Fall 2013 - EE 394V Modeling and Simulation of Wind Power Plants

Prof. S. Santoso (instructor)

Class Schedule: MWF 10:00 – 11:00 am at ENS 115

Office Hours: MW 1-2 pm or by appointment (ssantoso@mail.utexas.edu)

Focus	• Wind turbine technologies • Steady-state and dynamic modeling of fixed and variable speed wind turbines • Operation and control of wind turbines and farms in interconnected power systems
Pre-requisites	• Formal: Graduate standing in engineering • Additional: Knowledge and familiarity in analysis and modeling of power systems and electric machines[1].
Subjects	1. Fundamentals of wind turbines: components, design features, elementary momentum theory, Betz limit, aerodynamic power control, rotor power characteristics, drive train, one- and two-mass model, induction machines, fixed and variable speed wind turbines. 2. Basic of electric machines: magnetically coupled circuits, winding inductances and voltage equations, rotating fields, and developed torque. 3. Reference-frame theory: three-phase transformations and space vectors. 4. Dynamic models of induction machines: voltage and torque equations in machine variables, equations of transformation for rotor circuits, voltage and torque equations in arbitrary reference-frame variables. 5. Fixed speed direct-connect wind turbines: aerodynamic, drive train, state variable solutions, induction machine, power curve, stall regulation, self-excited condition, simulation and modeling, effect of tower shadow and wind shear 6. Wide-slip wind turbines – variable slip induction generator: external rotor resistor control, power controls, torque-speed curve, pitch controls, simulation and modeling, and operation 7. Doubly-fed induction generator: decoupled real and reactive power control, voltage control, speed controls, current regulated model, time-domain model. 8. Impacts of wind farm interconnections: short-circuit capacity, voltage regulation, protection and coordination, inertia and frequency response, and operating limits.
Reference Textbooks	1. J.F Manwell, J.G McGowan, A.L Rogers, *Wind Energy Explained: Theory, Design, and Application*, 2nd ed., John Wiley and Sons, 2009. (e-edition available from UTCAT). 2. Erich Hau, *Wind turbines: fundamentals, technologies, application, economics*, 3rd ed., Springer-Verlag, 2013. (e-edition available from UTCAT). 3. P.C Krause, O Wasynczuk, S.D Sudhoff, *Analysis of Electric Machinery and Drive Systems*, 3rd ed., Wiley-IEEE Press, 2013. (e-edition available from UTCAT). 4. C.M Ong, *Dynamic Simulations of Electric Machinery: Using Matlab/Simulink*, Prentice Hall, 1997. 5. Siegfried Heir, *Grid Integration of Wind Energy Conversion Systems*, 2nd ed., Wiley and Sons, 2006. 6. Bin Wu, *Power Conversion and Control of Wind Energy Systems*, Wiley-IEEE Press, 2011. (e-edition available from UTCAT).
Course Site	https://courses.utexas.edu/
Computing Tools	Matlab by Mathworks and PSCAD/EMTDC
Laboratory	Friday 10 – 11 am as needed
Grading Policy	Numerical grades (g) are as follows, with a total of 100 points Small projects and assignments: 55 points Final project and term paper: 35 points Class participation: 10 points

The correspondence of letter to numerical grade is:

EE 394V	A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
	100	95	90	87	83	80	77	73	70	67	63	60	0

Policies for submitting assignments, projects, , computer scripts: All assignments must be submitted on the due date.

Academic Integrity: Any scholastic dishonesty will not be tolerated. Please review this link:
http://deanofstudents.utexas.edu/sjs/academicintegrity.html#unauthor.%20collab

Accommodations for Student with Disabilities: *The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of Dean of Students at 471-6259.*

[1] For example, Glover's Power System Analysis and Design, Grainger's Power System Analysis, Chapman's Electric Machinery Fundamentals, and Sen's Principles of Electric Machines and Power Electronics.