Southwestern Indian Polytechnic Institute

A National Indian Community College

Division of Instruction

Department of Advanced Technical Education

Electronics Technology

ELEC 105A – Basic AC Electronics

ELEC 105L - Basic AC Electronics Lab

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Basic AC Electronics and Lab
ELEC 105A/105L

Introduction

Basic AC Electronics and Lab, ELEC 105A/105L, prepares the individual for continued progress in the advanced area of Alternating Current. Alternating Current or AC powers the lighting, heating, air conditioning, communications, and other modern conveniences in nearly every home, business and industry. AC also supplies the power for operating radio and television receivers and transmitters. The main reasons for the widespread use of alternating current are lower cost both in production and transmission, and the convenience of distribution.

The rules for series and parallel circuits and Ohm's Law calculations learned in Basic DC Electronics, ELEC 101A/101L, still apply. However, the new factor to consider with an AC source is that the voltage alternately reverses in polarity, producing current that reverses in direction. Consequently, voltage and current values are constantly changing instead of remaining at a steady value.

A good background in mathematics is essential as this course involves a great deal of mathematical calculations. Upon completion of this course, the individual will have a solid foundation in the laws that govern AC electronic principles, which is essential in the rapidly advancing field of electronics.

Basic AC Electronics and Lab
ELEC 105A/105L

Course Syllabus

Introduction

Basic AC Electronics, ELEC 105A/105L covers the basic concepts needed to understand alternating current theory. It is presented in a sequential manner with each unit of study based on principles studied in the previous trimester, Basic DC Electronics, ELEC 101A/101L. The course begins with an introduction to magnetic theory and the principles of electromagnetic induction. It continues with an introduction to AC circuit analysis in which time-varying electrical signals, particularly the sine wave, are presented. Particular emphasis is given to the sine wave because of its basic importance in AC circuit analysis. Complex numbers are introduced in the beginning and used throughout the course. Capacitors and Inductors are covered, followed by RC, RL, and RLC circuit analysis for continuity. Theorems in AC analysis are also studied and analyzed. The course concludes with an in-depth discussion of low-pass, high-pass, band-pass, and band-stop filters.

Prerequisites

The student must have successfully completed Basic DC Electronics, ELEC 101A/101L, and have a good understanding of mathematics from Intermediate Algebra, MATH 121.

Terminal Objectives

Upon completion of this course, the student will be able to:

A. Describe AC generation and calculate effective, average, peak, and peak-to-peak values in AC circuits;

B. Analyze AC circuits using the phasor concept and the complex number system;

C. Define capacitance and factors that determine capacity;

D. Calculate RC time constants;

E. Define and calculate capacitive reactance and determine phase angles for series and parallel RC circuits;

F. Define inductance and factors that determine inductance;

G. Calculate RL time constants;

H. Define and calculate for inductive reactance and determine phase angles for series and parallel RL circuits;

I. Define impedance and explain the concept of resonance;

J. Analyze RLC circuits and determine impedance, resonant frequency, bandwidth and the quality factor;

K. **E**xplain the operation of low-pass, high-pass, band-pass, and band-stop filters;

L. Describe the operation of a transformer and explain its uses.

Textbook

The text for the course is Foundations of Electronics: Circuits and Devices, 4th Edition, Meade, Thompson, 1999.

Equipment

Test equipment to be used for the AC lab are the transformer AC power supply, analog waveform generator, digital waveform generator, oscilloscope, analog multimeter, digital multimeter, PC computer, and various breadboard bases for circuit testing.

Grading System

In order to obtain the highest possible grade, the student is required to comply with the following: attend classes regularly (classes meet MW for a 80 minute lecture and Tues. for a three hour lab); maintain a positive attitude toward him/herself and work; and complete and turn in any given assignments on time, including quizzes. A quiz is given at the end of each unit or weekly, to insure complete understanding of the section.

There will be two major evaluations during the trimester, one at mid-term and another at the end of the trimester (final).

The Total Overall Grade is computed on the following basis:

Attendance/Participation: 5%
Homework: 15%
Quizzes: 30%
Mid-Term Exam: 25%
Final Exam: 25%

In accordance with **SIPI's** grading policy the final letter grade is based on the following scale:

90 to 100 = A
80 to 89 = B
70 to 79 = C
60 to 69 = D
59 and Below = F

Students in this course are required to maintain a 2.0 GPA (C). Any student receiving the grade of D or F will have to repeat the course.

EVALUATION:
Evaluations are accomplished in three categories:

1. Objective type: In this area, the student's recall ability is explored. The student will be required to respond with single answers such as True/False, Matching, and/or Multiple Choice statements.

