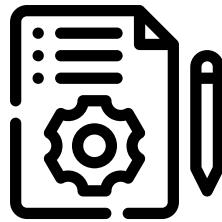
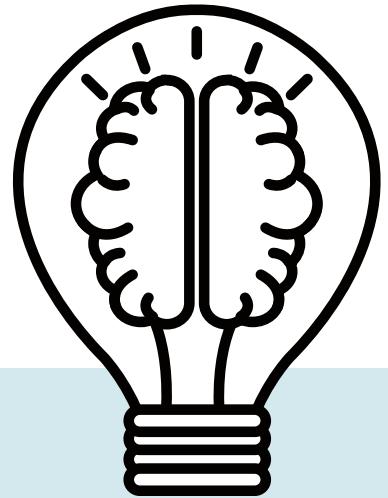


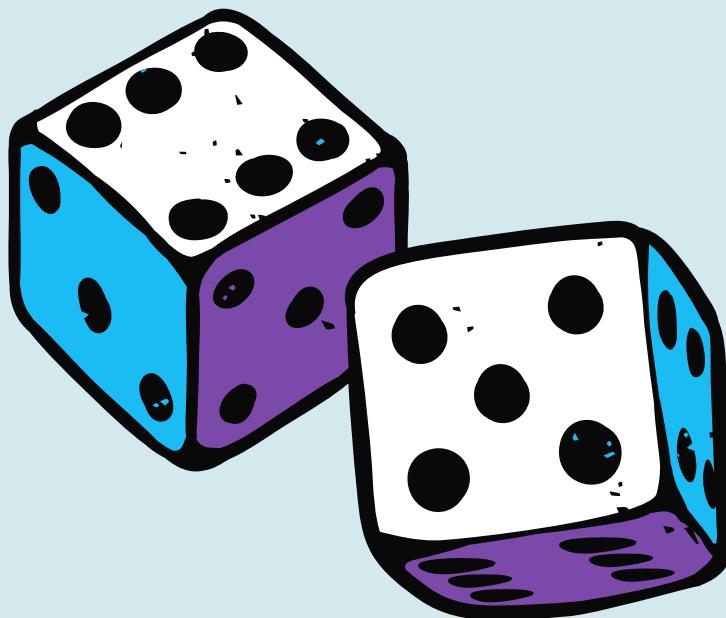
# ELL 201 PROJECT



APRIL 2024



## DIGITAL DICE SIMULATION



Prepared by:  
Rahul shah 2022MT11732

# 01 INTRODUCTION

The Digital Dice Simulator project aims to create a digital representation of a dice capable of generating random numbers from 1 to 6. By utilizing a combination of sequential and combinational logic circuits like CPLD Board,<sup>7</sup> segment display, verilog application etc. This project offers a versatile and efficient method for simulating the roll of a physical dice in a digital environment.

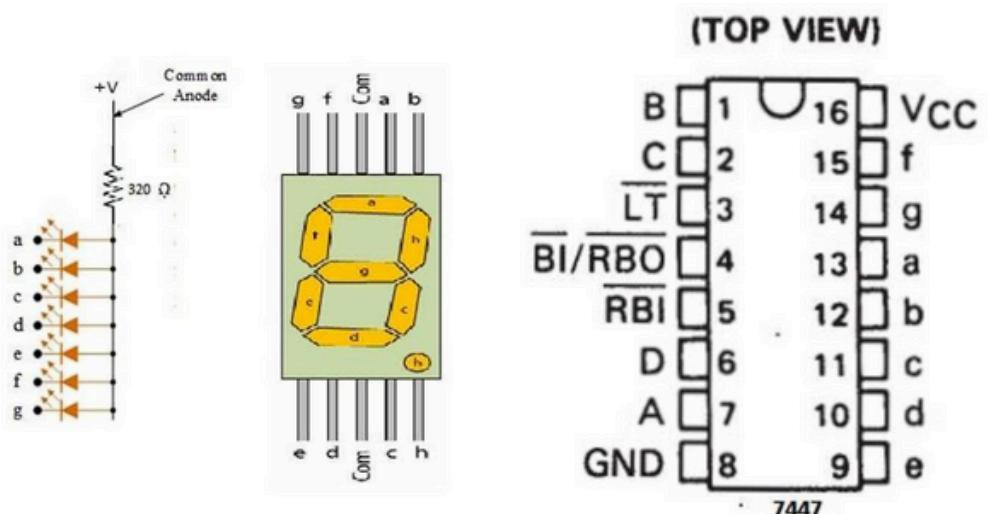
## OBJECTIVE/AIM

The main objective of this project is to create a digital alternative to the traditional physical dice. The key goals include:

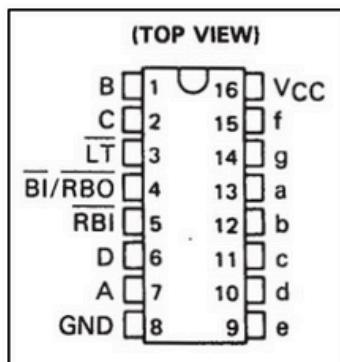
- Implementing sequential circuits to generate random numbers.
- Designing combinational circuits to display the output on LED indicators.
- Developing a user-friendly interface for rolling the digital dice.

# 02 COMPONENTS: COMBINATIONAL CIRCUIT

- 7-SEGMENT DISPLAY
- DECODER IC 7447



## Understanding IC 7447



- A to D : Binary Coded Decimal inputs 0-15
- a to f : Inputs to 7 segments of the LED
- LT : Lamp Test [*Active Low*]
- RBI/BI : Ripple Blanking Input [*Active Low*]
- RBO : Ripple Blanking Output [*Active Low*]
- Vcc/GND : IC Power

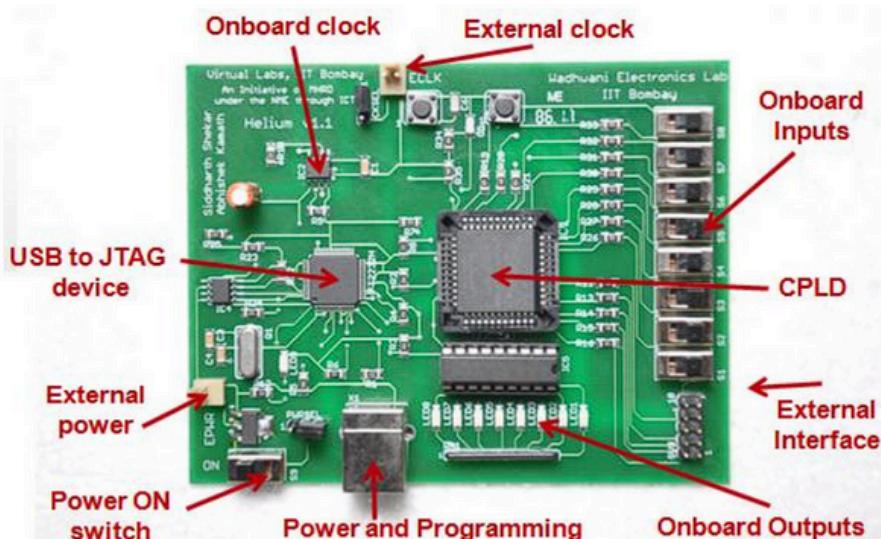
03

# TRUTH TABLE OF 7-SEGMENT DISPLAY

Segments ( $\checkmark$ = ON)							Display
a	b	c	d	e	f	g	
$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	0
		$\checkmark$	$\checkmark$				1
$\checkmark$	$\checkmark$			$\checkmark$	$\checkmark$		2
$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$			$\checkmark$	3
		$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	4
$\checkmark$		$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	5
$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	6
$\checkmark$	$\checkmark$	$\checkmark$					7

