CAMOSUN COLLEGE

ELECTRONICS & COMPUTER ENGINEERING DEPARTMENT

ELEN 149: Motor Controls

Fall 2022

COURSE OUTLINE

Objectives:

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.

ELEN 147 - Recommended to be taken either prior to or at the same time as this course, but is not required.

ELEN 149 Motor Controls

CREDITS:	3
IN-CLASS WORKLOAD:	3 hours lecture, 3 hours lab
OUT-OF-CLASS WORKLOAD:	3 hours
PREREQUISITES:	C in ELEN 147 or taken at the same time

Reserved for DND students

Instructor: Dr. Osman Goni
Lab Instructor: Dr. Osman Goni
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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

• Access to D2L (Course Notes, Labs, Assignments, Quizzes, Tests)

• **Electrical Machines, Drives and Power Systems, 6th Edition.** Theodore Wildi. Publisher: Pearson.

• **Industrial Electronics, ISBN 0-8273-5825-3.** Humphries and Sheets.

4. COURSE CONTENT

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 CONSIDARATION

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. No formal Lab (First day Of the Class)-Information about ELEN 149

Lab 2. Power diodes characteristics

Lab 3,4,5. BJT/IGBT/MOSFET switching characteristics

Lab 8. Switching losses

Lab 9. SCR

Lab 10. Rectifiers/inductive load

Lab 11. PWM

Lab 12. Sinusoidal PWM

Lab 13. Buck DC-DC converter

5. Basis of Student Assessment (Weighting)

Problem sets	10%
Quizzes	10%
Mid Term	20%
Final Exam	40%
Total theory	**80%**
Laboratory Evaluation	20%
Total	**100%**

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

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	Grade Point Equivalency	Description
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	0	Minimum level has not been achieved.

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,