SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE:	Power Electronics		
CODE NO. :	ELR236	**SEMESTER:**	FOUR
PROGRAM:	Electrical Engineering Technician - Process Automation - Process Automation & Trades		
AUTHOR:	R. Allen		
DATE:	January 2013	**PREVIOUS OUTLINE DATED:**	January 2012

APPROVED:

"Corey Meunier"

CHAIR **DATE**

TOTAL CREDITS:	7
PREREQUISITE(S):	ELR109, ELN213
HOURS/WEEK:	6

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For additional information, please contact Corey Meunier, Chair
School of Technology & Skilled Trades
(705) 759-2554, Ext. 2610

I. COURSE DESCRIPTION:

This course furthers the student's knowledge of power electronic devices and applications. Solid state drive packages and associated power and control circuitry are introduced. Lab exercises will provide the student with hands-on experience with typical AC and DC motor drives.

II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

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

1. Analyze the operation of various types of diode and rectifier circuits

Potential Elements of the Performance:

- Describe energy transfer between inductors and capacitors in diode /RLC circuits
- state the various types of diode rectifier circuits and draw the associated circuit diagrams
- choose the correct type and rating of rectifier diode for a given application
- draw associated voltage and current waveforms for single phase, three phase and six phase diode rectifiers
- identify safety issues of non-isolated oscilloscopes if used to test power circuits
- set-up and use isolated oscilloscopes and oscilloscope isolators in the lab environment
- connect, test and troubleshoot diode rectifier circuits

2. Understand the operation characteristics of Thyristors and Power Transistors

Potential Elements of the Performance:

- state the five major categories of power electronic switching devices
- describe the operating characteristics of power SCR's, BJT's, MOSFETs and IGBTs
- connect and test simple power electronic switching circuits in the lab environment

3. Analyze various types of SCR commutation circuits

Potential Elements of the Performance:

- define natural and forced commutation
- draw and describe the operation of various forced commutation circuits

4. Analyze the operation of various types of single and polyphase controlled rectifiers.

Potential Elements of the Performance:

- describe the principal of phase controlled converter operation
- draw circuit diagrams for, and describe the operation of, single and three-phase semi-converters, full converters and dual converters
- describe the effects of an inductive load on various controlled rectifiers
- describe the effects of controlled rectifiers on system power factor and harmonic content
- draw voltage and current waveforms associated with the various converter circuits
- build and test a three phase controlled rectifier

5. Analyze the operation of various types of static switches

Potential Elements of the Performance:

- draw circuit diagrams for, and describe the operation of various AC and DC static switches
- describe common applications of static switches

6. Analyze the operation of various types of AC voltage controllers

Potential Elements of the Performance:

- draw circuit diagrams for, and describe the operation of, various AC voltage controllers
- draw voltage waveforms associated with various AC voltage controllers
- describe common applications of AC voltage controllers

7. Analyze the operation of various types of DC chopper circuits

Potential Elements of the Performance:

- describe the principle of operation of a step down (buck) chopper
- describe the operation of a step up (boost) chopper
- describe the operation of specific buck, boost and buck/boost chopper circuits

***8.* Analyze the operation of various types of inverter circuits**

Potential Elements of the Performance:

- draw circuit diagrams for, and describe the operation of, common single and three phase inverters
- draw voltage waveforms associated with common inverters
- describe how pulse width modulation is used for wave shaping

- draw circuit diagrams for, and describe the operation of, various resonant pulse inverters
- draw voltage waveforms associated with various resonant pulse inverters

9. **Analyze the operation of various types of DC motor drives.**

Potential Elements of the Performance:

- describe the basic electrical and mechanical characteristics of DC motors
- describe how DC drives are used to control the operation of DC motors
- identify power and control sections of DC drive circuitry and produce simplified block diagrams of specific DC motor drives in the lab
- connect and test DC drives in the lab

10. **Analyze the operation of various types of DC chopper circuits**

Potential Elements of the Performance:

- describe the basic electrical and mechanical characteristics of AC motors
- describe how AC drives are used to control the operation of AC motors
- identify power and control sections of AC drive circuitry and produce simplified block diagrams of specific AC motor drives in the lab
- connect and test AC drives in the lab

11. **Analyze the operation of various types of industrial power supplies**

Potential Elements of the Performance:

- state the general requirements for industrial power supplies
- describe the operation of switched-mode, resonant and bi-directional DC power supplies
- describe the components of a basic UPS system
- state the purpose of multistage AC power supplies
- describe the operation of various multistage AC power supplies

12. **Develop and demonstrate basic functional block programming techniques**

Potential Elements of the Performance:

- list and describe the components of a generic programmable logic controller (PLC, PLnC)
- describe the construction and operation of the SAFphire PLnC

- describe how to interface the SAFphire PLnC to a computer
- describe how to interface the SAFphire PLnC to a SAF DD312 direct current drive motor
- create and implement functional block programs for the SAFphire PLnC
- demonstrate closed loop control of a direct current motor using the SAFphire PLnC and DD312 drive

III. TOPICS:

1. Diodes and diode rectifiers
2. Thyristors and power transistors
3. SCR commutation circuits
4. Controlled rectifiers
5. Static Switches
6. AC voltage controllers
7. DC choppers
8. Inverters
9. DC Motor Drives
10. AC Motor Drives
11. Power Supplies
12. Drive Control Utilizing Programmable Logic Controllers

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Power Electronics: Circuits, Devices and Applications, 3rd Edition by M.H. Rashid ISBN 0-13-1-1140-5

Numerous handouts

Students must provide safety glasses, boots and High Voltage Gloves as well as 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 (3 tests quizzes and homework)	*50%*
LABS	*30%*
LAB PRACTICAL'S	*20%*

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 musts 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 labs in which they were not in continuous attendance. Lab reports not submitted by the assigned deadline will receive a grade of 0

See special notes below.

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.

It is the departmental policy that once the classroom door has been closed, the learning process has begun. Late arrivers will not be granted admission to the room.

Class/Lab Conduct:
Attendance to scheduled lab activities is compulsory, unless permission has been granted by the instructor. Lab attendance and final grades are directly related . **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 PPE prior to entering the lab. The instructor will advise what specific PPE is required (safety glasses will definitely be required).** Unsafe conduct in the lab will not be tolerated.

Laboratory Reports shall be subject to the handout given at the start of the semester. All Lab Reports are due at the start of the following weeks Lab Class unless otherwise stipulated by the Instructor. A **penalty of 10% per day** will be assessed for late submissions (Weekends are included). Late Lab Reports will be accepted for feedback after the 10 day late period, but no marks will be awarded.

Completed Labs are to be delivered to the instructor in a clean neat folder and will include a computer generated cover label stating:

- Lab activity
- Due date
- Date Activity was performed
- Your name
- Your partners name

The content of the computer generated lab report will include:

- Cover page
- Usable Table of Contents
- Equipment/parts list
- All Drawings/charts/diagrams are required to have Figure numbers which are referenced in the report.
- A summary of activities which were performed
- A conclusion (personal statement about what you learned from this activity)
- And anything else that is appropriate for the activity.

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 considered absent for the entire class and will not be permitted to submit the associated lab report.

Use of cell phones/PDAs for any form of communication (voice text/internet) during class 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. If your phone should ring, or a student is found to be texting during scheduled lectures or labs a deduction of 5% per event will be subtracted from your final grade.

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 though the Sault College email system (as well as sharing other important information).

Any requests to deviate from the aforementioned 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 students 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.