KONGU ENGINEERING COLLEGE

(Autonomous)

Perundurai, Erode – 638 060

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

Estd : 1984

Transform Yourself

STOP WATCH

A MICRO PROJECT REPORT

for

22ECT31 - DIGITAL ELECTRONICS

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BONAFIDE CERTIFICATE

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Semester	:	**III**

Certified that this is a bonafide record of work for application project done by the above students for **22ECT31– DIGITAL ELECTRONICS** during the academic year **2024-2025.**

Submitted for the Viva Voce Examination held on ________________________

Faculty In-Charge **Year In-charge**

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Abstract :

a. Problem Statement :

In educational and experimental domains, there is a significant need for simple, customizable timing devices that can facilitate hands-on learning of digital electronics principles. While commercial stopwatches are ubiquitous, they are often designed as black-box systems, offering no insights into their internal mechanisms. This lack of transparency limits their use as educational tools for students and hobbyists. Additionally, constructing a stopwatch from basic components is a foundational project for understanding the workings of timers, counters, and display drivers.

b. Methodologies :

The stopwatch design leverages fundamental components to achieve its functionality. The IC 555 is configured in astable mode to generate clock pulses at one-second intervals. These pulses are fed into two cascaded IC 4026 counter ICs, which incrementally count seconds and directly drive 7-segment displays to show the elapsed time. The circuit incorporates two push buttons for start/stop and reset operations, enabling user control. The entire system is built on a dot board, emphasizing simplicity and ease of assembly while demonstrating the interconnection of basic components. The design is modular, allowing scalability to include additional features such as minute counting or microcontroller integration.

c. Results and Discussions :

The constructed stopwatch functions reliably, providing stable timekeeping from 0 to 59 seconds and clear visual output via the 7-segment displays. User interactions through the start/stop and reset buttons work effectively, validating the simplicity and efficiency of the design. The project underscores the potential of basic electronic components in building practical devices and serves as an excellent educational tool for understanding the principles of timing circuits and counters. Moreover, the modular and adaptable design encourages users to experiment further, making this project an ideal introduction to digital electronics.

Problem Statement :

- Accurate and accessible time measurement tools have long been a requirement in fields such as education, sports, and laboratory experiments. Historically, mechanical stopwatches were used, but they required intricate and expensive manufacturing processes. The advent of electronic stopwatches brought reliability and compactness but introduced a reliance on complex and often inaccessible microcontroller-based designs. These modern solutions are efficient but unsuitable for beginners who wish to learn the principles of timing circuits through hands-on experience.

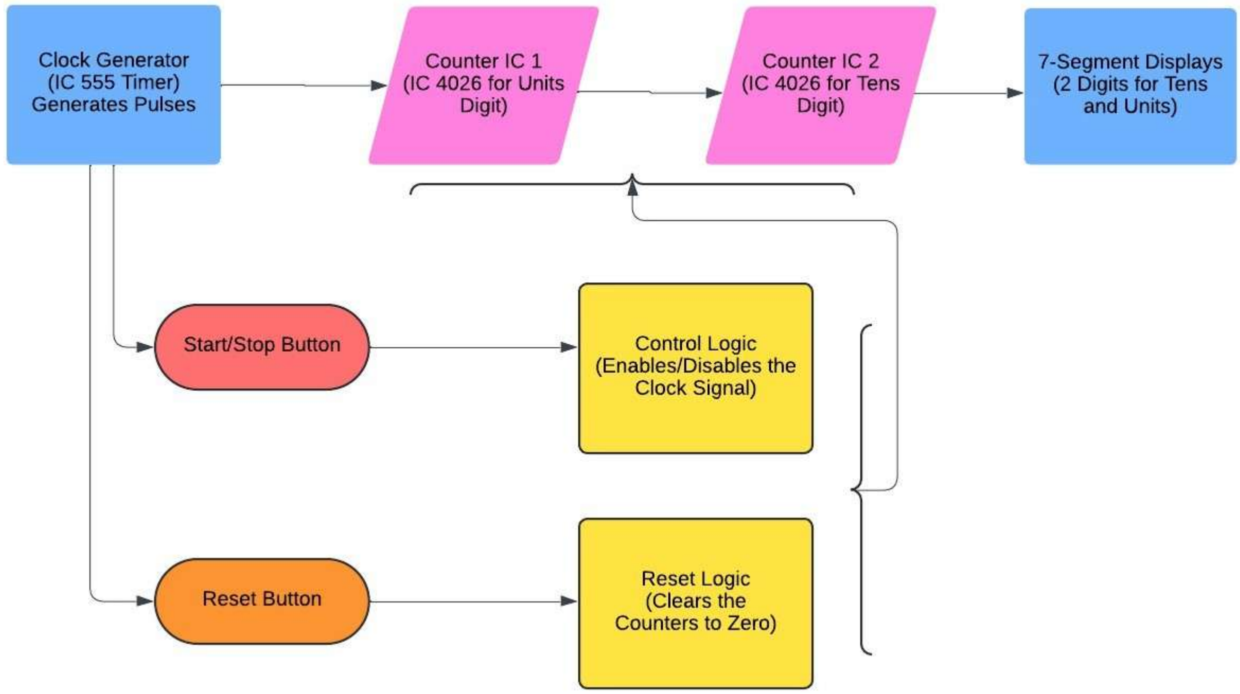
- Currently, there is a gap in the availability of simple, DIY stopwatch designs that are affordable, educational, and replicable. Commercially available digital stopwatches, while effective, fail to provide transparency into their inner workings, limiting their usefulness for teaching and experimentation. Learners aiming to understand the basics of timers, counters, and display systems must resort to complex setups or theoretical approaches, both of which can be barriers to learning.

