# ***Remote / Online Course Syllabus***

**Course Information**

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| *Course Number/Section* | MECH6342 |
| *Course Title* | **MECH 6342 Renewable Energy and Grid Integration** |
| *Term* | Spring 2021 |

**Professor Contact Information**


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| *Professor* | Jie Zhang |
| *Office Phone* | 972-883-4541 |
| *Email Address* | jiezhang@utdallas.edu |
| *Office Location* | ECSW 3.150F |
| *Online Office Hours* | Tuesday, Thursday 12:00 pm-1:00pm |
| *Office Hours Platform:* | MS Teams (click here to join) |


## Course Modality and Expectations

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| **Instructional Mode** | Online: All instruction and testing will be online. |
| **Course Platform** | **Recoreded Lectures:** The recorded lectures will be uploaded to MS Stream every Monday and Wednesday night. Recorded lecture links can be access via multiple ways: (i) a link will be posted on eLearning every Monday and Wednesday; (ii) students can direclty access the recorded lectures by logging into MS Stream.<br><br>**Professor Office Hours:** MS Teams. Links are provided above. Students can also see the meeting invitaiotn in their MS Teams.<br><br>**Homeworks:** All homeworks will be assigned and submitted through eLearning. Homeworks assignment dates are provided in the Tentative Course Schedule table at the end.<br><br>**Exams (open book):** The Final Exam will be open book. It will be assigend and submitted through eLearning.<br><br>**Final Project:** Studnets need to submit recorded presentation through MS Teams or eLeaerning. (details will be provided in the Final Project assignement) |

**COVID-19 Guidelines and Resources**

The information contained in the following link lists the University's COVID-19 resources for students and instructors of record.

Please see http://go.utdallas.edu/syllabus-policies.

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**Class Participation**

Regular class participation is expected regardless of course modality. Students who fail to participate in class regularly are inviting scholastic difficulty. A portion of the grade for this course is directly tied to your participation in this class. It also includes engaging in group or other activities during class that solicit your feedback on homework assignments, readings, or materials covered in the lectures (and/or labs). Class participation is documented by faculty. Successful participation is defined as consistently adhering to University requirements, as presented in this syllabus. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

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**Class Recordings**

Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Unless the Office of Student AccessAbility has approved the student to record the instruction, students are expressly prohibited from recording any part of this course. Recordings may not be published, reproduced, or shared with those not in the class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

The instructor may record meetings of this course. Any recordings will be available to all students registered for this class as they are intended to supplement the classroom experience. Students are expected to follow appropriate University policies and maintain the security of passwords used to access recorded lectures. Unless the Office of Student AccessAbility has approved the student to record the instruction, students are expressly prohibited from recording any part of this course. Recordings may not be published, reproduced, or shared with those not in the class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. If the instructor or a UTD school/department/office plans any other uses for the recordings, consent of the students identifiable in the recordings is required prior to such use unless an exception is allowed by law. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

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**Class Materials**

The Instructor may provide class materials that will be made available to all students registered for this class as they are intended to supplement the classroom experience. These materials are for registered students' use only. Classroom materials may not be reproduced or shared with those not in class, or uploaded to other online environments except to implement an approved Office of Student AccessAbility accommodation. Failure to comply with these University requirements is a violation of the Student Code of Conduct.

**Course Pre-requisites, Co-requisites, and/or Other Restrictions**
None

**Course Description**
As the amount of wind and solar power capacity has rapidly increased in the past few years, variable renewable energy has started to play an increasing role in power system operations and planning. This course will discuss renewable energy and energy efficiency systems modeling, design, and

optimization. This course will begin with an introduction to the power grid including planning and operations for the transmission and distribution level power grid. After examining the technological specifications of the most important renewable energy sources (wind energy, photovoltaics, and solar thermal power) and energy efficiency technologies (energy storage, home and building energy, electric vehicles), grid integration of renewable energy and energy efficiency technologies will be examined in detail. From the bulk power system level, the unit commitment and economic dispatch process will be thoroughly covered, with exercises that emphasize how it can change based on new variable generation. This includes topics such as dynamic reserve levels, stochastic unit commitment, and flexibility reserves, variable generation forecasting, and demand response. Distribution planning with high penetrations will be examined. All of these concepts will be explored in great detail and reinforced through the completion of a semester long project, where the students will be solving problems of broad interest in a group setting. Students will use Matlab and R for project design. The course builds on prerequisite knowledge in engineering system design, engineering mathematics, probability and statistics, and optimization methods.

