discussions to offer this course as a certificate course are going on between faculty and Continuing Education department of the University. According to the designed curriculum, students were to take 4 courses from within the Specialization Core (12 credits) and one elective on Environmental Law.

The timeline for offering courses under this specialization is

Year-1	Fall 2014	Renewable Energy Systems
	Summer 2015	Future Energy Systems
Year-2	Fall 2015	Power Electronics and Drives
	Summer 2015	Sustainable Power Systems: Planning, Operation, and Markets
Elective	Fall/Spring	Environmental Law

Since Oct 2014, the online study material for Future Energy Systems course which is second on the list of courses for specialization has been prepared and lecture notes are setup to aid the students in understanding the significance of sustainable energy systems. Please refer to syllabus below for the detailed course content for this course.

EEL 4990 - Future Energy Systems
Course Syllabus

General Information
Semester: Summer 2015
Course: EEL 4990 Future Energy Systems
Instructor: Dr. Bhuvana Ramachandran
Email: bramachandran@uwf.edu, BR@uwf.edu
Course Description and Scope: Study and analyze renewable energy sources and their integration into the grid, microgrid, smart grid power management, plug in electric vehicles, modern energy storage technologies, energy efficient buildings, cyber security and other new technologies that are revolutionizing the power industry.
Credits: 3 Credits
Course Delivery: Through online.
Course Web Page: All course handouts (e.g., syllabus, problem sets and solutions, lecture notes, lecture reference material, exam solutions, etc.) will be posted to https://elearning.uwf.edu.
Prereq/Correq : EEL3111- Electric Circuits-1.
Topics covered:
1) Concept of power plant efficiency and the implications for CO_2 emission impacts and appreciate the differences among main power plant variations,
2) Classical economic evaluation of power plant worth for energy and capacity (power), Concept of "levelized cost of energy" and how this tool can be used to evaluate and compare traditional coal or hydro with new solar or wind energy resource options ,
3) Basic distributed energy resources elements and how these "demand side" resources work to benefit the grid ,
4) Overview of renewable energy sources, smart devices for smart grids (inverters, meters, home area networks etc),
5) Current state of US power grid with examples of blackouts and brown outs,
6) Examples of small residential grid connected system and large scale grid connected plants,
7) Micro grids (residential and commercial scale) architecture, planning, centralized management and budgeting, Microgrids Vs macrogrids, network management service,
8) Tradeoffs between centralized versus distributed systems, overviews of current topologies, Challenges of local power generation (connection to the grid, dynamic loads, storage, power production deficit or over planning),
9) Emerging microgrid test bed examples, examples of demand side and load management, power line and other signaling approaches for flexible tariff scheduling of generation and load pattern,
10) Overview of current storage technologies, Storage integration into grid at various levels (small, medium and large-scales),
11) Electrification of transportation by means of plug in electric vehicles, G2V and V2G technologies and smart grid bi directional communication for sending price signal,
12) PSCAD modeling of smart grid with renewable energy sources,
13) Stability and control of smart grid,
14) Cyber security and protection aspects of smart grid

15) Green building concept- Energy management options- energy auditing and energy targeting, Energy efficiency of buildings

Textbook:

1) **Principles of Sustainable Energy Systems, Second Edition,** Frank Kreith, Susan Krumdieck., Mechanical and Aerospace Engineering Series , August 19, 2013 by CRC Press. ISBN 9781466556966 - CAT# K15449

2) **Sustainable Energy: Choosing Among Options-** Jefferson W. Tester, Elisabeth M. Drake ,Michael J. Driscoll ,Michael W. Golay and William A. Peters, The MIT Press; Second Edition (September 28, 2012), ISBN-10: 0262017474 , ISBN-13: 978-0262017473.

Course outcomes:

1) Understand and evaluate alternative modes of energy supply and their interplay, including renewable, fossil-fuelled and nuclear-based supply.

2) Recognize the physics of environmental issues, including greenhouse effect and global climate change.

3) Quantify current energy supplies and demands. Learn and appreciate the importance of geopolitical/social context in sustainability analysis.

4) Describe integration of intermittent renewable electricity into grid system and compare the efficiency of different energy storage solutions (e.g., batteries, fuel cell and hydrogen storage).

5) Solve simulation problems by designing and developing microgrids for residential, commercial and industrial communities.

6) Demonstrate an understanding of Smart Grid, electric transportation and smart building concepts and correlate these concepts to real life scenarios.

7) Complete a comprehensive design project, working in teams of two students each, that involves both oral and written communication of results.

Grading:

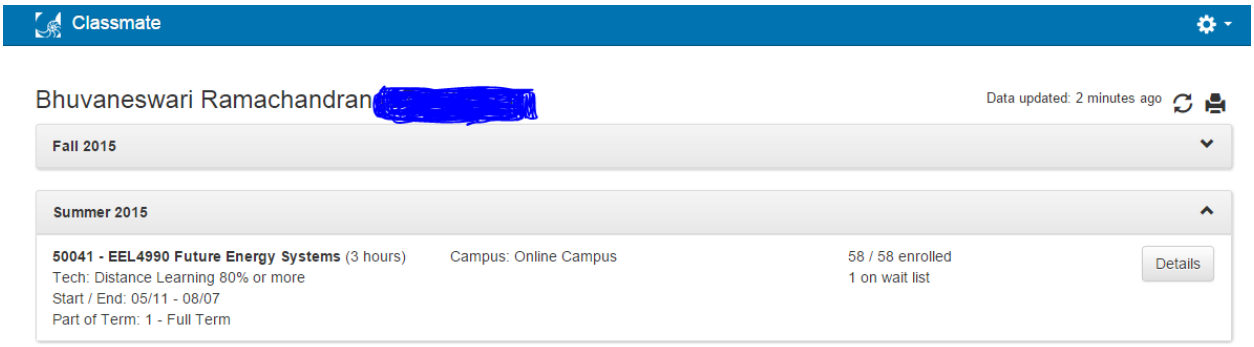
Online test-1: 20 points
Online test-2- 20 points
Design project: 10 points
Final Exam: 50 Points

Grading Scale:

93+	≤	A	≤	100
90+	≤	A−	≤	93−
87+	≤	B+	≤	90−
83+	≤	B	≤	87−
80+	≤	B−	≤	83−
75+	≤	C+	≤	80−
70+	≤	C	≤	75−
65+	≤	D+	≤	70−
60+	≤	D	≤	65−
0	≤	F	≤	60−

Note that a grade of incomplete (I) will only be issued to a student if all requirements stated in the UWF undergraduate catalog have been met. See http://catalog.uwf.edu/undergraduate/academicpolicies/grades/#gradesofincomplete.

I have also attached a snapshot of e-learning site at our university to indicate the level of interest displayed by students towards this specialization. We had originally set the maximum number of students to 45. But due to the huge interest shown by students, we increased the number of seats to 58 and there is still 1 more student on waiting list hoping to register himself for this course.



We in the Electrical and Computer Engineering department at UWF, recently confirmed a study abroad partnership with a leading University in France (INSA, Lyon). A bilateral agreement has been signed between the two institutions that paves way for student exchange for study as well as faculty collaboration for research. We expect this study abroad program to bring more interested students into the specialization. Since I have a grader to evaluate the tests and projects, we have set a maximum limit of 60 students for this summer course.