



**CAMOSUN COLLEGE**  
*School of Trades and Technology*  
*Electronics and Computer Engineering*

**ECET 251**  
**Digital Communications**  
**Winter 2018**

**COURSE OUTLINE**

---

The calendar description is available on the <http://camosun.ca/learn/calendar/current/web/ecet.html>  
web @ \_\_\_\_\_

*Ω 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 Russ Warren \_\_\_\_\_  
(b) Office hours \_\_\_\_\_  
(c) Location T207 \_\_\_\_\_  
(d) Phone 250-370-4420 Alternative: \_\_\_\_\_  
(e) E-mail warren@camosun.bc.ca \_\_\_\_\_  
(f) Website \_\_\_\_\_

**2. Intended Learning Outcomes**

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

- demonstrate the use of Smith charts for communication designs;
- explain the operation of digital modulation techniques in time and frequency domains;
- explain the features of digital radio transmitters and receivers;
- describe the effects of noise in digital communication systems;
- demonstrate error detection and correction techniques;
- explain characteristics of spread spectrum schemes;
- describe radio standards and regulations;
- measure electromagnetic compatibility and interference characteristics;
- perform power density and range calculations;
- demonstrate the implementation of a software-defined radio

**3. Required Materials**

HP Digital Modulation Introduction App Note 1298

ECET 251 Smith Chart Course Notes

Other documents and materials will be made available on the D2L site as the course progresses.

## 4. Course Content and Schedule

<b>1. Smith charts</b>	<b>6 hours</b>
1.1 Plotting points	
1.2 Matching with L or C	
1.3 Quarter-wave ( $\lambda/4$ ) transformer design	
1.4 Matching stub design	
1.5 Micro strip examples	
<b>2. Digital radio</b>	<b>4 hours</b>
2.1 Why use digital radio?	
2.2 What is digital radio?	
2.3 Keying (OOK, PSK, MPSK)	
2.4 I-Q modulator and demodulator	
2.5 Constellation diagrams	
2.6 Eye pattern	
2.7 Bit rate and symbol rate	
2.8 Encoding	
2.8.1 Balanced code	
2.8.2 Average DC voltage	
2.8.3 Multilevel codes	
2.8.4 Manchester encoding	
2.8.5 Return-to-zero (RZ) and Non-return-to-zero (NRZ)	
2.8.6 Unipolar and bipolar waveforms	
2.9 Bandwidth of digital signals	
2.9.1 Nyquist bandwidth	
2.9.2 Practical bandwidth	
2.9.3 Occupied bandwidth measurements	
<b>3. Digital radio transmitter and receiver</b>	<b>2 hours</b>
3.1 PLL detectors	
3.2 Data slicer	
3.3 Filters	
3.4 Start and stop sequences	
3.5 Data synchronization	
<b>4. Noise in digital radio</b>	<b>1 hour</b>
4.1 Effect on constellation diagram	
4.2 Eye pattern	
4.3 Bit error rate (BER)	
4.4 Coding gain	
4.5 Distance between points	
<b>5. Errors</b>	<b>2 hours</b>
5.1 Probability of errors	
5.1.1 Shannon-Hartley law	
5.1.2 $E_b/N_0$ ratio	
5.1.3 Probability of error (POE) calculation with waterfall diagram	
5.2 Error handling	<b>1.5 hours</b>
5.2.1 Error detection vs error correction	
5.2.2 Parity bit	
5.2.3 Redundancy and error determination	
5.2.4 Majority bit correction	
5.2.5 Hamming code	
5.2.6 Cyclic redundancy check (CRC) calculation	

