EE334 Course Objectives

Fall 2012

COURSE INTRODUCTION AND REVIEW

A. Describe the course policy.
B. Review and interpret the syllabus.
C. Review the fundamentals of a communication system.
D. Review peak and RMS voltage, current, resistance, and power relationships
E. Review sinusoids
F. Review voltage dividers.
G. Review complex impedance.

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.
I. Review lab procedures and safety.
J. Demonstrate proper soldering techniques.

NOISE

A. Identify the relationship for distortion less transmission and compare this to one affected by noise.
B. Describe several types of noise that effect communication systems.
C. Relate bandwidth, resistance, and temperature to thermal noise.
D. Calculate the noise power and voltage for thermal noise.

FOURIER, FREQUENCIES, AND TIME

A. Convert from a time domain representation of signals to the frequency domain and back.
B. Express complex signals as the combination of several sinusoidal waves.
C. Discuss fundamental concepts of Fourier theory
D. Convert a periodic non-sine signal into its Fourier equivalent.

FILTERS

A. Explain the concept of a transfer function.
B. Determine the transfer function for Low Pass (LPF), High Pass (HPF), and Band Pass (BPF) filters.
C. Explain the operation of LPF, HPF, BPF, and Band Reject filters (BRF).
D. Determine the resonant frequency, pass-band, cutoff frequencies, bandwidth, and Q for series BPF and BRF.
E. Demonstrate the effect of filters on complex multiple frequency signals especially the degradation of non-sine waves due to filtering effects.

AMPLITUDE MODULATION

A. Explain modulation.
B. Derive the equation for an Amplitude Modulated signal.
C. Explain the terms envelope, carrier, modulating signal, modulated wave, modulation index, sideband, single-sideband, upper sideband and lower sideband.
D. Given the spectrum of a modulating signal, sketch the spectrum of the corresponding AM-DSB LC signal.
E. Analyze an AM signal in the time and frequency domain.
F. For a sinusoidal modulating signal, determine the time-domain AM wave equation.

G. For an AM signal calculate total power, carrier power, sideband power, modulation index, carrier amplitude and modulating signal amplitude.
H. Explain the benefits and costs of suppressing the carrier and/or a sideband from the AM broadcast.
I. Discuss frequency division multiplexing.

FREQUENCY MODULATION

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. Derive and describe the operation of the block diagram of a FM system based on a generic communication system.

SUPER HETERODYNE RECEIVERS

A. Explain the requirements for each stage in a receiver and suggest suitable circuits to fulfill the requirements.
B. Analyze the circuit diagram for a receiver to determine the function of each stage.
C. Describe and draw the block diagram for the basic super heterodyne system.
D. Compare and contrast the super heterodyne receiver to the tuned radio frequency receiver.
E. Select and justify suitable intermediate frequencies for a receiver.
F. Calculate the image rejection for a receiver.
G. Predict the output at each stage in the block diagram of a Superhet receiver and represent the signal present at each location in the frequency domain.

BINARY NUMBERS

A. Demonstrate how binary numbers can be used to enumerate items.
B. Given *n* binary digits, how many items can be counted (labeled) and what is the lowest and highest value that can be represented?
C. Create a place-value diagram for binary numbers.
D. Convert from binary to decimal and the reverse.
E. Invert the sign of a binary number (two's complement is sufficient).
F. Perform addition and subtraction in binary.

BOOLEAN LOGIC

A. Describe the following logic functions using truth tables, circuit symbols, and Boolean representations: NOT, OR, NOR, AND, NAND, XOR, and XNOR.
B. Evaluate the truth value of a Boolean expression.
C. Develop Boolean expressions for logic circuits and vice-versa.
D. Discuss the usefulness of truth tables.
E. Develop a truth table from a Boolean expression and vice-versa.

BOOLEAN ALGEBRA

A. Simplify expressions using Boolean algebra.
B. Apply DeMorgan's Theorem to logic circuit design and analysis
C. Implement a given Boolean expression using only NAND or NOR gates.
D. Given any one of the following, derive the others: digital circuit diagram, Boolean expression, or truth table.

TRANSISTORS

A. List two applications of a 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.
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.

KARNAUGH MAPS & LOGIC DESIGN

A. Derive a sum-of-products (SOP) logic function solution from a truth table.
B. Minimize logical expressions using Karnaugh Maps (K-Maps).
C. Apply "don't care" conditions to reduce logical expressions.
D. Given a design problem, construct an appropriate truth table, derive the SOP expression, and diagram the resulting digital logic to implement the expression.
E. Explain the generic function of encoders and decoders.

