NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF INDUSTRIAL AND SYSTEMS ENGINEERING
SYSTEMS ENGINEERING PROGRAM

TP123 – DIGITAL SYSTEMS

I. GENERAL INFORMATION

CODE	**:**	TP123 Digital Systems
SEMESTER	**:**	7
CREDITS	**:**	3
HOURS PER WEEK	**:**	4 (Theory–Practice–Laboratory)
PREREQUISITES	**:**	TP113 Electrical and Electronic Systems
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Production Technologies

II. COURSE DESCRIPTION

The course prepares students for the analysis and design of combinatorial and sequential logic circuits. The characteristics of analog and digital systems and signals are analyzed, as well as their different applications. Boole algebra is applied for simplifying Boole functions, and for designing combinatorial logic circuits based on logic gates integrated with coders, decoders, multiplexers, demultiplexers and displays. Sequential components are used for designing different types of counters and sequencers. Memories, microprocessors and microcontrollers are analyzed and applied to solve digital problems.

III. COURSE OUTCOMES

At the end of the course, students:

1. Understand the characteristics of analog and digital signals, as well as their applications in different engineering fields.
2. Interpret Boole relations and properly apply the process for determining the truth value of a logic expression.
3. Design and draw combinatorial logic circuits using logic gates.
4. Describe the characteristics of commonly used Medium Scale Integration MSI combinatorial circuits.
5. Analyze sequential logic circuits and components and explain the process for designing sequential systems.

IV. LEARNING UNITS

1. ANALOG AND DIGITAL SYSTEMS. DIGITAL CODES

Analog systems / Digital systems / Numbering systems: decimal, binary, hexadecimal / Binary arithmetical operations / Conversions among numbering systems / Binary codes: gray code, natural BCD code, Aiken BCD code, Three-excess BCD code, ASCII code.

2. LOGIC GATES AND BOOLE ALGEBRA

Logic gates / Truth tables / Classic symbols / IEEE symbols / Boole algebra and Boole identities / Boole functions, normalization of Boole functions / Simplification of Boole functions: algebraic method, Karnaugh map method for 2, 3, 4 and 5 variables.

3. DESIGN OF COMBINATORIAL LOGIC CIRCUITS

Combinatorial systems / Design process of combinatorial systems / Design of: binary adder,

binary substracter, coder, decoder, multiplexer, demultiplexer / Design of logic comparators / Seven-segments displays / LCD displays / Applications of combinatorial logic circuits.

4. DESIGN OF SEQUENTIAL LOGIC CIRCUITS

Sequential system / Basic sequential devices: latch, flip-flop / Types of flip-flops: RS, D, T, JK / Truth tables / State transition tables / Analysis of sequential systems / Binary counter / Counter parameters / Counter types: asynchronous counter, synchronous counter, BCD counter / Registers / Register classes / Applications of sequential logic circuits.

5. MEMORIES AND LOGIC PROGRAMMABLE DEVICES

Memory / Types of memory: magnetic, semiconductor, optical / Memory general characteristics: capacity, access time, manufacturing technology / Semiconductor memories: ROM, RAM / Types of semiconductor memories: SRAM, DRAM, EEPROM, FPROM / Programmable logic devics PLD / PLD types: PLA, PAL, GAL.

6. MICROPROCESSORS AND MICROCONTROLLERS

Basic computer. Elements: microprocessor, memory, I/O controllers, communication buses / Microprocessor architecture: registers, ALU; control unit / Microprocessor instructions, micro-operations, instruction codes / Microcontroller architecture.

V. LABORATORY AND PRACTICAL EXPERIENCES

Laboratory 1. Design, simulation and implementation of a combinatorial system. First part.
Laboratory 2. Design, simulation and implementation of a combinatorial system. Second part.
Laboratory 3. Design and realization of a sequential system. First part.
Laboratory 4. Design and realization of a sequential system. Second part.

VI. METHODOLOGY

This course is carried out in theory, practice and laboratory sessions. In theory sessions, the instructor introduces the concepts, analysis of digital circuits, design methods. In practice sessions, the instructor and students solve different problems related to combinatorial and sequential circuits. In laboratory sessions, students experimentally analyze the behavior of electronic gates, combinatorial and sequential components and circuits using MultySim software. At the end of the course, students must submit and defend a design project. In all sessions, students' active participation is encouraged and graded.

VII. EVALUATION FORMULA

The Final Grade PF is calculated as follows (evaluation system: G):

$$\mathbf{PF} = (\mathbf{PP} + \mathbf{EP} + \mathbf{EF})/\mathbf{3}$$

EP: Mid-term exam EF: Final exam
PP: Average of four graded quizzes

VIII. BIBLIOGRAPHY

1. **TOCCI Ronald**
   Digital Systems. Principles and Applications.
   Prentice Hall Editions, 2012.

2. **MANO Morris**
   Digital Design
   Prentice Hall Editions. 2014