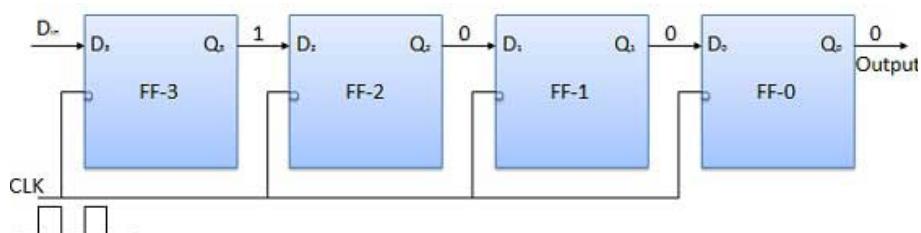
# 04 COMPONENTS: SEQUENTIAL

- CPLD BOARD
- REGISTER'S



#### Features:

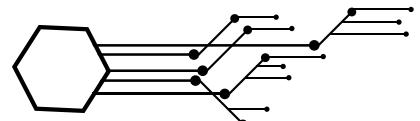
- Based on Altera MAX 3000 architecture.
- Device used on board: EPM3064A (1250 usable gates).
- Powered and Programmed through USB.
- 8 inputs and 8 outputs onboard.
- 8 user configurable I/O pins for interfacing to external circuitry.
- Onboard clock of 1Hz.



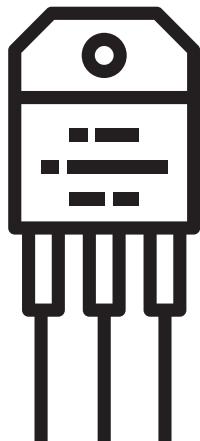
## APPARATUS USED:

- BREADBOARD
- JUMPER WIRES
- RESISTORS (1 KILO OHM)

# 05 CIRCUIT DESIGN:

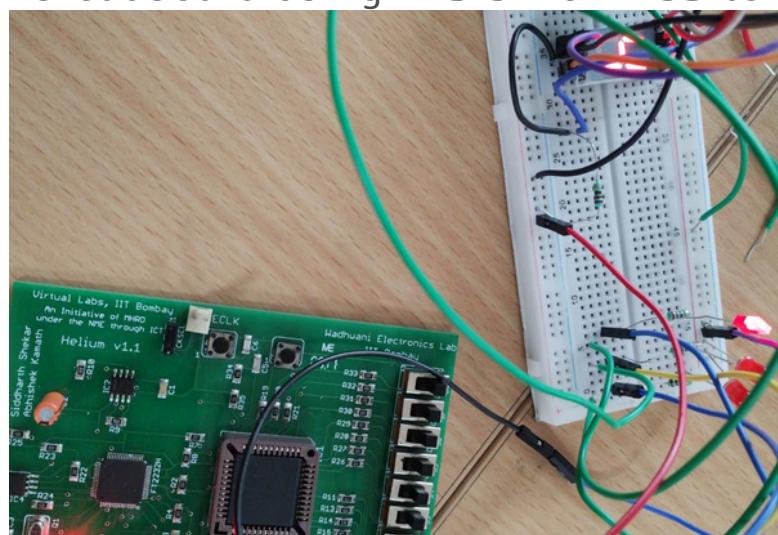


- **RANDOM NUMBER GENERATION:**
- The random number generation circuit employs sequential logic elements such as flip-flops and counters as well as combinational logic including usage of CPLD Board.
- A counter circuit generates pseudo-random binary numbers upon each manual input using verilog code which is then converted to 7 segment abcdefg output using IC 7447 reflecting on 7 segment display.
- The binary output of the random counter represents the faces of the traditional dice which is shown using 3 LED's showing 3 bits.



