



**I. COURSE DESCRIPTION:**

This course introduces the student to theory and devices related to protection and control of electrical power systems and equipment. Topics will include protective relaying, coordination of system protective devices, generator controls, grounding, SCADA systems, and codes and standards relating to electrical power generation.

**II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:**

Upon successful completion of this course, the student will demonstrate the ability to:

**1. *Identify requirements for, and analyze the operation of, protective relaying systems associated with electrical generating stations.***Potential Elements of the Performance:

- List and describe the function of various protective relays commonly associated with generator protection
- List and describe the function of various protective relays commonly associated with transformer protection
- List and describe the function of various protective relays commonly associated with transmission line protection
- Compare and contrast the operational characteristics and applications of fuses and circuit breakers
- Describe how protective relays interface with the power system and the control system
- Describe the construction, operation and connection of instrument transformers
- Connect, test and analyze various instrument transformer configurations in the lab environment
- Connect and test various protective relays in the lab environment

**2. *Analyze time/current characteristics of various protective devices and perform coordination studies for basic electrical power systems.***Potential Elements of the Performance:

- Use manufacturers' generic time current characteristic curves to develop protection schemes for specific applications
- Develop and analyze coordination schemes for small radial electrical systems that include transformers (multiple voltage levels)
- Identify problems associated with protection of parallel transmission lines

**3. *Identify and analyze components of a generating station used to control voltage, frequency, real power and reactive power.***

Potential Elements of the Performance:

- List and describe various types of generator excitation systems
- Describe the components and associated functions of a turbine governor system
- List and describe indicators and controlling factors relating to the real power balance in an electrical system
- List and describe indicators and controlling factors relating to the reactive power balance in an electrical system
- Compare and contrast synchronous generator systems with induction generator systems with particular focus on wind generation
- Connect, test and analyze various generator configurations in the lab environment
- Connect and test voltage, current, frequency and power transducers

**4. *Identify and analyze station grounding requirements.***

Potential Elements of the Performance:

- List and describe the reasons for, and requirements of, a station grounding system
- List and describe the components of a station grounding system
- Describe how to measure the impedance to ground of a grounding system
- Describe how a grounding system limits step and touch potentials within and around an electrical installation

**5. *Identify the components of, and requirements for, a SCADA (supervisory, control and data acquisition) system.***

Potential Elements of the Performance:

- Describe the functional requirements of a typical SCADA system
- List and describe the components (block level) of a typical SCADA system
- Describe various methods a SCADA system uses to interface with field equipment

**6. *Identify the various codes and standards associated with generating stations.***

Potential Elements of the Performance:

- List and describe various codes, standards and regulations associated with design and operation of generating stations

- List and describe various codes, standards and organizations associated with electrical installations and safety

### III. TOPICS:

1. Protective relaying
2. Coordination of protective devices
3. Generator control
4. Station grounding
5. SCADA systems
6. Codes and standards

### IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Students must provide safety glasses, hard toed shoes, insulated rubber gloves with leather protectors and basic hand tools for use in the lab (see special notes below).

### V. EVALUATION PROCESS/GRADING SYSTEM:

The final grade for the course will be determined as follows:

|                          |     |
|--------------------------|-----|
| THEORY (tests)           | 70% |
| LABS (see VI, VII, VIII) | 30% |

The student must maintain a minimum 50% average in **both the theory** portion **and lab** portion of the class in order to receive a passing grade. If a student misses a test/lab he/she must have a valid reason (i.e. medical or family emergency – documentation may be required). In addition, the instructor **must** be notified **prior** to the test or lab sitting. If this procedure is not followed the student will receive a mark of zero on the test/lab with no make-up option. Students may not submit lab reports for labs in which they were not in continuous attendance. Lab reports not submitted by the assigned deadline will receive a grade of 0.

If a student misses class time due to sickness, family emergency or other reason beyond his/her control the student must at his/her first opportunity meet with the course faculty to discuss if the missed time has placed the student at an increased risk of failing. The student must follow up the meeting by emailing the faculty with a summary of the meeting's discussions. Documentation validating the missed time may be required.

See special notes below.

The following semester grades will be assigned to students:

| <b>Grade</b> | <b>Definition</b>  | <i>Grade Point Equivalent</i> |
|--------------|--|-------------------------------|
| A+           | 90 – 100%  |                               |
| A            | 80 – 89%   | 4.00                          |
| B            | 70 - 79%   | 3.00                          |
| C            | 60 - 69%   | 2.00                          |
| D            | 50 – 59%   | 1.00                          |
| F (Fail)     | 49% and below  | 0.00                          |
| CR (Credit)  | Credit for diploma requirements has been awarded.  |                               |
| S            | Satisfactory achievement in field /clinical placement or non-graded subject area.  |                               |
| U            | Unsatisfactory achievement in field/clinical placement or non-graded subject area.   |                               |
| X            | A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course. |                               |
| NR           | Grade not reported to Registrar's office.  |                               |
| W            | Student has withdrawn from the course without academic penalty.  |                               |

## VI. SPECIAL NOTES:

### Attendance:

Sault College is committed to student success. There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session.

