APPENDIX A – COURSE SYLLABI

A. <u>Electrical Engineering Courses</u>

A.1. EE 214: Design of Logic Circuits

1. **Credits and contact hours:** Credits: 4(3-3); Contact hours: 3 50-minute lectures and 1 150-minute laboratory per week.

2. **Professor / Coordinator:** Scott Hudson

3. **Text book:**
   a. **None**
   b. **Other supplemental materials:**

4. **Specific course information**
   a. **Catalog description**
   Design and application of combinational logic circuits with exposure to modern methods and design tools; introduction to sequential logic circuits.
   b. **Prerequisites or co-requisites**
      - At least one programming course
      - Math 171
   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes instruction**
   This course presents the design skills and theoretical knowledge needed to design, simulate, and build combinational logic circuits and basic sequential circuits. An important component of this is learning to use the relevant CAD tools and design technologies used in industry today. The design projects are intended to give you ample exposure to these tools, so that on your successful completion of the course you will be able to design and implement a representative collection of combinational and sequential circuits using the same tools as are prevalent in industry.

   b. **Student outcomes addressed by the courses**
   (a) An ability to apply knowledge of mathematics, science and engineering.
   (b) An ability to design and conduct experiments as well as analyze and interpret data.
   (c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
   (d) An ability to function on multidisciplinary teams [Multidisciplinary refers to fields that are diverse in scope and nature such as physics, mathematics, economics as well as other engineering disciplines.]

(e) An ability to identify, formulate, and solve engineering problems.
(i) A recognition of the need for, and an ability to engage in life-long learning [Electrical engineering is a constantly changing discipline that, for its practitioners, clearly requires lifelong learning. For instance, the literature survey that is required at the beginning of the senior design projects is an example where the student has to engage in library activities to discover material not directly covered in the BSEE curriculum.]
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Introduction to electronic circuits, digital circuits, and terminology [a, e, k]
- Binary state terminology, CMOS circuits and symbols, basic logic functions and logic circuits [a, c, e, k]
- Logic circuits, representations, and minimization techniques [a, b, c, d, e, k]
- Inputs and outputs to and from digital circuits [a, b, c, e, k]
- Introduction to CAD tools, VHDL, and logic simulation [a, b, c, e, i, k]
- Combinational logic circuits including multiplexors, decoders, shifters, and comparators [a, c, e, k]
- Arithmetic logic circuits including adders, subtractors, multipliers, and ALUs [a, c, e, i, k]
- Circuit delays and timing defects in combinational circuits [a, b, c, e, k]
- Basic memory circuits and devices including flip-flops, latches, registers, and counters [a, b, c, e, k]
- Structural design of sequential circuits [a, b, c, e, k]
- Behavioral design of sequential circuits [a, b, c, e, k]

A.2. EE 234: Microprocessor Systems

Course Information

Course Name: Microprocessor Systems
Course Number: 234
Credits: 4
Lecture Hours: 3
Lab Hours: 3
Professor/Coordinator: Scott Hudson

Course Materials

Textbook(s): L. Di Jasio, *Programming 32-bit Microcontrollers in C: Exploring the PIC32*, Newnes, 2008.

Specific Course Information

Catalog Description: Microprocessor system architecture, instruction sets, and interfacing; assembly language programming.
Course Prerequisites: CPT S 122 with a C or better; EE 214 with a C or better.
Topic Pre-requisites: You should have a thorough understanding of programming in a high level language, and digital circuit design.
EE Course Required/Elective: required

Overview and Course Goals

This course will present concepts and hands-on experience necessary for understanding modern and cutting-edge microprocessors and microcontrollers. You will learn about the internals of a microcontroller/microprocessor. Internal components such as control unit, ALU, memory, and I/O units will be studied. Some of the microprocessor and microcontroller concepts explored in the course include, but are not limited to, the following:

- System and computer architecture
- Data and program memory accessing and interfacing
- Timing and synchronization including the use of interrupts
- Instruction sets
- Serial communication
- Assembly code efficiency
- Interfacing with on-chip and external devices, i.e. motors, timers, SPIs, LEDs, switches, buttons, sensors, etc.

Assembly language programming is introduced. The Microchip PIC32 family of microcontrollers is covered, with emphasis on the MIPS32 PIC32MX460F512L microcontroller. At times the differences between other microcontrollers and microprocessors are discussed. The underlying applications for this class will include robotic cars.

At the conclusion of this course, you should be able to:

- Develop well designed and documented assembly language programs to solve engineering problems

• Describe the architecture and operation of modern microprocessor/microcontroller-based systems
• Identify the differences between microprocessors and microcontrollers
• Discuss the central components of Microchip MIPS32 RISC microcontrollers
• Operate and control a basic robotic car
• Determine appropriate devices to interface with a microcontroller
• Draw and analyze timing diagrams
• Apply and discuss tradeoffs between interrupts and polling

Course Topics

Topics [with corresponding ABET outcomes]:
1. Introduction – Microcontrollers versus Microprocessors [a, c]
2. Digital circuits [a, c, e, k]
3. Data types [a, b, c, e, g, k]
4. Architecture [a, b, c, e, g, k]
5. Addressing modes [a, b, c, e, g, k]
6. Interrupts [a, b, c, e, g, k]
7. Timers/counters [a, b, c, e, g, k]
8. Comparators [a, b, c, e, g, k]
9. Programmers model [a, b, c, e, g, k]
10. Instruction set [a, b, c, e, g, k]
11. Subroutines and modules [a, b, c, e, g, k]
12. Macros [a, b, c, e, g, k]
13. Debugging [a, b, c, e, g, k]
14. Testing [a, b, c, e, g, k]
15. Development tools and C programming [a, b, c, e, g, k]
16. Hardware specifications [a, b, c, e, g, k]
17. Memory interface [a, b, c, e, g, k]
18. I/O interface [a, b, c, e, g, k]
19. Bus interface [a, b, c, e, g, k]
20. High-speed memory interfacing and cache [a, b, c, e, g, k]

A.3. EE 261: Electrical Circuits I

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minute lecture per week

2. **Professor /Coordinator:** David Lowry

3. **Text book:**
   a. Basic Engineering Circuit Analysis, Sixth Edition, J.D. Irwin, C.H WU,Prentice Hall, 1999, ISBN 0-13-792714-2
   b. **Other supplemental materials:**

4. **Specific course information**
   a. **Catalog description**
   Application of fundamental concepts of electrical science in linear circuit analysis; mathematic models of electric components and circuits.
   b. **Prerequisites or co-requisites**
   Math: 315 (or corequisite), Phys: 202, corequisite in EE: 262. Classical physics for scientists and engineers: electricity, magnetism, and light. Linear differential equations. Sufficient computer literacy to be able to use programs such as PSPICE.
   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes instruction**
   At completion of course, student will be able to
      - Create linear mathematical models of electric circuits consisting of power sources and passive components
      - Perform linear electrical circuit analysis

   b. **Student outcomes addressed by the courses**
   a. An ability to apply knowledge of mathematics, science and engineering.
   (e) An ability to identify, formulate, and solve engineering problems.

6. **Topics**
   - Definitions and units; independent power sources; resistors and Ohm's law; Kirchoff's laws; series and parallel circuit elements and circuit reduction. [a, e]
   - Nodal analysis; mesh analysis; superposition; Thevenin and Norton equivalent circuits; maximum power transfer. [a, e]
   - Dependent power sources and operational amplifiers. [a, e]
   - Energy storage elements; capacitors and inductors; first-order systems; natural and step responses of first-order electric circuits. [a, e].
   - Complex exponentials; second-order circuits; natural and step responses of second-order circuits. [a, e]

- Steady-state sinusoidal response; phasor analysis; impedance method for AC analysis. [a, e]
- Frequency response; frequency-selective circuits. [a, e]

Sinusoidal steady state power analysis; complex power; power triangles; power factor correction. [a, e]

A.4. EE 262: Electrical Circuits Laboratory

1. **Credits and contact hours:** Credits: 1(0-3); Contact hours: 1 150-minutes laboratory session per week.

