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- **Introduction :** ‘A Digital Clock’ Is widely used time keeping device that displays time in numeric form. This project aims to design a digital clock using ’Flip-Flops’
  and combinational logic circuits. The circuit integrates counters, 7-segment display’s
  logic gates to show hours, minutes and seconds accurately. Flip-Flops, as building Blocks of counters, allow us to store and manipulate binary data efficiency, while
  the 7-segment display provides a user friendly interface to read the time.

  This project demonstrates fundamental concepts of digital electronics, such as sequential logic, counters, and display control, making it suitable for understanding real world timekeeping systems.

- **Theory** : A Digital Clock operates based on sequential logic circuits that count and display time in a numerical format. At the core of this project are ‘Flip-Flops’ and ‘Counters’, which work together to track time increments, such as seconds, minutes, and hours. ‘Flip-flops’, which are basic memory elements, store binary data (0 or 1) and are the building blocks of counters. A Counter, like the ‘74LS90’ or ‘74LS76’ used here, is a sequential circuit that counts input pulses. In this project, these counters count clock pulses and generate Binary-Coded Decimal (BCD) outputs, which represent numeric values in binary form.

To display the counted values in a human-readable form, 7-segment displays are used. A BCD-to-7-segment decoder IC, such as the ‘74LS48’ or ‘4026’, converts the binary output of the counters into signals that illuminate specific segments of the display. This allows the numeric digits (0-9) to be displayed for each time unit.

The working of the digital clock is divided into stages: the seconds counter, minutes counter, and hours counter. Initially, the seconds counter increments from 0 to 59. Once the count reaches 60, a carry pulse is generated using combinational logic gates (e.g., ‘AND’ gates from the ‘74LS08 IC’), which triggers the minutes counter. Similarly, when the minutes counter reaches 60, another carry pulse triggers the hours counter. This cascading mechanism ensures the clock progresses accurately.

Logic gates play a vital role in controlling the flow of the circuit. They enable the transition from one stage to the next when specific conditions are met, such as reaching the maximum count (60 for seconds or minutes).

Resistors are used in the circuit to stabilize signals and prevent floating inputs, ensuring reliable operation.

Overall, the circuit combines 'Flip-Flop' based counters, logic gates, and display drivers to create a fully functional digital clock. The modular approach ensures that each stage—seconds, minutes, and hours—operates independently but remains synchronized through logic control, showcasing the principles of digital electronics and sequential logic design.

➢ Circuit Diagram :

<u>Schematic Design :</u> We designed diagrams for both the combinational & sequential circuits.

