EE302 Lesson Objectives (Fall 2012)

Lesson 1: Course Introduction

a. Review the course policy and syllabus.
b. Explain the functions of the three main parts of an electronic communication system.
c. Describe how communication systems are classified as simplex, duplex, analog or digital.
d. Define the electromagnetic spectrum and perform calculations involving signal frequency and wavelength.
e. Explain the relationship between frequency range and bandwidth and be familiar with the frequency ranges for spectrum uses ranging from ELF to EHF.
f. Describe the role of the FCC.

Lesson 2: Gain, Attenuation and Decibels

a. Define gain and attenuation.
b. Calculate voltage, current, and power gains for single and multistage systems.
c. Express power gain and voltage gain in decibels.
d. Express power levels in dBW/dBm and other reference levels.

Lesson 3: Noise

a. Define electrical noise and describe different types of internal and external noise.
b. Perform calculations of thermal noise voltage.
c. Performs calculations of signal-to-noise ratio, noise ratio, and noise figure.
d. Apply Friis's formula in determining effects of noise in a multistage amplifier system.

Lesson 4: Tuned Circuits

a. Review calculations of impedance for resistors, capacitors and inductors.
b. Define resonance.
c. Perform calculations of resonant frequency, half-power frequencies, bandwidth and quality factor for series RLC circuits.

Lesson 5: Filters

a. Explain how the use of filters can be applied to communication systems.
b. Describe the basic configuration of the different types of filters that are used in communication networks and compare and contrast active filters with passive filters.
c. Explain the function of Low Pass, High Pass, Passband and Reject-band filters and define cutoff frequenc0ies. Perform calculations involving simple RC, RL and RLC filters.

Lesson 6: Frequency Domain

a. Describe the difference between time-domain and frequency-domain representations of waveforms.
b. Identify the fundamental frequency, harmonic frequencies, Fourier coefficients and bandwidth of periodic waveforms.
c. Explain how filters operate in the frequency domain and compute the output of a filter for a given input.

d. Explain the importance of signal bandwidth in communication systems and what is meant by the baseband representation of a signal.

Lesson 7: Amplitude Modulation I

a. Define modulation.
b. Discuss the role of modulation in signal transmission and the methods of modulating a sinusoidal carrier.
c. Solve problems involving AM envelope, carrier amplitude, modulating signal amplitude, and modulation index for both time-domain and frequency-domain signal representations.
d. Define "over modulation" and explain how to alleviate its effects.
e. Compute bandwidth and sideband frequencies given carrier and modulating signal frequencies.
f. Sketch the frequency spectrum for an AM signal, given the frequency spectrum of the message.

Lesson 8: Amplitude Modulation II

a. Explain how the power in an AM signal is distributed between the carrier and the sideband, and then compute the carrier and sideband powers, given the percentage of modulation.
b. Explain what is meant by the terms DSB and SSB and state the main advantages of an SSB signal over a conventional AM signal.
c. Calculate peak envelope power (PEP), given signal voltages and load impedances.

Lesson 9: AM Demodulators

a. Explain the need for a demodulator.
b. Explain the operation of a diode.
c. Determine the output waveform of a simple diode rectifier circuit.
d. Explain in detail the operation of the diode detector and the function of each component.
e. Explain how diagonal clipping occurs and how it affects the demodulated waveform.

Lesson 10: Frequency Modulation

a. Define angle modulation and list its two subcategories.
b. Explain how modulating the signal amplitude and frequency affect the amount and rate of carrier frequency deviation for an FM signal.
c. Calculate the bandwidth of an FM signal using the Bessel function table and using Carson's rule.
d. Sketch the frequency spectrum of an FM signal.

Lesson 11: FM Noise Analysis

a. Explain the primary reason for FM's superiority to AM.
b. Explain the purpose of a limiter circuit and its limitation.
c. Define capture effect.

d. Explain preemphasis and de-emphasis and how they contribute to reducing the effect of noise.
e. Explain the advantages and disadvantages of FM.

Lesson 12: Superheterodyne (Superhet) Receivers

a. Define sensitivity and selectivity.
b. Describe the components of a tuned radio frequency (TRF) receiver and explain its shortcomings.
c. Describe and draw the block diagram for the basic superheterodyne receiver and represent the signal present at each location in the frequency domain.
d. Select and justify suitable intermediate frequencies for a receiver.
e. Describe the image frequency problem in superheterodyne receivers and explain how it can be minimized by the pre-selector filter.

Lesson 13: Antenna Fundamentals

a. Describe the purpose of an antenna.
b. Define Reciprocity.
c. State and describe the various polarizations possible in antennas.
d. Calculate the far-field distance for a given antenna.
e. Describe the construction of an antenna from a transmission line.

