NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHANICAL ENGINEERING PROGRAM

ML140 – ELECTRIC CIRCUITS

I. GENERAL INFORMATION

COURSE CODE	**:**	ML140 Electric Circuits
SEMESTER	**:**	4
CREDITS	**:**	5
HOURS PER WEEK	**:**	6 (Theory – Practice)
PREREQUISITES	**:**	M226 Physics III
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

This course prepares the student to be able to solve problems of electrical circuits of direct current (stable and transient state) and alternating current (single-phase and three-phase).
It is for this reason that the course begins with the development of the elements of the electric circuit and the variables that describe them, additionally, Kirchhoff´s laws are enunciated and explained. Resistive circuits are then studied to provide a solid introduction to the circuit concept and its analysis. Next we consider the different theorems and principles developed for the precise analysis of electrical circuits, as well as general methods of solution. Subsequently, we study the energy storage elements and the response in steady and transient regime with stored initial energy of circuits RL and RC.
In the second part of the course we work with sinusoidal alternating current circuits and start with an analysis of the periodic waves. We continue with a study of single-phase systems in instantaneous values and in phasor notation and also the concepts of impedance and admittance.
Then the electric power in alternating current is analyzed in instantaneous values and in phasor notation. Magnetically coupled circuits, including the ideal transformer, are also studied. Finally, we focus on three-phase balanced, unbalanced circuits and power measurement.

III. COURSE OUTCOMES

The student:

1. Knows and explains the properties and characteristics of the elements of an electric circuit.
2. Understands and applies the main laws and properties existing in an electrical circuit.
3. Applies the theory of algebraic and differential equations in solving problems of DC circuits (stable and transient states).
4. Applies the theory of complex numbers in solving sinusoidal AC circuits.
5. Interprets the concepts of active, reactive and apparent power, and applies them to perform a power balance in a sinusoidal alternating current electric circuit.

6. Interprets the results obtained when solving an electrical circuit and relates it to some practical application.

IV. LEARNING UNITS

1. FUNDAMENTAL CONCEPTS: VARIABLES AND ELEMENTS OF THE ELECTRICAL CIRCUIT. RESISTIVE CIRCUITS / 14 HOURS

Introduction / definitions and scope / electric circuit / Units systems / types of current / voltmeters and ammeter / linear models of circuit elements / active and passive circuit elements / Kirchhoff's laws / Power balance in an electric circuit . Reducing and transforming resistive circuits / Connecting independent resistors and sources / Independent branches for calculating the equivalent (RINCE) / Voltage and current divider / Equivalence between a real voltage source and a real current source / Dependent sources / Symmetry In electrical circuits / Applicative problems.

2. METHODS OF ANALYSIS OF RESISTIVE CIRCUITS AND APPLICATIONS OF PROPERTIES AND THEOREMS / 14 HOURS

Topological algebra / Analysis of circuits by mesh analysis methods and nodes analysis with independent and dependent sources / Transformations and restriction equations.

Proportionality and superposition properties / Thevenin and Norton Theorems / Maximum power transfer theorem / Measuring instruments connection / Applicative problems.

3. ELEMENTS OF ENERGY STORAGE. TRANSIENT CIRCUITS OF FIRST AND SECOND ORDER (RL, RC, RLC) / 14 HOURS

Elements of electrical energy storage: Capacitors and inductors / Energy stored in capacitors and inductors / Analysis of electrical circuits RL, RC and RLC with switches / Steady state DC circuits / Capacitors and inductors in series and in parallel / Application problems / First-order transient RL and RC circuits / RL and RC circuits with dependent sources. Applicative problems.

Second order transient circuits / RL, RC and RLC circuits with dependent sources / Unique functions / Application of the Laplace transform in the solution of first and second order transient circuits / Applicative problems.

4. SINUSOIDAL PERIODIC WAVES / 4 HOURS

Alternating wave / Periodic waves / Characteristics of periodic waves: Average value, effective value, shape factor, period, etc. / Generation of a sinusoidal alternating voltage wave / Applicative problems.

5. SINUSOIDAL CURRENT CIRCUITS IN STABLE SYSTEMS AND SINGLE-PHASE SYSTEMS / 18 HOURS

Passive elements response: Pure resistive branch, pure inductive branch, pure capacitive branch / RL and RC series branches / RLC series and parallel circuits / Impedance and admittance / Phasor representation / Principles, general methods and theorems used in phasor regime / Electric Power / Power Factor Correction / Geometric Locations / Electric Motor Applications / Applicative problems.

6. MAGNETICALLY COUPLED CIRCUITS / 6 HOURS

Inductance and self-induction / Mutual inductance / Mutual inductance / Air core transformer / Magnetic coupling coefficient / Magnetically coupled circuit response in sinusoidal mode / Natural current / Rule of points / Equivalent circuits with inductive coupling / ideal transformer / Applicative Problems.

7. BALANCED AND UNBALANCED THREE-PHASE CIRCUITS / 14 HOURS

Introduction / Concept of polyphase system / balanced systems / generation of three - phase systems of voltages / Comparisons between three - phase and single phase systems / Alternator connections: star and triangle / Generation sequence / Circuits balanced: star - star, delta - delta, star - delta / single-phase equivalent circuit for balanced loads / determination of power in balanced three-phase circuits / Application problems / Active power measurement: 2 volt meter / 3-phase unbalanced circuits / Application problems.

V. LABORATORIES Y PRACTICAL EXPERIENCES

Work is given to develop in the computer lab in order for students to solve electric circuits using the simulator ORCAD-PSPICE, also, practical experiences are left on the main topics of the course to be held in the electricity laboratory.

VI. METHODOLOGY

The course is developed in theoretical and practical sessions. In the sessions of theory, the teacher presents the concepts, theorems and applications. In practical sessions, various problems are solved and their solution is analyzed. In the laboratory sessions Orcad-Pspice simulation software is used to solve problems and analyze their solution. At the end of the course the student must present and present an integrative project or project. In all sessions to promote the active participation of the student.

VII. GRADING FORMULA

Evaluation system “F”. Calculation of final grade: FG = (ME + 2FE + QA)/4
MT: Midterm exam FT= Final exam QA: Quizzes average
There will be four quizzes, the quiz with the lowest grade will not be taken in consideration.

VIII. BIBLIOGRAPHY

1. **BOYLESTAD, Robert.** Introductory Circuit Analysis. Pearson Education, 2016.
2. **JOHNSON, David,** Electric Circuit Analysis, Prentice Hall hispanoamericana, 2005