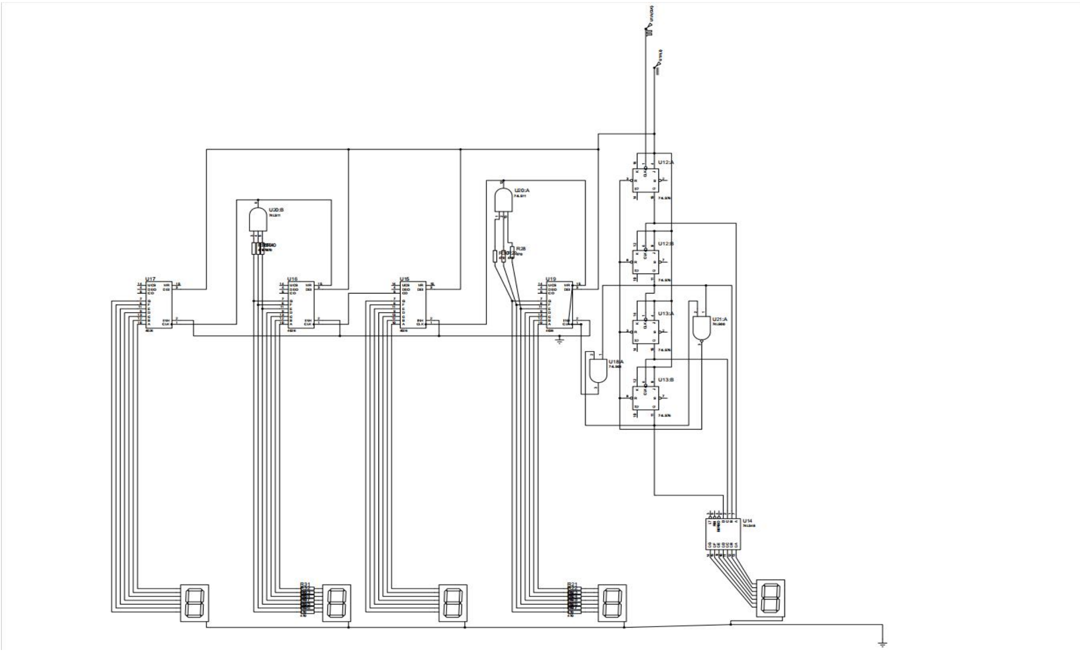

Fig 01: A Digital Clock

<u>Simulation :</u> We simulated the design in Proteus Software based on the schematic diagram and verified its functionality and performance

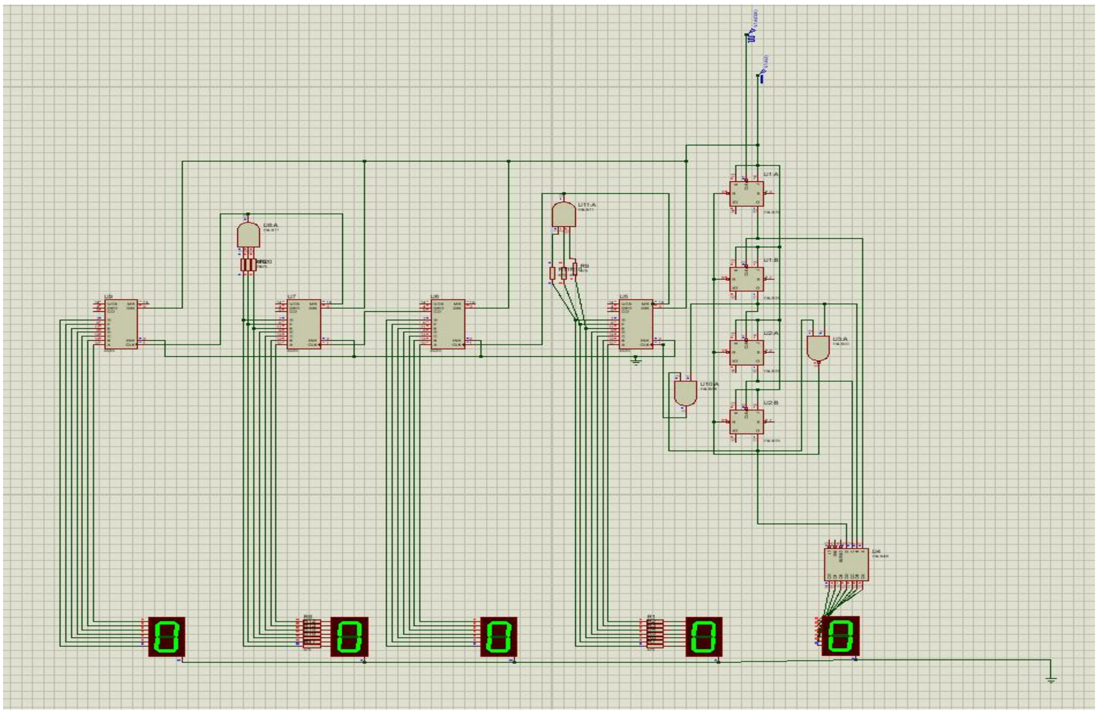

Fig 02: Simulation of a digital clock

➢ Components Required :

1. 74LS76 - Decade counters.
2. 74LS08 - AND gate IC.
3. 74LS11 - 3 INP AND gate IC.
4. 74LS48 - BCD to 7-segment decoder.
5. 4026 - BCD to 7-segment decoder.
6. 555 Timer
7. Battery (9V)
8. 7-Segment Displays (Common Cathode/Anode) - To display digits.
9. Resistors (470 ohm) - For signal stability and pull-down connections.
10. Breadboard
11. Connecting Wires

➢ Design and Implementation:

Generating Clock Pulses :

555 Timer IC is configured in astable mode to generate pulses at 1 Hz (1 pulse per second).
Resistors and capacitors are selected to get the desired frequency.
Output Pin 3 of the 555 Timer is used to drive the counters.

