

ECO 610: Offshore Wind Energy - Technology, Resources, Grid Integration, and Trends

Fall 2021 Course Instructor: Ramon Rosquete, Director of Operations, CREADIS (rrosquete@umass.edu)

Course Administrator and Teaching Assistant: Max Dilthey (mdilthey@umass.edu)

Meeting Place/Time: Wednesdays 6:00-7:00pm EST via Zoom
Office Hours: Mondays 6:00-7:00pm EST via Zoom

Visit the Moodle course site for Zoom info and access to all course modules:
<https://umass.moonami.com/> (live on Sept. 1)

Course Description:

Offshore wind farms are engineering projects of enormous scale and scope. It is vital for all professionals who work in the wind energy industry to understand the underlying science and engineering considerations that drive the siting of offshore wind farms. This course is designed for students without an engineering or scientific background, but provides the engineering context and basic scientific concepts to explain the source of wind energy, how wind turbines work, and why wind farms are sited where they are. Additionally, this course will provide students with perspective into the decisions made by developers and manufacturers in the emergent US wind industry.

The on-line course will consist of synchronous lectures that are recorded for asynchronous viewing and review. All assignments, course readings, and projects will be accessed through the course Moodle site. Students will engage with the instructor and fellow students through Zoom sessions and asynchronous discussion boards.

Attendance at the course Zoom lectures and course office hours is *strongly* encouraged for your own learning, but synchronous attendance is not necessary to complete this course.

Learning Objectives:

This course will prepare students and professionals to understand the technical design and development of an offshore wind farm from an engineering perspective, from wind resource measurement and statistical modeling, through turbine and tower design, installation, operation and maintenance, and on to the decommissioning process.

Upon successful completion of this module, students will understand:

- How offshore wind energy fits into the larger context of global, national, and regional energy development, use and resources
- The present and future of global energy needs and the role of offshore wind
- The location and source of offshore wind resources
- The present state of global energy transition, electrification and grid modernization, and the emergent industry of turbine manufacturing and deployment
- How wind resources are measured and statistically modeled

- The aerodynamics of wind turbine blades
- Power curves and capacity factors
- The components of wind turbines
- The varieties of foundations and substructures
- Offshore wind generation characteristics
- Array design
- Types of inter-array and export cables and the physics of electricity transmission
- Grid interconnection
- Types and benefits of energy storage
- Costs, performance measurements, and levelized-cost-of-energy analysis

Reading Materials:

Readings will be assigned from academic literature and applied professional reports on present-day offshore wind developments.

Course Outline:

Course outline subject to change; refer to the course Moodle site for updates throughout the semester.

Week 1: Aug 30 - Sept 3 Wind Farms as Power Plants	Intro to the class, offshore wind, history, electricity basics, wind energy potential, generation, and transmission
Week 2: Sept 6 - Sept 10 Energy in the Wind <i>Labor Day - Office hours held at usual time. Additional hours by appointment.</i>	Understanding energy, wind atlases and energy demand maps, basic wind resource calculations, wind category ratings
Week 3: Sept 13 - Sept 17 Measuring the Power of the Wind	Statistical modeling, basic Excel modeling and wind resource calculations
Week 4: Sept 20 - Sept 24 Wind Turbine Industry Breakdown	Materials science and manufacturing, major industry players/employers, wind turbine costs, projects and leases
Week 5: Sept 27 - Oct 1 Power Curves and Production	Blades and controls, power curves, advanced modeling
Week 6: Oct 4 - Oct 8 The Nacelle	Gear boxes and gearing, drivetrain, brakes, nacelle components
Week 7: Oct 11 - Oct 15 The Tower, Substructures, and Transition Pieces <i>Indigenous Peoples Day - Office hours held at usual time. Additional hours by appointment.</i>	Introduction to substructures, installation vessels, transition pieces, installation, and staging at port

Week 8: Oct 18 - Oct 22 Substructure Presentations	Class presentations for major substructure categories: monopile, jacket, gravity-based, floating
Week 9: Oct 25 - Oct 29 TBA (Guest Speaker)	TBA (Guest Speaker)
Week 10: Nov 1 - Nov 5 Getting Power Ashore	Transmission, financial impacts and risk, levelized cost of energy (LCOE)
Week 11: Nov 8 - Nov 12 Keeping the Turbines Running	Maintenance, vessels, and costs, hurricane and typhoon proofing, hurricane ratings
Week 12: Nov 15 - Nov 19 The Future of Wind <i>UMass Fall Break next week - No class Nov 22-25)</i>	Energy storage, floating foundations, wake effects
Week 13: Nov 29 - Dec 3 TBA (Guest Speaker)	TBA (Guest Speaker)
Week 14: Dec 6 - Dec 8 Course Wrap-Up	Happy Hour on Wednesday Dec. 8 (last day of classes) ALL assignments due Sunday, Dec. 19th (non-flexible deadline, grades due)

Course Policy and Requirements:

The course site and modules can be accessed at any time during the semester. All assignments have deadlines indicated to suggest the reading and assignment schedule, but all deadlines are flexible up until Sunday, December 19th.

All assignments will be completed and submitted through the Moodle course site. All readings should be treated as resources for completing homeworks - reading guides will be provided to help you manage your time for each assignment. Where possible, additional readings are provided as a resource.

Please download and save all readings and course materials to your own computer or cloud storage - course materials are yours to keep for future reference. Your access to the Moodle page may be revoked after all courses are completed and you finish your UMass enrollment.

Grading Scale and Criteria:

Individual grades for the course will be based on the following scale.

A 93-100%

A- 90-92%

B+ 87-89%

B 83-86%

B- 80-82%

C+ 77-79%

C 73-76%

F Per policy of the Graduate School, grades below a C will result in a failing grade. The weights of course assignments and activities are as follows.

Grade Weighting:

Projects and Group Assignments: 50%

Participation via Moodle Discussion Boards, Lectures, and/or Office Hours: 10%

Homework Assignments: 40%

Total 100%

Academic Honesty Policy Statement:

The integrity of the academic enterprise of any institution of higher education requires honesty in scholarship and research, and academic honesty is required of all students at the University of Massachusetts.

Academic dishonesty is prohibited in all programs of the University. Academic dishonesty includes but is not limited to: cheating, fabrication, plagiarism, and facilitating dishonesty. Appropriate sanctions may be imposed on any student who has committed an act of academic dishonesty. Instructors should take reasonable steps to address academic misconduct. Any person who has reason to believe that a student has committed academic dishonesty should bring such information to the attention of the appropriate course instructor as soon as possible. Instances of academic dishonesty not related to a specific course should be brought to the attention of the appropriate department Head or Chair.

For more information about what constitutes academic dishonesty, please see <https://www.umass.edu/honesty/>.

The procedures outlined at the website listed above are intended to provide an efficient and orderly process by which action may be taken if it appears that academic dishonesty has occurred and by which students may appeal such actions. Since students are expected to be familiar with this policy and the commonly accepted standards of academic integrity, ignorance of such standards is not normally sufficient evidence of lack of intent.

Accommodations:

The University of Massachusetts is committed to making reasonable, effective and appropriate accommodations to meet the needs of students with disabilities and help create a barrier-free campus. If you are in need of accommodation for a documented disability, register with Disability Services to have an accommodation letter sent to your faculty. It is your responsibility to initiate these services and to communicate with faculty ahead of time to manage accommodations in a timely manner. For more information, consult the Disability Services website at <http://www.umass.edu/disability/>.