SEQUENTIAL LOGIC

A. Analyze the behavior of an SR flip-flop.
B. Draw the truth tables (aka excitation tables) for SR, D, T, and JK flip-flops.
C. Explain the concept of asynchronous preset (PRE) and clear (CLR).
D. Explain what it means for a device to be “active low” or “active high”.
E. Differentiate between positive and negative edge-triggered flip-flops.
F. Draw the timing diagram for an SR, D, T, and JK flip-flops given a clock signal and various input signals (PRE, CLR, active high, active low, etc.).
G. Discuss shift registers.

COUNTERS

A. Explain the difference between synchronous and asynchronous logic.
B. Implement digital logic to modify the modulus of a counter.
C. Given a counter circuit diagram and clock waveform, diagram the waveform for each flip-flop in the counter.

STATE MACHINE DESIGN

A. Given a set of design constraints, determine and draw the corresponding state diagram.
B. Based on a state diagram, derive the state transition table and the sequential logic expressions for a given circuit.
C. Apply analysis techniques of combinational and sequential logic to derive the minimum synchronous flip-flop circuit that satisfies a given design criteria.

INTRODUCTION TO DIGITAL

A. Differentiate between digital and binary.
B. Demonstrate how binary numbers can be used to enumerate items.
C. Given *n* binary digits, how many items can be counted (labeled) and what is the lowest and highest value that can be represented?
D. Explain how you can convey an idea or transmit information using a digital signal. The digital signal does not have to be number based.
E. Show how a digital signal can resist noise better than an analog signal.

DIGITAL AND ANALOG CONVERSION

A. Give an overview of ADC/DAC

B. Explain how quantizing error occurs and how it relates to resolution
C. Identify techniques used to minimize Quantizing Error
D. Explain aliasing and how it relates to the sampling rate
E. Calculate the minimum sampling rate for a signal using the Nyquist Sampling Theorem
F. Design a flash ADC given desired output levels, resistor values, comparators and input signal
G. Design a binary weighted DAC, given a set of digital input levels, Op Amp, and resistor values.

DIGITAL MODULATION

A. Compare analog and digital communication techniques and discuss their appropriate uses.
B. Identify and describe the basic types of digital modulation, and be able to graphically represent each type in the time domain.
C. Describe ASK, FSK and PSK, performing simple calculations with each.

THE COMMUNICATION CHANNEL

A. Calculate the information capacity of a channel using the Shannon Hartley theorem.
B. Differentiate between the data rate and channel capacity of a system.
C. Explain and calculate the differences between bit rate and baud (symbol) rate.
D. Be able to solve basic problems in channel capacity and data rate.

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.

ERROR DETECTION AND CORRECTION

A. Explain the usefulness of bit-encoded error detection and correction techniques.
B. Add parity bits to a message to enforce even parity or odd parity.
C. Encode and decode a message using longitudinal redundancy checking.

HAMMING CODES

A. Encode and decode a message using Hamming codes.
B. Compute the efficiency of an encoded message.
C. Discuss situations in which error detection and correction techniques are not useful or not reliable.

INTERNET

A. Identify the basic components of a network.
B. List the parts of a basic packet.
C. Trace the flow of a packet and explain the decisions that have to be made to move a packet through a network.
D. Differentiate between a Repeater, Hub, Bridge, Switch, Router and Gateway and discern when it is appropriate to use each kind of device.
E. Describe the contents of a routing table and its relation to routing algorithms.
F. Describe the key parts of the TCP, UDP and IP header protocols and explain the tradeoffs between TCP and UDP protocols (packets).
G. Explain why data is split into multiple packets and why nested of protocols is often used.
H. Using TCP/IP nested headers, compute the total number of packets and total number of bits transmitted for a data message of *k* bits.

IP ADDRESSING

A. Describe and explain MAC and IP addresses
B. Identify the Class of a network address given a Host address.

C. Derive the Network Mask given a Host address .
D. Calculate the number of Network bits and Host bits given an IP address.

SUBNETTING

A. List the purposes and benefits of subnetting.
B. Properly subnet a network IP address when given Network design criteria.

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.

INTERNET OPERATIONS

A. Identify the parts of a URL and explain how each part is used when communicating between a client and a web server.
B. Describe the role ad benefits of the Domain Name Resolution service and trace the flow of a DNR request from an end device up through the DNR hierarchy and back.
C. Describe the purpose of port numbers and explain how they are used to keep track of communications going into and out of a device.
D. (optional) Define a proxy server and explain how the proxy server decreases response times.
E. (optional) Define a reverse-proxy server and explain its benefits.
F. (optional) Explain the idea of the “server farm” and how requests reaching the farm are processed and then returned to the user.