Project

Autonomous Greenhouse Control System

This project presents a real-time embedded automation and security system built on the STM32F405 microcontroller, integrating a diverse range of components including sensors (DHT11, LDR), actuators (fan via PWM, relay-controlled bulb), user interfaces (4x4 Keypad, LCD, TM1637 7-segment display), and indicator systems (5-level LED bar, Green/Red status LEDs).

The system monitors environmental conditions, restricts access through a dynamic keypad-based security code, and intelligently controls outputs based on real-time sensor readings.

Team Members:

Anshul Sharma

Ajay Kumar

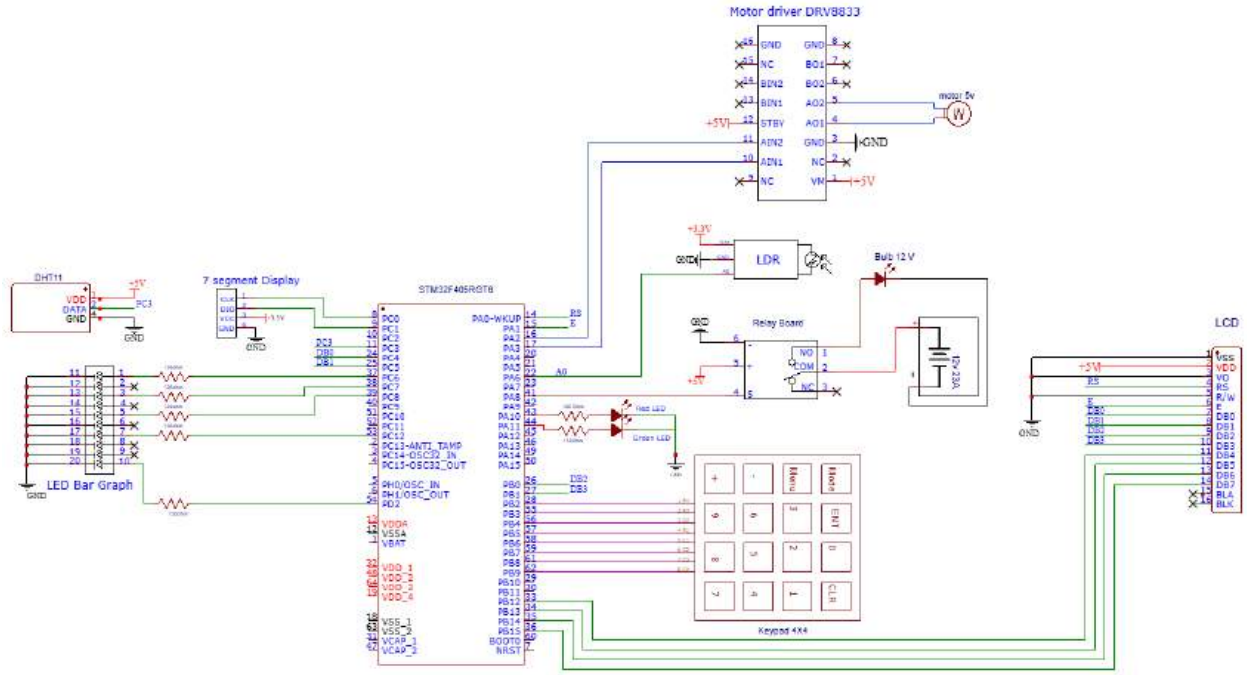
Akshay Verma

Ankit Dinkar

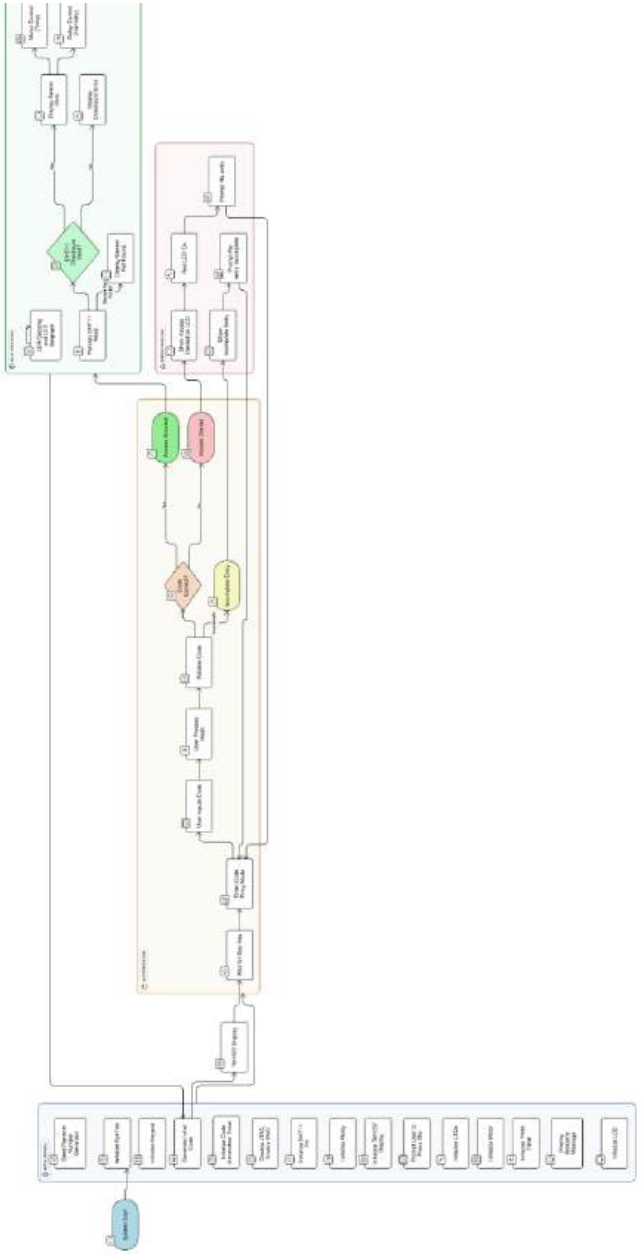
Arzoo Dixit

Muskan Kumari

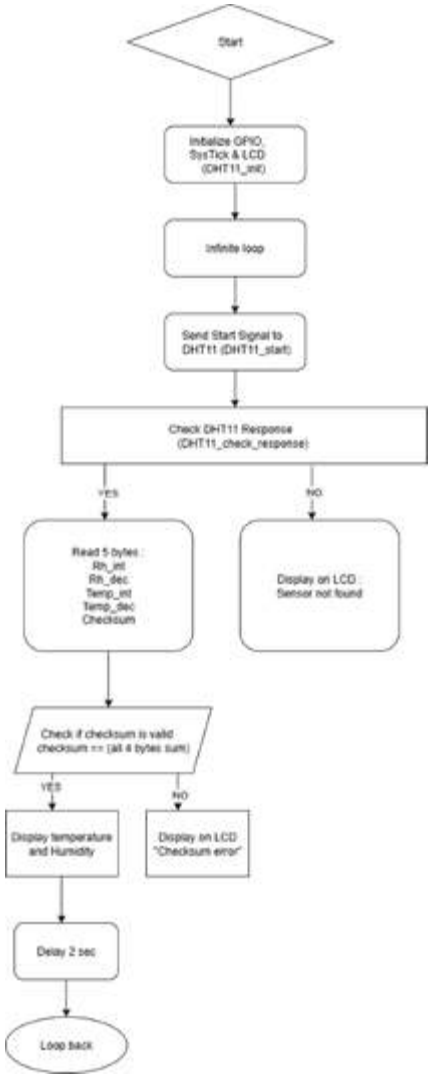
Schematic:


Motor driver DRV8833
LDR
Bulb 12 V
Relay Board
LCD
7 segment Display
DHT11
LED Bar Graph
STM32F405RGT6
Keypad 4X4