- The proposed project addresses this challenge by developing a digital stopwatch that uses fundamental electronic components. By incorporating **IC 555**, **IC 4026**, and 7-segment displays, the design ensures affordability, simplicity, and accessibility. This approach bridges the gap between theoretical concepts and practical applications, providing a platform for students and hobbyists to explore digital electronics and timing circuits. Additionally, the project lays the foundation for more advanced studies, as its modular nature allows for the integration of additional features and technologies in the future.

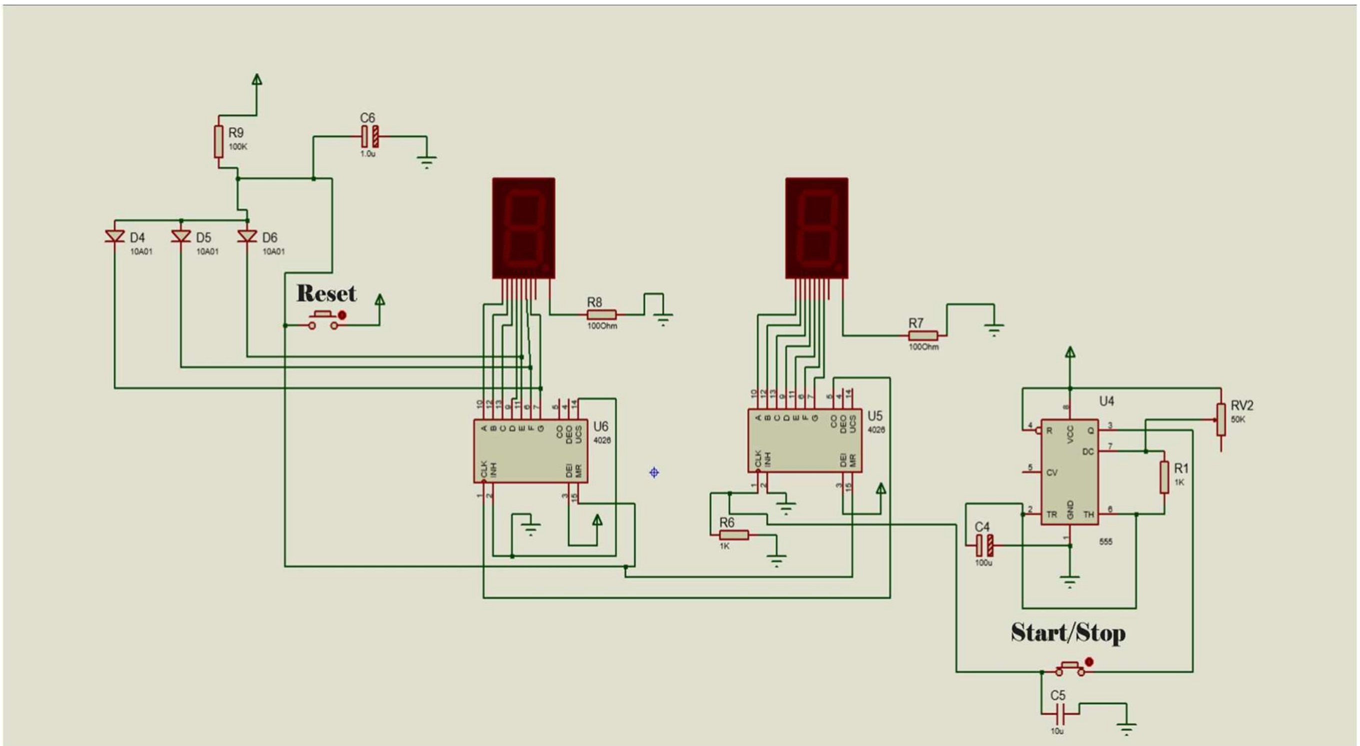
Methodology :

