CAMOSUN COLLEGE
Trades and Technology
Electronics and Computer Engineering

ECET141
Analog Devices

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.

1. Instructor Information

(a) Instructor	Godfried Pimlott		
(b) Office hours	n/a		
(c) Location	TEC 209		
(d) Phone	370-4430	**Alternative:**	
(e) E-mail	pimlott@camosun.ca		

Pre-requisites C in ECET 140

Course Hours Lecture: 3hrs/wk Lab: 2hrs/wk Duration: 14 weeks

2. Intended Learning Outcomes

Students are introduced to semiconductor devices. They will learn basic semiconductor theory, diodes, transistors and operational amplifiers. Students will study device characteristics and behaviour and learn how to analyze, design, modify and combine them to perform complex functions. Students will be prepared for further study of analog electronics when they complete this foundation course.

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

- follow prescribed safety procedures appropriate to an electronics laboratory;
- describe the construction and operation of semiconductor devices, including diodes, Zener diodes, light emitting diodes, and photovoltaic (PV) cells;
- compare the characteristics of transistors including BJTs, JFETs, D type MOSFETs and E type MOSFETs;
- analyze the bias point for a MOSFET circuit;
- design, construct, and evaluate a simple AC MOSFET amplifier;

- explain how a transistor can be used as a switch;
- analyze operational amplifier (op amp) circuits;
- describe ideal and non-ideal op amp characteristics;
- select suitable op amps and passive components to design a circuit with specified frequency response characteristics;
- build and test semiconductor circuits using a breadboard;
- read and interpret circuit schematic diagrams;
- analyze and troubleshoot circuits containing both active and passive components;
- select and employ the appropriate test equipment in a laboratory environment;
- make accurate measurements of relevant parameters in DC and AC circuits.

3. Required Materials

a) Text (Required)
Title: Fundamentals of Modern Electronics 2019 ed.
Author: Beasley, Jeffery et al

b) Other (Recommended) Access to a PC.

c) Student version of Multisim circuit simulator (Recommended). Available at:
http://www.ni.com/multisim/student-edition/
http://www.studica.com/multisim-student-edition.html
(Note: this is also for ECET242, ECET220 and other courses)

d) Course materials from D2L site

4. Course Content (Subject to change)

1. Diodes

1.1 Energy Band Model of Solids
1.2 Properties of Semiconductors
1.3 The PN Junction
1.4 The Ideal Diode
1.5 Actual Diodes
  1.5.1 Temperature effects
  1.5.2 Resistance
  1.5.3 Capacitance
  1.5.4 Equivalent Circuit
  1.5.5 Datasheets
  1.5.6 Diode Testing
1.6 Varactor Diodes
1.7 Zener Diodes
1.8 LEDs
1.9 PV Cells

2. Diode applications

- 2.1 Load Line Analysis
- 2.2 Diode Approximation
- 2.3 Basic Series and Parallel Configurations
- 2.4 Half and Full Wave Rectifier Circuits
- 2.5 Clippers and Clampers
- 2.6 Zener Regulator Circuits

3. Transistor construction and Operation

- 3.1 Bipolar junction transistors (BJTs)
  - 3.1.1 NPN
  - 3.1.2 PNP
  - 3.1.3 Characteristic Curves and Limits of Operation
  - 3.1.4 BJT Configurations
  - 3.1.5 Datasheets
- 3.2 FETs
  - 3.2.1 JFETs[2]
  - 3.2.2 D type MOSFETs
  - 3.2.3 E type MOSFETs
  - 3.2.4 FET Characteristic Curves, Transconductance
  - 3.2.5 FET Configurations
  - 3.2.6 Datasheets

4. Transistor Biasing

- 4.1 BJT Characteristic Curves and the DC Load Line
  - 4.1.1 Operating (Quiescent) Point
- 4.2 BJT Biasing
  - 4.2.1 Fixed Bias
  - 4.2.2 Voltage Divider Bias
  - 4.2.3 Emitter Follower
  - 4.2.4 Collector Feedback
  - 4.2.5 Common Base
  - 4.2.6 Design
  - 4.2.7 PNP
- 4.3 FET Characteristic Curves, Transconductance, and the DC Load Line
  - 4.3.1 Operating (Quiescent) Point
- 4.4 FET Biasing
  - 4.4.1 Fixed bias circuit
  - 4.4.2 Feedback Bias
  - 4.4.3 Voltage Divider Bias
- 4.5 Transistor Switches
  - 4.5.1 BJT
  - 4.5.2 FET