0 to 9 asynchronous counter using T flip flop (Seconds) :

IC 7476 : 2
IC 7400 : 1
IC 7448 : 1
7 segment display common cathode

Firstly ,we need 4 T-flip flop for counting 4 bit . As we short each J-K to make the T flip flop . For non- consecutive sequences, we have to go with synchronous circuits but for purposes like clocks where the counting sequence is consecutive, it is better to go with asynchronous circuits because they are simpler to construct.

Secondly , output of 2nd and 4th flip flop will connect to Nand gate , as per truth table and Nand Gate output is connect the clear pin of all the IC . As when both output are in high all flip flop will be reset and will be count from the Zero

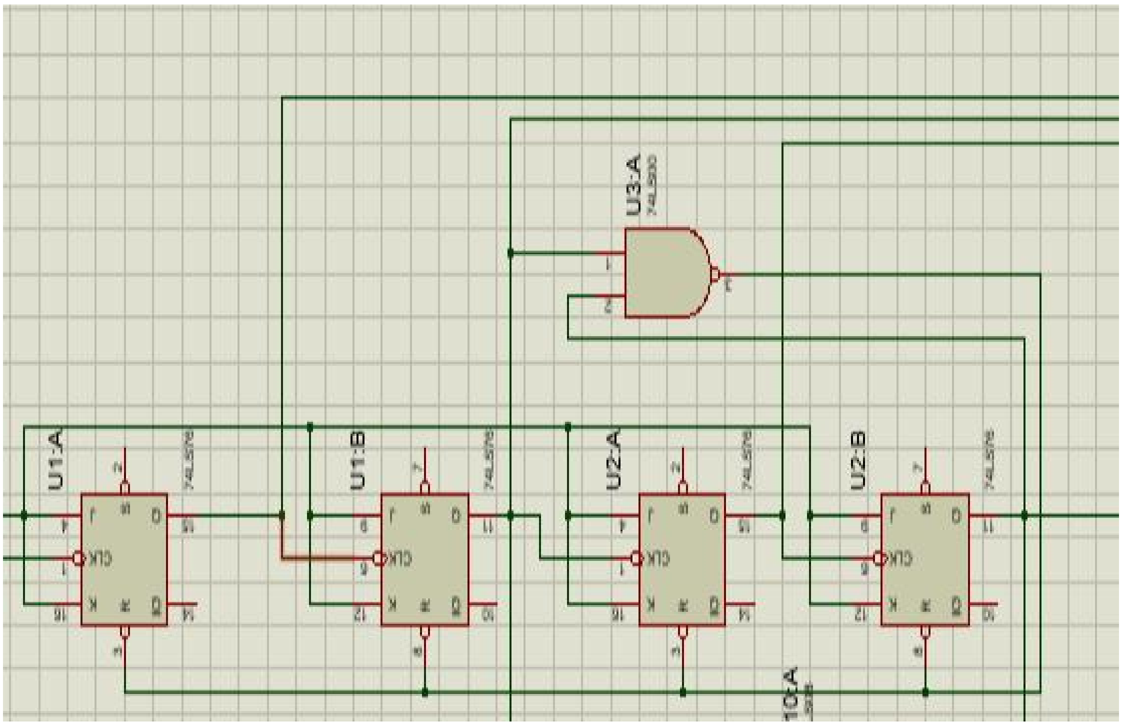

Fig 03

0 to 5 counter using Decade Counter IC 4026 (Seconds) :

IC 4026 : 1
IC 7408 : 1
IC 7411 : 1
7 segment common Cathode Display

We know that the IC 4026 is considered a Johnson counter; it is a 5-stage Johnson decade counter with a built-in decoder that allows it to directly drive a 7-segment display, making it commonly used in digital display applications where a numeric output is needed.

Firstly, for the clock in decade counter we take the input from the output of 2nd and 4Th flip and connect both with 2 input AND gate . when output of And gate is high the clock of decade counter is at high and then it count digit .

