NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHATRONICS ENGINEERING PROGRAM

MT127 – ANALYSIS AND DESIGN OF DIGITAL CIRCUITS

I. GENERAL INFORMATION

CODE	**:**	MT127 Analysis and Design of Digital Circuits
SEMESTER	**:**	5
CREDITS	**:**	5
HOURS PER WEEK	**:**	6 (Theory – Practice – Laboratory)
PREREQUISITES	**:**	MB165 Linear Algebra, ML140 Electrical Circuits
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

At the end of the course the student will be able to carry out the analysis and design of MSI combinational circuits, using mathematical tools such as Boolean algebra, and graph reduction techniques such as the Karnaugh map.

It encompasses: Numerical bases and numeral systems, numerical codes, simplification techniques of algebraic functions, Karnaugh maps, design and analysis of encoder, decoder, multiplexer, demultiplexer and comparator combinational circuits. Introduction to sequential circuits, flip-flop types, timing diagram, state diagrams and tables. Basic sequential circuit design such as 8-bits counter.

III. COURSE OUTCOMES

1. Differentiate between several types of numerical bases and codes.
2. Identify digital integrated circuits characteristics and their application.
3. Learn to use simplification methods for up to 4-variable functions.
4. Analyses various types of combinational circuits using the provided analysis tools: Boolean algebra and Karnaugh maps.
5. Design MSI combinational circuits and apply the best of them in problem solving.
6. Design synchronous and asynchronous sequential digital circuits.

IV. LEARNING UNITS

1. IDENTIFICATION OF NUMERICAL BASES AND LOGIC CIRCUITS CHARACTERISTICS

Numerical bases (base 2, base 8, base 16), base operations, conversions, logic families, characteristics, logic gates, integration scales, Boolean algebra functions and theorems. Minimums and maximums.

2. SIMPLIFICATIONS METHODS OF COMBINATIONAL CIRCUITS

2,3 and 4 variable logic functions, truth table, Boolean function simplification, and 3 & 4 variable Karnaugh maps, simplification techniques, application problems.

3. DESIGN AND APPLICATION OF COMBINATIONAL LOGIC CIRCUITS

MSI logic principles, dedicated integrated circuit, half-adder, subtractor, full adder, encoder, decoder, multiplexer, demultiplexer, code converters, arithmetic logic unit.

4. SEQUENTIAL CIRCUITS

Sequential logic circuit, Flip-flop, types and characteristics, tables and equations, basic design of synchronous and asynchronous counters.

5. ANALYSIS AND DESIGN OF SYNCHRONOUS SEQUENTIAL CIRCUITS

Flip-flop basic concepts / Characteristic tables / State diagrams and tables / Sequential circuits design/ State machines/ Counters: definition / Types of counters / Registers/ Register implementation with ICs.

6. ASYNCHRONOUS SEQUENTIAL CIRCUITS

Asynchronous sequential circuits design/ Flowchart/ Transitions table/ Hazard detection and elimination.

V. LABORATORY EXPERIENCES

Lab 1: Use of lab equipment.
Lab 2: Digital logic gates.
Lab 3: Logic circuits reduction with Boolean algebra.
Lab 4: Logic circuits reduction with the Karnaugh map.
Lab 5: Design of combinational circuits part 1.
Lab 6: Arithmetic Logic Unit.
Lab 7: Sequential circuits
Lab 8: (Combinational and Sequential) Digital circuits design

VI. METHODOLOGY

The course is carried out in computing lab, theory and practice sessions. In theory sessions, the instructor introduces concepts, theorems and applications. In practice sessions, several problems are solved, and their solutions are analyzed. In lab sessions, simulation software is used to solve problems and analyze their solutions. This analysis is the complement for the implementation of integrated circuits that students must hand in every lab session. In all sessions student's active participation is encouraged.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

PF=(EP+EF+((P1+P2+P3+P4)/4+(L1+L2+L3+L4+L5+L6+L7+L8)/8)/2)/3

EP: Mid-Term Exam EF: Final Exam P#: Quizzes L#: Labs

VIII. BIBLIOGRAPHY

1. **MORRIS – MANO**
   Digital Design (Spanish)
   Prentice Hall Editorial, 2010

2. **TOCCI, RONALD**
   Digital Systems (Spanish)
   Prentice Hall Editorial, 2010

3. **ENRIQUE MANDADO and YAGO MANDADO**
   Digital Electronic Systems (Spanish)
   Prentice Hall Editorial, 2008