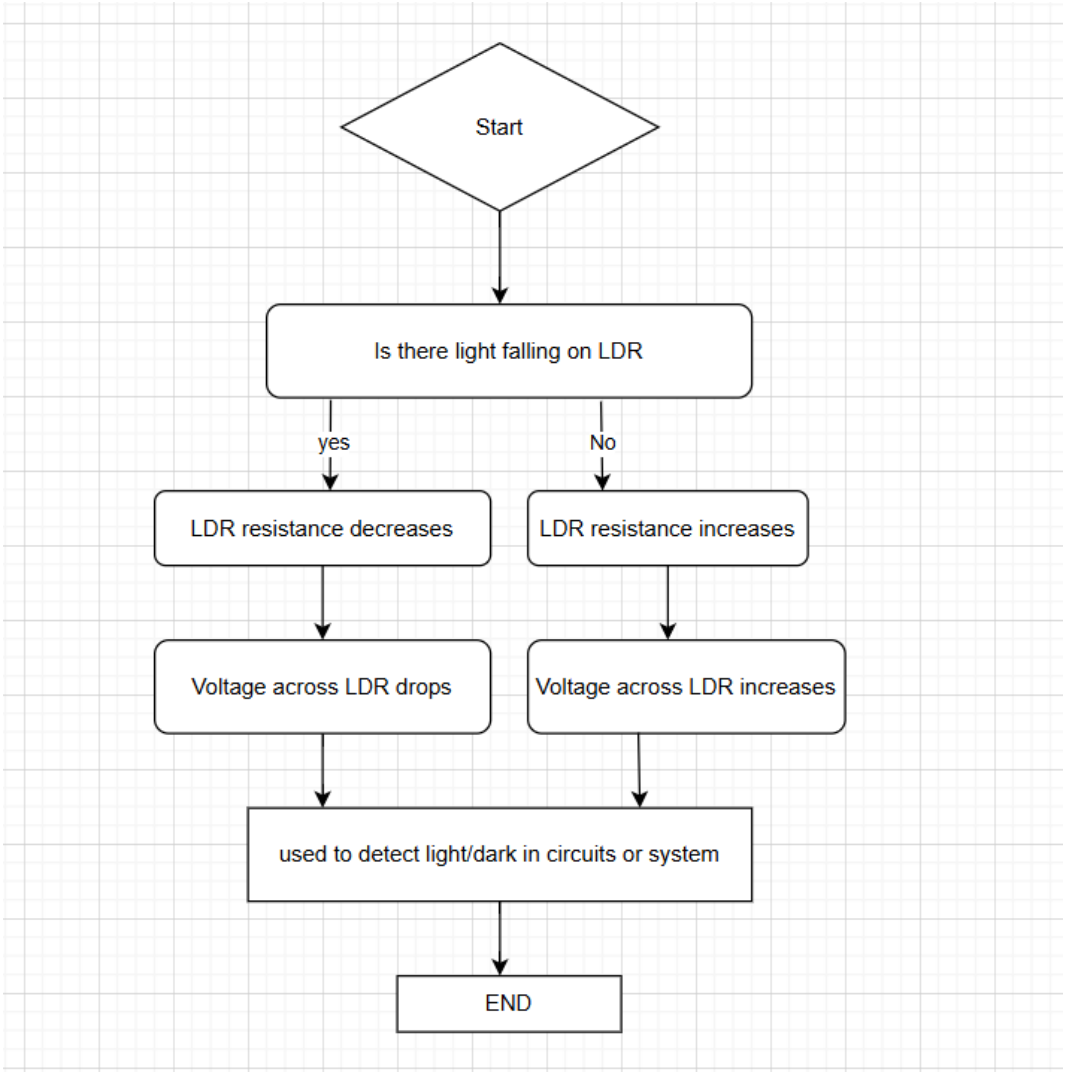
System Overflow:



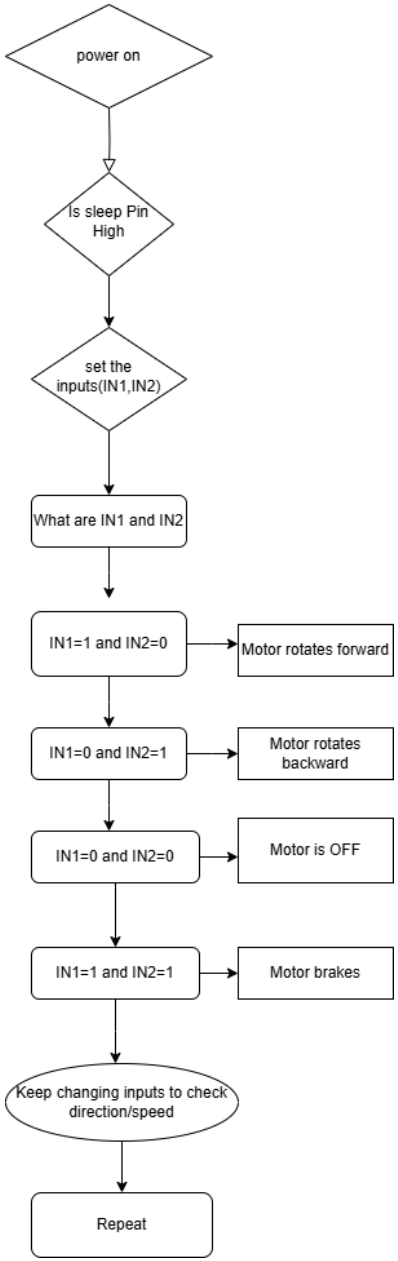
DHT 11:


Start
Initialize GPIO, SysTick & LCD (DHT11_init)
Infinite loop
Send Start Signal to DHT11 (DHT11_start)
Check DHT11 Response (DHT11_check_response)
YES
NO
Read 5 bytes : Rh_int Rh_dec Temp_int Temp_dec Checksum
Display on LCD : Sensor not found
Check if checksum is valid checksum == (all 4 bytes sum)
YES
NO
Display temperature and Humidity
Display on LCD "Checksum error"
Delay 2 sec
Loop back

LDR:


Start
Is there light falling on LDR
yes
No
LDR resistance decreases
LDR resistance increases
Voltage across LDR drops
Voltage across LDR increases
used to detect light/dark in circuits or system
END

DRV8833:


power on
Is sleep Pin High
set the inputs(IN1,IN2)
What are IN1 and IN2
IN1=1 and IN2=0
Motor rotates forward
IN1=0 and IN2=1
Motor rotates backward
IN1=0 and IN2=0
Motor is OFF
IN1=1 and IN2=1
Motor brakes
Keep changing inputs to check direction/speed
Repeat

Hardware Requirement Engineering:

Requirement ID	Description	Review Comment	Reviewed By	Implementation Status
AGHCS_HW_Req_001	Individual LEDs: Green LED anode → STM32 (pin TBD) through 150Ω Red LED anode → STM32 (pin TBD) through 150Ω Cathodes → GND	Mention the exact Port PIN for PIN for STM32 for both anode	Muskan kumari	Implemented by Muskan kumari on 25/06/2025
AGHCS_HW_Req_002	DHT11: Pin-1 VDD connected to +5V Pin-2 DATA connected to STM32 PC3 Pin-4 GND connected to GND		Muskan kumari	Implemented by Muskan kumari on 25/06/2025
AGHCS_HW_Req_003	Motor Driver DRV8833: VM connected to +5V GND connected to GND AIN1/2 to control pins (update exact pins of STM32) BO1/2 to motor terminals	Mention exact control pins for AIN1/2 Mention exact STM32 pins for motor control	Muskan kumari	Implemented by Muskan kumari on 02/07/2025
AGHCS_HW_Req_004	7-segment Display: CLK connected to STM32 PC0 DIO connected to STM32 PC1 VCC connected to +3.3V GND connected to GND	Make sure VCC to 3.3V	Muskan kumari	Implemented by Muskan kumari on 01/07/2025
AGHCS_HW_Req_005	Relay Board: Signal Pin connected to STM32 PA8, NO pin to anode of bulb and COM anode of battery VCC connected to +5V GND connected to GND	Do ground common of bulb and battery(Battery will run only for 4minutes)	Muskan kumari	Implemented by Muskan kumari on 27/06/2025