Secondly, to count the Decade counter at 5 . we know that E,F,G of display are open when it turns to 6 from 5. So when E,F,G are in high we add them with 3 input AND gate and add reset pin off decoder . Thus it count 0 to 5

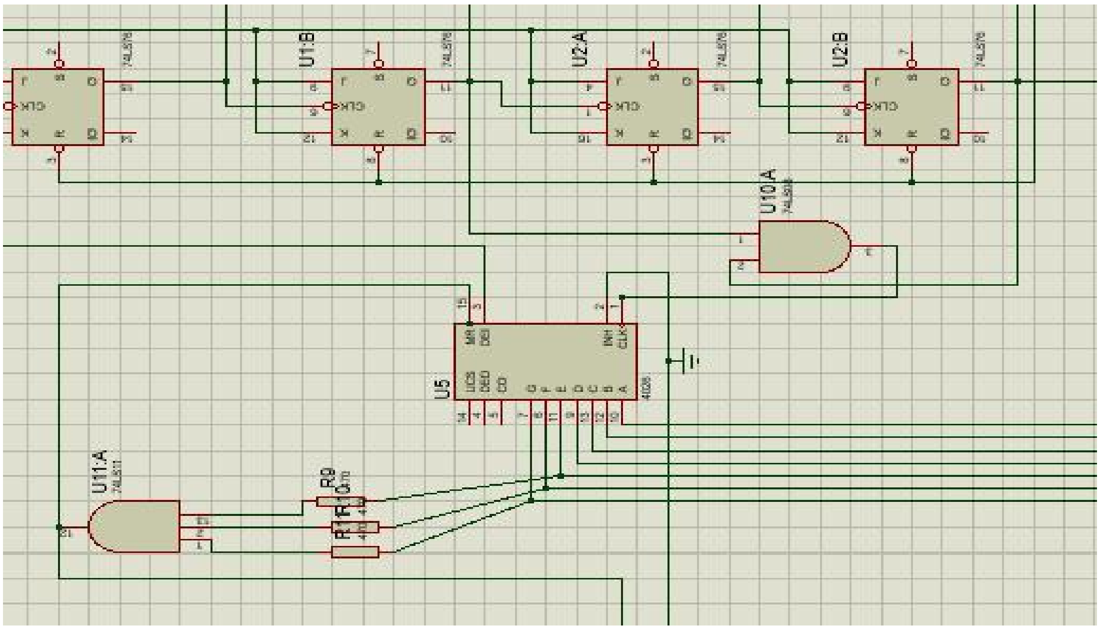

Fig 04

0 to 9 counter using IC 4026 (Minutes) :

IC 4026 : 1
7 segment display common cathode

Firstly, as we have to give all the connections as a decade counter . the clock pulse of this counter is came from the AND gate output of 0 to 5 counter . when its reset at 6, the pulse will be given then this counter will start counting .

