EE332 Course Objectives

Spring 2012

LESSON 1: COURSE INTRODUCTION AND REVIEW

A. Describe the EE332 course policy, as well as the section policy, if applicable.
B. Review and interpret the syllabus.
C. Review the fundamentals of DC and AC circuit analysis as covered in EE331, focusing on the ohm's law, voltage divider, current divider, Thevenin, sinusoids, complex numbers, and impedance analysis.

LESSON 2: GAIN, ATTENUATION, DECIBELS

A. Define gain and attenuation.
B. Perform calculations involving gain and attenuation.
C. Explain the principles of amplifiers in series and solve related problems.
D. Review operations with logarithms.
E. Convert from voltage, current, and power ratios to decibels and back.
F. Solve problems involving dBm and dBW.
G. Distinguish between dBm, and dBW.
H. Express gains and losses as decibels and unit-less ratios.

LESSON 3& 4: SEMICONDUCTORS AND DIODES

A. Review the ideal diode model.
B. Review the half-wave rectifier.
C. Review the zener shunt regulator.
D. Describe n and p-type semiconductors, and the basic structure and operation of the p-n junction diode.
E. Briefly describe how diodes fit in to the family of semiconductor electronic devices.

LESSONS 5: BIPOLAR JUNCTION TRANSISTORS

A. Define transistor
B. Describe the physical structure and physics of operation of an npn BJT in cutoff, forward active, saturation and breakdown.
C. Introduce the symbols and sign conventions for the npn bipolar junction transistors.
D. List the operation regions of the BJT and the governing current and voltage equations for each region.
E. Relate the operation regions of the BJT to amplification and switching.
F. Graph the base-emitter junction open collector curve and relate the characteristic to that of a diode.
G. Graph the collector-emitter output characteristics of a BJT and indicate the different operation regions on the graph.
H. Determine the operation region for an npn BJT for various operating conditions.
I. Use the BJT large signal model to analyze the operating point for a BJT in a circuit.
J. Describe the need for biasing for a BJT amplifier.
K. Describe circuit methods for establishing a desired bias point.

LESSONS 6-7: PASSIVE 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 frequencies. Perform calculations involving simple RC, RL and RLC filters.
D. Review calculations of impedance for resistors, capacitors and inductors.

E. Define resonance.
F. Perform calculations of resonant frequency, half-power frequencies, bandwidth and quality factor for series RLC circuits.

LESSONS 8-11: OPERATIONAL AMPLIFIERS AND ACTIVE FILTERS

A. Review the open-loop model for an op-amp.
B. Define and distinguish *open-loop* and *closed-loop* gain.
C. Review the two "golden rules" for an ideal op-amp with negative feedback.
D. Review the inverting amplifier, non-inverting amplifier, and summing amplifier configurations.
E. Analyze a differential amplifier
F. Design and analyze a level-shifter.
G. Analyze ideal integrator and differentiator amplifiers.
H. Explain the operation of an open-loop op-amp as a comparator.
I. Explain the operation of an op-amp with positive feedback as a Schmitt Trigger.
J. Determine the input-output transfer characteristic for op-amp comparator and Schmitt Trigger circuits.
K. Given a circuit, derive and plot the transfer function.
L. Describe the transfer function for ideal low-pass, high-pass, band-pass and band-stop filters.
M. Distinguish between *passive* and *active* filters.
N. Define and calculate *cut-off frequency* for a high-pass or low-pass filter.
O. Define and calculate *bandwidth*, *quality factor* and *resonant frequency* for a band-pass filter.
P. Explain resonance and derive the resonant frequency for a series RLC circuit
Q. Define and calculate *damping factor* and *half-power frequencies* for a band-pass filter.
R. Describe resonance and selectivity on your own words.
S. Define and calculate the *pass-band gain* and *3-dB frequency* for an active filter.
T. Plot the frequency response for an active filter.
U. Design an active low-pass or high-pass filter for a specified pass-band gain and cut-off frequency.