### Other (course specific):

Attendance to scheduled lab activities is compulsory, unless permission has been granted by the instructor. Lab attendance and final grade are directly related. If a student arrives late for, or is not continuously present and actively participating at (scheduled breaks excepted), a scheduled lab class he/she will be considered absent for the entire class and will not be permitted to submit the associated lab report.

Students must continuously wear all Sault College required personal protective equipment (PPE) during lab activities. Failure to do this will result in expulsion from the lab activity and a grade of zero being assigned. Students are expected to be wearing their required PPE prior to entering the lab. Students may not use the yellow taped zone at the lab entrance to put on PPE. The instructor will advise what specific PPE is required. If a student repeatedly neglects to wear PPE as required he/she will be considered to be in violation of the Sault College Academic Code of Conduct and may be sanctioned accordingly (see Student Code of Conduct & Appeal Guidelines). For instance, first violation – verbal warning, second violation written warning, third violation suspension from lab activities. Students must complete a lab safety orientation prior to participating in lab activities. Successful completion of this orientation will be demonstrated by the student completing a quiz with a minimum grade of 100%. If the student has completed this orientation in another course he/she does not have to repeat it.

Make-ups for up to 2 missed labs (only with valid reason and documentation) will be done as a lab test based on lab exercises done throughout the semester so that the same test may be used for multiple students who may have missed different labs. This lab test will be done during the last week of the semester. If more than two labs are missed (with valid reason and documentation) the instructor may use a lab test as outlined above or assign an X grade. The decision of lab test or X grade will be made solely by the instructor. Make-ups for missed tests (only with valid reason and documentation) will be written the week following the end of the semester. If this is not practical for the instructor an X grade may be issued.

Use of cell phones/PDAs for any form of communication (voice, text...) during class or lab time is strictly prohibited. Cell phones/PDAs must be silenced during regular class and lab times and **must be turned off and kept out of sight during test sittings. Failure to follow the latter requirement during a test sitting will result in a grade of 0 being assigned.**

Students may not wear earphones of any kind (i.e. for play back of recorded music/voice) during lab activities or test sittings. This does not include hearing aids required for hearing impaired.

Students are expected to maintain an active Sault College email account. They are required to check this email account daily. The instructor may announce details of lab and test requirements and scheduling through the Sault College email system (as well as sharing other important information).

Any request to deviate from the course outline requirements must be made to the instructor in writing or via Sault College email. If permission is granted it must also be granted in writing or via Sault College email. Verbal requests/permissions are not acceptable. It is the student's responsibility to maintain a copy of all such requests and associated permissions.

**VII. COURSE OUTLINE ADDENDUM:**

The provisions contained in the addendum located on the portal form part of this course outline.

**VIII LAB REQUIREMENTS:**

1. All lab reports are to be computer generated. Hand written report will not be accepted.
2. All lab reports are to include a title page with the following information:
  - Lab title and number
  - Due date
  - Date submitted
  - Course number
  - Names of group members
  - Instructor's name
3. Lab reports are to include all procedures and observations listed in the order they were performed/taken and numbered to match the lab handout.
4. One lab report submission per group. Maximum 2 members per group.
5. Lab reports submitted with grammatical and/or spelling errors will receive a grade of 0. Word processors have spell check, it is expected students will use it.
6. Lab reports are due at the beginning of class 1 week after the scheduled period in which it was done. Late submissions will receive a grade of 0. Early submissions are recommended to avoid problems such as bad weather, vehicle breakdowns etc.
7. Students are not permitted to work on live equipment outside of regular class time. If a student misses all or part of a lab class he/she will not be permitted to submit the corresponding lab report.
8. Students must supply their own hand tools, protoboards, meters, insulated rubber gloves, hard toed shoes/boots and safety glasses. Students will not be permitted in the lab without wearing safety glasses, hard toed shoes/boots and insulated rubber gloves must be worn as required by CSA Standard Z462. Students must never work alone in the lab. Unsafe work habits will not be tolerated.
9. Students must sign and provide the instructor with a copy of this page before being permitted to work in the lab.

I have read and understand the above requirements:

Name (print): \_\_\_\_\_

Signature: \_\_\_\_\_ Date: \_\_\_\_\_