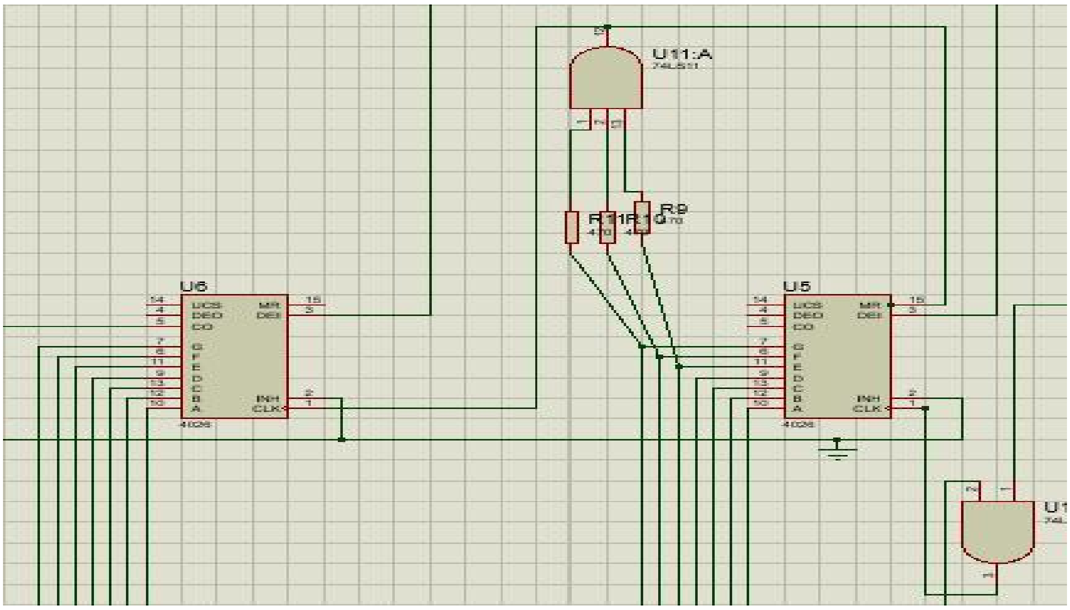

Fig 05

0 to 5 counter using IC 4026 (Minutes) :

IC 4026 : 1
IC 7411 : 1
7 segment display common cathode

Firstly, to count the Decade counter at 5 . we know that E,F,G of display are open when it turns to 6 from 5. So when E,F,G are in high we add them with 3 input AND gate and add reset pin off decoder . Thus it count 0 to 5 .

Secondly, the clock pulse of this counter is came from the Carry out pin of o to 9 counter. When it finishes count 9 then it gives the pulse and count 0 to 5

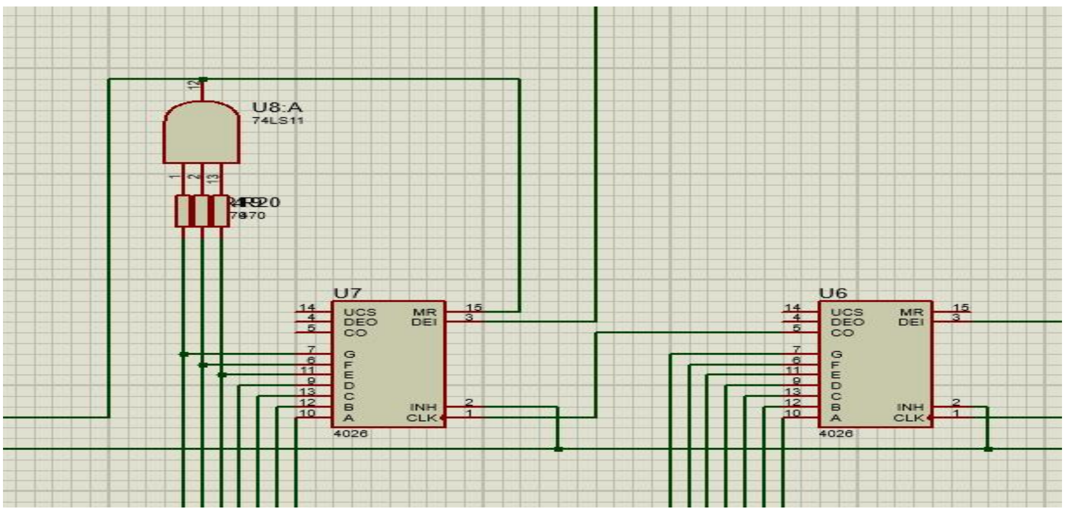

Fig 06

0 to 9 counter using IC 4026 (Hours) :

IC 4026: 1
7 segment display common cathode

As we have to give all the connections as a decade counter to count 0 to 9 . Clock pulse is given from output of AND gate of 0 to 5 counter .