2. Subjective Type: In this area, the student's critical thinking ability is explored. On written examinations, the student will be required to respond with an essay on procedures, functions, operations, or development of a single topic.

   Written reports are graded on their *c*omprehensiveness, originality, and accuracy.

3. Performance Type:
   A. Formal - The student will correctly complete a functional system from a schematic diagram, complete all measurements, and calculate all values for their comparability.

   B. Informal – The student will be observed on daily performance in the areas of class participation, assignment completion, and attendance.

Course Outline
Basic AC Electronics and Lab
ELEC 105A/105L

I. AC CHARACTERISTICS AND ANALYSIS (Ch. 11)

- A. Sine Waves
- B. Period, Frequency and Wavelength
- C. Voltage and Current Values
- D. Angular Relationships of a Sine Wave
- E. The Sine Wave Equation
- F. Introduction to Phasors
- G. The Complex Number System
- H. Rectangular and Polar Forms of Complex Numbers
- I. Nonsinusoidal Wave Forms
- J. Harmonics

II. THE INDUCTOR (Ch. 13)

- A. Basic Magnetic Theory
- B. The Basic Inductor
- C. Types of Inductors
- D. Inductors in DC Circuits
- E. Inductors in Series and Parallel
- F. Energy Stored in Inductors
- G. Inductors in AC Circuits
- H. τ, the L/R Time Constant
- I. Exponential Calculations for τ

III. INDUCTIVE REACTANCE (Ch. 14)

- A. V/I Relationships for Inductive Circuits
- B. The Concept of Inductive Reactance, X_L
- C. Relationship of X_L to Inductance
- D. Relationship of X_L to Frequency
- E. Methods to Calculate X_L
- F. Series and Parallel Inductive Reactance
- G. Inductor Q Factor

VII. TRANSFORMERS (Ch. 16)

- A. Mutual Inductance
- B. The Basic Transformer
- C. Step-Up Transformer
- D. Step-Down Transformer

E. Loading the Secondary
F. Reflected Impedance
G. Impedance Matching
H. The Transformer as an Isolation Device
I. Tapped Transformers
J. Multiple-Winding Transformers
K. Autotransformers
L. Transformer Construction

IV. THE CAPACITOR (Ch. 17)

A. Electrostatic Field Theory
B. Capacitor Charging and Discharging
C. The Basic Capacitor
D. Types of Capacitors
J. Energy Stored in Capacitors
E. Series Capacitors
F. Parallel Capacitors
K. τ, the RC Time Constant
L. Exponential Calculations for τ
G. Capacitors in AC Circuits
H. Testing Capacitors

V. CAPACITIVE REACTANCE (Ch. 18)

A. V/I Relationships for Capacitive Circuits
B. The Concept of Capacitive Reactance, X_C
C. Relationship of X_C to Capacitance
D. Relationship of X_C to Frequency
E. Methods to Calculate X_C
F. Series and Parallel Capacitive Reactance
G. Comparing Capacitive and Inductive Reactance

VI. RL CIRCUIT ANALYSIS (Ch. 15)

A. Sinusoidal Response of RL Circuits
B. Impedance of Series RL Circuits
C. Analysis of Series RL Circuits
D. Impedance of Parallel RL Circuits
E. Analysis of Parallel RL Circuits
F. Series-Parallel Analysis
G. Power in RL Circuits
H. Basic Applications
I. Pulse Response of RL Circuits
J. Troubleshooting

VII. RC CIRCUIT ANALYSIS (Ch. 19)

A. Sinusoidal Response of RC Circuits
B. Impedance of a Series RC Circuit
C. Analysis of Series RC Circuits
D. Impedance of a Parallel RC Circuit
E. Analysis of Parallel RC Circuits
F. Series-Parallel Analysis
G. Power in RC Circuits
H. Basic Applications
I. Pulse Response of RC Circuits
J. Troubleshooting

VIII. RLC CIRCUITS (Ch. 20)

A. Impedance of Series RLC Circuits
B. Analysis of Series RLC Circuits
C. Impedance of Parallel RLC Circuits
D. Analysis of Parallel RLC Circuits
E. Analysis of Series-Parallel RLC Circuits

VIII. RESONANCE AND FILTERS (Ch. 21)

A. Series Resonance
B. Parallel Resonance
C. Bandwidth of Resonant Circuits
D. Quality Factor (Q) of Resonant Circuits
E. Low-Pass Filters
F. High-Pass Filters
G. Band-Pass Filters
H. Band-Stop Filters
I. Filter Response Characteristics