2. **Professor /Coordinator:** Scott Hudson

3. **Text book:**
   a. Student Reference Manual for Electronics Instrumentation Laboratories, 2nd Edition, S. Wolf and R.F.M. Smith, Pearson Prentice-Hall, Inc, 2004.
   b. **Other supplemental materials:**

4. **Specific course information**
   a. **Catalog description**
      Electrical instruments; laboratory applications of electric laws; transient and steady-state responses of electrical circuits.
   b. **Prerequisites or co-requisites**
      EE 261: Electrical Circuits I
   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes instruction**
      At completion of course, student will be able to
      - Build and test electrical circuits; correlate experimental results with analytical expectations
      - Design, build, and test instrumentation and control systems; compare experimental results with analytical expectations.
      - Perform basic circuit analysis using computer-based tools such as PSPICE, TINA, LTSPICE, or MultiSim.

   b. **Student outcomes addressed by the courses**
      a. An ability to apply knowledge of mathematics, science and engineering.
      b. An ability to design and conduct experiments as well as analyze and interpret data.

      (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

6. **Topics**
   - Equipment familiarization. [a, b, k]
   - Resistors and Ohm' law. [a, b, k]
   - Kirchoff's laws. [a, b, k]

- Series and parallel resistor combinations; circuit reduction. [a, b, k]
- Thevenin’s theorem. [a, b, k]
- Non-ideal power supplies; non-ideal meters; operational amplifiers [a, b, k]
- Design project – instrumentation system design. [a, b, k]
- Design project – control system design. [a, b, k]
- First order electrical circuits. [a, b, k]
- Second order electrical circuits. [a, b, k]
- Steady-state sinusoidal response and phasors. [a, b, k]
- Frequency response. [a, b, k]
- Circuit simulation. [a, b, k]

A.5. EE 311: Electronics

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minutes lectures per week.

2. **Professor / Coordinator:** Mohamed Osman

3. **Text book:**
   - **a.** "Microelectronic Circuits," A. Sedra and K. C. Smith, Oxford University Press, Sixth Edition, 2010, 978-0195323030.
   - **b. Other supplemental materials:**
     - "Microelectronic Circuit Design," R. C. Jaeger and T.N. Blalock, McGraw Hill, Second Edition, 2004, ISBN 0-07-232099-0.
     - "SPICE," 2nd Edition, G. Roberts & A. Sedra, 1997, Oxford University Press.

4. **Specific course information**
   - **a. Catalog description**
     Fundamental device characteristics including diodes, MOSFETs and bipolar transistors; small- and large-signal characteristics and design of linear circuits.
   - **b. Prerequisites or co-requisites**
     EE 214, with grade of C or better.

     EE 261 with grade of C or better.

     KCL, KVL, basic circuit analysis including DC, AC, and transient analysis.

     EE 352: Electrical Engineering Laboratory I.

     Experiments in electrical circuits, measurements and electronics; principles of measurements and measuring instruments.
   - **c. Required**

5. **Specific goals for the course**
   - **a. Outcomes instruction**
     Students will learn to design, simulate using LTSpice and analyze basic analog circuits consisting of operational amplifiers, diodes, MOSFETs and bipolar transistors.

   - **b. Student outcomes addressed by the courses**
     (a) An ability to apply knowledge of mathematics, science and engineering.

     (c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

     (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

6. **Topics**
   a. Signals and amplifiers [a]
   b. Operational amplifiers
      - Ideal op-amps [a, c]
      - Frequency response of op-amps [a, c]
      - DC imperfections [a, c]
   c. Diodes
      - DC characteristics [a, c]
      - Diode models [a, c]
      - Diode circuits [a, c]
   d. Metal oxide semiconductor field effect transistors (MOSFETs)
      - Devices and I-V characteristics [a, c]
      - Biasing MOSFET amplifiers [a, c]
      - Small-signal MOSFET model [a, c]
      - MOSFET single-stage amplifiers [a, c, k]
   e. Bipolar junction transistors (BJTs)
      - Devices and I-V characteristics [a]
      - Biasing BJT amplifiers [a, c]
      - Small-signal BJT model [a, c]
      - BJT single-stage amplifiers [a, c, k]
   f. Current mirrors [a, c]
   g. Frequency response of common emitter and common source amplifiers [a, c, k]
   h. Miller's Theorem [a, c]
   i. Differential amplifiers [a, c]
   j. Multi-stage amplifiers [a, c]

A.6. EE 321: Electrical Circuits II

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minute lectures per week.

2. **Professor /Coordinator:** David Lowry

3. **Text book:**
   a. Nilsson and Riedel. Electric Circuits,
   b. **Other supplemental materials:**

4. **Specific course information**
   a. **Catalog description**
   EE 321 enhances the students' introduction to linear circuit analysis toward a systematic solution and design methodology, based on differential-equation formalisms. This general circuit analysis serves as a starting point toward an introduction to core tools in systems and signals analysis for electrical engineers.

   b. **Prerequisites or co-requisites**
   Completion of Circuits I (EE 261) and Differential Equations with grade of C or better, or permission of instructor.

   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes instruction**
   EE 321 provides a comprehensive development of core systems and signals concepts, and their application to linear circuits analysis and design. By the end of the course, students should be able to

      a. write down differential-equation models for linear circuits, and to put these circuit differential equations into standard, state-space-, and Laplace-domain forms;
      b. solve linear differential equations or circuits using several methods, including the method of undetermined coefficients, the convolution-based approach, Laplace-domain solutions, and state-space-based solutions (by computer);
      c. understand core system-theory concepts and constructs such as the transfer function, frequency response, and impulse response;
      d. design and analyze filter circuits;
      e. understand the operation of mutual inductors, as an additional circuit component;
      f. understand and be able to apply several mathematical techniques underlying systems/signal analysis, including Laplace-domain analysis, Fourier Series, and Fourier Transforms.

   b. **Student outcomes addressed by the courses**
      a. An ability to apply knowledge of mathematics, science and engineering.
      b. An ability to design and conduct experiments as well as analyze and interpret data.

(e) An ability to identify, formulate, and solve engineering problems.

(g) An ability to communicate effectively.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

6. Topics

- Developing differential-equation models for linear circuits [a,e,g]
- Solving differential equations using the method of undetermined coefficients [a,e]
- Using convolution to solve circuits/differential equations [a,e]
- Solving circuits and differential equations by computer using the state-space form [a,e,k]
- New circuit elements: mutual and ideal transformers [a,e]
- Laplace Transform mathematics [a,e]
- Solving circuits and differential equations using Laplace transforms [a,b,e,g,k]
- Core system-theoretic concepts: transfer function and impulse response [a,e,k]
- Frequency response (including drawing and interpreting Bode plots) [a,b,e,k]
- Design of filter and amplifier circuits [a,b,e,g,k]
- Fourier series: mathematics [a,e,k]
- Fourier series: application to circuits and systems analysis [a,e,k]
- Fourier transforms: introduction [a,e]

A.7. EE 331: Electromagnetic Fields and Waves

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minutes lectures per week.

