



*ELEN 149*  
**Motor Control Systems**

*Summer 2020*

**COURSE OUTLINE**

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CREDIT:	4
IN-CLASS WORKLOAD:	3 hours lecture, 3 hours lab
OUT-OF-CLASS WORKLOAD:	3 hours
PREREQUISITES:	Reserved for DND students

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**1. Instructor Information**

(a) Instructor	Dr. Mozhgan Moazzen zadeh-Bacon
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(f) Website	online.camosun.bc.ca <b>Alternative:</b> _____

**2. Intended Learning Outcomes**

Students will gain theoretical and applied knowledge of motor controllers and associated systems including power semiconductor devices used for switching applications, building blocks of power systems (power converters) motor control methods and circuit configurations. Students will analyze, build, and test a variety of power circuits used for AC and DC motor control and become familiar with the control and protection requirements of power control systems.

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

1. Classify and describe the characteristics and operation of semiconductor control devices for power switching applications.
2. Perform calculations to determine device losses, efficiency and heat-sink requirements.
3. Describe and analyze power system building blocks (power converters: DC-DC, AC-DC, DC-AC and AC-AC) including circuit topologies, waveforms and component parameter calculations.
4. Describe the operation of AC and DC motor controllers including, chopper circuits, inverter circuits, controlled rectifier circuits, and DC and AC motor drives.
5. Describe the operation of thyristor-based motor controllers used in motor drive systems and power control systems (cycloconverters and thyristor choppers).
6. Explain strategies for the control, protection and isolation of power devices.
7. Perform calculations to determine suitable component values for power circuits.

### **3. Required Materials**

#### 1. Textbooks:

(a) **Electrical Machines, Drives and Power Systems, 6<sup>th</sup> Edition.**

Theodore Wildi. Publisher: Pearson.

(b) **Industrial Electronics, ISBN 0-8273-5825-3.**

Humphries and Sheets.

2. Course materials from D2L -Course notes and labs

### **4. Course Content and Schedule (Subject to change)**

#### **1. INTRODUCTION**

1.1 Semiconductor control devices and their applications

1.2 Basic Concepts in Power Electronics

#### **2. POWER DEVICES**

2.1 Power Diodes

2.1.1. Switching Characteristics of Power Diodes and Reverse Recovery Time

2.1.2. General Purpose Rectifier, Schottky, Zener Diodes

2.1.3. Switching Power loss

2.1.4. Series and Parallel connection of Diodes

2.2 BJT power transistors.

2.3 Power MOSFETs

2.4 Insulated Gate Bipolar transistors (IGBT)

#### **3. THYRISTOR POWER DEVICES**

3.1 SCR Thyristors-Characteristics-Holding and Latching current, SCR Rating

3.2 Gate turnoff (GTO) thyristors

3.3 Unijunction Transistor UJT construction and their application as triggering thyristors

3.4 Programmable UJT (PUT)

3.5 Triac circuits and calculations

3.6 Diac circuits and calculations

3.7 Different types of relays (Electromagnetic, Solid State)

#### **4. CONTROLLED RECTIFIERS**

4.1 Operation of controlled rectifiers

4.2 DC motor control applications

#### **5. DC MOTOR CONTROL AND DRIVES**

5.1 Basic “chopper” control circuit

5.2 Half bridge, full H bridge, dual-bridge, Regenerative systems (4-quadrant)

5.3 Pulse Width Modulated (PWM) speed control

5.4 Stepper Motor speed control

#### **6. THERMAL CONSIDERATION**

6.1 Cooling and heat sinks

## **7. PROTECTION DEVICES**

7.1 Snubber circuits

## **8. AC MOTOR CONTROL AND DRIVES**

8.1 Motor types and control methods

## **9. INVERTERS**

9.1 Single-phase inverters, Three-phase inverters, VSI, CSI etc.

9.2 Stand-Alone inverters, Synchronous Inverters

## **10. CYCLOCONVERTER**

10.1 Principle of operation, Application

## **11. DC-DC CONVERTERS**

11.1 Step-down Buck converter

11.2 Step- up Boost converter

11.3 buck-boost converters

## **12. POWER SUPPLY SYSTEMS**

12.1 UPS Construction and types (off-line, on-line)

## **13. SYNCHRO AND SERVO MOTORS DRIVES**

13.1 Synchro transmitters and receivers, construction and basic operation.

13.2 AC/DC Servo Motors

### **Lab Topics (Subject to change)**

Lab 1. Introduction to Lab equipment use, lab safety, Multisim Software

Lab 2. Power diodes characteristics

Lab 3. Recovery time of power diodes

Lab 4. IGBT switching characteristics

Lab 5. SCR characteristics

Lab 6. No formal Lab (**Term Test I-Week 6<sup>th</sup>-09/Jun/20220**)

Lab 7. DC Drive-Dc power control using an SCR

Lab 8. PUT as a Relaxation oscillator

Lab 9. The programmable uni-junction transistor as a thyristor triggering device

Lab 10. No formal Lab (**Term Test II-Week 10<sup>th</sup> -07/July/20220**)

Lab 11. Triac / Diac principles

Lab 12. Triac phase control

Lab 13. Solid state relay (SSR) load control

Lab 14. Sinusoidal PWM

(Extra Labs: Rectifiers/inductive load, LC filter, Buck DC-DC converter, etc)

## Holidays

- Mon-May 18 - Victoria Day - College closed (Week 3)
- Wed-July 1 - College Closed, Closure, Holiday (Week 9)
- Mon-August 3 - British Columbia Day, College closed (Week 14)

## 5. Basis of Student Assessment (Weighting)

Problem sets	10%
Quizzes	10%
Term Tests (x2)	30%
Final Exam	40%
<b>Total theory</b>	<b>90%</b>
Laboratory Evaluation	10%
<b>Total</b>	<b>100%</b>

Students must obtain a minimum of 60% in both the theory and practical portions of the course and a minimum of 50% on the final exam.

Laboratory marks will be based on the completeness of each lab exercise, report and an instructor evaluation of the student's work habits and attitude.

## 6. Grading System

- Standard Grading System (GPA)
- Competency Based Grading System

## 7. 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>

## 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	<i>Incomplete</i> : 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	<i>In progress</i> : 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	<i>Compulsory Withdrawal</i> : 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.