AGHCS_HW_Req_006	LDR Sensor: One end to +3.3V Other end to PA6 (STM32 ADC input) Common GND	VCC to 3.3V make sure	Muskan kumari	Implemented by Muskan kumari on 2/07/2025
AGHCS_HW_Req_007	LED Bar Graph: Anode connected to STM32(PC6,PC7,PC8,PC12,PD2) with resistor of 150 ohms. Cathode connected to ground GND connected to GND	USE 5 pins only	Muskan kumari	Implemented by Muskan kumari on 3/07/2025
AGHCS_HW_Req_009	Keypad Matrix: R4,R3,R2,R1,C1,C2,C3,C4 connected with pin of STM32(PB2,PB3,PB4,PB5,PB6,PB7,PB8,PB9)		Muskan kumari	Implemented by Muskan kumari on 2/07/2025

Software Requirement Engineering:

Requirement ID	Title	Description	Review comment	Reviewed By	Implentation Status	Verification
SRE_TEMP_CTRL_001	Temperature-based Fan Control	Temperature-Based Fan Control Logic: 1. Measure ambient temperature using DHT11 sensor. 2. Compare measured temperature with threshold TEMP_THRESHOLD (30°C). 3. If temperature >= threshold, set PWM speed (40%) using TIM2 on PA3 to turn on fan. 4. Else, fan is turned off by setting PWM to 0. 5. Display current temperature and fan status on LCD.	Good to go.	Anshul sharma	Implemented by Ajay on 26/06/25	TC_Green_House_TEMP_FAN_001
SRE_HUMIDITY_CTRL_002	Humidity-based Relay Control	Humidity-Based Relay (Bulb) Control: 1. Read humidity using DHT11 sensor. 2. Compare with HUM_THRESHOLD (60%). 3. If humidity >= threshold, activate relay via GPIOA pin 8 to turn bulb ON. 4. If humidity < threshold, deactivate relay (bulb OFF). 5. Display current humidity and bulb status on LCD.	Good to go.	Anshul sharma	Implemented by Ajay 30/06/2025	TC_Green_House_HUMIDITY_RELAY_002
SRE_LDR_ADC_LED_003	LDR ADC and LED Indicator System	Ambient Light Sensing and LED Display: 1. Capture light intensity via LDR using ADC1_IN6 on PA6. 2. Calibrate light range for first 20 seconds post-power up. 3. Map light value into 5 discrete levels. 4. Illuminate LEDs PC6-PC8, PC12, PD2 to reflect mapped level. 5. Dynamically update LED levels every 200 ms.	Good to go.	Akshay verma	Implemented by Ajay and Akshay Verma on 1/07/2025	TC_Green_House_ADC_LDR_003

SRE_SENSOR_COMM_004	DHT11 Sensor Communication Protoco	DHT11 Sensor Communication Protocol: 1. Initialize GPIOC pin 3 for bidirectional data. 2. Send 20 ms LOW start pulse to DHT11. 3. Wait and validate 80us LOW-HIGH response. 4. Read 40 bits of data: humidity, temperature, checksum. 5. Store and parse bytes for system logic usage.	Good to go.	Akshay verma	Implemented by Ajay on 30/06/25	TC_Green_House_DHT11_COMM_004
SRE_VISUAL_FEEDBACK_005	LED Visual Feedback System	LED Feedback System Based on Light Level: 1. Read calibrated LDR value. 2. Map ADC range to LED level (0 to 5). 3. Set GPIOs to light corresponding number of LEDs. 4. Continuously update display every 200 ms. 5. Turn off all LEDs if LDR level is lowest.	Good to go.	Anshul sharma	Implemented by Ajay and Akshay Verma on 07/07/2025	TC_Green_House_LED_LEVEL_005
SRE_CHECKSUM_VALIDATION_	Checksum Validation for DHT11 Data	Checksum Validation for DHT11 Data: 1. Read RH_int, RH_dec, Temp_int, Temp_dec, checksum. 2. Validate checksum = RH_int + RH_dec + Temp_int + Temp_dec. 3. If checksum invalid, display 'Checksum Error' on LCD. 4. Prevent system from acting on invalid data. 5. Retry data read after delay.	Good to go.	Akshay verma	Implemented by Ajay on 02/07/2025	TC_Green_House_CHECKSUM_VERIF_006
SRE_LCD_DISPLAY_007	LCD Display for System Status	LCD Display Functionality: 1. Display temperature and humidity after each successful read. 2. First line shows: Temp: xxC and status (e.g., Mild Hot). 3. Second line shows: Hum: xx% and other messages. 4. On error, show 'Sensor Not Found' or 'Checksum Error'. 5. Clear LCD using lcd(0x01, 0) before writing new data.	Good to go.	Akshay verma	Implemented by Ajay 30/06/2025	TC_Green_House_LCD_DISPLAY_007
SRE_PWM_FAN_CONTROL_00	PWM Signal Generation for Fan Speed	PWM-Based Speed Control of Fan: 1. Initialize TIM2 PWM on PA3 using AF1. 2. Set prescaler to 84, ARR to 1000 for ~1kHz. 3. Adjust CCR4 to modify speed between 0–100%. 4. In code, use Motor_SetSpeed(percent) API. 5. System sets 40% when temperature >= 30°C.	Good to go.	Akshay verma	Implemented by Ajay 26/06/2025	TC_Green_House_PWM_SPEED_008

