UNIVERSITY OF ILLINOIS
DEPARTMENT OF NUCLEAR, PLASMA AND RADIOLOGICAL ENGINEERING (NPRE)
NPRE 475: Wind Power Systems
Spring 2024

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Course description:
Overview of wind energy systems; historical development, safety aspect, environmental considerations, wind properties and measurement, site selection, and wind turbine design; transmission systems considerations; mechanical, electrical, control aerodynamic and environmental engineering of modern wind turbines; fatigue failure; annual power production; economics and environmental aspects and accident prevention and mitigation; computational fluid dynamics (CFD) analysis of wind flow and blade interactions; energy storage options; hydrogen production; electrical power transmission issues; licensing issues; alternative wind energy systems; design project involving a wind farm or the construction of a specific type of wind turbine based on a wind park site visit.

Credit: 3 credit hours for UGs & 4 credit hours for Grads (1 unit for extra term project or paper)

Class schedule: MWF 2:00 to 2:50 PM, Spring 2024

Class location: all classes are on campus

Prerequisite: CS 101, MATH 241, or MATH 380; one of CHBE 421, ECE 110, ECE 205, ME 310, TAM 335.

Recommended references:

Note: All books are available online via Grainger Library

Wind Energy Explained, Theory Design and Application, Second Edition, by Manwell, McGowan, and Rogers. 2009.

Wind Energy Handbook, Third Edition, by Tony Burton et al. 2021.

Wind Power Plants: Fundamentals, Design, Construction and Operation. Springer, Second Edition, by Gasch and Twele, 2012.

Wind Turbines: Fundamentals, Technologies, Application, and Economics, Second Edition, by Erich Hau. 2006.

Suggested course topical outline:

1. Wind industry overview
2. The wind resource
3. Wind energy system components

4. Wind turbine design evolution
5. Aerodynamics of wind turbines
6. Drivetrain and generators
7. Electrical aspects of wind turbines
8. Fatigue and wind turbine design
9. Structural elements
10. Turbine design standards
11. Wind turbine control
12. Wind energy systems economics
13. Environmental impacts
14. Offshore wind technology

Suggested research topics:

A project is planned for the Grad students on the topics of students' choice. The topic has to be presented for approval by the end of the 3rd week

Course grading policy:

- Homework (UGs - 35%) and (Grads – 15%)
  - There will be a 5% penalty after the designated due date
  - The lowest ***homework*** score will be removed from the list
- Quizzes 5% (***impromptu & in-class***)
- Term Project (Paper) 20% ***(only Grads)***
- Midterm Exam 25%
- Final Exam 35%

Homework will be assigned almost every week through Canvas. Due dates will be announced (usually one week after it assigned). Homework should be uploaded to Canvas before class begins on the day, they are due, unless otherwise announced. Though there will be some flexibility in due dates, no credit will be given for homework turned in more than a week after the due date.

Office Hours:
Seyed Reihani, sreihani@illinois.edu
After class or by appointment

Teaching Assistants:

Pizarro Vallejos, Alvaro, alvarop2@illinois.edu
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Some Useful websites:

https://www.umass.edu/windenergy/ (UMass Wind Energy Center)
https://cleanpower.org/ (formerly American Wind Energy Association)
https://www.nrel.gov/wind/ (National Wind Technology Center)
https://windeurope.org/ (WindEurope, formerly European Wind Energy Association)
https://denmark.dk/innovation-and-design/clean-energy (Wind power in Denmark)