## • DISPLAY UNIT

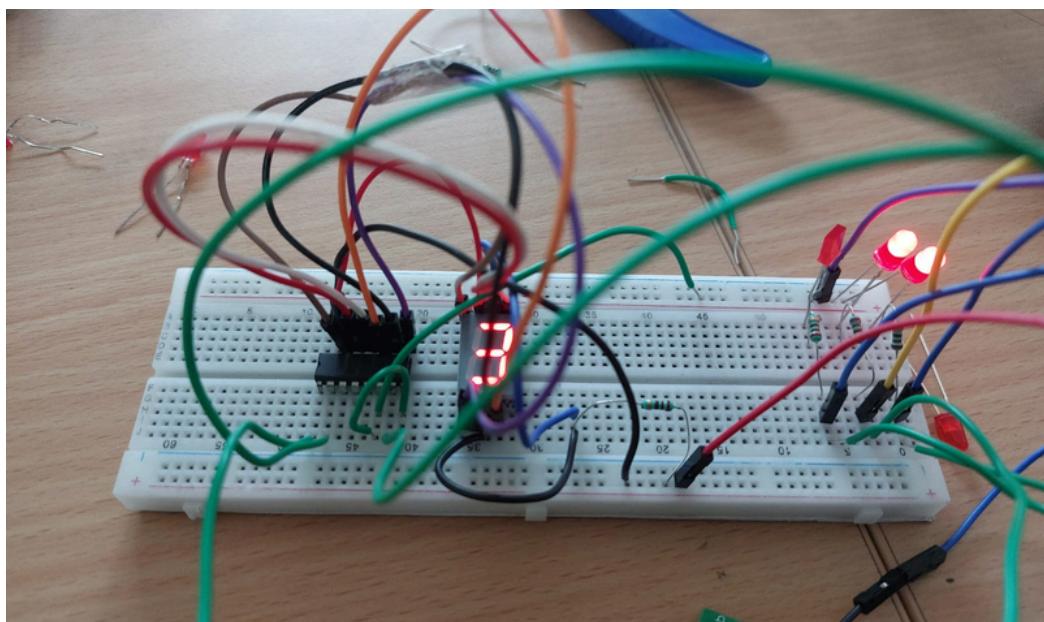
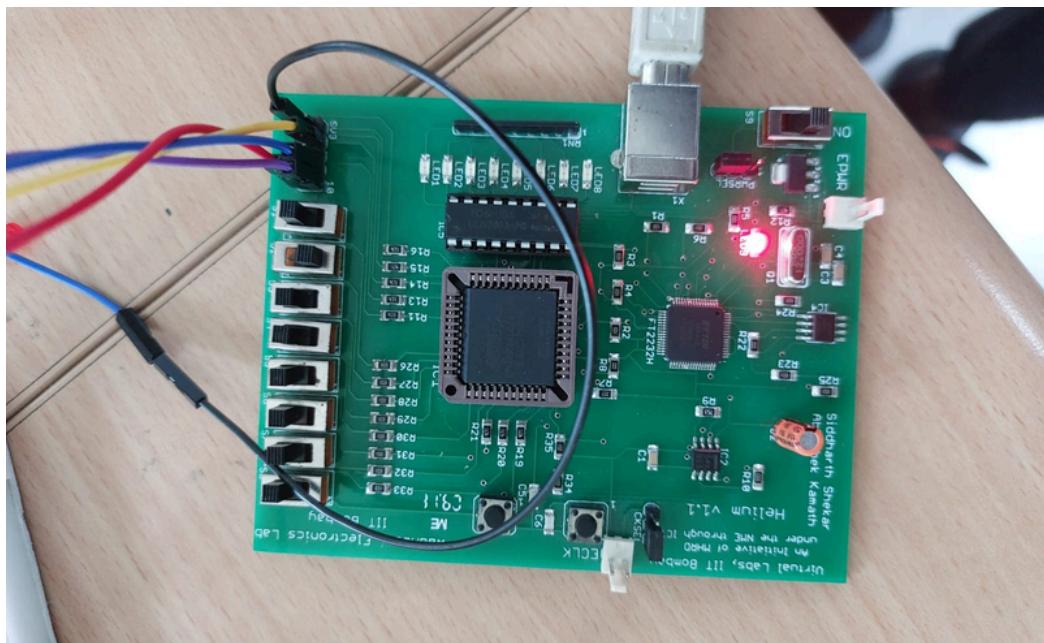
- Combinational logic circuits are used to interface the binary output to the LED indicators which is then converted to 7 segment output abcdefg being displayed on 7 segment display as well.
- 3 bit binary output is also displayed on breadboard using LED'S from LSB to MSB.