Lesson 14: Antennas

a. Compute the length of one-quarter wavelength and one-half wavelength antennas, given frequency of operation.
b. Compare and contrast a monopole antenna vs. dipole antenna (physical construction and radiation pattern).
c. Define parasitic element, reflector, and director and explain their role in an array antenna.
d. Explain the purpose of a counterpoise.
e. List the basic antenna types and give the characteristics of each.
f. Identify the 3dB down points and their significance given a 2-D antenna radiation pattern.
g. Calculate “Effective Radiated Power” (ERP) given a specific antenna type.
h. Define the relationship between beam width and antenna gain for a dipole antenna.
i. Define antenna array and phased array.
j. Perform calculations of Front-to-Back ratio.
k. Describe the importance of impedance matching.
l. Describe antenna gain in terms of dBi and dBd.

Lesson 15: Radio Wave Propagation

a. Define reflection, refraction and diffraction.
b. Describe the characteristics of ground waves, sky waves, and space waves.
c. Calculate the radio horizon distance for space waves based on antenna height.
d. Compute received power level for a communication system.
e. Describe the effects of the Ionosphere on radio waves.

Lesson 16: Binary Numbers

a. State differences between analog and digital signals.
b. Describe how binary values are represented by digital signals.
c. Convert between binary, decimal and hexadecimal numbers and perform binary addition.

Lesson 17: Combinatorial Logic

a. Describe the following logic functions, using truth tables, circuit symbols, and Boolean representations: NOT, OR, NOR, AND, NAND, XOR and XNOR.
b. Convert among Boolean expressions, combinational logic circuits, and truth tables.
c. Use 7400 series logic to implement simple logic expressions.

Lesson 18: Sequential Logic

a. Explain the difference between combinational and sequential logic.
b. Explain the operation of and write the truth table for an SR latch, T and D flip-flops.
c. Describe positive edge triggering, clock signals and timing diagrams.
d. Complete timing diagrams for single and interconnected SR latches, T and D flip-flops.
e. Describe the operation of a shift register constructed with D flip-flops.
f. Explain how T flip-flops can be combined as a ripple counter.
g. Evaluate combinatorial logic inputs to flip-flops.

Lesson 19: Introduction to Digital Communication

a. Provide examples of analog and digital communications systems.
b. Describe the advantages of digital over analog communications.
c. Explain the concept of serial and parallel transmission of digital signals and the advantages/ disadvantages of each method.
d. Discuss the basic steps of the analog-to-digital conversion process: sampling, quantizing and encoding.

Lesson 20: Analog and Digital Conversion

a. Explain the analog-to-digital (A/D) and digital-to-analog (D/A) conversion process.
b. Given an analog waveform, sampling rate and resolution, determine the resulting binary A/D output and sketch the reconstructed output of the D/A converter.
c. Calculate the minimum (Nyquist) sampling rate for an analog signal.
d. Calculate the resolution and dynamic range of an N-bit quantizer.
e. Explain how quantizing error occurs and how it is affected by sampling rate and quantizer resolution.
f. Calculate quantization signal-to-noise ratio for an N-bit quantizer.
g. Explain the purpose of non-uniform quantization and how it is achieved using companding.

Lesson 21: A/D and D/A Converters

a. Describe the function of the anti-aliasing filter and the sample-and-hold circuit.
b. Describe the operation of a comparator.
c. Understand the construction and operation of a successive-approximation converter and state its advantages.
d. Explain the construction operation of a flash converter and state its advantages/ disadvantages.
e. Understand the R-2R ladder D/A converter and calculate its output for a given binary input.

Lesson 22: Digital Transmission Fundamentals

a. Be familiar with binary digital codes such as the ASCII code and state how they are used to represent alphanumeric symbols.
b. Calculate the data rate for a serial transmission.
c. State the difference between a bit and a symbol.
d. Explain the difference between bit rate and baud rate.
e. Explain the difference between asynchronous and synchronous data transmission.
f. State the relationship between communication channel bandwidth and data rate on noise-free channels (Hartley's law) and on channels with noise (Shannon-Hartley theorem).
g. Calculate channel capacity using Hartley's Law and the Shannon-Hartley Theorem

Lesson 23: Digital Modulation I

a. Discuss the parallels between analog modulation of a sinusoidal carrier and digital modulation.
b. Describe how digital information is conveyed using various digital modulation techniques (ASK or OOK, FSK, PSK, and QAM) and recognize their waveforms/constellations.
c. State the advantage of DPSK modulation.
d. Explain how higher level modulation techniques, such as PSK or QAM, can reduce transmission bandwidth.