<b>6.</b>	<b>Channel sharing</b>	<b>0.5 hours</b>
6.1	Time division multiple access (TDMA)	
6.2	Frequency division multiple access (FDMA)	
6.3	Code division multiple access (CDMA)	
<b>7.</b>	<b>Software-defined radio</b>	<b>2 hours</b>
<b>8.</b>	<b>Spread spectrum (SS) modulation</b>	<b>2 hours</b>
8.1	Advantages and disadvantages of SS	
8.2	Wideband vs narrowband	
8.3	Direct-sequence SS (DSSS)	
8.4	Pseudo-noise (PN) codes	
8.5	Frequency-hopping SS (FHSS)	
8.6	Noise in spread spectrum	
8.7	Near-far problem	
8.8	SS on the spectrum analyzer	
<b>9.</b>	<b>Digital systems overview</b>	<b>3 hours</b>
9.1	Bluetooth	
9.2	Zigbee	
9.3	Cell phone systems	
9.4	IEEE 802 WiFi radio standards	
<b>10.</b>	<b>Radio regulations</b>	<b>1 hour</b>
10.1	International agreements	
10.2	Part 15 regulation	
10.3	Radio Canada and FCC	
10.4	Unlicensed bands and ISM	
10.5	Intentional and unintentional radiators	
10.6	Overview of regulations for various bands	
10.7	Certification	
10.8	Signal strength regulations	
10.9	Bandwidth regulations	
10.10	Antenna and connector regulations	
10.11	Responsibility of the designer or installer	
10.12	Periodic and non-periodic operation	
<b>11.</b>	<b>Introduction to electromagnetic propagation</b>	<b>1 hour</b>
11.1	Electric field strength	
11.2	Magnetic field strength	
11.3	Power density and the isotropic antenna	
11.4	Polarization	
<b>12.</b>	<b>Range calculations</b>	<b>2 hours</b>
12.1	Antenna effective area	
12.2	Power received	
12.3	Range equation	
<b>13.</b>	<b>Wireless propagation in obstructed space</b>	<b>2 hours</b>
13.1	Review of refraction, reflection and scattering	
13.2	Multipath propagation	
13.3	Intersymbol interference (ISI) and bit spreading	
13.4	Large-scale and small-scale path loss	
13.5	Friis free space equation	
13.6	Path loss in free space and obstructed space	
13.7	Doppler effect	
13.8	Strategies for propagation loss reduction	
<b>14.</b>	<b>Electromagnetism (EM)</b>	

14.1	EM theory	<b>3 hours</b>
	14.1.1 Importance of EM	
	14.1.2 Electric field theory	
	14.1.3 Magnetic field theory	
	14.1.4 Near field and far field	
	14.1.5 Introduction to Maxwell's equations	
14.2	EM measurement	<b>2 hours</b>
	14.2.1 EM measurement techniques	
	14.2.2 Antennas for EM measurement	
	14.2.3 dB $\mu$ V and dB $\mu$ V/m	
	14.2.4 EIRP	

## 5. Basis of Student Assessment (Weighting)

*(Should be directly linked to learning outcomes.)*

Labs	13%	
Quizz-Smith Chart	10%	
Wireless Project & Report	5%	
Assignments	2%	
Mid Term Exam(s)	35%	
Final Exam	35%	
Total	100%	

## 6. Grading System

*(If any changes are made to this part, then the Approved Course description must also be changed and sent through the approval process.)*

*(Mark with "X" in box below to show appropriate approved grading system – see last page of this template.)*

Standard Grading System (GPA)

Competency Based Grading System

## 7. Recommended Materials to Assist Students to Succeed Throughout the Course

## 8. College Supports, Services and Policies



### Immediate, Urgent, or Emergency Support

If you or someone you know requires immediate, urgent, or emergency support (e.g. illness, injury, thoughts of suicide, sexual assault, etc.), **SEEK HELP**. Resource contacts @

<http://camosun.ca/about/mental-health/emergency.html> or <http://camosun.ca/services/sexual-violence/get-support.html#urgent>

### College Services

Camosun offers a variety of health and academic support services, including counselling, dental, disability resource centre, help centre, learning skills, sexual violence support & education, library, and writing centre. For more information on each of these services, visit the **STUDENT SERVICES** link on the College website at <http://camosun.ca/>

### College Policies

Camosun strives to provide clear, transparent, and easily accessible policies that exemplify the college's commitment to life-changing learning. It is the student's responsibility to become familiar with the content of College policies. Policies are available on the College website at <http://camosun.ca/about/policies/>. Education and academic policies include, but are not limited to, Academic Progress, Admission, Course Withdrawals, Standards for Awarding Credentials, Involuntary Health and Safety Leave of Absence, Prior Learning Assessment, Medical/Compassionate Withdrawal, Sexual Violence and Misconduct, Student Ancillary Fees, Student Appeals, Student Conduct, and Student Penalties and Fines.

#### A. GRADING SYSTEMS <http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.5.pdf>

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.