Appendix A: Syllabi

Engineering Physics

Bachelor of Science in Engineering Physics

Self-Study Report

New Mexico State University

Electrical Engineering Courses

Course number and name: EE 161 Computer Aided Problem Solving

2. Credits and contact hours: 4 credits. Each week has three lectures of 50 minutes each and a lab session of 2 hours and 30 min.

3. Instructor's or course coordinator's name: Dr. Hong Huang

4. Textbook, title, author and year: *Problem Solving and Program Design in C*, 6th Edition, Jeri R. Hanly and Elliot B. Koffman, 2010

a. Other supplemental materials: None

5. Specific course information:

a. brief description of the content of the course (catalog description): The course is an introduction to scientific programming. Extensive practice in writing programs to solve engineering problems. Items covered will include: loops, input and output, functions, decision statements, and pointers.

b. prerequisites or co-requisities: Math 190G

c. indicate whether a required, elective, or selected elective (as per Table 5-1) course in the program: This is a required class for Engineering Physics students with the Electrical concentration.

6. Specific goals for the course:

a. specific course objectives:

- Understanding and interpreting problem statements by designing algorithms, based on problem statements that render correct solutions and implementing those algorithms as computer programs.
- Inputting and outputting data through both interactive and file mechanisms. Controlling program execution through decision statements and loops. Creating and calling user-defined routines with arguments passed by value and by reference. Performing operations using arrays, pointers, and data structures.
- Working and learning in teams in the lab environment.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Functioning effectively on teams - ABET outcome 3(d)
- Identifying, formulating, and solving engineering problems - ABET outcome 3(e)
- Communicating effectively - ABET outcome: 3(g)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:

- C program structure
- Input and output data in the interactive mode and the batch mode (through files)
- Top-down design with functions
- Selection structures
- Repetition and loops
- Function call by value and by reference
- Arrays, pointers and data structures

1. **Course number and name:** EE 162 Digital Circuit Design

2. **Credits and contact hours:** 4 credits (3+3P). Three 50 minute lectures each week, and a 2½ hour weekly lab.

3. **Instructor:** Dr. Krist Petersen

4. **Textbook:** *Fundamentals of Digital Logic with VHDL Design*, 3rd Edition, 2009 By Stephen Brown and Zvonko Vranesic, ISBN-10 : 0-07-352953
   a. **Other supplemental materials:** None

5. **Specific course information:**
   a. **catalog description:** Design of combinational logic circuits based on Boolean algebra. Introduction to state machine design. Implementation of digital projects with hardware description language.
   b. **prerequisites:** C or better in EE 161 (C programming) and MATH 190G (trigonometry).
   c. This is a required class for Engineering Physics students with the Electrical concentration.

6. **Specific goals for the course:**
   a. **specific outcomes of instruction:** To earn a grade of C, or better, students must satisfactorily demonstrate the following proficiencies:
      - Use Ohm's Law to solve basic voltage and current problems for resistors in series and parallel.
      - Use Boolean algebra, truth tables, and Karnaugh maps to manipulate logical expressions.
      - Design combinational logic circuits to meet specific requirements.
      - Represent numeric values in different bases. Convert values between bases. Perform logical and arithmetic operations with binary numbers.
      - Analyze Finite State Machines, including registers, counters, and shifters.
      - Use VHDL to program FPGA's to meet specific design requirements.

   b. **student outcomes addressed:** The course goals address the following student outcomes:
      - Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome 3(a)
      - Designing 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 - ABET outcome 3(c)
      - Functioning effectively on teams ABET outcome 3(d)
      - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice ABET outcome 3(k)

7. Brief list of topics to be covered:

- Binary numbers
- Truth tables
- Logic gates
- Boolean algebra
- Circuit synthesis
- Algebraic minimization
- Karnaugh maps
- Don’t care conditions
- Circuit analysis
- Numeric representations
- Multiplexors/Demultiplexors
- Feedback
- State diagrams
- Flip-flops
- State machines
- State minimization
- Registers, counters, & shifters
- Voltage, current, & resistance
- Ohm’s law
- Series & parallel circuits
- Pull-up, pull-down, & current-limiting resistors
- Laboratory topics: VHDL

1. Course number and name: EE 210 Engineering Analysis I

2. Credits and contact hours: 4 credits (3+3P). Each week has three lectures of 50 minutes each and a 2.5 hour lab.

3. Instructor's or course coordinator's name: Dr. Charles D. Creusere

4. Textbook, title, author and year:

- S. Lipschutz and M. Lipson, *Schaum's outlines Linear Algebra*, 4th Ed., McGraw Hill, 2009.
- H. Hsu, *Probability, Random Variables, and Random processes*, McGraw Hill, 2nd Ed.
- A. Gilat, *MATLAB an introduction with applications*, 4th Ed., JohnWiley & Sons. Inc., 2011.

a. Other supplemental materials:
References: R. D. Yates and D. J. Goodman, *Probability and Stochastic Processes: A friendly introduction for electrical and computer engineers*, John Wiley & Sons. Inc., 2005.
Software: Matlab 7.5 or higher

5. Specific course information:

a. brief description of the content of the course (catalog description): The application of linear algebra and matrices, probability, random variables and random processes to solve problems in electrical engineering. Applications to be covered include probabilistic modeling of electrical/electronic systems and an introduction to Matlab.

b. prerequisites: C or better in EE 161 and MATH 192G.

c. indicate whether a required or elective course: This is a required class for Engineering Physics students with the Electrical concentration.