2. **Professor /Coordinator:** David Lowry

3. **Text book:**
   - **a.** Elements of Electromagnetics, 5th ed., M. N. O. Sadiku, Oxford University Press, 2010, ISBN-13: 9780195387759, or similar textbook.
   - **b. Other supplemental materials:** Schaum's Outlines: Mathematical Handbook of Formulas and Tables, M.R. Spiegel and J. Liu, McGraw-Hill.

4. **Specific course information**
   - **a. Catalog description**
     Fundamentals of transmission lines, electrostatics, magnetostatics, and Maxwell's equations for static fields.
   - **b. Prerequisites or co-requisites**
     EE 261, EE 262, Phys 202, Math 315.

     Multivariable calculus, vector calculus, differential equations, previous exposure to the fundamental laws of electricity and magnetism, electrical circuits.
   - **c. Required**

5. **Specific goals for the course**
   - **a. Outcomes instruction**
     In this course students learn the fundamentals of transmission lines based on the lumped element model including how to use Smith charts, how to use single stub tuning to match a load to a line, and how to use bounce diagrams to perform analysis of transients. They are required to use vector and multivariable calculus to determine electrostatic and magnetostatic quantities based on the fundamental laws and concepts of electrostatic and magnetostatic fields both in free space and in material space. They learn how to solve Laplace's and Poisson's equations for one-dimensional canonical problems and how to apply boundary conditions to electrostatic and magnetostatic problems. The use of the Lorentz force equation is covered as well as magnetic forces, torque, and moments. Students are exposed to some of the practical applications of electrostatic and magnetostatic fields and learn Maxwell's equations for static fields.
   - **b. Student outcomes addressed by the courses**
     a. An ability to apply knowledge of mathematics, science and engineering.
     (e) An ability to identify, formulate, and solve engineering problems.

6. Topics

- Introductory material; wave equations; propagating waves. [a]
- Transmission lines; lumped element model; transmission line parameters; transmission line equations; characteristic, input, and load impedances; reflection coefficient; VSWR; Smith charts; shunt-stub tuning; bounce diagrams. [a, c]
- Review of vectors and vector calculus; position and distance vectors; vector fields; scalar and vector projection; vector algebra; vector calculus; coordinate systems; coordinate transformations. [a]
- Electrostatics; Coulomb's law; Gauss's law; charge and charge density; electric flux density; permittivity; dielectric constant; resistors; capacitors; boundary conditions; electric potential; work; Joule's law; Laplace's and Poisson's equations. [a, c]
- Magnetostatics; Biot-Savart law; Ampere's law; current and current density; magnetic flux density; permeability; inductors; boundary conditions; magnetic vector potential; Lorentz force equation; torque; magnetic moment. [a, c]
  Maxwell's equations for static fields.

A.8. EE 341: Signals and Systems

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minutes lectures per week.

2. **Professor /Coordinator:** David Lowry

3. **Text book:**
   a. Signals, Systems and Transforms, 3rd ed. by C. L. Phillips, J. M. Parr, and E. A. Riskin.
   b. **Other supplemental materials:**

4. **Specific course information**
   a. **Catalog description**
   Discrete and continuous-time signals, LTI systems, convolutions, sampling, Fourier transform, Z-Transform, filtering, DFT, amplitude and frequency modulation.

   b. **Prerequisites or co-requisites**
   EE 321 with a C or better; STAT 360 with a C or better or concurrent enrollment, or STAT 443 with a C or better or concurrent enrollment.

   Linear algebra, Laplace transforms, Linear circuits, Exposure to Matlab, Fourier series. Good understanding of Calculus, including differential equations, is essential. Basic understanding of probability is expected by the second half of the semester.

   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes instruction**
   This is an introductory course on signals and systems and deals with discrete and continuous time signals. Time domain analysis of linear time-invariant (LTI) systems --- convolution --- will be introduced first, followed by frequency domain analysis using Fourier transforms. Application to filtering, sampling analog signals, communications systems, and design of filters will also be considered. Course will conclude with some applications of probability to Electrical engineering problems. Approximate text chapter coverage: 1-6, 9, 10, and 12.

   b. **Student outcomes addressed by the courses**
   a. An ability to apply knowledge of mathematics, science and engineering.
   (c) An ability to design a system, component, or process to meet desired needs

   within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

6. **Topics**
   - Elementary signals and examples of systems, system properties, 7hrs
   - Linear time-invariant (LTI) systems: impulse response, convolution, properties of convolution and its application to LTI systems, 6hrs

- Fourier series (FS) and Fourier transform (FT), 6hrs
- Application of FS and FT to LTI systems, Filtering, Bandwidth, 3hrs
- Sampling analog signals and their reconstruction from samples, 3hrs
- Filter design, 3hrs
- Application to Communication systems --- Amplitude modulation schemes, demodulation, 3hrs
- Discrete time Fourier transform (DTFT), 3hrs
- Probability Applications --- Binary pulse amplitude modulation, Information Theory and Huffman Coding, 6hrs
- Midterm Exams and review, 5hrs.

A.9. EE 351: Distributed Parameter Systems

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50minute lectures per week.

2. **Professor /Coordinator:** David Lowry

3. **Text book:**

1 **a.** Elements of Electromagnetics, 5th ed., M. N. O. Sadiku, Oxford University Press, 2010, ISBN13: 9780195387759.
Electromagnetic Fields and Waves, 2nd ed., M. Iskander, Waveland Press, 2012, ISBN13: 9781577667834.
Fundamentals of Applied Electromagnetics, 6th ed., F. T. Ulaby, E. Michielssen, and U. Ravaioli, Prentice Hall, 2010, ISBN13: 9780132139311.

b. **Other supplemental materials:**

4. **Specific course information**

a. **Catalog description**
Maxwell's equations, plane waves, waveguides, resonators, antennas, numerical methods.
b. **Prerequisites or corequisites**
EE 331 with a C or better; certified major in Electrical Engineering, Computer Science, or Computer Engineering.
Vector calculus; Maxwell's equations; transmission lines.

c. **Elective**

6. **Specific goals for the course**

a. **Outcomes instruction**
This course builds on the largely theoretic material of EE 331 in order to teach students about practical applications of Maxwell's equations. Students will learn the math which governs the propagation of electromagnetic fields in both unbounded and bounded media (i.e., plane wave propagation and propagation within waveguides, respectively). Starting from the equations which govern radiation from an infinitesimally small element (a Hertzian dipole), students learn how to model radiation from actual antennas and from arrays of antennas. Because Maxwell's equations typically do not permit a closed-form solution to most real-world problems, a brief survey of the major numerical methods is presented. The course also requires the students to complete a project to help ensure they are able to perform practical applications of electromagnetic theory.

b. **Student outcomes addressed by the courses**
(a) An ability to apply knowledge of mathematics, science and engineering.
(b) An ability to design and conduct experiments as well as analyze and interpret data.
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
(d) An ability to function on multidisciplinary teams [Multidisciplinary refers to fields

that are diverse in scope and nature such as physics, mathematics, economics as well as other engineering disciplines.]
(e) An ability to identify, formulate, and solve engineering problems.
(g) An ability to communicate effectively.
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Topics

- Review of Maxwell's equations for static fields. [a]
- Maxwell's equations for time-varying fields. [a]
- Plane waves; propagation in lossless and lossy media; reflection and transmission at planar interfaces; oblique and normal incidence. [a]
- Antennas; dipole radiation; dipole antennas; loop antennas; antenna arrays. [a, b, c]
- Waveguides and resonators; rectangular guides; rectangular resonators. [a, c]
- Numerical methods; finite-difference methods; moment methods finite element methods. [a, b, e]
- Project. [a, b, c, d, e, g, k]

A.10. EE 352: Electrical Engineering Laboratory I

1. **Credits and contact hours:** Credits: 3 (1-6); Contact hours: 1 50-minute lectures and 2 150-minute laboratory session per week.