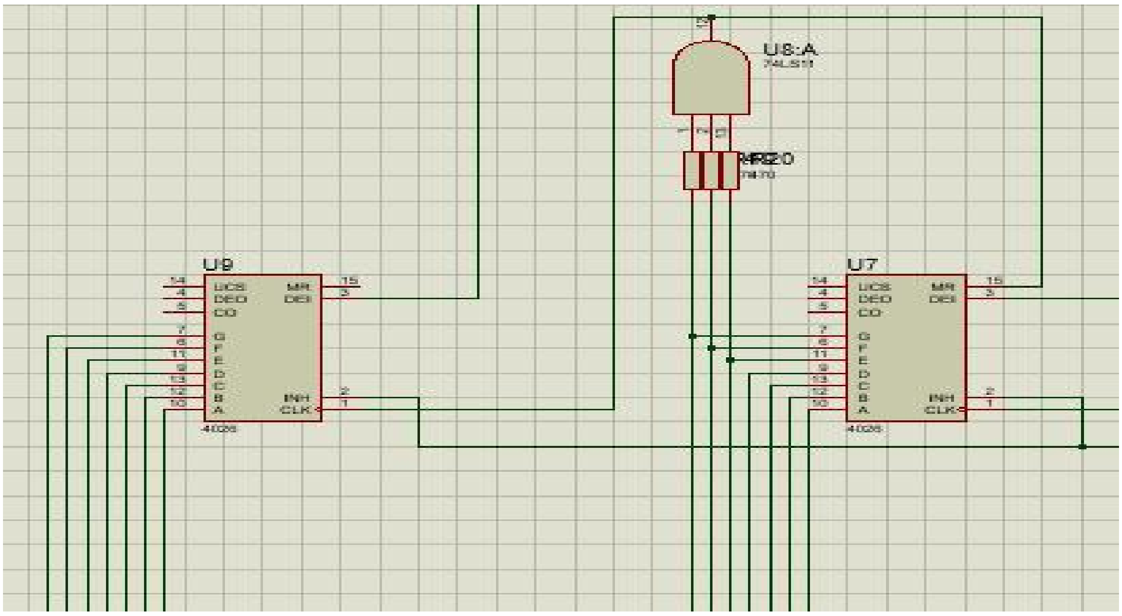

Fig 06

Breadboard Picture :

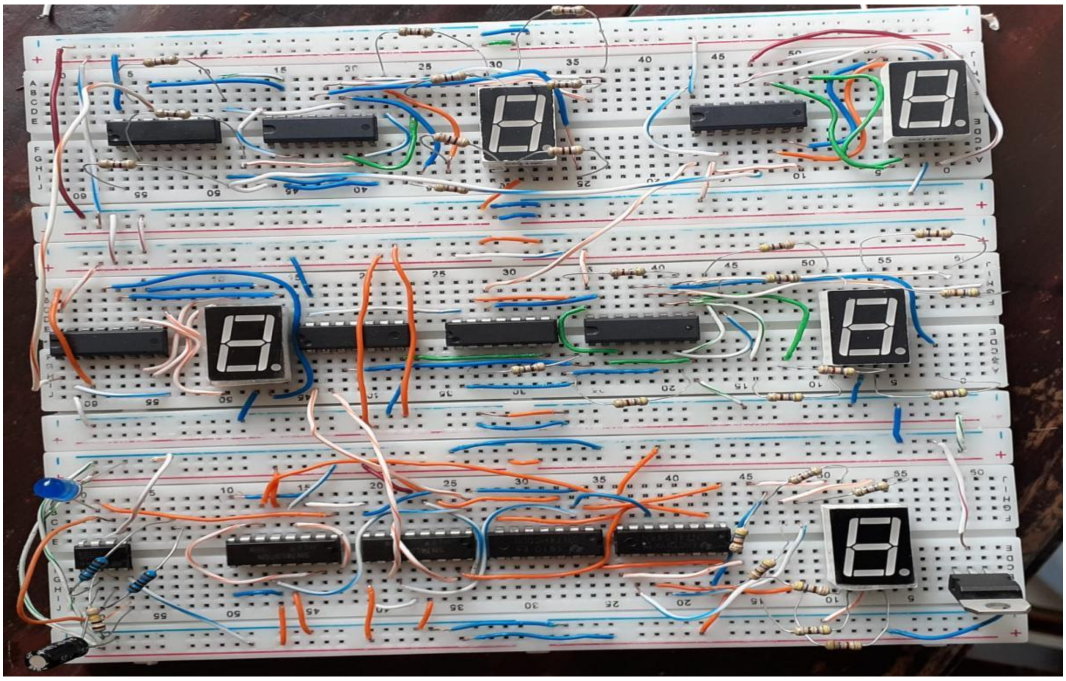

Fig 07

Truth Table : (OR GATE)

Input A	Input B	Output (A+B)
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table : (AND GATE)