6. Specific goals for the course:

a. specific course objectives:

- Perform vector and matrix operations, including matrix inversion, eigenvalue analysis, finding basis and dimension of vector spaces and rank of a matrix, and solving a set of linear equations.
- Calculate probabilities using probability mass, density, and cumulative distribution functions for single and multiple, discrete and continuous random variables, and relate them to electrical
- engineering applications.
- Perform simple parameter estimation, such as finding sample mean and variance, and relate to confidence intervals.
- Describe random processes in the context of signal processing and communications systems problems.
- Use MATLAB to solve problems involving linear algebra and probability, including designing and performing simple numerical experiments.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
- Designing and conducting experiments to simulate, test, validate, and/or verify - ABET outcome: 3(b)

- Identifying, formulating, and solving engineering problems – ABET outcome: 3(e)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:

- Vectors, matrices and matrix operations
- System of linear equations
- Vector spaces
- Eigenvalues and eigenvectors
- Probability axioms, conditional probabilities, Bayes' rule and applications
- Random variables, distribution and density functions
- Special distributions including Gaussian
- Multiple random variables
- Parameter estimation and confidence coefficient
- Random processes
- Laboratory topics will cover Matlab command window and environment, script files and data management, two-dimensional plots, conditional statements, logical operators and nested loops, function files, and solving problems for applications in parameter estimation and probability.

1. Course number and name: EE 260 Embedded Systems

2. Credits and contact hours: 4 credits (3+3P). Each week has three lectures of 50 minutes each and a 2.5 hour lab.

3. Instructor's or course coordinator's name: Dr. Hong Huang

4. Textbook, title, author and year:
TBA

5. Specific course information:

a. brief description of the content of the course (catalog description): Applications of microcontrollers, FPGAs, interfaces and sensors, introductionto language programming

b. prerequisites: C or better in EE 162

c. indicate whether a required or elective course: This is a required class for Engineering Physics students with the Electrical concentration.

6. Specific goals for the course:

a. specific course objectives:

EE 260 is a new class for digital electronics. The class is being designed to introduce microcontrollers with a view towards studying embedded systems. This class will also utilize the C programming from EE 161.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
- Designing 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 - ABET outcome: 3(c)
- Identifying, formulating, and solving engineering problems – ABET outcome: 3(e)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:
TBA

1. Course number and name: EE 280 DC and AC circuits

2. Credits and contact hours: 4 credits (3+3P). Each week has three lectures of 50 minutes each and a 2.5 hour lab.

3. Instructor's or course coordinator's name: Dr. Hong Huang

4. Textbook, title, author and year:
TBA

5. Specific course information:

a. brief description of the content of the course (catalog description): Electric component descriptions and equations.Kirchhoff's voltage and current laws, formulation and solution of network equations in the time and frequency domain. Applications of circuit analysis to ideal op amps. Complete solutions of RLC and switching networks. Mutual coupling.

b. prerequisites: C or better in MATH 192G and PHYS216G

c. indicate whether a required or elective course: This is a required class for Engineering Physics students with the Electrical concentration.

6. Specific goals for the course:

a. specific course objectives:

Combining the old EE 111 and EE 211 into a single course EE 280. This course occurs later in the sequence to allow the students to have the proper mathematics and physics preparation so that the basic circuit analysis for RLC components can be covered in a single semester. This will allow for articulation with the other programs in the state..

b. explicitly indicate which of the program outcomes are addressed by the course:

- Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
- Designing and conducting experiments to simulate, test, validate, and/or verify - ABET outcome: 3(b)
- Designing 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 - ABET outcome: 3(c)
- Identifying, formulating, and solving engineering problems – ABET outcome: 3(e)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:
TBA

1. **Course number and name:** EE 310 Engineering Analysis II

2. **Credits and contact hours:** 3 credits. Each week has two lectures of 75 minutes each.

3. **Instructor's or course coordinator's name:** Dr. Kwong T. Ng

4. **Textbook, title, author and year:** David K. Cheng, *Fundamentals of Engineering Electromagnetics*, Prentice Hall, 1993.

   a. Other supplemental materials: References: Harry M. Schey, *div, grad, curl, and all that*, 4th Ed., W.W. Norton & Company, 2005; Software: Matlab 7.5 or higher

5. **Specific course information:**

   a. Brief description of the content of the course (catalog description): Calculus of vector functions through electrostatic applications. Techniques for finding resistance and capacitance. Coulomb's law, gradient, Gauss divergence theorem, curl, Stokes' theorem, and Green's theorem. Application of complex algebra and Matlab.

   b. Prerequisites: C or better in EE 210 and MATH 291G.

   c. Indicate whether a required or elective course: This is a required class for Engineering Physics students with the Electrical concentration. It can be substituted by PHYS 461.