a. Block Diagram :

Here's the conceptual block diagram of the stopwatch system :



b. Circuit Diagram :



Explanation :

1. **Clock Generator (IC 555) :**
    - The IC 555 timer is configured in **astable mode** to generate a continuous clock pulse at a frequency of 1 Hz.
    - These pulses act as the timing source for the stopwatch, incrementing the counter once per second.
2. **Counter and Display Driver (IC 4026)** :
    - Two IC 4026 chips are used, one for the **units digit** and another for the **tens digit**.
    - The first IC 4026 counts from 0 to 9, and every 10th pulse, it triggers the second IC 4026 to increment by one. This cascading setup allows counting from **00 to 59 seconds**.
    - Both IC 4026s directly drive the 7-segment displays, eliminating the need for additional decoder ICs.
3. **Start/Stop Control** :
    - A **push button** is used to toggle the clock signal from the IC 555 to the counters.
    - When pressed, the clock signal is either enabled (to start counting) or disabled (to pause counting). This is achieved using a simple logic control circuit.
4. **Reset Control** :
    - A second **push button** is connected to a reset circuit that clears the counters in both IC 4026s.
    - When pressed, the display is instantly reset to **00**, preparing the stopwatch for a new timing cycle.
5. **7-Segment Displays** :
    - Two common cathode 7-segment displays are used to show the elapsed time.
    - The displays are driven directly by the IC 4026 outputs, simplifying the design.
6. **Dot Board Assembly** :
    - The entire circuit is assembled on a **dot board**, emphasizing modularity and ease of construction.
    - Connections are made using wires and soldering, ensuring a compact and reliable setup.

Workflow :

1. **Initial State** :
    - The circuit is powered on, and the display initializes to **00**.
2. **Start Counting** :
    - The user presses the start/stop button, enabling the clock signal from the IC 555 to the counters.

- The counters increment with each pulse, updating the display in real-time.

3. **Pause Counting** :
    - Pressing the start/stop button again disables the clock signal, freezing the count on the display.
4. **Reset** :
    - Pressing the reset button clears the counters, resetting the display to **00**.

Design and Implementation :

1. Introduction

The stopwatch design aims to demonstrate a functional timing circuit using basic electronic components such as the IC 555, IC 4026, and 7-segment displays. This device measures time from 0 to 59 seconds, displaying the count on two 7-segment displays. It includes a **start/stop button** to control the counting process and a **reset button** to clear the display and prepare the circuit for a new timing cycle.

The design is implemented on a dot board for simplicity and cost-effectiveness, targeting educational purposes and electronics enthusiasts.

2. Circuit Components and their Roles

1. **IC 555 Timer (U4)** :
    - Configured in astable mode to generate clock pulses at approximately 1 Hz (1-second interval).
    - The output of the 555 timer acts as the input clock signal for the counters (IC 4026).
2. **IC 4026 Counter and Display Driver (U5, U6)** :
    - IC 4026 (U5) : Drives the **units digit (0-9)** of the 7-segment display.
    - IC 4026 (U6) : Drives the **tens digit (0-5)**, cascading with the first IC 4026.
    - Both ICs handle counting and driving the displays directly without requiring a separate decoder.
3. **7-Segment Displays** :
    - Two common cathode displays are connected to the outputs of the IC 4026s, showing the elapsed time in seconds.
4. **Push Buttons** :
    - **Start/Stop Button**: Toggles the clock signal from the 555 timer to enable or pause counting.
    - **Reset Button**: Sends a reset signal to the counters in both IC 4026s, clearing the display.

