CAMOSUN COLLEGE
Trades and Technology
Electronics and Computer Engineering

ECET220

Industrial Electronics for Renewable Energy

Winter 2020

COURSE OUTLINE

Please note: This outline will not be kept indefinitely. It is recommended students keep this outline for their records, especially to assist in transfer credit to post-secondary institutions.

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1. Instructor Information

(a) Instructor	Todd Rayson		
(b) Office hours	n/a		
(c) Location	TEC 214		
(d) Phone	370-4573	**Alternative:**	
(e) E-mail	raysont@camosun.bc.ca		

Pre-requisites C in ECET 242

Course Hours Lecture: 3hrs/wk Lab: 2.5hrs/wk Duration: 14 weeks

Intended Learning Outcomes

Students will focus on power devices and power systems for renewable energy. They will study three-phase power, the "smart grid," DC and AC motors and generators, power devices such as IGBTs and thyristors, DC-DC converters, inverters, controlled rectifiers, and DC and AC motor drives. Students will apply this to wind and solar energy systems and electric cars.

Upon successful completion of this course a student will be able to:

- Describe the characteristics and operation of power control devices;
- Draw the characteristic curves of power control devices;
- Classify power devices according to speed, power and control type;
- Interpret power device specifications and specify power devices for a given application;
- Calculate power device losses and heat-sink requirements;
- Explain the fundamental concepts of three phase power systems and grid-tying;
- Describe the operation of AC and DC motors/generators;
- Describe the operation of inverter circuits;
- Describe the operation of controlled rectifier circuits;
- Describe the operation of circuits involving power diodes, thyristors and controlled switches;
- Describe the operation of DC and AC motor drives;
- Outline strategies for power device protection and isolation;
- Draw waveforms for industrial electronics circuits;
- Perform calculations to determine suitable component values for power circuits;
- Explain the operation of control circuits for power control devices;
- Apply a DC-DC converter for maximum power point tracking (MPPT);
- Explain the use of chopper circuits and inverters for photovoltaic power conversion;
- Outline the use of an H-bridge circuit in regenerative systems.

Required Materials

(a) Course materials from D2L site

(b) Text (Optional)

Title:	Electronic devices and circuits
Publisher:	Oxford University Press
Author:	Bell, David A.

Course Content and Schedule (Subject to change)

1. Introduction **(~~3~~) 5 hours**
- 1.1 The power grid and three-phase systems
- 1.2 Grid components
- 1.3 Three-phase calculations
- 1.4 Distributed vs. centralized renewable energy supply
- 1.5 The “smart grid”

2. DC motors and generators **3 hours**
- 2.1 Electromagnetics review
- 2.2 Electric machine physical construction
- 2.3 Series, shunt and compound wiring

3. AC generators **3 hours**
- 3.1 Three-phase induction generators
- 3.2 Three-phase synchronous generators
- 3.3 Grid synch and grid tie for wind energy applications

4. AC motors **3 hours**
- 4.1 Three-phase induction motors
- 4.2 Three-phase synchronous motors
- 4.3 Single-phase motors

5. Power electronics **3 hours**
- 5.1 Basic concepts
- 5.2 Power devices
  - 5.2.1 Power diodes
  - 5.2.3 Controlled switches: BJT, MOSFET, IGBT
- 5.3 Switching characteristics and snubbers
- 5.4 Drive circuits and isolation

6. DC-DC converters **3 hours**
- 6.1 Buck, boost and buck-boost
- 6.2 Application to PV charging systems
- 6.3 Maximum power point tracking (MPPT)

7. Inverters and AC motor drives **3 hours**
- 7.1 Single-phase inverters
- 7.2 Three-phase inverters
- 7.3 Three-phase and PM DC motor control application
- 7.4 Use of inverters in grid-tied PV systems

8. DC motor drives **3 hours**
- 8.1 Basic “chopper” circuit
- 8.2 Half bridge
- 8.3 Full H bridge
- 8.4 Regenerative systems