6. **Specific goals for the course:**

   a. specific course objectives:

   - To learn and apply techniques in differential and integral vector calculus.
   - To learn how to use vectors to perform analysis and solve problems with different coordinate systems.
   - To learn complex arithmetic and complex algebra.
   - To apply vector calculus techniques to calculate static fields and analyze their behavior in engineering problems.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Applying knowledge of mathematics, science and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
- Identifying, formulating, and solving engineering problems - ABET outcome: 3(e)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. **Brief list of topics to be covered:**

- Vector algebra, orthogonal coordinate systems
- Vector differential operators
- Line integral, surface integral and volume integral
- Vector theorems
- Static field theory
- Vector field calculations in free space and dielectrics
- Electric potential and its evaluation
- Circuit quantities and their calculation
- Complex arithmetic and algebra

1. Course number and name: EE 312 Signals and Systems I

2. Credits and contact hours: 3 credits. Each week has two lectures of 75 minutes each and two voluntary problem solving sessions, one hour each.

3. Instructor's or course coordinator's name: Dr. Joerg Kliewer

4. Textbook, title, author and year: Alan V. Oppenheim and Alan S. Willsky, *Signals & Systems*, 2^{nd} Edition, Prentice Hall, 1997

a. Other supplemental materials: Software: Matlab 7.5 or higher

5. Specific course information:

a. brief description of the content of the course (catalog description): Continuous- and discrete-time signals and systems. Time- and frequency- characterization of signals and systems. Transform-domain methods including Fourier-, Laplace-, and z-transforms.

b. prerequisites: C or better in EE 210, EE 280, and MATH 392.

c. indicate whether a required or elective course: This course is a required course for Engineering Physics students with the Electrical concentration

6. Specific goals for the course:

a. specific course objectives:

- Understanding different types of signals (continuous-time, discrete-time, periodic, etc.) and how these signals are represented mathematically and in a computer.
- Understanding systems representations (e.g., impulse responses), their implementations (e.g., convolution and difference/differential equations), and their properties (e.g., linearity).
- Understanding and being able to apply transform-domain analysis methods for signals and systems.
- Ability to apply transform domain and LTI analysis to simple applications in signal processing, communications, and controls using Matlab.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Applying knowledge of mathematics, science and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
- Identifying, formulating, and solving engineering problems -ABET outcome: 3(e)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:

- Signals and systems
- Linear time-invariant systems
- Fourier series representation of periodic signals
- The continuous-time Fourier transform
- The discrete-time Fourier transform
- Time and frequency characterizations of signals and systems
- The Laplace transform
- Sampling

1. **Course number and name:** EE 314 Signals & Systems II

2. **Credits and contact hours:** 4 credits (3+3P). Each week has two lectures of 75 minutes each and a 2.5 hour lab.

3. **Instructor's or course coordinator's name:** Dr. Laura E. Boucheron

4. **Textbook, title, author and year:**
   - V. Oppenheim, A. S. Willsky, and S. H. Nawab, *Signals & Systems*, 2nd Ed., Prentice Hall, 1997.
   - J. R. Buck, M. M. Daniel, and A. C. Singer, *Computer Explorations in Signals and Systems Using MATLAB*, 2nd Ed., Prentice Hall, 2002.

   a. Other supplemental materials: Software: Matlab 7.5 or higher

5. **Specific course information:**

   a. Brief description of the content of the course (catalog description): Introduction to communication systems including amplitude-, frequency-, and pulse-amplitude modulation. Introduction to control systems including linear feedback systems, root-locus analysis, Nyquist criterion. Introduction to digital signal processing including sampling, digital filtering, and spectral analysis.

   b. Prerequisites: C or better in EE 312.

   c. Indicate whether a required or elective course: This course is a possible elective for Engineering Physics students with the Electrical concentration.

6. **Specific goals for the course:**

   a. specific course objectives:
   - To model, analyze, simulate, and perform calculations with continuous- and discrete-time systems.
   - To develop an understanding of basic modulations in communication systems.
   - To gain insight into the basics of control systems.
   - To develop insight into filtering and analysis of digital signals.
   - To learn how to use MATLAB and SIMULINK to perform analysis, design, and simulation of communication, control, and signal processing systems.

   b. explicitly indicate which of the program outcomes are addressed by the course:
   - Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
   - Designing 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 - ABET outcome: 3(c)
   - Identifying, formulating, and solving engineering problems - ABET outcome: 3(e)
   - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:

- The sampling theorem
- Interpolation
- Aliasing
- The z-transform
- Analysis and characterization of LTI system using the z-transform
- Complex exponential and sinusoidal amplitude modulation
- Frequency division multiplexing
- Pulse amplitude modulation
- Sinusoidal frequency modulation
- Introduction to digital communications
- Linear feedback systems
- Root-locus analysis of linear feedback systems
- The Nyquist stability criterion
- Gain and phase margins
- Laboratory topics will cover Matlab and Simulink programming to solve problems covering the application of signal processing, communications, and control theory

1. **Course number and name:** EE 363 Computer Systems Architecture

2. **Credits and contact hours:** 4 credits (3+3P). Three 50 minute lectures each week, and a 2½ hour weekly lab.