SRE_RELAY_CONTROL_009	Relay Actuation via GPIO	Relay (Bulb) Control via GPIO: 1. Initialize PA8 as output for relay control. 2. Use Relay_ON() to set PA8 HIGH to activate relay. 3. Use Relay_OFF() to set PA8 LOW to deactivate. 4. Controlled by humidity threshold logic. 5. Confirm GPIOA->BSRR setting reflects output state.	Good to go.	Ajay	Implemented by Akshay and Muskan kumari on 07/07/2025	TC_Green_House_RELAY_OUTPUT_009
SRE_GPIO_INIT_010	GPIO Initialization Logic	GPIO Initialization Routine: 1. Enable AHB1 peripheral clocks for GPIOA, GPIOC, GPIOD. 2. Configure PC6-PC8, PC12 and PD2 as outputs for LEDs. 3. Set PA2, PA3 for motor control (PWM, direction). 4. PA8 set for relay control output. 5. PC3 configured for DHT11 (bidirectional).	Good to go.	Ajay	Implemented by Ajay on 30/06/25	TC_Green_House_GPIO_INIT_010
SRE_ADC_CALIBRATION_011	ADC Light Calibration on Boot	ADC Calibration for LDR: 1. During first ~20s after power-up, sample ADC values. 2. Track min (ldr_min) and max (ldr_max) values. 3. Set minimum calibration range to 300. 4. Map actual ADC values into range 0–5 levels. 5. Use this calibration to drive LED feedback accuracy.	Good to go.	Anshul sharma	Implemented by Akshay on 08/07/2025	TC_Green_House_ADC_CALIBRATION_011

Testing Case:

Test Case ID	Description	Expected Result	Requirement	Status
TC_Green_House_TEMP_FAN_001	1. Power up system 2.Raise temperature using heat source 3.Observe LCD and Fan 4.Reduce temperature 5. Observe Fan and LCD again	1. Temp ≥ 30°C triggers fan ON at 40% 2. LCD shows Temp & 3.T emp < "Mild Hot" 4.30°C turns fan OFF 5Temp & "Cool"	SRE_TEMP_CTRL_001	Pass
TC_Green_House_HUMIDITY_RELAY_002	1. Power up system 2.Spray mist to raise humidity 3.Observe relay/bulb 4.Let humidity drop 5.Observe relay again	1. RH ≥ 60% turns bulb ON 2. RH<60% turns bulb OFF 3. LCD reflects current RH	SRE_HUMIDITY_CTRL_002	Pass
TC_Green_House_ADC_LDR_003	1. Power up device 2. Cover/uncover LDR 3. Watch LEDs	1. System calibrates LDR 2.LEDs light up proportionally 3.Updates every 200ms	SRE_LDR_ADC_LED_003	Pass
TC_Green_House_DHT11_COMM_004	1. Power up 2.Inspect DHT11 waveform or response 3.Observe LCD status	1. 20ms start pulse 2. 80µs ACK from DHT11 3. Proper temp/RH reading	SRE_SENSOR_COMM_004	Pass
TC_Green_House_LED_LEVEL_005	1. Change light level 2.Observe PC6-PC8, PC12, PD2 LEDs	1. LEDs respond proportionally 2. All OFF when full light 3. All ON when dark	SRE_VISUAL_FEEDBACK_005	Pass
TC_Green_House_CHECKSUM_VERIF_006	1. Induce sensor error or disconnect 2. Check LCD	1. LCD shows "Checksum Error" 2. No action taken on invalid data	SRE_CHECKSUM_VALIDATION_006	Pass
TC_Green_House_LCD_DISPLAY_007	1. Operate system normally 2. Observe LCD messages	1. Temp, RH, and status messages displayed 2. Errors shown as needed	SRE_LCD_DISPLAY_007	Pass
TC_Green_House_PWM_SPEED_008	1. Power up the system 2.Increase temperature (e.g., by touch, breath, or heat gun) 3.Observe fan behavior 4.Let temperature drop	1. When Temp ≥ 30°C, fan starts spinning 2. LCD shows "Temp: xxC Mild Hot" 3. When Temp < 30°C, fan stops 4. LCD updates to "Temp: xxC Cool"	SRE_PWM_FAN_CONTROL_008	Pass
TC_Green_House_RELAY_OUTPUT_00G	1. Observe GPIOA pin 8 2.Vary RH around 60%	1. GPIOA PA8 goes HIGH when RH ≥ 60% 2. LOW when RH < 60%	SRE_RELAY_CONTROL_00G	Pass
TC_Green_House_GPIO_INIT_010	1. Power up 2.Inspect GPIO mode registers	1. GPIOA/PC/PD correctly initialized 2.All output pins set correctly	SRE_GPIO_INIT_010	Pass
TC_Green_House_ADC_CALIBRATION_011	1. Power on 2.Watch LED behavior for 20s 3.Test light-level mapping	1. ldr_min/max 2. sampledMapping adapts to ambient 3.5-leve LED logic active	SRE_ADC_CALIBRATION_011	Pass
TC_Green_House_KEYPAD_ENTRY_012	1. Press * on keypad . 2.Enter 4-digit code 3.Press #	1. LCD prompts entry 2. User input accepted 3.Evaluated after #	SRE_KEYPAD_ENTRY_012	Pass
TC_Green_House_RANDOM_CODE_GEN_013	1. Observe 7-segment 2. Wait 20s 3. Repeat	1. Random 4-digit code updates every 20s 2. Properly displayed on TM1637	SRE_RANDOM_CODE_GEN_013	Pass
TC_Green_House_SECURITY_ACCESS_014	1. Enter wrong code 2. LCD shows denial 3. Enter correct code	1. Denial activates RED LED 2.Acceptance activates GREEN LED & proceeds	SRE_SECURITY_ACCESS_014	Pass
TC_Green_House_TM1637_DISPLAY_015	1. Power on 2.Observe TM1637 7-segment	1. Proper display of 4-digit number 2.Consistent refresh	SRE_TM1637_DISPLAY_015	Pass
TC_Green_House_TIMER2_INTERRUPT_016	1. Start device 2. Measure refresh interval of random code	1.TIM2 triggers interrupt every 20s 2.Update_random_code() called	SRE_TIMER2_INTERRUPT_016	Pass

Team	1			Associate Name	Role
Project	Green House			ANSHUL SHARMA	Integration,Function Testing
Project Start Date	24-6-2025			AKSHAY VERMA	Coding & Unit Testing, Debugging and Bug Fixing
Project End Date				ANKIT DINKAR	Hardware setup, Design, Integration
				MUSKAN KUMARI	Architecture, Hardware setup, Design
				AJAY KUMAR	Coding & Unit Testing, Debugging and Bug Fixing
				ARZOO DIXIT	Architecture, Design, Hardware setup, Documentation