# 06

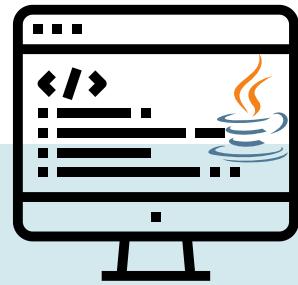
# IMPLEMENTATION

*The circuit was implemented on a breadboard using the specified components. Connections were made according to the circuit diagrams designed during the planning phase. Careful attention was paid to component placement and wiring to ensure proper functionality and minimize errors.*



# 07 VERILOG CODE

```
MODULE DICE(
    INPUT RESET,
    INPUT ROLL_BUTTON,
    OUTPUT REG [2:0] RANDOM_NUM,
);
```



```
REG [15:0] LFSR;
```

```
ALWAYS @(POSEDGE RESET OR POSEDGE ROLL_BUTTON) BEGIN
    IF (RESET) BEGIN
        LFSR <= 16'HACE1;
    END ELSE BEGIN
        LFSR <= {LFSR[0] ^ LFSR[13] ^ LFSR[14] ^ LFSR[15], LFSR[15:1]};
    END
END
```

```
ALWAYS @(POSEDGE RESET OR POSEDGE ROLL_BUTTON) BEGIN
```

```
    IF (RESET) BEGIN
        RANDOM_NUM <= 3'B000;
    END ELSE BEGIN
        IF (ROLL_BUTTON) BEGIN
            RANDOM_NUM <= (LFSR[2:0] % 6) + 1;
        END
    END
END
ENDMODULE
```



# 08 TEST BENCH CODE

```

MODULE DICE_TB;

REG RESET;
REG ROLL_BUTTON;

WIRE [2:0] RANDOM_NUM;

DICE DUT (
    .RESET(RESET),
    .ROLL_BUTTON(ROLL_BUTTON),
    .RANDOM_NUM(RANDOM_NUM)
);

REG CLK = 0;
ALWAYS #5 CLK = ~CLK;

INITIAL BEGIN
    RESET = 1;
    #10;
    RESET = 0;
END

INTEGER TOGGLE_COUNT = 0;
INITIAL BEGIN
    ROLL_BUTTON = 1;
    REPEAT (4) BEGIN
        @(POSEDGE CLK);
        ROLL_BUTTON = ~ROLL_BUTTON;
        @(POSEDGE CLK);
        ROLL_BUTTON = ~ROLL_BUTTON;
        @(POSEDGE CLK);
        TOGGLE_COUNT = TOGGLE_COUNT + 1;
    END
    $DISPLAY("NUMBER OF ROLL_BUTTON TOGGLES: %D", TOGGLE_COUNT);
    $FINISH;
END

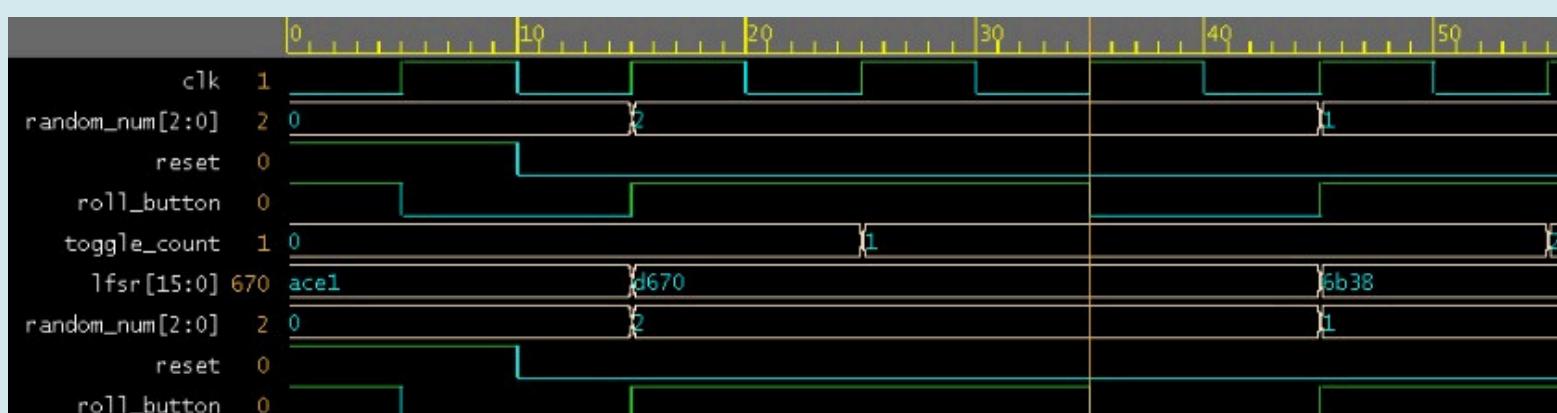
INITIAL BEGIN
    $DUMPF("DUMP.VCD");
    $DUMPVARS;
END

ENDMODULE