LESSONS 12: ELECTRONICS REVIEW

LESSON 13-15: COMMUNICATION SYSTEMS AND AM COMMUNICATIONS

A. Draw and describe the block diagram of a generic communication system.
B. Explain the need for modulation in communication system.
C. Differentiate between a baseband, carrier, and modulated signal.
D. Derive the equation for a modulated signal and explain the various types of modulation.
E. Explain the relationship between channel bandwidth, signal bandwidth, and transmission time.
F. Describe several type of noise that effect communication systems.
G. Explain terms *AM envelope*, *carrier*, *modulating signal*, *modulated wave*, *USB*, & *LSB*.
H. For a given modulating signal and carrier, sketch the time-domain AM signal.
I. Given carrier frequency and maximum modulating signal frequency, calculate AM bandwidth and frequency limits for the USB and LSB.
J. Solve problems involving AM: envelope, carrier amplitude, modulating signal amplitude, and modulation coefficient.
K. Given the spectrum of the modulating signal, sketch the spectrum of the corresponding AM signal.
L. Calculate the power in the AM carrier and sidebands and draw the power spectrum.
M. Discuss the requirements and specifications of AM transmitters.
N. Draw and describe the operation of the block diagram for an AM-DSBFC transmitter.

O. Describe and draw the block diagram for the basic superheterodyne system.
P. Contrast the superheterodyne receiver to the tuned radio frequency receiver.
Q. Explain suitable intermediate frequencies for a receiver.
R. Calculate the image rejection for a receiver.
S. Explain the requirements for each stage in a receiver and suggest suitable circuits to fulfill the requirements.
T. Analyze the circuit diagram for a transmitter or a receiver to determine the function of each stage.
U. Relate a circuit diagram to a block diagram for a transmitter or receiver.

LESSON 16-17: FM COMMUNICATIONS

A. Describe and explain the differences between amplitude and frequency modulation schemes and the advantages and disadvantages of each.
B. For an FM signal, calculate the bandwidth, sideband frequencies, carrier and sideband voltages, carrier and sideband power levels, and the modulation index.
C. Relate deviation, bandwidth, and signal-to-noise (SNR) improvement in FM systems.
D. Explain the capture effect and noise threshold level.
E. Calculate the SNR for a basic FM system.
F. Explain the use of pre-emphasis and de-emphasis in FM systems.
G. Derive and describe the operation of the block diagram of a FM system based on a generic communication system.
H. Compare analog and digital communication techniques and discuss appropriate uses for each.

LESSON 18-22: ANTENNAS AND PROPAGATION

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.
F. Compute the length of ¼ wavelength and ½ wavelength antennas, given frequency of operation.
G. Compare and contrast a monopole vs. dipole antenna (physical construction and radiation pattern).
H. Define parasitic element, reflector, and director and explain their role in an array antenna.
I. Explain the purpose of a counterpoise.
J. List the basic antenna types and give the characteristics of each.
K. Identify the 3dB down points and their significance given a 2-D antenna radiation pattern.
L. Calculate "Effective Radiated Power" (ERP) given a specific antenna type.
M. Define the relationship between beam width and antenna gain for a dipole antenna.
N. Define antenna array and phased array.
O. Perform calculations of Front-to-Back ratio.
P. Describe the importance of impedance matching.
Q. Describe antenna gain in terms of dBi and dBd.
R. Define reflection, refraction and diffraction.
S. Describe the characteristics of ground waves, sky waves, and space waves.
T. Calculate the radio horizon distance for space waves based on antenna height.
U. Compute received power level for a communication system.
V. Describe the effects of the Ionosphere on radio waves.

