SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

Sault College

COURSE OUTLINE

COURSE TITLE:	Power Electronics		
CODE NO. :	ELR 236	**SEMESTER:**	4
PROGRAM:	Electrical Engineering Technician/Technology		
AUTHOR:	R. McTaggart		
DATE:	12/2005	**PREVIOUS OUTLINE DATED:**	12/2004
APPROVED:			
	_____		_____
	DEAN		**DATE**
TOTAL CREDITS:	7		
PREREQUISITE(S):	ELR 109, ELN 213		
HOURS/WEEK:	6		

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COURSE DESCRIPTION:

I. This course furthers the students' knowledge of power electronic devices and applications. Solid state drive packages and associated power and control circuitry are introduced. Lab exercises will provide the students with hands-on experience with typical commercial 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
   - connect, test and troubleshoot diode rectifier circuits

2. Understand the operating 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 SCRs, BJTs, 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 rectifier circuits.
   Potential Elements of the Performance:

   - describe the principle 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 principle of operation of a step up (boost) chopper
- describe the operation of specific buck, boost and buck/boost chopper circuits
- build a chopper circuit using a power transistor to control the armature voltage of a DC motor

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:

- state the three general classifications of DC motor drives
- 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 AC motor drives.
    Potential Elements of the Performance:

    - state the two general classifications of AC motor drives
    - 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 bidirectional 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 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 motor drive
- 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

Students must provide safety glasses 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 and quizzes)	70%
LABS (see Special Note IX)	30%

Quizzes will not be announced and will be worth 1% each.

See special notes below.

The following semester grades will be assigned to students in postsecondary courses:

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:

Special Needs:
If you are a student with special needs (e.g. physical limitations, visual impairments, hearing impairments, or learning disabilities), you are encouraged to discuss required accommodations with your professor and/or the Special Needs office. Visit Room E1101 or call Extension 493 so that support services can be arranged for you.

Retention of Course Outlines:
It is the responsibility of the student to retain all course outlines for possible future use in acquiring advanced standing at other postsecondary institutions.

Plagiarism:
Students should refer to the definition of “academic dishonesty” in *Student Rights and Responsibilities*. Students who engage in “academic dishonesty” will receive an automatic failure for that submission and/or such other penalty, up to and including expulsion from the course/program, as may be decided by the professor/dean. In order to protect students from inadvertent plagiarism, to protect the copyright of the material referenced, and to credit the author of the material, it is the policy of the department to employ a documentation format for referencing source material.

Course Outline Amendments:
The professor reserves the right to change the information contained in this course outline depending on the needs of the learner and the availability of resources.

Substitute course information is available in the Registrar's office.

Students must wear safety glasses in the lab when working on or around live circuits and equipment. Any student not doing so will be asked to leave the lab immediately. Unsafe conduct in the lab will not be tolerated.
In order to maintain a passing grade (D) the student must maintain a minimum 50% average in both the theory and lab portions of this course.
If a student misses a test or lab period he/she must have a valid reason (i.e. medical or family emergency – documentation will be required). In addition, the instructor must be notified prior to the test sitting or lab period. If this procedure is not followed the student will receive a mark of zero on the test or lab with no rewrite option.

If a student arrives late for, or is not continuously present 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.

VII. PRIOR LEARNING ASSESSMENT:

Students who wish to apply for advanced credit in the course should consult the professor. Credit for prior learning will be given upon successful completion of a challenge exam or portfolio.

VIII. DIRECT CREDIT TRANSFERS:

Students who wish to apply for direct credit transfer (advanced standing) should obtain a direct credit transfer form from the Dean’s secretary. Students will be required to provide a transcript and course outline related to the course in question.

IX LAB REQUIREMENTS:

1. All lab reports are to be computer generated. Hand written reports 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. Every lab report is to conclude with a summary (whether requested in the lab document or not). The summary is to be a minimum 1 page (double spaced, Arial size 12 font, maximum 1 inch margins) in length and is to be an analysis of the results. The summary is not to be a regurgitation of the results. It is expected that students will use course notes, library resources and Internet research to assist in writing lab summaries. Labs submitted with a substandard summary will receive a grade of 0.
5. One lab report submission per group. Maximum 2 members per group.
6. 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.
7. 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.
8. 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.
9. Students must supply their own hand tools, protoboards, meters and safety glasses. Students will not be permitted in the lab without safety glasses and must wear the safety glasses whenever working on or around live equipment. Students must never work alone in the lab. Unsafe work habits will not be tolerated.
10. 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: _____