https://www.wind-energie.de/english/association/ (German Wind Energy Association)
https://wwindea.org/ (World Wind Energy Association)
https://rewi.org/nwcc-timeline/ National Wind Coordinating Collaborative
https://www.eia.gov/ (U. S. Energy Information Administration)
https://wind-works.org/ (Articles and commentary on wind and solar energy)
http://www.ipcc.ch/ (International Governmental Panel on Climate Change)
https://www.eawe.eu/ (European Academy of Wind Energy)
https://www.nawea.org/ (North American Wind Energy Academy)
http://www.gwec.net/ (Global Wind Energy Council)
http://www.bwea.com/ (British Wind Energy Association)
http://www.canwea.ca/ (Canadian Wind Energy Association)
http://www.iwea.com (The Irish Wind Energy Association)
http://www.gepower.com/businesses/ge_wind_energy/en/index.htm (General Electric Wind Energy)
http://www.eere.energy.gov/windandhydro/ (US Department of Energy Wind and Hydropower Program)
http://www.tuulivoimayhdistys.fi/ (Finnish Wind Power Association)
http://www.me3.org/issues/wind/ (Minnesota Wind Energy Information Index Page)
http://www.cres.gr/kape/index.htm (Centre for Renewable Energy Sources, Greece)
http://www.ecn.nl/ (Energy Research Centre of the Netherlands)
http://www.dewi.de/ (German Wind Energy Institute)
http://www.nrel.gov/wind/ (National Wind Technology Center, USA)
http://www.risoe.dk/ (Risø National Laboratory, Denmark)
http://www.eurec.be/ (The European Renewable Energy Centers Agency, Brussels)
www.e-co-op.com (Illinois Rural Electric Cooperative)
www.eere.energy.gov (U.S. Department of Energy / Energy Efficiency and Renewable Energy)
www.dsireusa.org (DSIRE / Database of State Incentives for Renewable Energy)
www.serconline.org/RPS/fact.html (SERC / State Environmental Resource Center / RPS Info Center)
www.nrel.gov (National Renewable Energy Laboratory (NREL))
www.awea.org/ (AWEA / American Wind Energy Association)
www.20percentwind.org/ (20% Wind Energy by 2030)
www.eere.energy.gov/ (U.S. Department of Energy, Wind Powering America)
www.nrel.gov/wind/ (NREL / National Renewable Energy Lab / Wind)
http://cwec.ucdavis.edu (CWEC / California Wind Energy Collaborative)
www.energy.ca.gov/ (California Government Energy Home Page)
www.energy.ca.gov/commission/index.html (CEC / California Energy Commission)
www.awea.org/smallwind/ (AWEA / Small Wind Section)
www.nrel.gov/gis/wind.html (NREL / National Renewable Energy Lab / Wind Maps)
http://rredc.nrel.gov/wind/pubs/atlas/ (NREL / Wind Energy Resource Atlas of the United States)
www.irecusa.org/ (Interstate Renewable Energy Council)
www.windustry.org/ (Windustry / Wind Farmers Network)

Academic Integrity:

- The University of Illinois at Urbana-Champaign requires all students to adhere to the Student Code [see Part 4 on Academic Integrity, Part (d) on Plagiarism]

https://studentcode.illinois.edu/article1/part4/1-401/

- To generate ideas and methods for finding solutions, the homework assignments and computer projects can be discussed with other students, but you then must independently create and develop your own solutions. Your submitted solutions should reflect your individual effort and creativity.

Copyright Statement:

All materials related to this course are copyrighted. This means that you do not have the right to copy, share, or utilize any materials outside of the normal course applications. Certain violations of these copyrights could be treated as violations of academic integrity. Such materials include, but are not limited to:

- Syllabus
- Lecture slides
- Homework assignments
- Term project topics
- Exams
- All posted materials on Compass2g
- In-class materials
- Review sheets and solutions
- Software codes and tutorials

Anti-Racism and Inclusivity Statement

The intent is to raise student and instructor awareness of the ongoing threat of bias and racism and of the need to take personal responsibility in creating an inclusive learning environment.

The Grainger College of Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, or religious beliefs. The College recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course director if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (https://bart.illinois.edu/). Based on your report, BART members will follow up and reach out to students to make sure they have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

American with Disabilities Act:

The Americans with Disabilities Act of 1990 (ADA) is a federal anti-discrimination statute which provides civil rights protection to individuals with disabilities in the areas of employment, public accommodations, state and local government services, and telecommunications. The ADA was designed to remove barriers which prevent qualified individuals with disabilities from enjoying the same opportunities that are available to persons without disabilities. Please contact the instructor or the TA if you need any assistance in this regard. To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities should contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 217-333-4603, e-mail disability@illinois.edu, or go to the DRES website. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available on campus that can help diagnosis a previously undiagnosed disability by visiting the DRES website and selecting "Sign-Up for an Academic Screening" at the bottom of the page.