EEE 1: Essentials of Electrical & Electronics Engineering

Credits: 4.0 units [3.0 units lecture + 1.0 unit laboratory]

Course Description:

Analysis of DC and AC Circuits. Ideal Transformers. Motors and Generators, characteristics and Methods of Control. Diode and Transistor Circuits. Digital Circuits and Logic Gates. Transducers and Transducer Circuits. Operational Amplifiers. Motor Control. Feedback Control Systems. Introduction to Digital Control. Introduction to Programmable Logic Controllers.

Prerequisites: Applied Physics, ChE, and ME students;
Physics 72/Physics 102, and ES 21/Math 121.1

Goals:

The course is designed to make students:

- Understand basic electrical and electronics engineering concepts, laws and principles
- Appreciate the applications of electrical and electronics engineering concepts in relation to their chosen field of study

Objectives:

At the end of the course, the students are expected to:

- Describe the basic laws and principles of electrical circuits
- Solve AC and DC circuits using fundamental circuits analysis techniques
- Describe the operating principles and characteristics of transformers and AC and DC machines and their applications in industry.
- Solve simple diode and transistor circuits and identify and appreciate their use in simple practical applications
- Analyze, design and implement simple digital logic circuits
- Differentiate the different types of transducers and their applications in industry
- Illustrate the use of signal conditioning and data acquisition circuits in digital control
- Analyze, design and implement simple op-amp circuits and describe their applications
- Describe and appreciate the basic operation of feedback control systems and their applications in industry
- Describe the operation and applications of Programmable Logic Controllers in industry.
- Create ladder diagrams and implement simple application programs on the Programmable Logic Controller.

Schedule of Activities:

Meeting	*Topics*	*Session Objectives*
1 Jan. 17 / 18	Class Outline and Policies Introduction Basic Concepts: Charge, Current, Potential, Voltage, Power and Energy	Clarify class policies; Have an idea of what to expect in the course; Note important ideas and insights on the course; Distinguish potential, voltage, charge, current, resistance, power and energy;
2 Jan. 19 / 20	Ohm's Law, KCL, and KVL Resistance and Source Combination Single Loop/node-pair circuits	Apply Ohm's law, Kirchhoff's Current and Voltage Laws (KCL and KVL), and resistance/source combination to analyze simple circuits of up to two loops.
3 – 4 Jan. 24 / 25 Jan. 26 / 27	Voltage and Current division Two– to three-loop circuits Thevenin and Norton Theorems Superposition	Use Voltage and Current division, Thevenin and Norton's Theorems, and superposition to simplify and analyze circuits of up to three loops.
Jan. 31 / Feb. 1 (**BUFFER**)		
1st Long Exam – Feb 6 (6:00 – 8:00pm)		
	AC Circuits	
5-6 Feb. 2 / 3 Feb. 7 / 8	Phasor Analysis AC Waveforms Impedance Sinusoidal Steady-State Analysis	Solve for the period, frequency, magnitude, phase, peak and RMS values of AC waveforms. Describe the concept of impedance and inductive and capacitive reactance. Represent AC waveforms and impedances in vector form. Solve simple circuits of up to three loops or three non-reference nodes using concepts learned in DC analysis as applied to AC circuits.