5. **Resistors and Capacitors** :
    - Used to set the timing frequency of the 555 timer and stabilize the circuit.
    - For example, **R1** and **RV2** (variable resistor) along with **C4** determine the 1 Hz clock pulse from the 555 timer.
6. **Power Supply** :
    - The circuit operates on a 5V DC supply, suitable for all components.

3. Circuit Operation

1. **Clock Pulse Generation** :
    - The IC 555 timer produces a continuous square wave signal with a frequency of 1 Hz, which serves as the timing source for the stopwatch.
    - The frequency can be fine-tuned using the variable resistor (RV2).
2. **Counting and Display** :
    - The clock signal from the 555 timer feeds into IC 4026 (U5), which counts the pulses and updates the units digit on the first 7-segment display.
    - Every 10th pulse, IC 4026 (U6) increments the tens digit on the second 7-segment display.
3. **User Controls** :
    - **Start/Stop Button**: Interrupts or allows the clock signal to flow to the counters. When pressed, the stopwatch pauses or resumes counting.
    - **Reset Button**: Sends a high signal to the reset pins of both IC 4026s, clearing the counters and resetting the display to **00**.
4. **Counting Range** :
    - The system counts from 00 to 59 seconds and rolls over to 00 upon reaching 60 seconds.

5. Advantages of the Design

1. **Simplicity** : The use of IC 555 and IC 4026 reduces complexity, as the IC 4026 integrates both counting and display driving functions.
2. **Cost-Effectiveness** : The design uses commonly available and inexpensive components, making it ideal for students and hobbyists.
3. **Educational Value** : Demonstrates fundamental principles of timing circuits, counters, and display systems.
4. **Scalability** : The design can be extended to include minute counting or integrated with microcontrollers for advanced functionality.

5. Implementation Steps :

1. **Circuit Assembly on Dot Board** :
   - Place all components on a dot board, following the schematic.
   - Ensure proper connections for the IC 555, IC 4026s, push buttons, and 7-segment displays.
2. **Clock Calibration** :
   - Adjust the variable resistor (RV2) to fine-tune the clock frequency to 1 Hz.
3. **Testing the Start/Stop Functionality** :
   - Verify that the start/stop button enables and pauses the clock signal effectively.
4. **Testing the Reset Functionality** :
   - Confirm that pressing the reset button clears both counters and sets the display to **00**.
5. **Final Testing** :
   - Power the circuit and ensure the stopwatch counts accurately from 0 to 59 seconds.
   - Test the rollover from 59 to 00 and verify proper functionality of the user controls.

6. Observations and Challenges :

1. **Stability of the Clock Signal** :
   - Proper selection of resistors and capacitors ensures stable 1 Hz pulses from the IC 555 timer.
2. **Display Brightness** :
   - Using appropriate resistors in series with the 7-segment displays ensures optimal brightness without overloading the components.
3. **Button Debouncing** :
   - Capacitors can be added to the start/stop and reset button circuits to eliminate signal noise caused by bouncing.
4. **Scalability** :
   - The modular design allows for easy addition of a third IC 4026 to count minutes.

Results and Discussion :

Simulation Results :

The stopwatch circuit was simulated using Proteus 8 software to verify the functionality of the proposed design. The simulation demonstrated the following key outcomes:

1. **Clock Signal Generation** :
    - The IC 555 timer successfully generated a stable 1 Hz clock pulse in the simulation.
    - The pulse frequency could be adjusted using the variable resistor (RV2), ensuring precise timing.
2. **Counting Mechanism** :
    - The IC 4026 counters correctly incremented their values based on the input clock signal.
    - The first IC 4026 counted from 0 to 9 (units place), and upon reaching 9, it triggered the second IC 4026 to increment the tens place.
    - The cascading mechanism between the two IC 4026 chips allowed the stopwatch to count seamlessly from 00 to 59 seconds.
3. **Display Output** :
    - The 7-segment displays correctly showed the elapsed time.
    - The units digit updated every second, while the tens digit updated after every 10 seconds.
4. **Start/Stop Button** :
    - The simulation verified that the start/stop button effectively paused and resumed the counting process by toggling the clock signal to the counters.
5. **Reset Button** :
    - Pressing the reset button in the simulation cleared both counters, resetting the display to 00.
6. **Rollover Behavior** :
    - The circuit successfully reset to 00 after reaching 59 seconds, validating the counting loop.

