

**SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY**

**SAULT STE. MARIE, ONTARIO**



**SAULT  
COLLEGE**

**COURSE OUTLINE**

**COURSE TITLE:** Electrical Machines

**CODE NO. :** ELR232 **SEMESTER:** THREE

**PROGRAM:** Electrical Engineering Technician  
- Process Automation  
- Process Automation & Trades  
- Power Generation

**AUTHOR:** R. McTaggart

**DATE:** September 2015 **PREVIOUS OUTLINE DATED:** September 2014

**APPROVED:** *“Corey Meunier”*  
CHAIR

**TOTAL CREDITS:** SEVEN

**PREREQUISITE(S):** ELR109

**HOURS/WEEK:** FIVE

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**I. COURSE DESCRIPTION:**

This course is an analytical study of characteristics, performance and control of rotating electrical machinery, transformers and associated equipment. An integrated laboratory program supports the theory.

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

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

**1. Analyze and test direct current (dc) motors and generators.****Potential Elements of the Performance:**

- Describe the construction of dc machines.
- Describe how a dc generator generates voltage.
- Describe how a dc motor develops torque.
- Perform calculations to determine electrical, mechanical and magnetic operating parameters of dc machines.
- Connect and test various configurations of dc machines.

**2. Analyze and test single and polyphase transformers.****Potential Elements of the Performance:**

- Describe the construction of various power, control and instrument transformers.
- Describe the principles of operation of ideal and real transformers.
- Utilize phasor diagrams to explain the characteristics of transformers operating at various power factors.
- Perform calculations involving power, voltage, current and flux.
- Connect and test various configurations of single and polyphase transformers.
- Describe safety issues regarding transformers.

**3. Analyze and test three phase alternating current (ac) generators.****Potential Elements of the Performance:**

- Describe the construction of ac synchronous generators.
- Perform calculations to determine electrical, mechanical and magnetic operating parameters of ac synchronous generators.
- Utilize phasor diagrams to explain the characteristics of ac synchronous generators operating at various power factors and under various load conditions.
- Connect and test ac synchronous generators.

**4. Analyze and test single and polyphase ac induction motors.**Potential Elements of the Performance:

- Describe the construction of three phase ac induction motors.
- Describe how a rotating magnetic field is set up in a three phase ac motor.
- Describe how torque is developed by a three phase induction motor.
- Describe the construction of various types of single phase induction motors.
- Describe how torque is developed by single phase induction motors.
- Perform calculations to determine electrical and mechanical operating parameters of ac induction motors.
- Connect and test various types of ac induction motors.

**5. Analyze and test single and polyphase ac synchronous motors.**Potential Elements of the Performance:

- Describe the construction of a three phase synchronous motor.
- Describe how a synchronous motor develops torque.
- Describe methods of starting synchronous motors.
- Perform calculations to determine electrical, mechanical and magnetic operating parameters of ac synchronous motors.
- Utilize phasor diagrams to explain the characteristics of ac synchronous motors operating at various power factors and under various load conditions.
- Describe how synchronous motors are used for power factor correction and perform related calculations.
- Describe the construction and operation of common fractional horsepower single phase synchronous motors.

**6. Construct and test various motor control circuits.**Potential Elements of the Performance:

- Describe power and control components of typical ac and dc motor control schemes.
- Define wiring diagram, schematic diagram, ladder logic, relay logic.
- Draw and interpret wiring, schematic, ladder logic and relay logic diagrams.
- Connect and test various motor control circuits.
- Apply rules from the Canadian Electrical Code relating to motor installation.

**III. TOPICS:**

1. Direct Current Machines
2. Transformers
3. Synchronous Generators
4. Induction Motors
5. Synchronous Motors
6. Motor Control

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

Electric Machinery 2<sup>nd</sup> Edition by Peter F. Ryff

Safety Glasses, Safety Boots/Shoes (hard toe minimum),  
Class 00, 500 volt, Insulating Rubber Gloves with Leather protector gloves.

**V. EVALUATION PROCESS/GRADING SYSTEM:**

4 Theory Tests* (equal weighting)	70%
Laboratory Work*	30%
<b>Total</b>	<b>100%</b>

**\*Refer to SPECIAL NOTES and LAB REQUIREMENTS\***

The following semester grades will be assigned to students:

<b>Grade</b>	<b><u>Definition</u></b>	<b><i>Grade Point Equivalent</i></b>
A+	90 – 100%	4.00
A	80 – 89%	
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.

If a faculty member determines that a student is at risk of not being successful in their academic pursuits and has exhausted all strategies available to faculty, student contact information may be confidentially provided to Student Services in an effort to offer even more assistance with options for success. Any student wishing to restrict the sharing of such information should make their wishes known to the coordinator or faculty member.

## 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. 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%.**

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.

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.

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.

**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).

**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 reports will not be accepted. Circuit diagrams are to be generated using AutoCad.
2. All lab reports are to include a title page with the following information in the following sequence:
  - 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, observations and questions listed in the order they appear in the lab handout and numbered to match the lab handout. Students will typically be provided with the Word file for the lab handout. They are expected to generate their lab submission from this file so all submissions follow one format and include all original documentation. Failure to follow this format will result in a grade of 0 being assigned.
4. One lab report submission per group. Maximum 2 members per group unless approved by the instructor.
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. **It is recommended students submit lab reports prior to the deadline to avoid late submissions due to unforeseen circumstances** (i.e. bad weather, transportation problems...).
7. Students are not permitted to work unsupervised in the lab.
8. Students must supply their own personal protective equipment (PPE). Students will not be permitted in the lab if not wearing required PPE. Safety glasses and hard toe shoes/boots must be put on prior to entering B1060. Students must never work alone in the lab. Unsafe work habits will not be tolerated.
9. Students are expected to maintain a clean and organized work area. Failure to put away equipment (in assigned location) and to clean up after a lab activity will result in a grade of 0 being assigned for that activity.
10. Some labs may have a pre-lab assignment associated with them. Pre-lab assignments must be completed (questions correctly answered, drawings correctly and neatly produced with AutoCAD...) and submitted prior to the associated lab class. Students who failure to submit the completed pre-lab assignment will not be allowed to attend the associated lab class and will receive a grade of 0 for that lab.