9. Thyristor power devices **3 hours**
- 9.1 Thyristor devices (SCR, TRIAC, DIAC, GTO)
- 9.2 Solid-state relays

10. Controlled rectifiers **3 hours**
- 10.1 Operation of controlled rectifiers
- 10.2 DC motor control applications

11.	**Renewable energy (RE) systems** 11.1 Further applications of power electronics in RE 11.2 Case studies[1]	**3 hours**
12.	**Series/parallel devices**	**1 hour**
13.	**Thermal considerations**	**1 hour**
Tests and review		7 hours
Total		**42 hours**

Lab Topics (Subject to change)

1. Introduction to Lab-Volt (equipment use, lab safety, power theory review)
2 Three phase systems (Lab-Volt)
3. DC motor (Lab-Volt)
4. AC generator/motor (Lab-Volt)
5. Reverse recovery time of diodes
6 PWM choppers and IGBTs
7. DC-DC converters
8. DC-DC converter MPPT
9. Single-phase inverter
10. Three-phase inverter
11. H-bridge motor control
12. SCR motor control
13. Solid state relay
14. TRIAC/DIAC control

Basis of Student Assessment (Weighting)

Exams:	Mid-term1:	20%
	Mid-term2:	20%
	Final:	30%
Labs:		30%

Note:

- Lab and lecture portions ***MUST*** be passed individually.
- Late penalties of ***50% and 10% per day*** will be applied at the instructor's discretion.
- Lab attendance is **MANDATORY**. Failure to attend labs will result in an F grade
- A **20% penalty** will be applied to lab mark for **Late Attendance** of lab
- All labs and assignments must be handed in at least 3 days prior to the final exam
- Lab grades will not be awarded for missed labs without a valid reason for absence and a doctor's note if sick

Grading System

[X] Standard Grading System (GPA)

[ ] Competency Based Grading System

Recommended Materials or Services to Assist Students to Succeed Throughout the Course

LEARNING SUPPORT AND SERVICES FOR STUDENTS

There are a variety of services available for students to assist them throughout their learning. This information is available in the College Calendar, Student Services or the College web site at http://www.camosun.bc.ca

STUDENT CONDUCT POLICY

There is a Student Conduct Policy. It is the student's responsibility to become familiar with the content of this policy. The policy is available in each School Administration Office, Registration, and on the College web site in the Policy Section.
http://www.camosun.bc.ca/policies/policies.html

A. GRADING SYSTEMS *http://www.camosun.bc.ca/policies/policies.php*

The following two grading systems are used at Camosun College:

1. Standard Grading System (GPA)

Percentage	Grade	Description	Grade Point Equivalency
90-100	A+		9
85-89	A		8
80-84	A-		7
77-79	B+		6
73-76	B		5
70-72	B-		4
65-69	C+		3
60-64	C		2
50-59	D		1
0-49	F	Minimum level has not been achieved.	0

2. Competency Based Grading System (Non GPA)

This grading system is based on satisfactory acquisition of defined skills or successful completion of the course learning outcomes

Grade	Description
COM	The student has met the goals, criteria, or competencies established for this course, practicum or field placement.
DST	The student has met and exceeded, above and beyond expectation, the goals, criteria, or competencies established for this course, practicum or field placement.
NC	The student has not met the goals, criteria or competencies established for this course, practicum or field placement.

B. Temporary Grades

Temporary grades are assigned for specific circumstances and will convert to a final grade according to the grading scheme being used in the course. See Grading Policy at http://www.camosun.bc.ca/policies/E-1.5.pdf for information on conversion to final grades, and for additional information on student record and transcript notations.

Temporary Grade	Description
I	*Incomplete*: A temporary grade assigned when the requirements of a course have not yet been completed due to hardship or extenuating circumstances, such as illness or death in the family.
IP	*In progress*: A temporary grade assigned for courses that are designed to have an anticipated enrollment that extends beyond one term. No more than two IP grades will be assigned for the same course.
CW	*Compulsory Withdrawal*: A temporary grade assigned by a Dean when an instructor, after documenting the prescriptive strategies applied and consulting with peers, deems that a student is unsafe to self or others and must be removed from the lab, practicum, worksite, or field placement.