3. **Instructor:** Dr. Krist Petersen

4. **Textbook:** *Computer Organization and Design: The Hardware/Software Interface*, 4th edition, 2008, By David A. Patterson and John L. Hennessy, ISBN-13 : 978-0-12-374493-7
   a. **Other supplemental materials:** None

5. **Specific course information:**
   a. **Catalog description:** Concepts of modern computer architecture. Processor micro-architectures, hardwired vs. micro-programmed control, pipelining and pipeline hazards, memory hierarchies, bus-based system architecture, memory mapping, hardware-software interface, and operating system concepts. Comparison of architectures to illustrate concepts of computer organization; relationships between architectural and software features.
   b. **prerequisites:** C or better in CS 273 (machine programming and organization) or EE 260 (embedded systems).
   c. This course is a possible elective for Engineering Physics students with the Electrical concentration.

6. **Specific goals for the course:**
   a. **specific outcomes of instruction**: To earn a grade of C, or better, students must satisfactorily demonstrate the following proficiencies:
      - Understand the macro components of a computer system, including displays, keyboards, disk drives, mice, serial & parallel ports, and networks.
      - Understand the micro components of a computer system, including memory, cache, registers, ALU's, pipelines, instruction decoding, and interrupts.
      - Understand the function of an operating system, including file systems, multi-tasking, multi-user, and program execution.
      - Understand the operation of the processor, including the fetch/execute cycle, memory access, virtual memory, addressing modes, data types, instruction sets, and interrupt handling.
      - Understand the relationship between hardware and software.
      - Understand their professional and ethical responsibilities with respect to computer architectural design decisions.
      - Understand the potential global, economic, environmental, and societal impact of their engineering decisions.
      - Awareness of current topics in computer architecture

b. student outcomes addressed: The course outcomes of instruction address the following program student learning outcomes:

- Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, computer science, and physics); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome 3(a)
- An understanding of professional and ethical responsibility - ABET outcome 3(f)
- Understanding the impact of engineering solutions in a global, economic, environmental, and societal context - ABET outcome 3(h)
- Maintaining a knowledge of contemporary professional, societal and global issues - ABET outcome 3(j)

7. Topics covered:

- CPU architecture
- Memory interfacing
- Cache strategies
- RISC vs. CISC
- Multi-processors
- Micro-programmed control
- Pipelining
- Address binding
- Memory hierarchies
- Paging
- Virtual memory
- Data types
- Data alignment
- Interrupt handling
- I/O devices
- Asynchronous communication protocols
- Hardware/software interface
- Operating system concepts
- Laboratory topics: MIPS architecture and Simpler Scalar simulator

1. **Course number and name:** EE 380, Electronics I
2. **Credits and contact hours:** 4 credits. Each week has three lectures of 50 minutes each and a 2.5 hour lab.
3. **Instructor's or course coordinator's name:** Dr. Sang-Yeon Cho
4. **Textbook, title, author and year:** *Microelectronic Circuits*, 6^{th} edition, by Adel S. Sedra and Kenneth C. Smith, Oxford University Press, 2010.
   a. Other supplemental materials: None.
5. **Specific course information:**
   a. **Brief description of the content of the course (catalog description):** Analysis and design of single-time-constant circuits, op-amp applications, diode circuits, linear power supplies, and single-transistor MOS and BJT amplifiers. Introduction to solid-state devices and digital CMOS circuits.
   b. **Prerequisites:** C or better in EE162, EE280, and CHEM 111G.
   c. **Indicate whether a required, elective course:** This is a required course for Engineering Physics students with the Electrical concentration.
6. **Specific goals for the course:**
   a. **Specific course objectives:**
   - Analysis and design of single time-constant circuits, opamp circuits, and linear power supplies.
   - Understanding of solid state devices.
   - Biasing and small-signal analysis of MOS and BJT single transistor amplifiers.
   - Using computer tools to simulate electronic circuits and lay out PCBs.
   - Testing electronic circuits using power supplies, function generators, digital multi-meters, and oscilloscopes.
   - Writing and documenting laboratory results and presenting a project in front of peers.

   b. **Explicitly indicate which of the program outcomes are addressed by the course:**
   - Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
   - Designing 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 - ABET outcome: 3(c)
   - Communicating effectively - ABET outcome: 3(g)
   - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:

- Single-time-constant networks
- Frequency response of amplifiers
- Difference amplifiers
- Integrators and differentiators
- Large-signal operation of Op Amps
- Semiconductor materials
- Current flow in semiconductors (Drift and diffusion currents)
- The pn junction (terminal characteristics, capacitive effects)
- Modeling of the diode forward characteristics
- Rectifier circuits
- Physical operation of metal-oxide-semiconductor field effect transistors
- MOSFET circuits at DC
- Biasing and small-signal analysis of MOSFET circuits
- Physical operation of bipolar junction transistors
- BJT circuits at DC
- Biasing and small-signal analysis of BJT circuits
- Testing electronic circuits using power supplies, function generators, digital multi-meters, and oscilloscopes.
- Writing and documenting laboratory results and presenting a project in front of peers

1. **Course number and name:** EE 391 Introduction to Electric Power Engineering
2. **Credits and contact hours:** 4 credits (3+3P). Each week has three lectures of 50 minutes each and a 2.5 hour lab.
3. **Instructor's or course coordinator's name:** Dr. Wenxin Liu
4. **Textbook, title, author and year:**
   - Stephen Chapman, *Electric Machinery and Power System Fundamentals*, 1st Edition, McGraw-Hill, 2001.
   - Stephen Chapman, *Electric Machinery Fundamentals*, 4th Edition, McGraw-Hill, 2003.
   - Fawwaz T. Ulaby & Michael M. Maharbiz, *Circuits*, 1st Edition, NTS Press, 2009.

   a. **Other supplemental materials:** Software: MatLab, MathCAD, PowerWorld
5. **Specific course information:**
   a. **Brief description of the content of the course (catalog description):** Introduction to the principles, concepts, and analysis of the major components of an electric power system, basic electromechanics, energy conversion and source conversion, transformers, transmission lines, rectifiers, regulators, and system analysis.
   b. **Prerequisite:** C or better in EE 280.
   c. **Indicate whether a required or elective course:** This is course is a possible elective Fore Engineering Physics students with the Electrical concentration.
6. **Specific goals for the course:**
   a. **specific course objectives:**
      - Solve single-phase and three-phase ac circuits problems, compute complex power and power factor, and make power and energy measurements
      - Understand operation of conventional and renewable sources of generation
      - Analyze and safely operate generators, transformers, and other electric machinery
      - Develop and solve mathematical models using linear algebra and iterative techniques for linear and nonlinear problems
      - Analyze power system using state of the art simulation software

   b. **explicitly indicate which of the program outcomes are addressed by the course:**
      - Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
      - Designing and conducting experiments to simulate, test, validate, and/or verify - ABET outcome: 3(b)
      - Designing 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 - ABET outcome: 3(c)
      - Functioning effectively on teams - ABET outcome: 3(d)
      - An understanding of professional and ethical responsibility - ABET outcome: 3(f)

- Communicating effectively - ABET outcome: 3(g)
- Maintaining a knowledge of contemporary professional, societal and global issues - ABET outcome: 3(j)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. **Brief list of topics to be covered:**

- Single-phase AC circuits
- Three-phase AC circuits
- Magnetostatics
- Transformers
- Per unit system
- Synchronous generators
- Transmission lines
- Power flow studies
- Induction motors
- Power conversion
- Power converters
- Laboratory topics will cover computation (MathCAD, MatLab, and PowerWorld) and machine (measurements, magnetic and inductors, power electronics, transformers, field trip, synchronous machines, power system operation)

1. Course number and name: E E 418 Capstone Design I

2. Credits and contact hours: 3 credits. Each week has one lecture of 150 minutes. Teams meet with Faculty Mentor and Capstone Coordinator outside of class.

3. Instructor's or course coordinator's name: Robert Hull

4. Textbook, title, author and year: N/A

- **a. Other supplemental materials:** Lecture notes and presentation slides. Library of materials on class web site: learn.nmsu.edu

5. Specific course information:

- **a. Brief description of the content of the course (catalog description):** Application of engineering principles to a significant design project. Includes teamwork, written and oral communication, and realistic technical, economic, and public safety requirements. Consent of instructor required.
- **b. Prerequisites or co-requisities:** Prerequisite(s): C or better in E E 260, E E 314, E E 351, E E 380, and E E 391. Pre/Corequisite(s): E E 461. Senior standing.
- **c. Indicate whether a required or elective course:** This course is required for Engineering Physics students with the Electrical concentration. However, it can be substituted by PHYS 450 – Capstone I, if the project is in electrical-engineering type in nature.

6. Specific goals for the course:

a. specific course objectives:

- To be able to determine performance requirements for a design.
- To design a system to meet constraints imposed by safety, materials, and related factors.
- To document the design process and communicate the design process both orally and written.
- To appropriately delegate and integrate individual team member tasks.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Designing 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 - ABET outcome 3(c)
- Functioning effectively on teams – ABET outcome 3 (d)
- Identifying, formulating, and solving engineering problems -ABET outcome 3(e)
- Communicating effectively - ABET outcome 3(g)
- Understanding the impact of engineering solutions in a global, economic, environmental, and societal context - ABET outcome 3(h)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered: Topics vary by project but are meant to be a comprehensive summary and application of the EE curriculum as applied to a senior design project.

