Electronics & Computer Engineering Technology

ECET 250 Analog Communications
COURSE SYLLABUS- 2020F

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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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[1]
- 2.3 Spectrum analyzer parameters (span, amplitude, dB, dBm)

3. RF components
- 3.1 Review of filter types and characteristics[2]
- 3.2 Transfer functions[3]
- 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[4]
- 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 (λ/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 (λ/2) dipole antenna
10.1.5 Quarter-wave (λ/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

Labs (Tentative due to COVID-19):
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

TEXTS AND REFERENCES:

1. Beasley and Miller, ***Modern Electronic Communication*** , 9th 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.

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.**

Evaluation

Labs	15%
Quizzes	10%
Term Tests (2)	40%
Final Exam	35%

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.