2. **Professor /Coordinator:** Scott Hudson

3. **Text book:**
   a. National 43-648 lab notebook, or equivalent (required).
   Optional:

   SPICE, 2nd Edition, G.W. Roberts and A.S. Sedra, Oxford University Press, 1997.

   Student Reference Manual for Electronics Instrumentation Laboratories, 2nd Edition, S. Wolf and R.F.M. Smith, Pearson Prentice-Hall, Inc, 2004.

   b. **Other supplemental materials:**
   References:

   - Online lab assignments, lecture notes, and background modules.
   - Microelectronic Circuits, 6th Edition, A.S. Sedra and K.C. Smith, Oxford University Press, 2009.
   - Electric Circuits, 9th Edition, J.W. Nilsson and S.A. Riedel, Pearson Prentice-Hall, 2010.

4. **Specific course information**
   a. **Catalog description**
   Experiments in electrical circuits, measurements and electronics; principles of measurements and measuring instruments.

   b. **Prerequisites or co-requisites**
   - Concurrent enrollment in EE 311
   - EE 321 with a C or better or concurrent enrollment
   - certified major in Electrical Engineering, Computer Science, or Computer Engineering.
   - Electronics at the 3rd year undergraduate level (concurrent enrollment):
   - theory and circuit applications of op-amps, diodes, MOSFETS, and bipolar junction transistors.
   - Circuit theory at the 3rd year undergraduate level (concurrent enrollment):
   - mutual inductance, state space, Laplace transform, transfer function, frequency response, introductory analog filter design.
   - Previous exposure to MATLAB helpful.

   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes instruction**

EE 352 is a laboratory course for third year electrical engineering students. Working in teams of two, students spend six hours a week in a dedicated circuits laboratory doing experiments with electronic devices and circuits. Students learn to use the measurement instruments in the lab such as digital multi-meters, digital oscilloscopes, function generators, LRC meters, and transistor curve tracers, as well as circuit simulation software such as SPICE. There is one lecture hour per week covering the theory behind the lab assignment to be done the following week. Students keep a detailed lab notebook recording experimental results and associated calculations. Students turn in written laboratory reports every week that summarize the lab experiments they did the previous week. The lab assignments cover time and frequency responses of 1st and second order LRC circuits, state space analysis of circuits, mutual inductance, operational amplifier properties and circuit applications, diodes and circuit applications, transfer functions, MOSFETs and circuit applications, and bipolar junction transistors and circuit applications. A semester project is assigned that involves significant design effort of a control or communication system circuit. A written interim project report is turned in for instructor feedback midway through the project, and then a written final project report is turned in at the end of the semester. Part of the final project report grade is a student demonstration of their circuit. The interim and final project reports are graded for both technical content as well as writing style, as EE352 is the writing-in-the-major course for electrical engineering majors.

b. Student outcomes addressed by the courses

(a) An ability to apply knowledge of mathematics, science and engineering.

(b) An ability to design and conduct experiments as well as analyze and interpret data.

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

(e) An ability to identify, formulate, and solve engineering problems.

(g) An ability to communicate effectively.

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Basic Equipment Familiarization and First Order Electrical Circuits (7 hours) [A,B,E,G,K]
- State Variable Models and Mutual Inductance (7 hours) [A,B,E,G,K]
- Operational Amplifier Applications (7 hours) [A,B,C,E,G,K]
- Non-Ideal Operational Amplifier Behavior (7 hours) [A,B,E,G,K]
- Diode Circuits (7 hours) [A,B,E,G,K]
- Transfer Function Analysis (7 hours) [A,B,E,G,K]
- MOSFET Circuits (7 hours) [A,B,E,G,K]

- BJT Characteristics (7 hours) [A,B,E,G,K]
- BJT Current Mirror Circuits (7 hours) [A,B,E,G,K]
- BJT Amplifier Circuits (7 hours) [A,B,E,G,K]
- Course design project (20 hours) [A,B,C,E,G,K]

A.11. EE 361: Electrical Power Systems

1. **Credits and contact hours:** Credits: 3; Contact hours: 1 50-minutes lectures per week.

2. **Professor /Coordinator:** Mohamed Osman

3. **Text book:**
   - **a.** Electric Machinery and Power System Fundamentals, S.J. Chapman, McGraw-Hill Science/Engineering/Math, 2001, ISBN: 0072291354
   - **b. Other supplemental materials:**

4. **Specific course information**
   - **a. Catalog description**
     Power system components including electromechanical machines, transmission lines, transformers; and introduction to power system steady state operation.
   - **b. Prerequisites or co-requisites**
     EE321: Electrical Circuits II (With Grade C or Better),

     EE331: Electromagnetic Fields and Waves (With Grade C or Better)
   - **c. Required**

5. **Specific goals for the course**
   - **a. Outcomes instruction**
     This course deals with a basic understanding of power system components, operation and analysis. Course will cover basic power system components including generating machines, transmission lines and transformers. Introduction to power system analysis will be also covered.

     At the conclusion of the course, students should be able to have basic understanding of power system components and how these components interact in steady state.

   - **b. Student outcomes addressed by the courses**
     A) An ability to apply knowledge of mathematics, science and engineering.

     B) An ability to design and conduct experiments as well as analyze and interpret data.

     C) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

     E) An ability to identify, formulate, and solve engineering problems.

     H) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context [This can be considered primarily a general education requirement. However,there are economic and social implications of electrical engineering that are, or may be, discussed within EE courses themselves. For example, wireless and satellite technologies have the potential to offer services to developing countries that could not afford to first deploy wired services. Additionally, smart-card and electronic information technologies have the potential to affect huge changes in society.]

I) A recognition of the need for, and an ability to engage in life-long learning

[Electrical engineering is a constantly changing discipline that, for its practitioners, clearly requires lifelong learning. For instance, the literature survey that is required at the beginning of the senior design projects is an example where the student has to engage in library activities to discover material not directly covered in the BSEE curriculum.]

J) A knowledge of contemporary issues [Contemporary issues are those pertinent

to electrical engineers entering or in the workforce today. Examples of contemporary issues include such things as the impact of deregulation on the power industry, and the infrastructure problems related to the creation of a wireless society.]

K) An ability to use the techniques, skills, and modern engineering tools

necessary for engineering practice.

6. Topics

- Review of prerequisites: three-phase AC systems (Ch. 1 & 2)[a, b, c]
- Transformers (Ch. 3) [a, b, c]
- Rotating machine fundamentals (Ch. 4) [a, b, c]
- Induction machines (Ch. 7) [a, b, c]
- Synchronous machines (Ch. 5 & 6) [a, b, c]
- DC motors (Ch. 8) [a, b, c]
- Transmission lines (Ch. 9) [a, b, c].

A.12. EE 362: Power Systems Laboratory

1. **Credits and contact hours:** Credits: 3 (1-6); Contact hours: 1 50-minutes lecture and 2 150-minutes laboratory per week.

2. **Professor /Coordinator:** Scott Hudson

3. **Text book:**
   a. Stephen J. Chapman, "Electric Machinery and Power System Fundamentals", McGraw-Hill 2002.
   b. **Other supplemental materials:**

4. **Specific course information**
   a. **Catalog description**
      Practical Laboratory for understanding the components (e.g. transformers, rotating machines) of a power system through performing experiments and studies
   b. **Prerequisites or co-requisites**
      EE 262 with a C or better; EE 352 with a C or better; concurrent enrollment in EE 361 and EE 341; certified major in Electrical Engineering, Computer Science, or Computer Engineering.