Input A	Input B	Output (A·B)
0	0	0
0	1	0
1	0	0
1	1	1

Truth Table : (T FLIP-FLOP)

T	Qn (Present State)	Qn+1 (Next State)
0	0	0
0	1	1
1	0	1
1	1	0

Truth Table : (JK FLIP-FLOP)

J	K	Qn (Present State)	Qn+1 (Next State)
0	0	0	0
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1

1	1	0	1
1	1	1	0

- ## Working principle of the project:

1. Generating Clock Pulses

555 Timer:
We use a 555 Timer IC to create clock pulses. It is set up in a way called "astable mode." This means it will keep making a square wave signal. We want the timer to make one pulse every second (1 Hz). We choose the right resistors and capacitors to get this frequency. The output of the timer is at Pin 3, and we will use this to count time.

2. Counting Seconds

T Flip-Flops:
For counting seconds, we use four T flip-flops. These are special circuits that can count in binary.
We connect the J and K inputs of the flip-flops to make them toggle (change state) with each pulse from the 555 Timer. This way, they count from 0 to 9.
The output from the 2nd and 4th flip-flops goes to a NAND gate. When both outputs are high (1), the NAND gate sends a signal to reset all flip-flops back to 0. This happens when we reach 10.

3. Counting Minutes

Decade Counter IC 4026:
We use an IC called 4026 to count minutes. This IC can count from 0 to 5 and can directly show the number on a 7-segment display.
The clock for this counter comes from the NAND gate output of the seconds counter. So, when the seconds counter resets, the minute counter will count up.
To make sure the minute counter only goes from 0 to 5, we check the outputs for 6 (E, F, G). When these are high, we use an AND gate to reset the minute counter.

4. Counting Hours

Another Decade Counter IC 4026:
We need another 4026 IC to count hours from 0 to 9.

The clock pulse for the hour counter comes from the output of the AND gate connected to the minute counter. So, when the minute counter resets from 5 to 0, the hour counter will count up.
The hour counter is also set up like a decade counter.

5. Displaying the Count

7-Segment Displays:
Each counter (seconds, minutes, and hours) is connected to a common cathode 7-segment display. This display shows the current count.
We can use a BCD to 7-segment decoder (like IC 7448) to convert the binary output from the counters into signals that light up the correct segments on the display.

- **Conclusion:** The digital clock project demonstrates the use of flip-flops, counters, and combinational logic circuits to design a time-keeping system. The clock accurately counts seconds, minutes, and hours, displaying them on a 7-segment display. This project highlights the importance of sequential logic and digital electronics in real-world applications. Future enhancements like alarms or LCD displays can make the design more advanced and user-friendly.

- **Future scope:** 1.Alarm Functionality: Add an alarm feature to notify at a set time.

2.Stopwatch Integration: Enhance the project to include a stopwatch mode.
3.Power Backup: Use a battery or RTC module for continuous operation during power failures.
4.Display Upgrade: Replace the 7-segment display with an LCD display for better visuals.

- **Cost Calculation:**

Components	Quantity	Unit Price (BDT)	Total Price (BDT)
1) 74LS08	1	25	25
2) 74LS48	1	25	25
3) 74LS11	2	30	60
4) 74LS76	2	45	90
5) 4026 IC	4	40	160
6) 555 IC	1	20	20

7) 470 ohm Resistor	6	10	60
8) battery	1	60	60
9) 7-Segment Display	5	10	50
10) Breadboard	4	120	480
11) Wire		50	50
Total	27	435	1080

➢ **Contribution of the members:** Each group member contributed significantly to the completion of the project :

i) ET231008 (Ankon Barua):

1. Doing research
2. Report writing
3. Collect information and Idea
4. Implementation on breadboard

ii) ET231009 (Mishfer Alam):

1. Buying instrument and collect necessary equipment
2. Designing the Diagram
3. Collect information and idea
4. Implementation on breadboard

iii) ET231010 (MD.Habibul Bashar):

1. Buy instrument and collect equipment
2. Report writing
3. Collect information and idea
4. Implementation on breadboard

iv) ET231011 (Emat Sayed):

1. Buying instrument and collect necessary equipment
2. Designing the diagram
3. Collect information and idea
4. Implementation on breadboard