



Electronics & Computer Engineering Technology  
**ECET 250 Analog Communications**  
**COURSE SYLLABUS- 2019F**

Students will study analog voice and data communications. They will also learn radio frequency analysis, radio frequency (RF) components, amplitude modulation (AM) and frequency modulation (FM) techniques, single side band (SSB) transmission, transmission lines, RF propagation and noise. Students will make extensive use of RF test equipment, including spectrum analyzers, and simulation techniques during lab exercises.

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Instructor: Dr. Sahitya Yadav Kandur  
TEC 264  
250-370-4420  
KandurS@camosun.bc.ca

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**Course outline:**

**1. Introduction**

- 1.1 Communication overview
- 1.2 Terminology

**2. Frequency analysis**

- 2.1 Spectrum analysis
- 2.2 Introduction to Fourier analysis and Fourier tables<sup>1</sup>
- 2.3 Spectrum analyzer parameters (span, amplitude, dB, dBm)

**3. RF components**

- 3.1 Review of filter types and characteristics<sup>2</sup>
- 3.2 Transfer functions<sup>3</sup>
- 3.3 Oscillator types and characteristics
- 3.4 Mixers and mixer transfer functions

**4. Amplitude modulation (AM)**

- 4.1 AM waveform
  - 4.1.1 Modulation factor
  - 4.1.2 Bandwidth
  - 4.1.3 Overmodulation
  - 4.1.4 Harmonic distortion
  - 4.1.5 Power
- 4.2 AM transmitters
  - 4.2.1 Mixers
  - 4.2.2 Filters
  - 4.2.3 Oscillators
  - 4.2.4 Low and high level modulation topologies
- 4.3 AM receivers
  - 4.3.1 Tuned radio frequency (TRF) receiver
  - 4.3.2 Superheterodyne block diagram and operation
  - 4.3.3 Frequency conversion

- 4.3.4 Image frequency
- 4.3.5 Diode (peak) detector<sup>4</sup>
- 4.3.6 Bandwidth

## 5. Noise

- 5.1 Types and sources of noise
- 5.2 Thermal noise
- 5.3 Cascaded noise calculations
- 5.4 Noise factor and signal-to-noise ratio
- 5.5 Cascaded noise factor
- 5.6 Automatic gain control (AGC) in receivers
- 5.7 Signal-to-noise and distortion (SINAD) ratio

## 6. Frequency modulation (FM)

- 6.1 FM waveform
  - 6.1.1 Frequency sensitivity
  - 6.1.2 Frequency deviation
  - 6.1.3 Modulation factor
  - 6.1.4 Bandwidth
  - 6.1.5 Bessel tables
  - 6.1.6 Carson's rule
  - 6.1.7 Narrowband and wideband FM
- 6.2 FM transmitters
  - 6.2.1 Frequency mixing and multiplying
  - 6.2.2 Phase-locked loop (PLL) modulator
  - 6.2.3 Direct and indirect transmitters
- 6.3 FM receivers
  - 6.3.1 Slope detector
  - 6.3.2 PLL detector
  - 6.3.3 Limiter
  - 6.3.4 Frequency control
  - 6.3.5 Noise and FM
  - 6.3.6 Pre-emphasis and de-emphasis

## 7. Single Side Band (SSB)

- 7.1 SSB transmission
  - 7.1.1 Variations on AM modulation
  - 7.1.2 Power characteristics of a SSB signal
  - 7.1.3 SSB filter method
  - 7.1.4 SSB phase method
- 7.2 SSB reception
  - 7.2.1 Beat frequency oscillator (BFO)
  - 7.2.2 Double conversion and frequency inversion

## 8. Transmission lines

- 8.1 Transmission line model
  - 8.1.1 Types of transmission lines
  - 8.1.2 Distributed transmission line model
  - 8.1.3 Characteristic impedance
  - 8.1.4 Velocity of propagation
  - 8.1.5 Reflections and termination impedance

- 8.2 Time domain reflectometry (TDR)
  - 8.3 Standing waves
    - 8.3.1 Incident and reflected waves
    - 8.3.2 Standing wave ratio (SWR)
    - 8.3.3 Reflection coefficient
    - 8.3.4 Standing wave power calculations
    - 8.3.5 Input impedance of unmatched lines
    - 8.3.6 Importance of impedance matching
    - 8.3.7 Transformer matching
    - 8.3.8 Quarter-wave ( $\lambda/4$ ) impedance transformer
    - 8.3.9 Matching stub
  - 8.4 Applied transmission line theory
    - 8.4.1 Balanced and unbalanced lines
    - 8.4.2 Baluns
    - 8.4.3 Impedance matching techniques
    - 8.4.4 Transmission line attenuation
- 9. RF propagation**
- 9.1 Power density
  - 9.2 Gain
  - 9.3 Reflection, refraction and scattering
  - 9.4 Line of Sight, surface wave and ionospheric propagation
- 10. Antennas**
- 10.1 Antenna characteristics
    - 10.1.1 Radiation pattern
    - 10.1.2 Antenna gain
    - 10.1.3 Antenna impedance
    - 10.1.4 Half-wave ( $\lambda/2$ ) dipole antenna
    - 10.1.5 Quarter-wave ( $\lambda/4$ ) monopole antenna
    - 10.1.6 Counterpoise
    - 10.1.7 Antenna loading
    - 10.1.8 Reciprocity
  - 10.2 Additional antenna types
    - 10.2.1 Folded dipole
    - 10.2.2 Long wire antenna
    - 10.2.3 Loop antennas
    - 10.2.4 Broadside and end-fired arrays
    - 10.2.5 Yagi array
    - 10.2.6 Log periodic array
    - 10.2.7 Phased array and steered beam
    - 10.2.8 Parabolic reflector

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**Labs (Tentative):**

1. hands on experience with Lab equipment
2. Spectrum analyzer
3. AM function generator
4. Class C AM modulator and mixer
5. AM transmitter SPICE simulation
6. AM receiver SPICE simulation

7. WWV analyses
  8. Multiplier DSBSC
  9. FM modulator
  10. PLL and PLL FM demodulator
  11. Crosstalk
  12. Time domain reflectometry (TDR)
  13. Multisim transmission line model
  14. Antenna and path loss
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#### TEXTS AND REFERENCES:

1. Beasley and Miller, *Modern Electronic Communication*, 9<sup>th</sup> Ed.
  2. Labs for ECET 250 Analog Communications (available on D2L)
  3. ECET 250 Introduction to Analog Communications Part 1 (Available on D2L)
  4. ECET 250 Introduction to Analog Communications Part 2 (Available on D2L)
  5. Various online resources as needed.
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#### GRADING (in accordance with College policy):

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%

**A minimum of 60% must be achieved in both the theory and lab portions to pass the course.** Less than 60% in either portion will result in a failure of the entire course and **minimum of 50% must be achieved in Final exam to pass the course.**

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#### Evaluation

Labs	10%
Quizzes (Online and Inclass)	10%
Term Tests (2)	40%
Final Exam	40%

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.