SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE:	ELECTRICAL POWER SYSTEM ANALYSIS AND DESIGN		
CODE NO. :	ELR330	**SEMESTER:**	SIX
PROGRAM:	ELECTRICAL ENGINEERING TECHNOLOGY		
AUTHOR:	R. MCTAGGART		
DATE:	January 2015	**PREVIOUS OUTLINE DATED:**	January 2014

APPROVED: *"Corey Meunier"*

CHAIR **DATE**

TOTAL CREDITS:	6
PREREQUISITE(S):	ELR 232, MTH 577
HOURS/WEEK:	6

For additional information, please contact Corey Meunier, Chair
School of Technology & Skilled Trades
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I. COURSE DESCRIPTION:

Design and analysis of large and small scale electrical power systems will be studied. Topics include balanced and unbalanced faults, load flow, system stability (classical control theory utilizing Laplace Transform analysis) instrument and power transformers, protective relaying, alternative energy systems and Fourier series analysis. 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. Perform fault calculations for balanced and unbalanced faults in a three phase AC system.

Potential Elements of the Performance:

- Convert actual power, voltage, current and impedance values to per unit values.
- Convert per unit electrical values to actual values.
- Solve a network using per unit and/or actual values for power, voltage and current levels throughout (balanced conditions).
- Use symmetrical components to analyze unbalanced faults.

2. Analyze Basic AC Power Systems In Steady State.

Potential Elements of the Performance:

- Analyze real and reactive power flow in two and three bus systems.
- Describe real and reactive power balances and indicators for each.
- Derive and explain the static load flow equations.

3. Simplify and analyze a variety of control systems utilizing Laplace Transforms.

Potential Elements of the Performance:

- Utilize block diagrams and transfer functions to model basic control systems.
- Derive the Laplace transform of a time domain function.
- Use tables to find inverse Laplace transforms.
- Simplify block diagrams.
- Discuss criteria for system stability using Bode diagrams and s-plane analysis.

4. Assist in the design and installation of instrument and power transformers.

Potential Elements of the Performance:

- List and describe various types of large power transformers.
- List and describe various cooling methods used with large power transformers.
- List and describe name plate information provided with large power transformers.
- List and describe various protection schemes used with large power transformers.
- Describe the construction, operation and connection of instrument transformers.
- Discuss safety concerns of instrument transformers.

5. Describe the purpose and operation of various protective relays and how they interface with the power system.

Potential Elements of the Performance:

- List common electrical and mechanical faults that may occur in a power system.
- State the primary functions of protective equipment.
- Define protective relay.
- List various types of protective relays and describe their operation.
- Analyze time – current characteristic curves for various protective relays.
- Discuss the concepts of coordinated fault protection and zone coverage of power systems.
- Connect and test various protective relays.

6. Analyze the viability and application of various alternative energy systems..

Potential Elements of the Performance:

- List various types of alternative energy systems.
- Describe where and how commercially available alternative energy systems are currently being utilized.
- Describe alternative energy systems proposed for future use (i.e. in prototype stage).

7. *Analyze periodic, non-sinusoidal waveforms.*

Potential Elements of the Performance:

- Define harmonics and describe their affect on electrical power systems.
- Use Fourier series analysis to determine the harmonic content of various periodic, non-sinusoidal waveforms.

III. TOPICS:

1. FAULT ANALYSIS
2. STEADY STATE ANALYSIS OF POWER SYSTEMS
3. CONTROL SYSTEMS
4. INSTRUMENT AND POWER TRANSFORMERS
5. PROTECTIVE RELAYS
6. ALTERNATIVE ENERGY SYSTEMS
7. FOURIER SERIES ANALYSIS

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Notes supplied by instructor.

Safety Glasses, Hard toe safety shoes or boots, Class 00, 500 volt, Insulating Rubber Gloves with Leather protector gloves, multimeter, hand tools.

V. EVALUATION PROCESS/GRADING SYSTEM:

Theory Tests*	60%
Laboratory Work*	25%
Research Report*	10%
Presentation of Research Report*	5%
Total	**100%**

*** Refer to SPECIAL NOTES, LAB REQUIREMENTS and RESEARCH REPORT REQUIREMENTS**

The following semester grades will be assigned to students:

Grade	Definition	*Grade Point Equivalent*
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.

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.

The student must maintain a minimum 50% average in **both** the **theory** (tests and research report) 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.

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%. If the student has completed this orientation in another course he/she does not have to repeat it.

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 and LMS daily. The instructor may announce details of lab and test requirements and scheduling through the Sault College email system and/or LMS (as well as sharing other important information).

Any request to deviate from the aforementioned course outline requirements and/or the following Lab Requirements and Research Report Requirements (VIII, IX) 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 reports will not be accepted. Circuit diagrams are to be generated using AutoCad. Students must only submit work which is a product of their own efforts. All other content, where allowed, must be appropriately referenced. Students are required to review Article 2, Section 2 of the *Student Code of Conduct.* Sanctions for academic dishonesty can be severe (i.e. assignment of 'F' grade for course).
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 may 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 on live equipment outside of regular class time and may not work in the lab without faculty permission. This permission will not be considered outside of the regular 8:30am to 4:30pm, Monday – Friday time period.
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 toed shoes). **PPE must be put on before entering the lab**. Failure to follow this rule may result in a 0 grade being assigned for the lab and/or expulsion from lab activities. Students must never work alone in the lab. Unsafe work habits will not be tolerated.

IX. RESEARCH REPORT REQUIREMENTS:

1. This will be a formal report and presentation to the class.
2. Students will work in pairs.
3. Three copies of the report are to be prepared. One to be submitted and one for each member of the group. Each report to consist of:
    a. Title page including name of report, course ID, authors, instructor's name.
    b. Table of Contents.
    c. Summary - brief summary of report contents/conclusions.
    d. Main body of report. Minimum 6 pages, Ariel 12 point font, ¾" margins, 1" header and 1" footer, 1.5 line spacing (using the same spacing between lines as in this sentence), maximum one extra line between paragraphs. Bibliography. All information must be sourced. Any direct quotations must be shown as such and sourced.
    e. Use of pictures, drawings and diagrams will increase the length of the main body accordingly.
4. Presentation to be PowerPoint and minimum length 30 minutes (20 minute presentation 10 minutes question and answer allowance). A copy of the PowerPoint file is to be submitted to the instructor prior to the presentation to the class.
5. Topics must be approved by the instructor and will be based on Alternative Energy Systems and Learning Outcome 6.
6. Report to be submitted no later than 11:30AM March 27, 2015. Late reports will receive a grade of 0. It is recommended a rough draft is submitted two weeks prior to this date for preliminary feedback.