**Student Learning Objectives/Outcomes**

- Students will demonstrate an understanding of the fundamental principles involved in renewable sources.
- Students will demonstrate proficiency analyzing complex power systems, particularly evaluating the effect of increasing the penetration levels of renewable sources on system performance.
- Students will demonstrate an understanding of how to integrate renewable energy into transmission systems by addressing variability in system planning, developing system models for renewable energy, and addressing renewable energy characteristics in system operations.

**Topics:**

- Energy and Electricity Fundamentals
- Renewable energy sources: wind energy and solar energy
- Energy efficiency technologies: energy storage, home and building energy, and electric vehicles
- Wind energy system design and optimization: wind resource assessment, wind farm siting, wind farm optimization, wind power forecasting, grid integration of wind energy
- Solar energy system design and optimization: solar resource assessment, solar plant design (PV and CSP), solar plant optimization, grid integration of solar energy
- Overview of design and optimization methods: gradient based algorithms, heuristic optimization, multi-objective optimization, uncertainty quantification and propagation, and design optimization under uncertainty
- Statistical analysis in energy systems: probability, distribution, visualization
- Energy storage design and optimization: different types of energy storage techniques, battery thermal management, energy storage management in electric grids
- Power system operations and planning: transmission system operations, demand response, renewable energy forecasting, power system analysis fundamentals, renewable energy generation in distribution systems, renewable energy generation in distribution systems, future grid needs

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**Computer Usage:**

Students will be expected to perform some amount of coding for the course projects. The analysis platform is left up to the student, though Matlab, R, and/or Python are recommended. There are

also a number of freely available tools for renewable energy and power system analysis that may be utilized, as long as they are properly attributed.

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**Assignments:**

Projects
Exam

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**Grading Policy:**

**[25%] Final Exam:** There will be one final exam. Make-up exams will only be allowed for the cases of illness, attendance of a university-sponsored event (such as an athletic activity) or under unusual circumstances. For each case, you are required to provide proper documentation (such as note from athletic advisor).

**[25%] Project 1:** You will be given enough time to complete all assignments in a timely manner.

**[25%] Project 2:** You will be given enough time to complete all assignments in a timely manner.

**[25%] Final Course Project:** You will be given enough time to complete all assignments in a timely manner.

**[0%] Quizzes:** There will be several quizzes given at the beginning of several lectures. The goal is to help students understand the materials.

You have five business days to appeal any grade (contact the instructor or TA during office hours). The five days will be counted starting from the day the assignment or exam is returned or the grade has been provided in eLearning.

The standard grading scale will be used for this course.
A: 90 – 100 B: 80 – 89 C: 70 – 79 D: 60 – 69 F: below 60

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**Required Textbook:**

- **Renewable Energy in Power Systems**, by Freris & Infield, First Edition, ©2008, John Wiley & Sons, Ltd., United Kingdom, ISBN 978-0-470-01749-4

**References and Materials:**

- **Wind Power in Power Systems**, Edited by Thomas Ackermann, Second Edition, John Wiley & Sons, Ltd., United Kingdom, ©2012, ISBN 978-0-470-97416-2
- **Renewable Energy System Design**, by Ziyad Salameh, 1st Edition, ©2014, Elsevier Inc., ISBN: 978-0-12-374991-8
- **Renewable Energy Forecasting**, by Georges Kariniotakis, 1st Edition, ©2017, Elsevier Inc., ISBN: 9780081005040

**Reference Software:**

- R, MATLAB

Textbooks and some other bookstore materials can be ordered online or purchased at the UT Dallas Bookstore.

**Technical Requirements**
In addition to a confident level of computer and Internet literacy, certain minimum technical requirements must be met to enable a successful learning experience. Please review the important technical requirements on the Getting Started with eLearning webpage.

**Course Access and Navigation**
This course can be accessed using your UT Dallas NetID account on the eLearning website.

Please see the course access and navigation section of the Getting Started with eLearning webpage for more information.

To become familiar with the eLearning tool, please see the Student eLearning Tutorials webpage.

UT Dallas provides eLearning technical support 24 hours a day, 7 days a week. The eLearning Support Center includes a toll-free telephone number for immediate assistance (1-866-588-3192), email request service, and an online chat service.

**Communication**
This course utilizes online tools for interaction and communication. Some external communication tools such as regular email and a web conferencing tool may also be used during the semester. For more details, please visit the Student eLearning Tutorials webpage for video demonstrations on eLearning tools.

Student emails will be answered within 3 working days under normal circumstances.