      EE 341: Signals and Systems

      EE 361: Electrical Power Systems
   c. **Elective Elective**

5. **Specific goals for the course**
   a. **Outcomes instruction**
      - The student will be able to perform tests to determine the parameters for the equivalent models of various rotating machines
      - The student will be able to apply concepts learnt from EE 361 about components of the power systems and perform experiments to confirm the theory learnt.
      - The student will be able to operate a small synchronous machine and parallel it into the power system through a synchronization process.
      - The student will be able to perform analysis on data captured during lab experiments using MATLAB
   b. **Student outcomes addressed by the courses**
      A) An ability to apply knowledge of mathematics, science and engineering.
      B) An ability to design and conduct experiments as well as analyze and interpret data.

      E) An ability to identify, formulate, and solve engineering problems.

      F) An understanding of professional and ethical responsibility [This can be considered ethical responsibility within the profession]

G) An ability to communicate effectively

K) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Review of power system components and analysis [a,e]
- Work in groups to perform experiments with an understanding of the importance of safety [b, e, f, g]
- Write lab reports for each set of lab experiments completed to explain work done [a, b, g]
- Understand how components are connected and incorporated into a power system [b, c, e].

A.13. EE 415: Design Project Management

1. **Credits and contact hours:** Credits: 2 (1-1); Contact hours: 1 50-minutes lecture and 1 150-minutes laboratory per week.

2. **Professor /Coordinator:** Mohamed Osman

3. **Text book:**
   - **a.** Product Design and Development, by Karl T. Ulrich and Steven D. Eppinger, fifth edition, NY: McGraw-Hill, 2012.
   - **b. Other supplemental materials:**

4. **Specific course information**
   - **a. Catalog description**

     Electrical engineering design of specific projects including design specification; written and oral presentations and reports.
   - **b. Prerequisites or co-requisites**

     Senior standing; EconS 101 or 102; completion of all required 300-level EE and CptS courses.

     Electrical circuit analysis and synthesis, laboratory equipment such as voltmeter, ammeter, oscilloscope, basic computer programming, and technical writing.

     EE 416: Electrical Engineering Design.
   - **c. Required**

5. **Specific goals for the course**
   - **a. Outcomes instruction**
     - Clarify a design problem.
     - Identify stakeholders.
     - Identify client needs.
     - Map client needs to target technical specifications.
     - Conduct impact analysis with techniques such as use case scenarios, fault trees and design for environment algorithms.
     - Decompose a system into a set of subsystems.
     - Generate design concepts that meet the target technical specifications.
     - Apply decision matrices to select the optimal concept from a matrix of concepts.
     - Demonstrate competency with teaming skills.
     - Communicate in written, oral and graphical formats.
   - **b. Student outcomes addressed by the courses**

     A) An ability to apply knowledge of mathematics, science and engineering.

     B) An ability to design and conduct experiments as well as analyze and interpret data.

C) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

D) An ability to function on multidisciplinary teams.

E) An ability to identify, formulate, and solve engineering problems.

F) An understanding of professional and ethical responsibility.

G) An ability to communicate effectively.

H) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

I) A recognition of the need for, and an ability to engage in life-long learning.

J) A knowledge of contemporary issues.

K) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Introduction: Design algorithm and course rubric. (1 hrs) [c]
- Form teams: Survey student interests and form teams. (2 hrs) [d]
- Problem clarification: Interview client, identify stakeholder, locate raw data, and determine needs. (6 hrs) [b, f, e, i]
- Engineering ethics: Workshop with professional from industry. (1 hrs) [f, i]
- Impact analysis: use case scenarios, fault trees, design for environment. (6 hrs) [h, i]
- Technical specifications: identify metrics and values important to the design. (2 hrs) [b, e]
- Teaming skills: personality types; “forming, norming, storming and performing” behaviors. (2 hrs) [d, i]
- Concept generation: system decomposition to subsystems, knowledge searches, brainstorming. (6 hrs) [c, e]
- Total quality management: sources of variance, measuring and recording properties of manufactured products. (1 hr) [a, b]
- Concept Selection: scoring matrices, benchmarking. (6 hrs) [b]
- Professional skills: competencies with lifelong learning, knowledge of contemporary issues. (1 hour) [j, i]
- Executive summary: writing for the busy executive, proof reading, effective use of appendixes. (5 hrs) [g]
- Presentation skills: giving engineering presentations. (1 hr) [g]
- Technical writing issues: references, attributing intellectual property, document organization, producing graphics with adequate resolution. (2 hr) [g, f]

- Prototype construction: various kinds of prototypes including “looks like” and “works like”. (1 hr) [c, e, k]
- Public presentation: presentation to client and the public then answer questions. (2 hrs) [g].

A.14. EE 416: Electrical Engineering Design

1. **Credits and contact hours:** Credits: 3 (1-6); Contact hours: 1 50-minutes lecture and 2 150-minutes laboratory per week.

2. **Professor /Coordinator:** Mohamed Osman

3. **Text book:**
   a.
   b. **Other supplemental materials:**

4. **Specific course information**
   a. **Catalog description**
      Electrical engineering design of specific open-ended projects including design specifications; written and oral presentations and reports.
   b. **Prerequisites or co-requisites**
      EE 415, English 402 (C or better, or concurrent)
   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes instruction**
      - Apply an iterative design algorithm to continual improvement of an engineering design.
      - Construct and utilize a prototype in the iterative design process.
      - Work effectively within a multidisciplinary engineering team environment.
      - Write test and verification plans for a prototype.
      - Communicate effectively with professionals such as clients, stakeholders, manufacturers, software vendors and other persons who are experts within various sub-disciplines.
      - Demonstrate awareness of professional responsibilities, including safety considerations.
      - Demonstrate awareness of contemporary issues that are coupled to the team's design.
      - Consider the impact of their design in multiple contexts such as global, economic, environmental, and cultural/societal.
      - Deliver a professional quality design that meets the client's preferences and meets primary stakeholders' needs.
      - Describe engineering progress at face-to-face technical meetings.
      - Demonstrate proficiency with technical writing by producing a high quality engineering progress report and a high quality engineering final report.
      - Participate professionally in a poster session.
      - Effectively utilize an online collaboration resource such as Socialcast to enhance engineering team work.
      - Generate and protect engineering intellectual property.

- Conduct impact analysis associated with the students' design project.

b. Student outcomes addressed by the courses

A) An ability to apply knowledge of mathematics, science and engineering.

B) An ability to design and conduct experiments as well as analyze and interpret data.

C) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

D) An ability to function on multidisciplinary teams.

E) An ability to identify, formulate, and solve engineering problems.

F) An understanding of professional and ethical responsibility.

G) An ability to communicate effectively.

H) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.

I) A recognition of the need for, and an ability to engage in life-long learning.

J) A knowledge of contemporary issues.

K) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Write test and validation plans. (3 hrs) [a, b, e, g, k]
- Fabricate various versions of the team's prototype. (12 hrs) [a, b, c, d, e, k]
- Test and validate various versions of the team's prototype. (8 hrs) [a, b, d, e, k]
- Apply engineering analyses, modeling and simulation to the team's design. (10 hrs) [a, b, e, i, k]
- Gantt chart used to partition responsibilities, specify work plans, and define timelines. (4 hrs) [a, d, f, g, k]
- Write progress report. (5 hrs) [a, c, d, e, f, g, h, i, j, k]
- Iteratively refine the team's design. (4 hrs) [a, c, d, e, j, k]
- Team work at an EECS-hosted online collaboration platform such as Socialcast. (10 hrs) [d, f, g, h, i, j]
- Participation in biweekly design reviews. (8 hrs) [a, d, f, g, h, i, j, k]
- Read, discuss and utilize refereed journal articles and other sources of engineering technical literature (standards, application notes, manufacturer's specification sheets, etc.) (8 hrs) [a, e, f, i, j, k]

- Broader impacts analysis and consideration of how contemporary technical and non-technical issues couple to (are influenced by or influence) the team's design. (8 hrs) [d, f, h, i, j]
- Participate in EECS poster session. (8 hrs) [a, b, c, d, e, f, g, h, i, j, k]
- Describe a final design with technical specifications. (3 hrs) [a, c, g]
- Specify limitations, recommendations, conclusions and future work. (3 hrs) [a, d, e, f, g, i, j]
- Write final report. (8 hrs) [a, b, c, d, e, f, g, h, i, j, k].

A.15. EE 432: RF Engineering for Telecommunications

1. **Credits and contact hours:** Credits: 4 (3-3); Contact hours: 3 50-minutes lecture and 1 150-minutes laboratory per week.

2. **Professor/Instructor:** Scott Hudson

3. **Text book:**
   - **c.** Wireless Communications: Principles and Practice, 2nd ed., T. S. Rappaport, Prentice-Hall PTR, 2002, ISBN 0-13-042232-0.
   - **d. Other supplemental materials:**
     References:
     1. Online lecture and lab notes by Scott Hudson and Ben Belzer.
     2. Literature references.

4. **Specific course information**
   - **d. Catalog description**
     System and radio propagation issues for wireless telecommunications. Cellular, PCS, microwave, and satellite system analysis, design, measurement and testing.
   - **e. Prerequisites or co-requisites**
     EE 341 with a C or better, EE 351 with a C or better, Math 360 or Math 443 with a C or better.
     Linear system theory. Fourier transform and spectral analysis. Amplitude modulation and basic communication theory. Solution of wave equation in free space. Plane wave reflection. Programming in C or MATLAB.
   - **f. Required**
     Elective.

5. **Specific goals for the course**
   - **a. Outcomes instruction**
     This is a survey course on wireless communications systems aimed at fourth year undergraduates and first year graduate students who plan to work in the wireless industry or need a background in wireless communications for their graduate studies. The course begins by considering radio wave propagation issues for terrestrial wireless systems, including ground effects, log-normal shadowing, link budgets, multipath fading and Doppler effects, and diffraction. The course then moves into cellular system design and analysis, covering frequency reuse, queuing theory, and cell sectoring and splitting. The second half of the course covers digital communications and signal processing techniques relevant to wireless, including FSK, BPSK, QPSK, and QAM, channel estimation with PSAM, spread spectrum, channel coding, and an introduction to OFDM. The course also includes some coverage of past, current, and proposed wireless communication standards. Concepts taught in lecture are reinforced by laboratory experiments involving indoor and outdoor propagation measurements, and design and computer simulation of digital communication systems for terrestrial and satellite communication channels.

b. Student outcomes addressed by the courses

(a) An ability to apply knowledge of mathematics, science and engineering.

(b) An ability to design and conduct experiments as well as analyze and interpret data.

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

(g) An ability to communicate effectively.

(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context [There are economic and social implications of electrical engineering that are, or may be, discussed within EE courses themselves. For example, wireless and satellite technologies have the potential to offer services to developing countries that could not afford to first deploy wired services. Additionally, smart-card and electronic information technologies have the potential to affect huge changes in society.]

(i) A recognition of the need for, and an ability to engage in life-long learning [Electrical engineering is a constantly changing discipline that, for its practitioners, clearly requires lifelong learning. For instance, the literature survey that is required at the beginning of the senior design projects is an example where the student has to engage in library activities to discover material not directly covered in the BSEE curriculum.]

(j) A knowledge of contemporary issues [Contemporary issues are those pertinent to electrical engineers entering or in the workforce today. Examples of contemporary issues include such things as the impact of deregulation on the power industry, and the infrastructure problems related to the creation of a wireless society.]

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Radiowave propagation. (3 hours) [A, B, G, K]
- Empirical propagation models and link budgets. (3 hours) [A]
- Multipath and fading. (4 hours) [A]
- Diffraction and computer propagation tools. (3 hours) [A, B, G, K]
- Cellular concept, frequency reuse, and queuing theory. (6 hours) [A, J]
- Health issues for wireless (1 hour) [A,H,J]
- Digital modulation/demodulation: FSK & GMSK, BPSK, QPSK, QAM (5 hours) [A,B,C,G,J,K]
- Wireless channel modeling, and channel estimation with PSAM (4 hours) [A,B,G,I,K]
- Spread spectrum and CDMA (4 hours) [A, J]
- Channel coding. (2 hours) [A]
- OFDM, LTE and 4G (2 hours) [A,J]
- In-class midterm (1 hour) [A]
- Quizzes (5) (2.5 hours) [A]
- Final course review (2.5 hours) [A].

A.16. EE 489: Introduction to Control Systems

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minutes lecture per week.

2. **Professor/Coordinator:** Mohamed Osman

3. **Text book:**
   - **a.** Franklin, Powell, and Emami-Naeini. Feedback Control of Dynamic Systems, Prentice Hall.
     Also, lecture notes are provided to the students.
   - **b. Other supplemental materials:**
     The textbook of Dorf and Bishop (Modern Control Systems) is suggested as a supplemental reference.

4. **Specific course information**
   - **a. Catalog description**
     EE 489 provides an introduction to classical control theory. Building on students' background in modeling and analyzing electrical systems, this course will study how dynamical systems can be controlled (modified) through feedback, so that they achieve desired design goals. Throughout the course, these control methods will be applied to realistic examples from several disciplines.
   - **b. Prerequisites or co-requisites**
     Completion of EE 321 with grade of C or better .

     EE 341: Signals and Systems

     concurrent registration in EE 341, or permission of instructor.
   - **c. Elective**

5. **Specific goals for the course**
   - **a. Outcomes instruction**
     EE 489 provides a comprehensive introduction to the analysis and design of feedback control systems. By the end of the course, students should be able to,

     - develop linear-systems abstractions and pose control-design problems for a range of electrical, mechanical, and heat/fluid-flow devices;
     - solve linear systems, and characterize their stability and performance;
     - analyze feedback control systems, by computing closed-loop responses (given tracking inputs and possible disturbances), and characterizing closed-loop stability and performance;
     - design feedback control systems, by choosing appropriate control architectures, and applying root-locus- and frequency-response-based design techniques.

b. Student outcomes addressed by the courses

A) An ability to apply knowledge of mathematics, science and engineering.

B) An ability to design and conduct experiments as well as analyze and interpret data.

C) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

E) An ability to identify, formulate, and solve engineering problems.

H) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context [This can be considered primarily a general education requirement. However,there are economic and social implications of electrical engineering that are, or may be, discussed within EE courses themselves. For example, wireless and satellite technologies have the potential to offer services to developing countries that could not afford to first deploy wired services. Additionally, smart-card and electronic information technologies have the potential to affect huge changes in society.]

K) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Introduction/Motivation: control applications, control-system types and components [a,g,h,i]
- Introduction/Motivation: example illustrating benefits/tradeoffs in feedback control [a,c,e]
- Modeling: forms of linear systems models (standard, state-space, transfer function) [a,e,k]
- Modeling: mechanical systems (including translational and rotational ones) [a,b,e,g,k]
- Modeling: electrical circuits [a,e,k]
- Modeling: electromechanical systems, with a focus on the DC motor [a,e,k]
- Modeling: heat and fluid flow [a,b,e,k]
- Modeling: linearization and scaling [a,e,k]
- Analysis of linear systems: review how to solve [a,e,k]
- Analysis of linear systems: internal and bounded-input-bounded-output stability, Including definitions, conditions, and tests (e.g., Routh criterion) [a,e,k]
- Analysis of linear systems: steady-state and transient performance, including definitions of measures and simple characterizations of these measures [a,e,k]
- Analysis of feedback systems: block-diagram analysis [a,e,k]
- Analysis of feedback systems: basic analysis of standard feedback configuration (compensation ahead of plant, unity-feedback-gain) [a,e,k]

- Analysis of feedback systems: stability and performance analysis by applying tools developed for linear systems [a,e,k]
- Design of feedback controllers: common control architectures (e.g., P, PI, PID, lead/lag networks); understanding their time-domain characteristics and selection [a,e,k]
- Design of feedback controllers: root-locus design, including drawing root loci, designing control gains, and interpreting performance using the root-locus [a,e,k]
- Design of feedback controllers: frequency-response-based design [a,b,e,k].

A.17. EE 491: Performance of Power Systems

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minutes lecture per week.

2. **Professor /Coordinator:** Mohamed Osman

3. **Text book:**
   - **a.** Power System Analysis, Authors: J.J. Grainger and W.D. Stevenson Jr., Publisher: McGraw Hill Inc., ISBN: 0-07-061293-5
   - **b.** **Other supplemental materials:**

4. **Specific course information**
   - **a.** **Catalog description**
     Static and dynamic behavior of power systems, power flow, and economic considerations.
   - **b.** **Prerequisites or co-requisites**
     EE 361 with a C or better;

     EE 362 with a C or better,

     certified major in Electrical Engineering, Computer Science, or Computer Engineering.
   - **c.** **Elective**

5. **Specific goals for the course**
   - **a.** **Outcomes instruction**
     - The student will be able to carry out power-flow analysis of small-scale static power system models.
     - The student will be able to apply concepts of economics for generation cost minimization in simple power system models.
     - The student will be able to apply concepts of small-signal stability analysis and transient stability analysis of small-scale power system models.

   - **b.** **Student outcomes addressed by the courses**
     A) An ability to apply knowledge of mathematics, science and engineering.

     B) An ability to design and conduct experiments as well as analyze and interpret data.

     E) An ability to identify, formulate, and solve engineering problems.

     G) An ability to communicate effectively.

     H) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context [This can be considered primarily a general education requirement. However,there are economic and social implications of electrical engineering that are, or may be, discussed within

EE courses themselves. For example, wireless and satellite technologies have the potential to offer services to developing countries that could not afford to first deploy wired services. Additionally, smart-card and electronic information technologies have the potential to affect huge changes in society.]

K) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Review of power system components and analysis [a, e]
- Power flow analysis - Newton-Raphson, fast decoupled [a, e, g, k]
- Economic operation, hydrothermal coordination [a, e, h]
- Generator controls, and inter-area exchange [a, e]
- Concepts of small-signal stability and transient stability [a, e]
- Introduction to power system security and state estimation [a, b].

A.18. EE 492: Renewable Energy

1. **Credits and contact hours:** Credits: 3 (2-3); Contact hours: 2 50-minutes lecture and 1 150-minutes laboratory per week.

2. **Professor /Coordinator:** Mohamed Osman

3. **Text book:**
   a. "Renewable and Energy Efficient Power Systems,", Gilbert Masters, CRC Press Wiley, 2004.
   b. **Other supplemental materials:**
   "Photovoltaics: Design & Installation Manual" by Solar Energy International, 2004.

4. **Specific course information**
   a. **Catalog description**
   Renewable energy resources, wind energy, fuel cells, solar cells and modules, stand alone and grid connected PV system design, experiments on PV system components, fuel cells and wind turbines.
   b. **Prerequisites or co-requisites**
   MSE 302, with a grade of C or better, or instructor approval.

   EE 361 with a grade of C or better, or instructor approval.

   semiconductors, inductions and synchronous generators.
   c. **Elective**

5. **Specific goals for the course**
   a. **Outcomes instruction**
   This course introduces students to renewable energy sources such as wind energy, solar energy, fuel cells. Students will learn about the components of PV energy system such as the inverters, batteries, charge controllers, PV modules and how to size them for stand alone and grid connected PV systems. They will hands experience on the use and characterization of components of PV systems, wind turbines, fuels cells and the use of PVWatts software to generate solar irradiation data.

   b. **Student outcomes addressed by the courses**
   A) An ability to apply knowledge of mathematics, science and engineering.

   B) An ability to design and conduct experiments as well as analyze and interpret data.

   C) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

E) An ability to identify, formulate, and solve engineering problems.

F) An understanding of professional and ethical responsibility [This can be considered ethical responsibility within the profession]

H) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context [This can be considered primarily a general education requirement. However,there are economic and social implications of electrical engineering that are, or may be, discussed within EE courses themselves. For example, wireless and satellite technologies have the potential to offer services to developing countries that could not afford to first deploy wired services. Additionally, smart-card and electronic information technologies have the potential to affect huge changes in society.]

J) A knowledge of contemporary issues [Contemporary issues are those pertinent to electrical engineers entering or in the workforce today. Examples of contemporary issues include such things as the impact of deregulation on the power industry, and the infrastructure problems related to the creation of a wireless society.]

K) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

6. Topics

- Energy resources, electric power generation, energy usage and sustainability [h,j]
- Non-renewable energy sources: Reserves, environmental impacts, and economic cost. [f, h, j]
- Renewable energy resources: Energy density, economics, environmental and social costs. [f, h,j]
- Solar Cells and modules: Operation principles of solar cells, IV characteristics and the effect of radiation, temperature and shading. [a, e]
- Photovoltaic system components [a]
- Photovoltaic system Design: DC and AC PV system sizing, Stand-alone vs grid connected PV systems [a, c, k]
- Wind Energy: Wind turbine components and operation principles, output power estimation and regulation: for given wind speed and rotor size. [a]
- Fuel Cells [a]

Laboratory Experiments: [b, c, e, j, k]

- Energy efficiency: Track energy usage rates at homes, offices, and Labs using “Kill=a-Watt”
- Fuel Cells: Fuel cells and electrolyzers, IV characteristics
- Solar Modules and cell electrical characterization
- PV system components: Batteries, inverters & charge Controllers

- Stand-alone-Solar System design:
- Wind turbine: Energy vs speed characterization.

A.19. EE 493: Protection of Power Systems I

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minutes lecture per week.

2. **Professor /Coordinator:** Scott Hudson

3. **Text book:**
   - **a.** S. Horowitz and A. G. Phadke, Power System Relaying, 3rd Ed, Wiley, 2009. The fault current calculation methods are based on J. J. Grainger and W. D. Stevenson, Jr., Power System Analysis, McGraw Hill, 1994.
   - **b. Other supplemental materials:** Electrical Distribution - System Protection, 3rd Edition, 1990, Cooper Power Systems.

