

Course Outline

1. COURSE INFORMATION

Session Offered	Fall 2023	
Course Name	Power System Analysis and Control	
Course Code	ENR TECH 4PD3	
Date(s) and Time(s) of lectures	Thursdays, 6:30 – 9:30 pm	
Program Name	Power & Energy Engineering Technology, Bachelor of Technology Program	
Calendar Description	Basics of Steady State and Dynamic Modelling of Main Components of a Power System, Power Flow Algorithms, Voltage Stability, Transient Stability, Frequency Stability, Analysis & Control of Real and Reactive Power, Simulation of Power Systems by PSSE software, Use of Simulation Results to Analyze Power Systems	
Instructor(s)	Dr. Nilkamal Fernandopulle, P.Eng.	E-Mail: fernann@mcmaster.ca Office Hours : Thursdays by Appointment or Online

2. COURSE SPECIFICS

Course Description			
Instruction Type	Code	Type	Hours per term
	C	Classroom instruction	39
	L	Laboratory, workshop or fieldwork	
	T	Tutorial	
	DE	Distance education	
	Total Hours		39
Resources	ISBN	Textbook Title & Edition	Author & Publisher
	ISBN: 9781111425777	Power Systems Analysis and Design, 5th Edison	J. Duncan Glover, Mulukutla S. Sarma & Thomas J. Overbye
		PSSE Program Application Guide V1 & V2, Program Operation Manual, Model Library	Siemens Power Technologies International
	Other Supplies	Source	
	PSSE Software	Siemens Industry Inc.	
Prerequisite(s)	ENRTECH 3PD3 and registration in Power & Energy Engineering Technology		
Corequisite(s)			
Antirequisite(s)			
Course Specific Policies			
Departmental Policies	<p>Students must maintain a GPA of 3.5/12 to continue in the program. In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation for tests and examinations.</p> <p>Where group work is indicated in the course outline, such collaborative work is mandatory.</p>		

	<p>The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during class time, unless the instructor makes an explicit exception.</p> <p>Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class.</p> <p>Instructor has the right to submit work to software to identify plagiarism.</p>	
3. SUB TOPIC(S)		
Week 1	<p>Introduction</p> <ul style="list-style-type: none"> • History and Evolution of Power Systems • General Structure of a Large Power Grid • Nature of North American Power Grid • Administration Hierarchy of North American Power Grid • Power System Reliability • Overview of Ontario Power System • Review of Per Unit System 	
Week 2	<p>Device Modelling for Power System Steady State Analysis</p> <ul style="list-style-type: none"> • Modelling Transmission Lines for Power System Analysis • Modelling Transformers for Power System Analysis • Modelling Generators for Power System Analysis • Modelling Loads for Power System Analysis • Modelling Shunt Capacitors for Power System Analysis 	Ch. 3, 4, 5
Week 3	<p>Power System Steady State Analysis - Power Flow Equations</p> <ul style="list-style-type: none"> • Power System Admittance Matrix • Gauss Seidel Power Flow Algorithm • Newton- Raphson Power Flow Algorithm • Fast-Decoupled NR Power Flow Algorithm • DC or Linearized Power Flow Algorithm • Test System Simulations and Results 	Ch. 6
Week 4	<p>Transient Stability Analysis – Part 1</p> <ul style="list-style-type: none"> • Synchronous Generator Basics • Concept and Types of Power System Angle Stability • Classical Generator Model, Rotor Angle • Swing Equation, Power-Delta Curve • Equal Area Criterion, Critical Clearing Angle • Factors Influencing Transient Stability • Test System Simulations and Results 	Ch 11
Week 5	<p>Sample Questions and Solutions</p>	

Week 6	Midterm Exam	
Week 7	Transient Stability Analysis – Part 2 <ul style="list-style-type: none"> • Time Domain Simulation by Euler and Trapezoidal Methods • Generator Control Methods to Improve Transient Stability <ul style="list-style-type: none"> • Different Automatic Voltage Control (AVR) Systems • Fundamentals of Power System Stabilizer (PSS) • Test System Simulations and Results • Detailed Generator Model, Park Transformation • Response of a Generator to a Fault Near Terminal • Sub-Transient and Transient Stages 	Ch. 11
Week 8	Voltage Analysis <ul style="list-style-type: none"> • Voltage Decline and Voltage Instability • Power-Flow Based Voltage Analysis Methods - PV & QV Curves • Stability Based Voltage Analysis Method - Use of Eigenvalues • Prevention of Excess Voltage Decline and Collapse by : <ul style="list-style-type: none"> • Use of Switchable Shunt Capacitors • Use of Synchronous Generators and Condensers • Use of Static Var Compensator 	
Week 9	Active Power and Frequency Control – Part 1 <ul style="list-style-type: none"> • Different Frequency Control Methods • Primary Frequency Control - Use of Turbine-Governors Issues with Isochronous Operation of Governors 	Ch. 12
Week 10	Active Power and Frequency Control – Part 2 <ul style="list-style-type: none"> • Addition of Speed Droop to Governor • Secondary Frequency Control - Automatic Generation Control • Test System Simulations and Results • Area Control Errors (ACE) in Interconnected Power Systems • Emergency Frequency Control Measures 	Ch 12
Week 11	Use of PSSE for Simulation of Power Systems <ul style="list-style-type: none"> • Simulation of Transient Stability • Simulation of Frequency Stability 	PSSE Manuals
Week 12	Sample Questions and Solutions	
Week 13	Course Review	
Classes end : December 7, 2023 Final Examination Period: Thursday, December 8 – 21, 2023 All examinations MUST be written during the scheduled examination period.		
Note that this structure represents a plan and is subject to adjustment term by term.		

The instructor and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.

4. ASSESSMENT OF LEARNING *including dates*	Weight
Assignments	20
Mid-term test	35
Final examination (tests cumulative knowledge)	45
TOTAL	100%

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES

1. To be able to explain the basic concepts of power system planning and operation.
2. To be able to characterize power system and its operating constraints.
3. To be able to model power networks for steady state and dynamic performance analysis.
4. To be able to analyze power system voltage stability.
5. To be able to perform power system transient stability analysis.
6. To be able to analyze power system frequency deviations due to loss of load/generation disturbances
7. To be able to perform computer-based power system analysis through the use of PSSE

6. COURSE OUTLINE – APPROVED ADVISORY STATEMENTS

ANTI-DISCRIMINATION

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&Response.pdf

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behavior in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behavior can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/> The following illustrates only three forms of academic dishonesty: The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly

to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com, please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

COMMUNICATIONS

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviors that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests. <http://www.mcmaster.ca/policy/Students-AcademicStudies/Studentcode.pdf>

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labor disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.