**Distance Learning Student Resources**
Online students have access to resources including the McDermott Library, Academic Advising, The Office of Student AccessAbility, and many others. Please see the eLearning Current Students webpage for more information.

**Server Unavailability or Other Technical Difficulties**
The University is committed to providing a reliable learning management system to all users. However, in the event of any unexpected server outage or any unusual technical difficulty which prevents students from completing a time sensitive assessment activity, the instructor will provide an appropriate accommodation based on the situation. Students should immediately report any problems to the instructor and also contact the online eLearning Help Desk. The instructor and the eLearning Help Desk will work with the student to resolve any issues at the earliest possible time.

**Comet Creed**
This creed was voted on by the UT Dallas student body in 2014. It is a standard that Comets choose to live by and encourage others to do the same:

*"As a Comet, I pledge honesty, integrity, and service in all that I do."*

**Academic Support Resources**
The information contained in the following link lists the University's academic support resources for all students.

Please go to Academic Support Resources webpage for these policies.

**UT Dallas Syllabus Policies and Procedures**
The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus.

Please go to UT Dallas Syllabus Policies webpage for these policies.

***The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.***

**MECH 6342: Renewable Energy and Grid Integration**
**Spring 2021 Tentative Course Schedule**

| Class | Date | Lecture Topic | Reading | Assignments |
|---|---|---|---|---|
| 1 | Wednesday January 20 | Introduction | | |
| 2 | Monday January 25 | Energy and Electricity Fundamentals | Chapter 1 Pages 1-20 | |
| 3 | Wednesday January 27 | Conventional and conventional renewable power Generation | Chapter 2 Pages 21-35 | |
| 4 | Monday February 1 | Wind Power | | Project #1 Assigned |
| 5 | Wednesday February 3 | Wind Power | | |
| 6 | Monday February 8 | Wind Power | | |
| 7 | Wednesday February 10 | Solar Photovoltaics and Solar Thermal | Chapter 2 Pages 36-42 | Quiz #1 |
| 8 | Monday February 15 | Other Renewable Power Sources | Chapter 2 Pages 42-53 | |
| 9 | Wednesday February 17 | Renewable Energy Forecasting | | |
| 10 | Monday February 22 | **Project 1 Presentation** | | Project #1 Due |
| 11 | Wednesday February 24 | Renewable Energy Forecasting | | Project #2 Assigned |
| 12 | Monday March 1 | Renewable Energy Forecasting | | |
| 13 | Wednesday March 3 | Renewable Energy Forecasting | | Quiz #2 |
| 14 | Monday March 8 | **R in class (MS Teams) Practice** | **With Professor** | |
| 15 | Wednesday March 10 | Load Forecasting | | |
| | **March 15 and 17** | **No Class (Spring Break)** | | |
| 16 | Monday March 22 | Power Generation Fundamentals | Chapter 4 Pages 97-121 | Project #2 Due & Final Project Assigned |
| 17 | Wednesday March 24 | Power Generation Fundamentals | Chapter 4 Pages 97-121 | |
| 18 | Monday March 29 | **R in class (MS Teams) Practice** | **With Professor** | |
| 19 | Wednesday March 31 | Transmission System Operations | Chapter 3 Pages 55-64 | |
| 20 | Monday April 5 | Demand Response & Energy Storage | | |

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| 21 | Wednesday<br>April 7 | Wind and Solar Resource Data | WIND Toolkit and SIND Toolkit | Quiz #3 |
| 22 | Monday<br>April 12 | Renewable Energy Generation in Distribution Systems | Chapter 6<br>Pages 184-193 | |
| 23 | Wednesday<br>April 14 | Renewable Energy Generation in Distribution Systems | High Penetration PV Integration Handbook for Distribution Engineers<br>Pages 1 - 26 | |
| 24 | Monday<br>April 19 | Renewable Energy Generation in Distribution Systems | High Penetration PV Integration Handbook for Distribution Engineers<br>Pages 71 - 87 | |
| 25 | Wednesday<br>April 21 | Renewable Energy Generation in Transmission Systems | Chapter 6<br>Pages 175-184 | Quiz #4 |
| 26 | Monday<br>April 26 | Renewable Energy Generation in Transmission Systems | Chapter 6<br>Pages 175-184 | |
| 27 | Wednesday<br>April 28 | **Final Exam** | | **Open Book** |
| 28 | Monday<br>May 3 | **Project Presentations** | | **Presentations** |
| 29 | Wednesday<br>May 5 | **Project Presentations** | | **Presentations** |