1. Course number and name: E E 419 Capstone Design II

2. Credits and contact hours: 3 credits. Each week has one lecture of 150 minutes. Teams meet with Faculty Mentor and Capstone Coordinator outside of class.

3. Instructor's or course coordinator's name: Robert Hull

4. Textbook, title, author and year: N/A

a. Other supplemental materials: Lecture notes and presentation slides. Library of materials on class web site: learn.nmsu.edu

5. Specific course information:

a. Brief description of the content of the course (catalog description): Realization of design project from E E 418 within time and budget constraints.

b. Prerequisites or co-requisities: Prerequisite(s): Prerequisite(s): (C or better in E E 260, E E 314, E E 351, E E 380, and E E 391) OR (C or better in E E 418). Pre/Corequisite(s): E E 461. Senior standing.

c. Indicate whether a required or elective course: This course is required for Engineering Physics students with the Electrical concentration. However, it can be substituted by PHYS 450 – Capstone II, if the project is in electrical-engineering type in nature.

6. Specific goals for the course:

a. specific course objectives:

- To build and test a design to validate established requirements and constraints.
- To make the design interface properly with other hardware and software entities.
- To document the test process and communicate the testing processes both orally and in writing.
- To appropriately delegate and integrate individual team member tasks.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Designing and conducting experiments to simulate, test, validate, and/or verify - ABET outcome 3(b)
- Designing 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 - ABET outcome 3(c)
- Functioning effectively on teams – ABET outcome 3 (d)
- Communicating effectively - ABET outcome 3(g)

7. Brief list of topics to be covered: Topics vary by project but are meant to be a comprehensive summary and application of the EE or EP-EE curriculum as applied to a senior design project.

1. **Course number and name:** EE 425, Introduction to Semiconductor Devices
2. **Credits and contact hours:** 3 credits. Each week has two lectures of 75 minutes each.
3. **Instructor's or course coordinator's name:** Dr. Sang-Yeon Cho
4. **Textbook, title, author and year:** Ben G. Streetman and S. K. Banerjee, *Solid State Electronic Devices*, Prentice Hall (6^{th} Edition), 2006.
   a. other supplemental materials:
   S. M. Sze and Kwok K. Ng, *Physics of Semiconductor Devices*, John Wiley & Sons, 2007.
   Robert F. Pierret, *Advanced Semiconductor Fundamentals*, Addison-Wesley, 1987.
   P. Bhattacharya, *Semiconductor Optoelectronic Devices*, Prentice Hall, 1997.
5. **Specific course information:**
   a. **Brief description of the content of the course (catalog description):** Energy bands, carriers in semiconductors, junctions, transistors, and optoelectronic devices, including light-emitting diodes, laser diodes, photodetectors, and solar cells.
   b. **Prerequisites:** C or better in EE 380 and EE 351.
   c. **Indicate whether a required, elective course:** This is an elective class for Engineering Physics students with the Electrical concentration.
6. **Specific goals for the course:**
   a. **Specific course objectives:**
      - Understanding of conduction and valence energy bands and bandgaps.
      - Determining carrier concentrations, drift and diffusion currents.
      - Determining the energy band diagram, current flow, capacitance of a p-n diode under different bias conditions, and heterojunctions.
      - Understanding of MOS C-V behavior, threshold voltage, MOSFET band diagrams, effective channel mobility, and body effect.
      - Understanding of optoelectronic devices (PDs, LEDs, and LDs).

   b. Explicitly indicate which of the program outcomes are addressed by the course:
   Applying knowledge of mathematics, science and engineering to the design and/or analysis of analog and digital circuits and other systems - ABET outcome: 3(a)
   An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)
7. **Brief list of topics to be covered:**
   - Semiconductor materials; Crystal lattices; The Bohr Model
   - Quantum Mechanics: Potential wells, Kronig-Penny Model
   - Charge carriers in semiconductors: Fermi level, Diffusion, Drift, The Hall effect
   - Excess carriers: Carrier lifetime and photoconductivity, The Haynes-Shockley experiment
   - PN Junctions: Equilibrium conductions, forward- and reverse-biased junctions, parasitic capacitances, metal-semiconductor junctions, heterojunction
   - Field-effect transistors: The junction FET, The MS FET, The MIS FET, The MOS FET
   - Bipolar junction transistors: Carrier distributions and terminal currents in BJTs, Biasing
   - Optoelectronic Devices: Photodiodes, LEDs, and LDs.

1. **Course number and name:** EE 431 Power Systems II

2. **Credits and contact hours:** 3 credits. Each week has three lectures of 50 minutes each.

