CAMOSUN COLLEGE
Trades and Technology
Electronics and Computer Engineering

ECET220

Industrial Electronics for Renewable Energy

Winter 2022

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.

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
Co-Requisites: N/A
Exclusions: N/A

Course Hours

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

Out of Class Work:

- *The ECET 220 course covers a lot of topics and is content heavy*
- *Expect to put in 2 hours of work for every 1 hour of lecture*

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
- Perform calculations to determine voltage, current and power values of three phase power systems
- Describe the operation of AC and DC motors/generators
- Perform basic calculations for AC and DC motors and 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
- 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 **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		**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)

Midterms: 20%
Final Exam: 45%
Labs: 35%

Note:

- All Labs ***MUST*** be passed with a minimum of 50%.
- Late penalties of ***50% and 5% per day*** will be applied to late submission of any assignments or labs
- Lab attendance is **MANDATORY**
  - Failure to attend labs will result in an F grade
- A **20% penalty** will be applied to the current lab mark for **Late Attendance**
- All labs and assignments must be handed in **before** the final exam
- A lab grade of zero will not be awarded for missed labs without a valid reason for the absence and a doctor's note if sick
- ***Please communicate with your instructor if you know you will be late or absent prior to the start of the class or lab***

To Pass

- You must achieve a minimum of 60% on your final exam
- You must have an average of 50% in labs, assignments and tests

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.

STUDENT RESPONSIBILITY

Enrolment at Camosun assumes that the student will become a responsible member of the College community. As such, each student will display a positive work ethic, assist in the preservation of College property, and assume responsibility for their education by researching academic requirements and policies; demonstrating courtesy and respect toward others; and respecting expectations concerning attendance, assignments, deadlines, and appointments.

SUPPORTS AND SERVICES FOR STUDENTS

Camosun College offers a number of services to help you succeed in and out of the classroom. For a detailed overview of the supports and services visit http://camosun.ca/students/.

Support Service	Website
Academic Advising	http://camosun.ca/advising
Accessible Learning	http://camosun.ca/accessible-learning
Counselling	http://camosun.ca/counselling
Career Services	http://camosun.ca/coop
Financial Aid and Awards	http://camosun.ca/financialaid
Help Centres (Math/English/Science)	http://camosun.ca/help-centres
Indigenous Student Support	http://camosun.ca/indigenous
International Student Support	http://camosun.ca/international/
Learning Skills	http://camosun.ca/learningskills
Library	http://camosun.ca/services/library/
Office of Student Support	http://camosun.ca/oss
Ombudsperson	http://camosun.ca/ombuds
Registration	http://camosun.ca/registration
Technology Support	http://camosun.ca/its
Writing Centre	http://camosun.ca/writing-centre

If you have a mental health concern, please contact Counselling to arrange an appointment as soon as possible. Counselling sessions are available at both campuses during business hours. If you need urgent support after-hours, please contact the Vancouver Island Crisis Line at 1-888-494-3888 or call 911.

COLLEGE-WIDE POLICIES, PROCEDURES, REQUIREMENTS, AND STANDARDS

Academic Accommodations for Students with Disabilities

The College is committed to providing appropriate and reasonable academic accommodations to students with disabilities (i.e. physical, depression, learning, etc). If you have a disability, the Centre for Accessible Learning (CAL) can help you document your needs, and where disability-related barriers to access in your courses exist, create an accommodation plan. By making a plan through CAL, you can ensure you have the appropriate academic accommodations you need without disclosing your diagnosis or condition to course instructors. Please visit the CAL website for contacts and to learn how to get started: http://camosun.ca/services/accessible-learning/

Academic Integrity

Please visit http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.13.pdf for policy regarding academic expectations and details for addressing and resolving matters of academic misconduct.

Academic Progress

Please visit http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.1.pdf for further details on how Camosun College monitors students' academic progress and what steps can be taken if a student is at risk of not meeting the College's academic progress standards.

Course Withdrawals Policy

Please visit http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.2.pdf for further details about course withdrawals. For deadline for fees, course drop dates, and tuition refund, please visit http://camosun.ca/learn/fees/#deadlines.

Grading Policy

Please visit http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.5.pdf for further details about grading.

Grade Review and Appeals

Please visit http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.14.pdf for policy relating to requests for review and appeal of grades.

Mandatory Attendance for First Class Meeting of Each Course

Camosun College requires mandatory attendance for the first class meeting of each course. If you do not attend, and do not provide your instructor with a reasonable reason in advance, you will be removed from the course and the space offered to the next waitlisted student. For more information, please see the "Attendance" section under "Registration Policies and Procedures" (http://camosun.ca/learn/calendar/current/procedures.html) and the Grading Policy at http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.5.pdf.

Medical / Compassionate Withdrawals

Students who are incapacitated and unable to complete or succeed in their studies by virtue of serious and demonstrated exceptional circumstances may be eligible for a medical/compassionate withdrawal. Please visit http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.8.pdf to learn more about the process involved in a medical/compassionate withdrawal.

Sexual Violence and Misconduct

Camosun is committed to creating a campus culture of safety, respect, and consent. Camosun's Office of Student Support is responsible for offering support to students impacted by sexual violence. Regardless of when or where the sexual violence or misconduct occurred, students can access support at Camosun. The Office of Student Support will make sure students have a safe and private place to talk and will help them understand what supports are available and their options for next steps. The Office of Student Support respects a student's right to choose what is right for them. For more information see Camosun's Sexualized Violence and Misconduct Policy: http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.9.pdf and camosun.ca/sexual-violence. To contact the Office of Student Support: oss@camosun.ca or by phone: 250-370-3046 or 250-3703841

Student Misconduct (Non-Academic)

Camosun College is committed to building the academic competency of all students, seeks to empower students to become agents of their own learning, and promotes academic belonging for everyone. Camosun also expects that all students to conduct themselves in a manner that contributes to a positive, supportive, and safe learning environment. Please review Camosun College's Student Misconduct Policy at http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.5.pdf to understand the College's expectations of academic integrity and student behavioural conduct.

Changes to this Syllabus: Every effort has been made to ensure that information in this syllabus is accurate at the time of publication. The College reserves the right to change courses if it becomes necessary so that course content remains relevant. In such cases, the instructor will give the students clear and timely notice of the changes.