5. Transistor Amplifiers

- 5.1 General 2-Port Model for BJT's
  - 5.1.1 h – parameters
  - 5.1.2 r_e parameter Model
- 5.2 BJT Small Signal Model
- 5.3 FET Small Signal Model

5.4 Coupling and Bypass Capacitors
5.5 Class A, B, AB, C and D amplifiers
5.6 Types of amplifier distortion

6. Frequency Response of Transistor Amplifiers

6.1 Review Filters and Bode Plots
6.2 General Frequency Considerations
6.3 Miller Effect Capacitance
6.4 Gain Bandwidth Product
6.5 Frequency Response of BJTs
6.6 Frequency Response of FETs
6.7 Multistage Frequency Effects
6.8 Square Wave Testing

7. Feedback

7.1 Negative and Positive Feedback
7.2 Feedback configurations
7.3 Effects of Negative and Positive Feedback
7.4 Gain and Phase Margins

8. The operational amplifier: basic configurations and calculations

8.1 Internal structure of an op amp
8.2 Inverting amplifier analysis
8.3 Non-inverting amplifier analysis
8.4 Feedback and the op amp
- 8.4.1 Non-inverting configuration
- 8.4.2 Inverting configuration
- 8.4.3 Voltage follower

8.5 Summing amplifier
8.6 Comparator
8.7 Schmitt trigger

9. Operational amplifier characteristics

9.1 Model of an op amp (including definition of dependent source)
9.2 Datasheets and device selection
- 9.2.1 Input and output resistance
- 9.2.2 DC limitations (input offset voltage, biasing currents, input offset current, offset null)
- 9.2.3 AC limitations
- 9.2.4 Frequency response characteristics (open loop gain and bandwidth, unity gain and the gain-bandwidth product, closed loop gain and bandwidth, slew rate)
- 9.2.5 Effect of passive components on frequency characteristics
  - 9.2.5.1 Op amp integrator circuit
  - 9.2.5.2 Op amp differentiator circuit
- 9.2.6 Supply voltage sensitivity
- 9.2.7 Common mode rejection
- 9.2.8 Noise in operational amplifiers

9.3 Practical considerations
- 9.3.1 Amplifier selection and design specification
- 9.3.2 Selection process

9.3.3 Selecting passive components

Lab Topics (Subject to change)

1. Filters, Phasors, and Transfer Functions (Review)
2. Diodes Characteristics and Resistance
3. Light-emitting diodes (LEDs)
4. Rectifier Circuits
5. Voltage Regulation and Zener Diodes
6. Transistor Characteristics
7. Transistor Biasing
8. E type MOSFET amplifier
9. Two Stage MOSFET Amplifier
10. Introduction to Op Amps
11. Simple Op Amp Circuits
12. Input and Output Impedances of an Op Amp
13. Op Amp Frequency Response

5. Basis of Student Assessment (Weighting)

Quizzes (and assignments):	10%
Labs:	20%
Term Test(s):	30%
Final:	40%

GRADING (rounded to nearest per cent):

A+	90 – 100%	**B-**	70 – 72%
A	85 – 89%	**C+**	65 – 69%
A-	80 – 84%	**C**	60 – 64%
B+	77 – 79%	**D**	50 – 59%
B	73 – 76%	**F**	0 – 49%

To pass the course, students need to achieve a minimum of 60% on labs and 60% on the theory portion of the course (quizzes+tests+final) AND a **minimum score of 50% on the final exam**.

All labs and lab reports must be completed satisfactorily to obtain credit for the course. Normally, the lab report is due by the start of the lab period in the following week. Late labs will be penalized by 10% per day. You are required to attend and be on time for ALL labs. Failure to attend a lab without a valid excuse may result in being assigned a failing grade for that lab. If you cannot attend a lab (for a valid reason) please inform your lab instructor (ahead of time if possible) and arrange to make it up.

6. Grading System

[X] 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

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.