# ECE214: Digital Circuits and Systems

Programme: B. Tech. (ECE) Year: 2nd Semester: I
Course: Core for ECE, CSE, and CCE Credits: 3 Hours: 40

**Course Context and Overview (100 words):**

Introduction to the digital logic circuits and systems is towards the aim of designing the fastest growing technology digital systems over given specifications. This course will equip the students to think of their own digital processors and build them on hardware (ASICs or FPGAs). Some very common and daily life examples of digital systems out of millions are as follows: Digital watch, Vending Machine Controller (ATM machine), Digital Scientific Calculator using CORDIC algorithms, Washing machine controller (Hardware Part), Digital remote controls, Automatic digital locks, Digital games, Automatic digital control in cars, robots, Digital Cameras, Mobile Phones, etc.

**Prerequisites Courses:** NIL

**Course Outcomes (COs):**

| On completion of this course, the students will have the ability to: | |
|---|---|
| CO1: | Know the basics of Digital design, number systems, and Boolean algebra |
| CO2: | Convert from one number system to other and perform computations in various number systems |
| CO3: | Minimize the Boolean expressions using Boolean algebra, K-maps and QM method |
| CO4: | Describe a logic function using CMOS logic |
| CO5: | Design combinational circuits including adders, encoder, decoders, multiplexers and complex structures using logic gates and CMOs logic |
| CO6: | Design and analyze various sequential circuits like latches, flip flops and counter using logic gates |
| CO7: | Describe and design Finite state machine and system implementation using FSM |

**Course Topics:**

| Topics | Lecture Hours | |
|---|---|---|
| **UNIT - I**<br>**1. Topic** Number Systems & Codes | 3 | 3 |
| 1.1 About Digital Design, Analog versus Digital, Digital Devices, Electronic and Software aspects of digital design, Integrated Circuits. | 1 | |
| 1.2 -Positional Number Systems, Octal and Hexadecimal Numbers, Number System Conversions, Representation of negative numbers | 2 | |
| **UNIT - II** | 4 | 4 |

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|---|---|---|
| **2. Topic** Boolean Algebra and Minimization techniques | | |
| 2.1 Axioms, Single-Variable Theorems, Two and Three Variable Theorems | 2 | |
| 2.2 Duality, Standard representation, combinational circuit minimization using K-Maps | 1 | |
| 2.3 QM method | 1 | |
| **UNIT - III**<br>**3. Topic** CMOS Logic Design | 9 | 9 |
| 3.1 Digital Logic levels, MOS Structure and Transistor, Threshold Voltage, MOSFET $V_{DS}$-$I_D$ Characteristics | 2 | |
| 3.2 , Resistive Load Inverter, Active Load Inverter, CMOS Inverter, Calculation of VOH, VOL, VIL, VIH and Noise Margin | 2 | |
| 3.3 Design and sizing of CMOS digital circuits | 5 | |
| **UNIT - IV**<br>**4. Topic** Combinational Circuit Design | 8 | 8 |
| 4.1 Combinational logic circuit design, half and full adder, subtractor, Binary serial and parallel adders. BCD adder, Binary multiplier | 3 | |
| 4.2 Decoder: Binary to Gray decoder, BCD to decimal, BCD to 7-segment decoder, Multiplexer, De-multiplexer, Encoders and Priority Encoders, Diode switching matrix | 3 | |
| 4.3 Design of logic circuits using multiplexers, encoders, decoders and de-multiplexers. Designing of combinational systems: ALU etc. | 2 | |
| **UNIT-V**<br>**5. Topic** Sequential Circuit Design | 10 | 10 |
| 5.1 Latches, flip-flops, R-S, D, J-K, and Master Slave flip flops, Conversions of flip-flops: Counters | 3 | |
| 5.2 Asynchronous (ripple), synchronous and synchronous decade counter, Modulus counter, skipping state counter, counter design. Ring counter, Counter applications | 4 | |
| 5.3 Registers: buffer register, shift register | 3 | |
| **UNIT-V**<br>**6. Topic** Finite State Machines | 6 | 6 |
| 6.1 Definition, classification, state machine analysis, excitation table of flip flops | 2 | |
| 6.2 Designing various synchronous sequential circuits using state machines | 2 | |
| 6.3 Design Problems (Sequence detectors, Vending Machine Controllers etc.) | 2 | |

**Text Book:**

1. Milos D. Ercegovac, "*Introduction to Digital Systems"*, Tom Lang, Jaime H. Moreno
2. J. F. Wakerly, "*Digital Design: Principles & Practices"*, Pearson Education.

3. Thomas L. Floyd and R. P. Jain**,** "*Digital Fundamentals"*, Pearson Education, 8th Ed.

**Reference books:**

1. Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Circuits: Analysis and Design"*, Tata McGraw Hill.
2. S. Salivahanan & S. Arivazhagan, "*Digital Circuits and Design"*, Vikas Publication House Pvt. Ltd., 2nd Ed.

**Additional Resources (NPTEL, MIT Video Lectures, Web resources etc.):**
https://onlinecourses.nptel.ac.in/noc15_ec01

**Evaluation Methods:**

| Item | Weightage |
|---|---|
| Quiz 1 | 20 |
| Quiz 2 | |
| Quiz 3 | |
| Quiz 4 | |
| Mid-term Examination | 30 |
| End-term Examination | 50 |