4. **Specific course information**
   - **a. Catalog description**
     Analysis and equipment fundamentals of power system protection; symmetrical components, fault calculations; fuses; and relays including burden calculations.
   - **b. Prerequisites or co-requisites**
     EE 361 with a C or better;

     certified major in Electrical Engineering, Computer Science, or Computer Engineering.
   - **c. Elective**

5. **Specific goals for the course**
   - **a. Outcomes instruction**
     This goal of this course is to help students develop an in-depth understanding of analytical techniques for faults (such as short circuits) that occur on a power system and the corresponding protection schemes that are designed to minimize the impact. The purpose of protection is to isolate the faulted portion of the power system and allow the remaining power network to continue its operation. This course covers the fault analysis techniques and power system protection schemes for transmission and distribution systems.
   - **b. Student outcomes addressed by the courses**
     (A) An ability to apply knowledge of mathematics, science and engineering.

     (E) An ability to identify, formulate and solve engineering problems.

6. **Topics**
   - Overview [e]
   - Symmetrical fault current calculations [a, e]
   - Symmetrical components [a]

- Unsymmetrical fault calculations [a, e]
- Introduction to protective relaying [a, e]
- Relay operating principles [a, e]
- Current and voltage transformers [a, e]
- Over-current line protection [a, e]
- Distance protection of lines [a, e]
- Pilot line protection [a, e]
- Rotating machine protection [a, e]
- Transformer protection [a, e]
- Bus protection [a, e]
- Distribution feeder protection [a, e].

A.20. EE 496: Introduction to Semiconductor Devices

1. **Credits and contact hours:** Credits: 3; Contact hours: 3 50-minutes lecture per week.

2. **Professor /Coordinator:** Mohamed Osman

3. **Text book:**
   a. Chenming Hu, "Modern Semiconductor Devices for Integrated Circuits", Prentice Hall, 2010, ISBN 978-0-13-608527.
   B. Streetman and S. Banerjee, "Solid State Electronic Devices (6th edition)", Prentice Hall, 2006, ISBN 0-13-149726-X.

   b. Other supplemental materials:
   References:

   - R.F. Perret, "Semiconductor Device Fundamentals," Addison Wesley, 1996.
   - S. M. Sze, "Semiconductor Devices Physics and Technology".
   - Y. Taur&T. H. Ning, "Fundamentals of Modern VLSI Devices".

4. **Specific course information**
   a. Catalog description
   Equilibrium statistics of electrons and holes; carrier dynamics; p-n junctions, metal-semiconductor junctions, BJTs, MOSFETs, LEDs, Fabrication processes.

   b. Prerequisites or co-requisites
   Atomic structure, functional description of pn diodes, transistors and probability theory.

   c. Elective

5. **Specific goals for the course**
   a. Outcomes instruction
   - semiconductors and electron transport in semiconductors,
   - how characteristics of different semiconductor materials affect their electrical and optical properties,
   - operation principles of diodes, MOSFETs, BJT , scaling issues and fabrication processes.
   - online and library research on a semiconductor device or process technology not covered in class, write a term paper and present to class.

   b. Student outcomes addressed by the course: ABET [a, b, g, h, i]

6. **Topics**
   - Semiconductors and the parameters that control their characteristics [a]
     - Crystal Structure, electrons, holes, energy gap and effective mass
     - Intrinsic vs extrinsic semiconductors
     - Direct band gap vs indirect band gap; Narrow vs wide band gap.

- Semiconductor statistics: [a]
    - Fermi –Dirac and Maxwell-Boltzmann Distributions, Density of states , Fermi levels.
- Transport in Semiconductors: [a, b]
    - Scattering processes, mobility and its temperature and doping level dependence
    - Drift and diffusion currents under the influence of electric field
    - Generation, recombination, recombination lifetimes.
- Semiconductor devices and their operation principles [a , h]
    - PN Diodes, solar cells and Light emitting diodes
    - MOS Capacitors and CCDs
    - MOSFET and MOSFET Scaling issues
    - Biploar Junction Transistors.
- Semiconductor device and IC Fabrication processes [a]
- Impact of semiconductors on energy, communication and computer aided design [h].

B. Computer Science Courses

B.1. CptS 121: Program Design and Development

1. **Credits and contact hours:**
   Credits: 4 (3-1)
   Contact hours: 2.5 lecture hours and one 2.8 hour laboratory per week

2. **Instructor/Coordinator:** Robert R. Lewis
3. **Textbook:**
   J.R. Hanly & E.B. Koffman, Problem Solving & Program Design in C (7th ed.), Pearson Education, Inc., AddisonWesley, 2013.
   a. **Other supplemental materials**:
      P. J. Deitel & H. M. Deitel, C: How to Program (7th ed.), Pearson Education, Inc., Prentice Hall, 2013.

4. **Specific course information**
   a. **Catalog description**
      Formulation of problems and topdown design of programs in a modern structured language for their solution on a digital computer.
   b. **Prerequisites or corequisites**
      Math106 with a C or better; Math108, 171, 172, 182, 201, 202, 206, 220, 273, 315, or ALEKS math placement score of 70% or higher.
   c. **Required**

5. **Specific goals for the course**
   a. **Outcomes of instruction**
      1. Realize that the field of computer science is about more than just programming, and appreciate its foundations in algorithmic problem solving.
      2. Design, implement, and test a program applying modern tools and techniques.
      3. Analyze a specification of a problem of moderate complexity, and construct a structured, elegant C program that solves the problem.
   b. **Student outcomes addressed by the course**
      (C): The ability to program in modern programming languages.

6. **Topics covered**
   - Introduction to Algorithms
   - Software Development Process
   - Variables, Data Types, and Operators
   - Numeric Expressions
   - Functions (standard library and userdefined)
   - File Processing
   - Selection Structures
   - Loops (loop patterns)
   - Modular Programming
   - Arrays

- Pointers
- Strings
- Structures
- Recursion
- Bit Manipulation
- Dynamic Data Structures
- Command Line Arguments
- Testing and Debugging
- Macros
- Multifile Programs
- Problem Solving with Algorithms
- Memory Organization
- Pseudocode
- Software Design and Engineering Concepts
- Problem Solving Strategies

B.2. CptS 122: Data Structures

1. **Credits and contact hours:**
   Credits: 4 (31)
   Contact hours: 2.5 lecture hours and one 2.8 hour laboratory per week
2. **Coordinator:** Robert R. Lewis
3. **Textbook:**
   Paul Deitel and Harvey Deitel, C++: How To Program (8^{th} ed.), Pearson/PrenticeHall, 2011.

   a. **Other supplemental materials**: Paul Deitel and Harvey Deitel, C: How To Program (7^{th} ed.), Pearson/PrenticeHall, 2012.

4. **Specific course information**
   a. **Catalog description**
   This course is about advanced programming techniques, data structures, recursion, sorting, searching, and basic algorithm analysis.
   b. **Prerequisites or corequisites**
   CptS 121 (Program Design and Development).
   c. **Required**

5. **Specific goals for the course**
   a. Outcomes of instruction
   1. Apply and implement data structures
   2. Apply and implement several sorting algorithms
   3. Analyze algorithmic complexity
   4. Design, implement, and test a C++ program applying modern tools and techniques
   5. Solve problems using the various data structures and algorithms and write programs for their solutions.

   b. Student outcome addressed by the course
   (C): The ability to program in modern programming languages.

6. **Topics covered**
   - Setting up Visual Studio.
   - Review C (Functions, Recursion, Pointers, Characters & Strings).
   - Linked Lists, Stacks, Queues & Trees in C.
   - Introduction to C++.
   - Classes & Objects.
   - Operator Overloading.
   - Inheritance.
   - Polymorphism.
   - Templates.
   - Exception Handling.
   - Abstract Data Types.
   - Templated Linked List, Stacks, Queues & Trees.
   - Introduction to Standard Template Library (STL). Sorting and Algorithm Analysis.