ENGINEERING
McMaster-Mohawk
Bachelor of Technology
Partnership

McMaster University

Course Outline

1. COURSE INFORMATION

Session Offered	Fall 2021	
Course Name	Power Protection and Maintenance - I	
Course Code	ENRTECH 4PM3	
Date(s) and Time(s) of lectures	Fridays, 6:30 pm – 9:30 pm	
Program Name	Power & Energy Engineering Stream, Bachelor of Technology Program	
Calendar Description	Various power devices such as relays, circuit breaker, power monitor, control devices and other components used in power system protection. Other devices such as CTs, PTs and substation hardware will also be covered.	
Instructor(s)	Dr. Chi Tang, P.Eng.	E-Mail: cktang@mcmaster.ca Office Hours & Location: 9 am to 9 pm, Online

2. COURSE SPECIFICS

Course Description

Instruction Type

Code	Type	Hours per term
C	Classroom instruction	
L	Laboratory, workshop or fieldwork	
T	Tutorial	
DE	Distance education	39
	Total Hours	

Resources

ISBN	Textbook Title & Edition	Author & Publisher
ISBN: 9781439888117	Protective Relaying, Principles and Applications, 4th Edition	J. Lewis Blackburn, Thomas J. Domin CRC Press

Other Supplies	Source
ETAP Software	Operation Technologies, Inc.

Prerequisite(s)	ENRTECH 3MI3, ENRTECH 3PD3 and Registration in Energy Engineering Technologies
Corequisite(s)	
Antirequisite(s)	
Course Specific Policies	
Departmental Policies	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. Where group work is indicated in the course outline, such collaborative work is mandatory. The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception.

	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. Instructor has the right to submit work to software to identify plagiarism.	
3. SUB TOPIC(S)		
Week 1	**Introduction** • The Ontario Power Grid • Power System Reliability • Overview of the 1965 North American Blackout • Overview of the 2003 North American Blackout	
Week 2	**Fault Analysis – Part I** • Review of Per Unit System • Symmetrical Component Theory • Power System Sequence Networks	Ch. 2, 3, 4
Week 3	**Fault Analysis – Part II** • Short Circuit Calculations for 3ϕ, SLG, LLG Faults	Ch. 2, 3, 4
Week 4	**Symmetrical and Asymmetrical Fault Currents** • Characteristics of Fault Currents Near Generators • Fault Current Asymmetrical Factor • Breaker Duty Assessment • Mitigation of Excessive Short Circuit Levels	Ch. 4
Week 5	**Basic Principles of Protective Relaying** • Protection Philosophy • Protection Zones • Reliability Vs Security • Elements of Protective Relaying Systems	Ch. 1
Week 6	**Midterm Exam – to be finalized**	
Week 7	**Medium Voltage Distribution Feeder Protection - Part I** • Instantaneous Overcurrent Relay • Inverse Time Overcurrent Relay • Circuit Reclosers, Sectionalizers and Fuses • Protection Coordination	Ch. 6, 12
Week 8	**Medium Voltage Distribution Feeder Protection - Part II** • Digital Simulation	Ch. 6, 12
Week 9	**High Voltage Transmission Line Protection – Part I** • Apparent Impedance	Ch. 6, 12

	• R-X Diagram • Distance Relays and Relay Operating Characteristics • Relay Protection Schemes	
Week 10	**High Voltage Transmission Line Protection – Part II** • Current Differential Relays • Line-end-open (LEO) Protection • High Impedance and Open Phase (HIROP) Protection • Breaker Failure Protection • Autoreclosure of Transmission Lines	Ch. 6, 12, 13
Week 11	**Power Transformer Protection** • Transformer Operating Characteristics: Tap-changing, Inrush Current, Ferroresonance • Current Transformer Connections • Percentage Differential Relays • Transformer Thermal Monitoring	Ch. 9
Week 12	**Protection of Bus Bars and Capacitor Banks**	Ch. 9, 10
Week 13	**Course Review**	
Week 14		

Classes end: Wednesday, December 8th, 2021
Final Examination Period: Thursday, December 9 to Wednesday, December 22
All examinations MUST be written during the scheduled examination period.

List of experiments	
Lab 1	
Lab 2	
Lab 3	
Lab 4	
Lab 5	
Lab 6	
Lab 7	
Lab 8	
Lab 9	
Lab 10	
Lab 11	
Lab 12	

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. Be able to explain power system protection design philosophy and assemble basic components to form a protective relaying system.
2. Be able to apply symmetrical component method to calculate fault currents
3. Be able to apply computer tools such as PSSE to perform short circuit calculations.
4. Be able to apply different types of protective relays for protecting power system components
5. Be able to analyze and design protection systems for distribution feeder lines by using ETAP
6. Be able to analyze and design protection systems for high voltage transmission lines based on the use of distance relays and R-X diagrams.
7. Be able to analyze and design protection systems for power transformers, shunt capacitor banks and bus bars.

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 behaviour 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 behaviour 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 behaviours 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, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.