ECE656 Power System Dynamics Syllabus

Course Modality
This online course will utilize Canvas for asynchronous learning and Zoom for the synchronous portion. For more information on using Canvas and other supported learning tools, visit the IST Service Desk Knowledgebase.

Synchronous Zoom meetings will take place (date/time).

Instructor Information

Instructor	Email	Office Hours
Marcos Netto	**marcos.netto@njit.edu**	**By appointment via Zoom.**

I will respond to all emails/Inbox messages within 48 business hours.

General Information

Course Description

Restrictions: Students are required to have electrical engineering background or related engineering or physical science backgrounds. The aim of this course is to provide students with knowledge in the analysis of power system dynamics and stability, focusing on practical applications in the energy market. The course presents power system stability, representation of synchronous machines, AC transmission modeling in stability studies, static and dynamic load models, steam and hydro turbines, governing systems, HVDC systems and their representation in stability studies, small-signal stability, small-signal stability of a single machine and multimachine systems, transient stability, simulation of power system dynamic response, direct method of transient stability analysis, voltage stability and voltage collapse, wide-area monitoring, and the impact of wind integration on power system dynamics. Additionally, the course explores the operation of wind energy in the power market to provide a comprehensive understanding of the evolving energy landscape.

Prerequisites/Co-requisites

While not required as prerequisites, students are strongly encouraged to possess basic knowledge of power systems and steady-state analysis.

Course Learning Outcomes

By the end of the course, students will be able to:

1. Define the core concepts underlying power system dynamics, stability, and control.
2. Develop synchronous machine models.
3. Analyze synchronous machine excitation systems.
4. Analyze synchronous machine turbine governors.
5. Develop synchronous machine two-axis and flux-decay models and study their underlying hypotheses.
6. Model interconnected multimachine power systems with a set of first-order ordinary differential-algebraic equations.
7. Evaluate and apply numerical solution methods of differential-algebraic equations governing multimachine power systems.
8. Analyze methods of small-signal stability analysis of multimachine power systems.
9. Design power system stabilizers to dampen inter-area modes of oscillation.
10. Apply the equal area criterion and the energy function method for transient stability analysis.
11. Apply the continuation power flow method for voltage stability analysis.
12. Develop wind and solar power plant dynamic models for power system stability analysis.

Required Materials

Peter W. Sauer, M. A. Pai, and Joe H. Chow, "Power System Dynamics and Stability: With Synchrophasor Measurement and Power System Toolbox," 2nd Edition, Wiley-IEEE Press, 2017.

Non-required Additional References:

- Prabha S. Kundur and Om P. Malik, "Power System Stability and Control," 2nd Edition, McGraw Hill, 2022.
- Jan Machowski, Zbigniew Lubosny, Janusz W. Bialek, James R. Bumby, "Power System Dynamics: Stability and Control," 3rd Edition, Wiley, 2020.

We will provide PDF versions of readings from the non-required books, so there is no need to purchase them. You can find links to these PDFs in the relevant Canvas modules.

A Windows operating system is necessary for running the PSSE software and completing assignments for this course.

Grading Policy

NJIT Grading Legend

Final Grade Calculation

Final grades for all assignments will be based on the following percentages:

Participation	**6%**
Quizzes	**10%**
Assignments	**30%**
Midterm project 3 milestones at 8% each	**24%**
Final project 3 milestones at 10% each	**30%**

Course Work

Participation (6% of grade): Please see the table below for details on the grading policy for participation. Being present entails both physical and mental presence, refraining from distractions such as device usage during synchronous sessions to ensure a focused and respectful learning atmosphere for all participants.

Student Participates in Lectures	**Grade**
Student attended all lectures	6
Student missed 1 lecture	3
Student missed 2 lectures	1
Student missed 3 or more lectures	0

Quizzes (10% of grade): Quizzes will assess specific module concepts and include T/F, multiple choice, and fill-in-the-blank question types. They serve as a tool to reinforce learning and identify gaps in understanding and will help students stay engaged with the material throughout the course.

Assignments (30% of grade): Assignments in this course are designed to assess various dimensions of power system dynamics knowledge. They challenge students to demonstrate theoretical understanding, critical thinking, and problem-solving skills. While assignments may involve programming tasks in MATLAB or Python, the emphasis is on applying a broad range of dynamical systems concepts to real-world power system models. Students will showcase their ability to analyze and address complex challenges, fostering a deeper understanding of theoretical principles and practical applications.

Midterm project (24% of grade): The midterm project will be completed independently. There are three milestones, each with a different due date. The students will submit PSSE files, Python codes, MATLAB codes, and a partial report at each milestone. Each student will build a PSSE model of the two-area system using IEEE standard models for the synchronous generators, the excitation system,

and the turbine governor. They will analyze the dynamic response of the two-area system to a set of disturbances/faults using the PSSE user interface and Python programming. They will implement the same models in MATLAB and initialize them. Finally, they will compare the model initializations in MATLAB versus PSSE. This project aims to motivate the students to understand the most common models used for power system stability analyses and to become proficient with some of the mainstream software tools used in the area.

Final Project (30% of grade): The final project will completed independently. There are three milestones with different due dates. The students will submit MATLAB codes and a partial report at each milestone. Each student will implement a code in MATLAB to perform a small-signal stability analysis on the two-area system using the two-axis model for the generator and constant power load representation. They will analyze the impact of power system stabilizers on the eigenvalues of the linearized system. Finally, they will design a PSS to dampen an inter-area oscillation mode. This project aims to demonstrate to the students, based on hands-on experience, the relevance of small-signal analysis for power system stability studies and control design.

Feedback

I will deliver feedback on each assignment within a week using the Canvas comments feature.