3. **Instructor's or course coordinator's name:** Dr. Sukumar Brahma

4. Textbook, title, author and year: Glover, Sarma, and Overbye, *Power System Analysis and Design*, Thomson, 4th Edition.

a. Other supplemental materials: Software: Matlab 7.5 or higher, Powerworld (comes with the book).

5. Specific course information:

a. brief description of the content of the course (catalog description): Analysis of a power system in the steady-state. Includes the development of models and analysis procedures for major power system components and for power networks.

b. prerequisites or co-requisities: Prerequisites: C or better in EE 391.

c. indicate whether a required or elective course: This is a possible elective for Engineering Physics students with the Electrical concentration.

6. Specific goals for the course:

a. specific course objectives:

- Ability to calculate power system parameters in per unit format, and to analyze power systems using this format.
- Ability to formulate and solve Power Flow problem to calculate the state of power systems.
- Ability to calculate parameters of transmission lines, given line configuration and conductor
- data.
- Ability to calculate performance of transmission line.

b. explicitly indicate which of the program outcomes are addressed by the course:

- Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. Brief list of topics to be covered:

- Review of three-phase ac circuits, power factor
- Three-Phase Power Transformers
- Per Unit System
- Transmission line parameters
- Transmission line modeling and operation
- Analysis of power system in healthy state: Power Flow
- Analysis of power system in healthy state: Economic Dispatch

1. **Course number and name:** EE 473 Introduction to Optics *(cross-listed with PHYS 473)*
2. **Credits and contact hours:** 3 credits. Each week has three lectures of 50 minutes.
3. **Instructor's or course coordinator's name:** Dr. Michael D. DeAntonio
4. **Textbook, title, author and year:** Hecht, *Optics*, 4th Edition, Addison Wesley, 2001.
5. **Specific course information:**
   a. **Brief description of the content of the course (catalog description):** The nature of light, geometrical optics, basic optical instruments, wave optics, aberrations, polarization, and diffraction. Elements of optical radiometry, lasers and fiber optics.
   b. **Prerequisites or co-requisities:** PHYS 216 or 217.
   c. **Indicate whether a required or elective course:** This is an elective class for Engineering Physics students with the Electrical concentration.
6. **Specific goals for the course:**
   a. **specific course objectives:**
      - Describe general waves and wave motion including harmonic waves, plane waves, cylindrical waves and spherical waves. Use Maxwell's laws of electromagnetism and calculate the energy, momentum and Poynting vector for electromagnetic waves.
      - Describe the dipole source of waves including basic radiation theory and polarization, and the effect of waves on dielectric by the use of simple forcing functions.
      - Predict the final color of light when two colors are mixed in emitting sources, after reflection and after transmitting through color filters.
      - Calculate the angles and intensity of light after single or multiple reflection or refraction and the effect of multiple mirrors and lenses and apertures in a complex optical system.
      - Find the entrance and exit pupil in a complex optical system. Perform ray traces for complex optical systems graphically. Describe various types of aberration and their effect on the focus of an optical system.
      - Discuss and identify various types of polarization using the Mueller matrix and Stoke's parameters, and calculate the intensity of light when two or more waves interfere with one another.
      - Describe and predict the effects of interference between two beams of light directed at various angles, and the basics of advanced optical theory including nonlinear optics, Fourier optics, material optics, fiber optics and quantum optics.
   b. **explicitly indicate which of the program outcomes are addressed by the course:**
   - Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
   - Designing 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 - ABET outcome: 3(c)

- Identifying, formulating, and solving engineering problems - ABET outcomes: 3(e)
- Maintaining a knowledge of contemporary professional, societal and global issues - ABET outcome: 3(j)
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. **Brief list of topics to be covered:**
   - Wave Motion
   - Electromagnetic Theory, Photons and Light
   - Geometrical Optics
   - Polarization
   - The Superposition of Waves
   - Interference
   - Advanced Optics

1. **Course number and name:** EE 478 Optical Sources, Detectors and Radiometry
2. **Credits and contact hours:** 4 credits (3+3P). Each week has three lectures of 50 minutes each and a 2.5 hour lab.
3. **Instructor's or course coordinator's name:** Dr. David G. Voelz
4. **Textbook, title, author and year:** *Infrared Detectors and Systems*, by Dereniak and Boreman, Wiley-Interscience, 1996.
   a. **Other supplemental materials:** Instructor notes on radiometry and ray tracing. Access to technical computer software such as MATLAB, MathCAD or IDL is recommended for design calculations.
5. **Specific course information:**
   a. **Brief description of the content of the course (catalog description):** Fundamentals of optical sources, detectors and radiometric measurements in the visible and infrared. Radiometry of imaging and nonimaging sensor systems.
   b. **Prerequisites or co-requisities:** PHYS 217.
   c. **Indicate whether a required or elective course:** This is a possible elective for Engineering Physics students with the Electrical concentration.
6. **Specific goals for the course:**
   a. **specific course objectives:**
      - Calculate irradiance and flux at a receiver for a given source radiance or exitance and geometrical arrangement.
      - Determine the stops, pupils and windows of an optical system using ray tracing methods and apply these results to determine the flux collected by the system.
      - Describe exitance and spectral characteristics of natural and artificial sources.
      - Describe different types of optical detection materials; their limitations and application in an optical detector. Design a transimpedance amplifier for a photodiode detector.
      - Use figures of merit, including signal-to-noise ratio, noise equivalent power, and detectivity, to compare detector performance. Calculate the end-to-end radiometric signal-to-noise ratio for an optical system application.

