EEE598 – Renewable Electric Energy Systems
Spring 2011

Instructor	:	Raja Ayyanar	Class hours	:	TuTh 9:00 – 10:15 AM
Office	:	ERC587	Class room	:	SCOB 105 and on internet
Email	:	rayyanar@asu.edu	Office hours	:	W 3:00-4:30 PM, F 1:30-3:00 PM
Phone	:	480.727.7307	Web page	:	http://myasucourses.asu.edu

Course description: Renewable energy resources are widely expected to be a significant portion of the energy mix in the near future. Wind and solar (photovoltaic) based electric generation are the dominant and fastest growing renewable energy technologies at present. Power electronics is a key enabling technology in the utilization of renewable resources, especially wind and solar. EEE 598 is an advanced course on power electronic converters and control for renewable energy interface, and on electric grid integration technologies including emerging smart grid concepts to ensure reliable operation of electric grid under high penetration of intermittent renewable resources. The course is broadly divided into three interrelated modules or topic areas – (1) power converters and control for distributed and utility-scale solar PV, (2) power converters and control for various types of wind generators and (3) topics in large-scale grid integration of wind and solar both at the bulk transmission systems and distribution systems.

Pre-requisites:
- The course is open to Electrical Engineering graduate students who have done at least one basic course in Power Electronics (EEE472 or equivalent) and one course in Electrical Machines (EEE473 or equivalent)
- The course involves extensive simulation exercises in homework assignments and two required course projects. The simulations are typically performed using MATLAB/Simulink, PLECS, PSpice or SABER. Proficiency in any one of the above or similar tools, as well as in analytical tools such as MATLAB or MathCAD is a pre-requisite for the course.

Textbook: None. Lecture slides, and notes on selected topics will be provided.

Main topics:

1. **Power converters and control for PV**
   - Overview of solar cells technology, characteristics and circuit models
   - Topologies, principles of operation and design of single- and three-phase inverters for PV
   - Harmonic analysis, power quality and filter design
   - Current injection control at unity power factor, reactive power control and smart inverters
   - Maximum power tracking algorithms and implementation
   - Anti-islanding methods and interconnection standards such as IEEE 1547
   - Steady-state and dynamic models of PV systems and implementation in simulation tools

2. **Power converters and control for wind generators**
   - Overview of wind turbine systems and configurations
   - Detailed analysis of doubly fed induction generator and PMSM based wind generators
   - Dynamic modeling of wind generators
   - Field oriented control of rotor side and grid side power converters
   - Control methods for maximum power extraction, active and reactive power control

3. **Grid integration of large-scale wind and solar resources**
   - Impacts on transmission and distribution system operation and control at high penetration levels
   - Voltage profile and fault current levels at high penetration
   - Transient operation with grid faults, and low voltage ride through (LVRT) requirements for wind and utility-scale PV
   - Supplementary control of wind generators for enhancing transient and dynamic stability
   - Grid support features of utility-scale PV with storage

- Microgrids, and frequency/voltage control in islanded mode of operation
- Demand response, distributed storage and smart grid concepts

Homework: Five (5) homework assignments will be given. They are due strictly by the start of class on the due date. Most of the assignments will require use of simulation and analytical tools mentioned under pre-requisites. Students are expected to typically spend about six to eight hours on each homework.

Course Projects: A significant part of the grade is based on two (2) required, simulations-based course projects – one on PV power converters, control and grid integration, and the other on wind generators, control and grid integration. The projects will involve literature search, modeling, analysis, design and extensive simulation. Formal technical reports are required for each of the two projects.

Grading: Course projects (2) – 40%, Homework - 15%, Midterm exam - 20%, Final exam - 25%