Letter to Number Grade Conversions

A	90-100
B+	85-89
B	70-79
C+	65-69
C	60-64
F	0-59

Policy for Late Work

Assignments should be uploaded on Canvas by the due time. Late assignments will be accepted up to 48 hours after the due date and penalized as follows. After 48 hours, submissions on Canvas will not be accepted.

Number of hours late	Number of points deducted
less than 6 hours	6 out of 100 points
less than 12 hours	12 out of 100 points
less than 24 hours	18 out of 100 points
less than 48 hours	24 out of 100 points

Exam Information and Policies

This course does not have any exams. Per the NJIT Online Course Exam Proctoring Policy, this course will use authentic assessment, meaning you will be assessed and graded on your ability to deliver real-world outputs as well as your participation and feedback to other students.

Academic Integrity

"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the NJIT academic code of integrity policy.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu"

AI Policy

The expectation of this course is for students to work through the course without assistance from any type of artificial intelligence to better develop their own skills in this content area. As such, artificial intelligence usage is not permitted throughout this course.

Netiquette

Throughout this course, you are expected to be courteous and respectful to classmates by being polite, and active participants. You should respond to discussion forum assignments in a timely manner so that your classmates have adequate time to respond to your posts. Please respect opinions, even those that differ from your own, and avoid using profanity or offensive language.

Weekly Expectations

This course follows a structured weekly sequence. On Mondays, we will have 90-minute synchronous sessions that require your attendance for interactive learning. Please complete the readings before each session. Assignments are due on Saturdays by 11:59 PM, giving you ample time to engage with the material and submit your work. For more details, refer to the Course Schedule on the next page.

Additionally, the Overview and Learning Pathway pages in each Canvas module provide more specific information on readings, videos, assignments, quizzes, and project milestones.

Course Schedule

Module	Topic	Reading	Assignment	Due Date
M1	Introduction & Numeric Solution of Differential Equations	• Textbook - Chapter 1 • Article - Definition and Classification of Power System Stability • Article - PTI Timeline	1. M1 Discussion 2. M1 Assignment 3. M1 Quiz	1. Initial post due Wednesday. Replies to classmates are due on Friday. 2. Software packages must be installed before the first day of class. 3. Saturday
M2	Electromagnetic Transient and Transmission Line Models	• Article – Digital Computer Solution of Electromagnetic Transients… • Textbook - Chapter 2	1. M2 Quiz	1. Saturday
M3	Stability Overview with PSSE	• Textbook - Sections 3.1, 3.2, 3.3, and 3.4 of Chapter 3	1. M3 Quiz	1. Saturday
M4	Stability Overview and Synchronous Machine Modeling Part I	• Textbook - Sections 3.5, 3.6, and 3.7 of Chapter 3	1. M4 Assignment	1. Saturday
M5	Synchronous Machine Modeling Part II & III	• Textbook - Chapter 5	1. M5 Assignment 2. Midterm Project Milestone 1	1. Saturday 2. Saturday

		• Article – IEE Guide for Synchronous Generator Modeling…		
M6	Excitation System Modeling	• Textbook - Sections 4.1, 4.2, and 4.3 of Chapter 4	1. M6 Assignment	1. Saturday
M7	Turbine Governor Modeling	• Textbook - Sections 4.4 and 4.5 of Chapter 4 • Article – Dynamic Models for Fossil-fueled... • Article – Hydraulic Turbine and Turbine Control..	1. M7 Assignment 2. Midterm Project Milestone 2	1. Saturday 2. Saturday
M8	Multimachine Simulation Part 1	• Textbook - Sections 7.1 - 7.6 of Chapter 7	1. M8 Assignment	1. Saturday
M9	Multimachine Simulation Part 2	• Textbook - Sections 7.7 - 7.11 of Chapter 7	1. M9 Assignment 2. Midterm Project Milestone 3	1. Saturday 2. Saturday
M10	Small-Signal Stability Part 1	• Textbook - Sections 8.1 - 8.3 of Chapter 8 • Article – Selective Modal … Part 1 • Article – Selective Modal … Part 2	1. M10 Assignment	1. Saturday
M11	Small-Signal Stability Part 2	• Textbook - Sections 8.4 - 8.7 of Chapter 8 • Sections 12.1 - 12.3 of Chapter 12 in the book by Kundur	1. M11 Assignment 2. Final Project Milestone 1	1. Saturday 2. Saturday
M12	Transient Stability	• Textbook - Chapter 9 • Article – Scholarpedia…	1. M12 Assignment	1. Saturday
M13	Load Modeling & Voltage Stability	• Chapter 14 (Kundur and Malik)	1. M13 Assignment 2. Final Project Milestone 2	1. Saturday 2. Saturday
M14	Modeling Wind & Solar Power Plants	• Chapter 7 of Machowski, Lubosny, Bialek, and Bumby • Article – Revisiting Grid	1. M14 Quiz	1. Saturday

M15	Impact of Renewables on Power System Dynamics	• Chapter 17 of Machowski, Lubosny, Bialek, and Bumby	1. M15 Quiz 2. Final Project Milestone 3	1. Saturday 2. Saturday

Additional Information and Resources

Accessibility:
This course is offered through an accessible learning management system. For more information, please refer to Canvas's Accessibility Statement.

Requesting Accommodations:

The Office of Accessibility Resources and Services partners with administrators, faculty, and staff to provide reasonable accommodations and support services for students with disabilities who have provided their office with medical documentation to receive services.

If you need accommodations due to a disability, please contact the Office of Accessibility Resources and Services to discuss your specific needs.

Resources for NJIT Online Students
NJIT is committed to student excellence. To ensure your success in this course and your program, the university offers a range of academic support centers and services. To learn more, please review the "Student Services" page in Canvas, which includes information related to technical support.