LESSON 23-27: DIGITAL MODULATION

A. Compare analog and digital communication techniques and discuss appropriate uses for each.
B. Draw a block diagram for a digital communications system.
C. Define pulse-code modulation (PCM) and relate it to analog-to-digital conversion.
D. Derive the number of quantizing levels, the bit rate, and the dynamic range for PCM systems.
E. Describe the process of coding and decoding of PCM signals.
F. Define and explain TDM as it applies to PCM signals.
G. Describe common error detection methods for digital communications.
H. Explain *amplitude-shift keying*, *frequency-shift keying* and *phase-shift keying* in your own words.
I. Explain why multiplexing techniques are necessary in telemetry, telephone systems, radio, and TV broadcasting and internet access.
J. Describe how frequency division multiplexing (FDM) and time division multiplexing (TDM) allow multiple signals to be transmitted over the same channel.
K. Describe spatial multiplexing.
L. Trace the steps in the transmission and reception of multiplexed signals.

LESSON 28: COMMUNICATIONS REVIEW

LESSON 29-30: ANALOG/DIGITAL CONVERSION

A. Explain the function of an analog-to-digital converter (ADC).
B. Define and explain *quantization* and *quantization error*.
C. Explain the operation of the *successive-approximation* and *flash* ADCs.
D. Define *ADC resolution* and *sampling interval*; explain significance to system complexity.
E. State and apply the Nyquist sampling criterion.
F. Explain the function of a digital-to-analog converter (DAC).
G. Explain the following terms for DACs: *resolution* and *range*.
H. Determine the number of bits needed given range and resolution required from a DAC.

LESSON 31-38: LOGIC AND DIGITAL SYSTEMS

A. List three advantages of digital technology compared to analog technology.
B. Describe the concept of a binary variable and explain why it is a natural application of electrical engineering
C. Explain digital words (bit, byte, and nibble)
D. Convert between the decimal, binary, and hexadecimal number systems.
E. Perform binary addition and subtraction.
F. Describe the following logic functions, using truth tables, circuit symbols, and Boolean representations: NOT, OR, NOR, AND, NAND, XOR, and XNOR.
G. Convert among Boolean expressions, combinational logic circuits, and truth tables.
H. Simplify expressions using Boolean algebra theorems.
I. Implement a given Boolean expression using only NAND gates.
J. Derive a sum-of-products (SOP) logic function solution from a truth table.
K. Design a logic circuit implementing a simple logical word problem.
L. Minimize logic circuits using two-, three- , and four- variable Karnaugh Maps (K-Maps).
M. Apply the “don’t care” conditions to optimize logical expressions.

N. Given a word problem, determine the truth table and minimal sum-of-products Boolean expression for the solution, and implement the solution using logic gates.
O. Draw the truth tables for RS, D, JK and T flip-flops.
P. Explain the concept of asynchronous preset (Pr) and clear (Cl).
Q. Differentiate between leading and trailing edge-triggered flip-flops.
R. Describe what is represented in a timing diagram.
S. Complete a timing diagram for a single flip flop with given inputs.
T. Complete a timing diagram for a circuit with interconnected flip flops.
U. Analyze and explain a Ripple Counter using JK, D, or T Flip-Flops.
V. Analyze and explain a Synchronous Counter using JK, D, or T Flip-Flops.
W. Given a counter circuit diagram and clock waveform, diagram the waveform for each Flip-Flop in the counter/register.
X. Design a counter or a similar state machine to specifications.

LESSON 39-40: ERROR DETECTION

A. Discuss the difference between error detecting and error correcting codes. Provide examples of each.
B. Explain the concept of code rate and perform calculations to determine code rate.
C. Describe the purpose of parity codes.
D. Describe the purpose and applications of cyclic redundancy check (CRC) codes.
E. Perform calculations involving simple parity codes and longitudinal redundancy check (LRC) codes.
F. Determine the number and location of Hamming bits.
G. Perform encoding and decoding of Hamming code words and determine location of single bit errors.
H. Define channel coding.

LESSON 41: DIGITAL REVIEW