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Meeting	*Topics*	*Session Objectives*
7-8 Feb. 9 / 10 Feb. 14 / 15	Power in AC Circuits Real, Reactive, Apparent and Complex Power Power Factor	Differentiate real, reactive, apparent and complex power. Describe the concept of power factor and its significance in energy conservation. Compute power in simple AC circuits of up to three loops or three non-reference nodes.
9 Feb. 16 / 17	Polyphase Circuits Single Phase Circuits Three-Phase Circuits Y and Delta Connections Single Phase Analysis	Recognize three-phase circuits, their basic connections/configurations and applications. Analyze three-phase circuits using concepts and techniques in single-phase AC analysis
10 Feb. 21 / 22	Ideal Transformers	Describe the principle of operation of ideal transformers. Solve circuits of up to two loops involving ideal transformers.
11-12 Feb. 23 / 24 Feb. 28 / Mar. 1	Introduction to AC Machines a. The Generalized Machine Model b. Induction Machines c. Synchronous Machines	Describe the operation of AC machines; Determine the factors that affect speed, torque, and power generated/consumed by AC machines using equivalent circuit models; Identify useful applications of the different AC machines
13 Mar. 2 / 3	DC Shunt Machines	Describe the operation of DC Shunt machines; Determine the factors that affect speed, torque, and power generated/consumed by DC Shunt machines using equivalent circuit models; Identify useful applications of DC machines.
Mar. 7 / 8 **(BUFFER)** ***2nd Long Exam – Mar. 13 (6:00 – 8:00pm)***		
14 Mar. 9 / 10	Semiconductors; PN Junction Diodes and Zener Diodes	Describe the concept of semiconductors; Learn how they work and how they are formed; Describe the V-I characteristics of PN Junction and Zener diodes
15 Mar. 14 / 15	Diode Circuits	Determine the different circuits and applications employing diodes; To solve simple diode circuits such as rectifiers, clippers, and voltage regulators/reference
16-17 Mar. 16 / 17 Mar. 21 / 22	Transistors, Operating Regions, Transistor Circuits and Biasing;	Describe how transistors work; Identify the different operating regions: cut-off, forward active and saturation; Solve simple transistor circuits; Identify applications of transistors.
18-19 Mar. 23 / 24 Mar. 28 / 29	Digital Circuits Boolean Theorems Logic Gates Logic Circuits Analysis and Design	Use the Boolean theorems to simplify Boolean expressions; Apply Boolean theorems in analyzing, designing and implementing digital circuits; Use K-Maps to minimize design of digital circuits.
Mar. 30 / 31 **(BUFFER)** ***3rd Long Exam – Apr. 17 (6:00 – 8:00pm)***		
20-21 Apr. 4 / 5 Apr. 6 / 7	Transducers and Transducer Circuits	Identify and describe the various classes and examples of transducers, their operating principles and applications in industry; Solve simple circuits involving transducers
22-23 Apr. 18 / 19 Apr. 20 / 21	Op-Amps	Solve basic circuits involving op-amps; Identify practical circuits/applications of op-amps
24-25 Apr. 25 / 26 Apr. 27 / 28	Feedback Control Systems a. Open-loop vs. Closed-Loop b. Regulators and Servomechanisms c. Continuous and Discontinuous (discrete) FCS d. System Modeling e. Transient and Steady-state Response f. System Stability	Differentiate open-loop from closed-loop feedback control systems; Identify and describe control schemes used in particular control systems; Describe the performance characteristics of some examples of simple control systems such as position control systems, motor control systems, and temperature/process control systems.
26-27	Intro to Digital Control	Learn the basics of digital control;

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Meeting	*Topics*	*Session Objectives*
May 2 / 3 May 4 / 5	A/D and D/A converters, signal conditioning circuits, sample and hold circuits	Know how to interface analog, real-world signals and systems with digital systems.
28 May 9 / 10	Programmable Logic Controllers Relays Ladder Diagrams PLC Programming	Describe the basic operation and function of Programmable Logic Controllers (PLCs); Identify applications of PLCs in Process and Motor Control; Create simple ladder diagrams and programs on the PLC;
May 11 / 12 **(BUFFER)**	***4th Long Exam – May 15 (6:00 – 8:00pm)***	

■ **- TTh class**
■ **- WF class**

Schedule of Laboratory Activities:

Meeting	Activity	Session Objectives
1	Introduction to the Lab. Jan 16 – 21	Discuss laboratory rules, proper use of equipment, laboratory safety; Overview of laboratory activities and expectations
2	DC Measurements Jan 23 – 28	Learn to use the power supply, protoboard, and VOMs, and DVMs. Learn to measure voltage, current and resistance in simple circuits. Appreciate the significance of power and power ratings.
3	DC Circuits Jan 30 – Feb 4	Verify concepts learned in DC circuit analysis through measurement of voltages and currents.
4-5	AC Measurements Feb 6 – 11 Feb 13 – 18	Learn how to use the oscilloscope, AC supply, and signal generator. Appreciate the concept of peak voltages, rms voltages, and average voltage, and frequency and period, through the use of the oscilloscope, signal generator and simple AC circuits. Verify the concepts in AC analysis such as phase angles, power factors etc…
	Buffer (Feb 20 – 25)	
6	***Practical Exam 1***	**Feb 27 – Mar 4**
7	Electrical Machines (Demo) Mar 6 – Mar 11	Demonstrate the characteristics of DC and AC Machines; Demonstrate methods of speed and torque control; Demonstrate how power is generated by generators.
8	Diode Circuits Mar 13 - 18	Observe the switching and V-I characteristics of actual diodes and zener diodes. Appreciate applications of diodes in simple useful circuits such as rectifiers, voltage regulators, etc…
8	Transistor Circuits Mar 20 - 25	Determine the operating regions of the transistor. Learn the use of BJT transistors in switching and amplifying circuits.
9-10	Digital Circuits (Design) Mar 27 – Apr 1 Apr 3 – 8	Design and implement a simple digital circuit given some specifications and component constraints (minimal design).
11-12	Op amps and Transducers (Design) Apr 17 – 22 Apr 24 – 29	Use op-amps and transducers in a practical application.
	Buffer (May 1 – 6)	
14	***Practical Exam 2***	**May 8 – 13**