```



# WAVEFORM

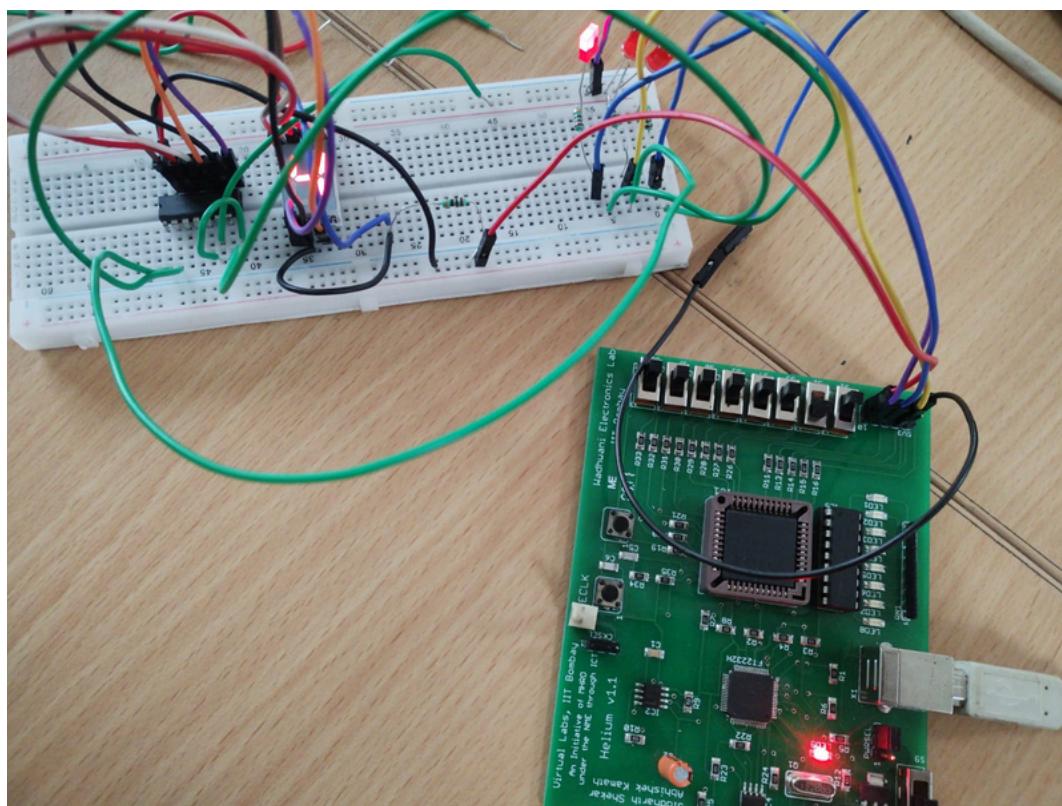


# 09 TESTING

Extensive testing was conducted to validate the functionality of the digital dice. This involved:

- Verifying the random number generation by observing the sequence of LED illuminations.
- Checking the accuracy of the displayed faces compared to the expected results.
- Testing the responsiveness of the push-button switches and ensuring reliable operation.

## Demonstration



# PROJECT OVERVIEW

Project Overview: The digital dice project consists of two main components: sequential logic for generating random numbers and combinational logic for displaying the results on a 7-segment display. The sequential logic is realized using a CPLD, which generates random numbers through a pseudo-random number generator (PRNG) algorithm. The output of the PRNG is then fed into combinational logic, which decodes the random number and drives the corresponding segments of the 7-segment display.

## 12 CONCLUSION

The Digital Dice project effectively demonstrates the application of sequential and combinational logic circuits in generating random numbers and displaying results in a user-friendly manner. This project provides a fun and educational insight into digital electronics and serves as a practical example of circuit design and implementation.

## MY CONTRIBUTION

The main objective of this project is to create a digital alternative to the traditional physical dice. My contribution includes:

- Designing combinational circuits to display the output on LED indicators.
- Giving idea of implementing any random number using polynomial of degree 17 then converting it to random number 1 to 6 by taking number modulo 6.