Hardware Results :

The circuit was implemented on a dot board, and its functionality was tested under real-world conditions. The following observations were made:

1. **Clock Pulse Stability** :
    - The IC 555 timer provided a stable and reliable clock pulse. Minor adjustments to RV2 allowed fine-tuning of the timing frequency, matching the desired 1 Hz signal.
2. **Counting Accuracy** :
    - The IC 4026 counters accurately tracked time, incrementing the displays at precise intervals.
    - The hardware implementation mirrored the simulation results, counting from 00 to 59 seconds without errors.

3. **User Controls** :
    - The start/stop button reliably paused and resumed the counting process.
    - The reset button cleared the counters and set the display to 00 instantly.
4. **Display Visibility** :
    - The 7-segment displays provided clear and bright output. Resistors connected to the display segments ensured optimal brightness without overheating.
5. **Power Consumption** :
    - The circuit operated efficiently with a 5V DC power supply, consuming minimal current due to the simplicity of the components used.

Comparison of Simulation and Hardware Results :

Aspect	**Simulation**	**Hardware**
Clock Pulse Accuracy	Stable at 1 Hz	Stable with minor adjustments to RV2
Counting Mechanism	Accurate from 00 to 59 seconds	Accurate from 00 to 59 seconds
Start/Stop Button	Worked as intended	Worked reliably
Reset Button	Cleared counters in simulation	Cleared counters effectively in hardware
Display Brightness	Adjustable through resistor values	Bright and easily visible

Discussion :

1. **Simulation Validation** :
    - The simulation phase was crucial for identifying potential issues in the design. All components, including the IC 555, IC 4026, and the 7-segment displays, behaved as expected in the simulation, providing confidence in the circuit's functionality.
2. **Hardware Challenges** :
    - **Clock Calibration** : Fine-tuning RV2 required precision to achieve a stable 1 Hz frequency.
    - **Debouncing** : The mechanical buttons introduced minor bouncing issues, which were mitigated by adding small capacitors across the button terminals.
    - **Power Supply Stability** : Ensuring a steady 5V DC power source was essential for stable operation of the ICs and displays.
3. **Educational Value** :
    - The project effectively demonstrated how basic electronic components could be combined to create a functional stopwatch.
    - The hands-on nature of the design allowed for deeper understanding of counters, display drivers, and timing circuits.

4. **Future Enhancements** :

    - Adding a third IC 4026 would enable minute counting, extending the stopwatch's range to 59 minutes and 59 seconds.
    - A buzzer could be integrated to signal when the count reaches a specific time, adding auditory feedback to the design.
    - Transitioning to a PCB design would improve the circuit's durability and compactness.

Conclusion :

The stopwatch circuit designed and implemented using IC 555, IC 4026, two 7-segment displays, and push buttons for start/stop and reset functionalities successfully meets the outlined objectives. The project demonstrates a simple yet effective method to create a digital stopwatch that counts from 00 to 59 seconds.

Summary of the Project :

The project started with the identification of the problem statement, where the need for a simple, efficient, and user-friendly stopwatch was highlighted. A detailed methodology was adopted to address this need, utilizing basic electronic components that are widely available and cost-effective. The IC 555 was configured in astable mode to generate a stable 1 Hz clock pulse, which served as the timing signal for the counters. The IC 4026 was employed to drive the 7-segment displays, enabling the circuit to visually present the elapsed time.

In the simulation phase, Proteus 8 software was used to validate the design. The simulation confirmed that all components worked seamlessly together, with accurate counting, reliable user controls, and clear display output. This provided a strong foundation for hardware implementation.

The hardware implementation mirrored the simulation results, with the stopwatch functioning as intended. The buttons for start/stop and reset provided a user-friendly interface, and the counters displayed numbers in a clear and visible manner. The circuit proved to be stable, reliable, and efficient during testing, operating smoothly with a 5V power supply.

This project has been an excellent demonstration of combining theoretical knowledge with practical application. It provides insights into the working of counters, 7-segment displays, and timing circuits, making it an educational and skill-enhancing experience.

Future Scope :

The stopwatch can be further enhanced by extending its range to include minutes and seconds using an additional IC 4026 and 7-segment display. Features such as an audible alarm or buzzer can be integrated for additional functionality. The transition from a dot board to a PCB design would improve the compactness and durability of the circuit, making it more practical for real-world applications.

In conclusion, this project not only meets the stated objectives but also serves as a platform for learning and future innovation in digital electronics.