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Class Policies:

1. Attendance will be checked everyday. A student who is 20 min. late (lecture) / 30 min. late (lab) is considered absent. University rules on attendance (both for the lecture and laboratory classes) will be strictly implemented.
2. No makeup long exams/practical exams will be given for unexcused absences. Those with a valid excuse will be given a **comprehensive** exam at the end of the course provided that the *average of the remaining three exams is at least 60%* (for a missed long exam) and a special **design** project (for a missed practical exam). A student with more than one missed exam will be asked to drop the course or will be given a failing grade if dropping period is over.
3. Exam papers may only be submitted for re-grading up to one week from the time the papers/exam solution were released.
4. Each laboratory exercise will be composed of questions related to the experiment. The answer sheet for these questions will be provided. These will be collected at the end of every meeting.
5. A written Report shall be required of every design exercise. It is due on the first 20 min. of the next laboratory class meeting after required completion of activity. The report shall include the following sections:

   Title of Exercise, Objectives, Background and Concepts, Design Strategy and Considerations, Final Circuit Design (circuit schematics, block diagram and design computations and explanations), Problems Encountered and How They Were Resolved, Insights, Essay of Individual Contribution, References
6. Acts of dishonesty will be dealt with accordingly.
7. Grade Distribution:

	Academic Requirement	Weights
LECTURE (100%)	Four Long Exams 22.5% - Exam 1 22.5% - Exam 2 22.5% - Exam 3 22.5% - Exam 4	90 %
	Quizzes, and Recitation	10 %
LABORATORY (100%)	Eight Laboratory Exercises/Reports	60 %
	Two Practical Exams	30 %
	Laboratory Presence (laboratory conduct, participation, critical thinking, eagerness, attendance)	10 %

8. A student shall pass the course if he gets a grade credit of at least 60% under lecture and 60% under laboratory requirements. The final grade shall be computed as:

   FINAL GRADE = 60% LECTURE + 40% LABORATORY

References:

*Johnson, Johnson and Hilburn. "**Electric Circuit Analysis 2nd Edition.**" ©1992.Prentice-Hall, NJ.*	*AC and DC Circuits Transformers*
***B.L. Theraja. "Fundamentals of Electrical Engineering and Electronics 28th Ed.."** © 1997. S. Chand and Co. Ltd., Ram Nagar, New Delhi, India.*	*AC and DC Machines, Transformers*
*A. E. Fitzgerald. "**Electric Machinery 5th Edition**". ©1989 McGraw-Hill Companies.*	*AC and DC Machines*
*Vincent Del Toro. "**Principles of Electrical Engineering 2nd Ed**" ©1972. Prentice-Hall.*	*AC and DC Machines, AC and DC motor control, Control Systems examples*
*Boylestad and Nashelsky. "**Electronic Devices and Circuit Theory.**" © 1992. Prentice Hall, NJ.*	*Diodes and Transistor Circuits*
*M. Morris Mano. "**Digital Design 3rd Ed.**" ©2001. Prentice-Hall.*	*Digital Logic Circuits*
*Larry D. Jones and A. Foster Chin. "**Electronics Instruments and Measurement 2nd Ed.**" ©1991. Prentice-Hall Intl. Editions.*	*Transducers Introduction to Digital Control DC and AC Measurements (lab).*
*Robert F. Coughlin and Frederick F. Driscoll. "**Operational Amplifiers and Linear Integrated Ckts. 4th Ed.**" ©1991. Prentice-Hall Int'l. Editions.*	*Operational Amplifiers; A/D and D/A Converters*
*Richard C. Dorf and Robert H. Bishop." **Modern Control Systems.**" ©1998. Addison Wesley Longman Inc.*	*Feedback Control Systems*
*Dale R. Patrick. "**Electronic Instruments 4th Edition.**" ©1992. Prentice-Hall Englewood Cliffs, NJ.*	*PLCs*
*Charles Moberg. "**AC and DC Motor Control.**"*	*AC and DC Motor Control; PLCs*

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