   b. **explicitly indicate which of the program outcomes are addressed by the course:**
      - Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
      - Designing and conducting experiments to simulate, test, validate, and/or verify - ABET outcome: 3(b)
      - Identifying, formulating, and solving engineering problems - ABET outcome: 3(e)
      - An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. **Brief list of topics to be covered:**

- Radiometric and photometric quantities
- Lambertian source
- Radiometric calculations for imaging and non imaging systems
- Optical system stops, pupils and windows
- Paraxial ray tracing of an optical system
- Natural and artificial optical sources
- Blackbody and graybody radiation
- Temperature estimation from IR measurements
- Optical detector materials and sensing modes
- Photodiode detectors: electrical characteristics and transimpedance amplifiers
- Responsivity, noise equivalent power, detectivity
- Detector circuit frequency response
- System signal-to-noise
- Laboratory topics will cover: radiometric measurements without optical systems, radiometric measurements using optical systems, blackbody radiation and detector responsivity, electrical characteristics of photodiode detectors, noise & performance measurements of detection systems, final lab project

1. **Course number and name:** EE 486 Digital VLSI Design

2. **Credits and contact hours:** 3 credits (3). Each week has three lectures of 50 minutes each.

3. **Instructor's or course coordinator's name:** Dr. Paul M. Furth

4. **Textbook, title, author and year:** N. Weste and D.M. Harris, *Principles of CMOS VLSI Design: A Circuits and Systems Perspective*, 4th Ed., Addison-Wesley, 2011.
   a. **Other supplemental materials:**
   R. J. Baker, *CMOS Circuit Design, Layout, and Simulation*, 3rd Ed., John Wiley & Sons, 2010.
   Software: LTSpice, http://www.linear.com/designtools/software/#LTspice

5. **Specific course information:**
   a. **Brief description of the content of the course (catalog description):** An introduction to VLSI layers. Static and dynamic logic design, memory circuits, arithmetic operators, and digital phase-locked loops.
   b. **Prerequisites or co-requisities:** C or better in EE 380 and EE 260.
   c. **Indicate whether a required or elective course:** This is a possible elective for Engineering Physics students with the Electrical concentration.

6. **Specific goals for the course:**
   a. **specific course objectives:**
   - Describe CMOS process and draw layouts.
   - Analyze and design CMOS inverters/buffers, static logic gates, dynamic logic gates, transmission gates, and flip-flops.
   - Analyze and design arithmetic operators – adders, multipliers, and encoders/decoders.
   - Analyze and design special-purpose digital circuits, including static and dynamic RAM and digital phase-locked loops.
   - Enter schematics and simulate circuits using LT-Spice.
   - Understand professional and ethical responsibility.
   - Understand the impact of engineering solutions.
   - Maintain a knowledge of contemporary issues.

   b. **explicitly indicate which of the program outcomes are addressed by the course:**
   - Applying knowledge of mathematics (including probability and statistics, differential and integral calculus, differential equations, linear algebra, and complex variables); science (chemistry, physics, and computer science); and engineering to the design and/or analysis of analog and digital circuits, signals and systems, electromagnetics, and electric power systems - ABET outcome: 3(a)
   - Designing 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 - ABET outcome: 3(c)
   - An understanding of professional and ethical responsibility - ABET outcome: 3(f)
   - Understanding the impact of engineering solutions in a global, economic, environmental, and societal context - ABET outcome: 3(h)
   - Maintaining a knowledge of contemporary professional, societal and global issues - ABET outcome: 3(j)

- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice - ABET outcome: 3(k)

7. **Brief list of topics to be covered:**
   - Introduction, Fabrication Process, and Cross Sectional Views
   - CMOS Design, Pass Transistors, Transmission Gates, and Stick Diagrams
   - MOS Transistor Theory (Ideal Characteristics, Gate Capacitance)
   - Non Ideal Transistor Theory (Leakage, Body effect)
   - Introduction to SPICE
   - DC and Transient Response
   - Logical Effort of Paths, Delay in Logic, Multi-Stage Logic Networks
   - Combinational Circuits
   - Circuit Families
   - Latches and Flip Flops
   - Dynamic and Static Power Dissipation
   - Adder Circuits
   - Data-path Functional Units
   - Memory Arrays, Static RAM
   - Phase-Locked Loops and Delay-Locked Loops
   - Wires and Interconnect