Lesson 24: Digital Modulation II

a. Describe the relationship between a signal constellation and its susceptibility to noise.
b. Calculate the required bandwidth using the spectral efficiency for various digital modulation formats.
c. Define carrier-to-noise (C/N) ratio.
d. Determine the bit error rate performance of various digital modulation formats for a given channel carrier-to-noise ratio using tables.
e. Define Eb/No.

Lesson 25: Wideband Modulation

a. Describe the basic principles of operation of Frequency Hopping and Direct Sequence Spread Spectrum (DSSS) systems and their advantages.

b. State the purpose of a pseudonoise (PN) sequence generator and calculate PN sequences and maximal sequence length.
c. Perform calculations involving processing gain for DSSS systems.

Lesson 26: Error Detection I

a. Define channel coding.
b. Discuss the difference between error detecting codes and error correcting codes. Provide examples of each.
c. Explain the concept of code rate and perform calculations to determine code rate.
d. Describe the purpose of parity codes.
e. Describe the purpose and applications of cyclic redundancy check (CRC) codes.
f. Perform calculations involving simple parity codes and longitudinal redundancy check (LRC) codes.

Lesson 27: Error Detection II

a. Determine the number and location of Hamming bits.
b. Perform encoding and decoding of Hamming code words and determine location of single bit errors.
c. Describe the purpose and applications of Reed-Solomon codes.

Lesson 28: Multiplexing Principles

a. Explain why multiplexing techniques are necessary in telemetry, telephone systems, radio, and TV broadcasting and internet access.
b. Describe how frequency division multiplexing (FDM) and time division multiplexing (TDM) allow multiple signals to be transmitted over the same channel.
c. Describe spatial multiplexing.
d. Trace the steps in the transmission and reception of multiplexed signals.

Lesson 29: Microwave Communications

e. Explain the fundamental microwave concepts.
f. Describe the advantages and disadvantages of using microwaves.
g. Explain the need for a waveguide and calculate the cutoff frequency (fco).
h. Describe the different types of microwave antennas.
i. Calculate the beamwidth and gain for a pyramidal horn and parabolic reflector antenna.

Lesson 30: Satellite Communications

a. Define the terms geocenter, apogee, perigee, period, angle of inclination, azimuth and elevation, geosynchronous, latitude and longitude.
b. Explain the difference between an elliptical and a circular orbit.
c. Describe the characteristics of the 3 satellite orbits (LEO, MEO and GEO).
d. Describe how the communication subsystem in a communication satellite works.
e. Identify the three main subsystems of a satellite and describe the operation of each.

f. Identify the five main subsystems of a satellite ground station and explain the operation of each.
g. Explain the concept and operation of the Global Positioning System (GPS).

Lesson 31: Optical Communications

a. Name the two sources of light used in a fiber-optic communication system.
b. Describe the basic operation of a fiber-optic communication system.
c. Describe how a light source is modulated.
d. Explain the benefits of using fiber optics.
e. Explain how light is propagated through a fiber-optic cable.
f. Name the three basic types of fiber-optic cables and state the two materials from which they are made.
g. Calculate the transmission loss and maximum data rate of a fiber-optic communication system.

Lesson 32: Intro to Networking

a. Describe the various types of networks (LAN, MAN and WAN).
b. Explain the various LAN Topologies; linear, mesh, tree, star and completely connected.
c. Discuss the functions of the different types of equipment used in networking (routers, switches, etc.)

Lesson 33: Internet Addressing

a. Explain the difference between a MAC address and an IP address.
b. Define the five classes of IP addresses.
c. Demonstrate the ability to develop a network addressing scheme, including sub-dividing a network.
d. Define the purpose of subnet masking.
e. Apply subnet masking concepts to allocate space for hosts in a subnet.
f. Define the addressing structure of IPv6.

Lesson 34: The Internet

a. Define the Internet.
b. List the main applications of the Internet.
c. Explain how data is transmitted over the Internet using packet switching.
d. Define the function of a networking protocol.
e. Describe the TCP/IP protocol and messaging format.
f. Describe the purpose of a Uniform Resource Locator (URL), the Domain Name System (DNS) and a port number.

Lesson 35: Network Security

a. Discuss the importance of Data Security
b. Identify and discuss the various threats to data security, such as: physical attacks, viruses, spam, spyware and denial of service.

c. Identify and discuss the various preventative measures available to minimize threats to data security, such as: physical security, data encryption, authentication, firewalls and protective software.