EPIC	STORY	TASK_ID	Discription	Comments	Task Assigned to	Status	Start Date	End Date	Est. Effort Required per day	Daily Efforts																Total Effort
										WEEK1					WEEK2						WEEK3					
										24-Jun	25-Jun	26-Jun	27-Jun	30-Jun	1-Jul	2-Jul	3-Jul	4-Jul	7-Jul	8-Jul	9-Jul	10-Jul	11-Jul	14-Jul	
Project Planning	TASK Creation	TASK01	Requirement Study and Prepare Story and TASK for ASSOCIATE 0		Anshul Sharma	Done	24/6/2025	25/6/2025	13	5	7														
		TASK02	Requirement Study and S/W architecture		Akshay Verma	Done	24/6/2025	25/6/2025	13	5	5														
		TASK03	Requirement Study and Prepare Story and TASK for ASSOCIATE 2		Ajay Kumar	Done	24/6/2025	25/6/2025	9	5	6														
		TASK04	Requirement Study and Prepare Story and TASK for ASSOCIATE 3		Muskan Kumari	Done	24/6/2025	25/6/2025	8	4	5														
		TASK05	Requirement Study and Prepare Story and TASK for ASSOCIATE 4		Ankit Dinkar	Done	24/6/2025	25/6/2025	9	4	6														
		TASK06	Requirement Study and Prepare Story and TASK for ASSOCIATE 5	Leave	Arzoo Dixit		24/6/2025	13/07/2025		0	0	0	0	0	0	0									
		TASK07	Task assign., Helping in H/W Setup		Anshul Sharma	Done	26/6/2025	26/6/2025	7			6													
		TASK08	Helping in H/W setup,Working of LDR and LED Bar graph		Ankit Dinkar	Done	30/06/2025	30/06/2025																	
		TASK09	LDR working		Ajay Kumar	Done	27/6/2025	27/6/2025	7				7												
		TASK10	Algorithm and Flow Chart Development for DC Motor		Ankit Dinkar	Done	26/6/2025	26/6/2025	7			6													
		TASK11	Complete Functional Architecture and Flow Chart Development	Leave	Akshay Verma		27/6/2025	4/7/2025	0				0	0	0	0									
		TASK12	Flow Chart of LDR and Helping in H/W		Ankit Dinkar	Done	27/6/2025	27/6/2025	2				2												
	Hardware Architecture	TASK13	Schematic Development for Keypad Interface with STM uC		Akshay Verma	Done	25/6/2025	26/6/2025	4			2													
		TASK14	Schematic Development for DHT11 Sensor with STM uC		Muskan Kumari	Done	25/6/2025	25/6/2025	6	5															
		TASK15	Schematic Development for Photoresistor with STM uC		Muskan Kumari	Done	26/6/2025	26/6/2025	6		6														
		TASK16	Schematic Development for DC Motor and Motor Driver with STM uC		Ankit Dinkar	Done	27/6/2025	27/6/2025	5				5												
		TASK17	Schematic Development for Relay Module and Bulb with STM uC		Muskan Kumari	Done	11/07/2025	11/7/2025	4															3	
		TASK18	Complete Schematic Development		Muskan Kumari	Done	27/6/2025	27/6/2025	3				3												
Requirement Engineering	Software Requirement Engineering	TASK19	Security check Algorithm		Akshay Verma	Done	07/10/2025	10/7/2025	18																
		TASK20	DHT11 Sensor Intreface and functional Requirements		Ankit Dinkar	Done	30/6/2025	30/06/2025	6				5												
		TASK21	Photoresistor Interface and functional Requirements		Muskan Kumari	Done	03/07/2025	03/07/2025	3																
		TASK22	DC Motor Interface and functional Requirements		Muskan Kumari	Done	02/07/2025	02/07/2025	3							2									
		TASK23	Relay Logic and functional Requirements		Muskan Kumari	Done	01/07/2025	01/07/2025	3						2										
	Hardware Requirement Engineering	TASK24	Key Pad Interface with uC		Muskan Kumari	Done	10/07/2025	10/7/2025	4														3		
		TASK25	DHT11 Sensor Interface with uC		Ankit Dinkar	In Progress	02/07/2025	7/3/2025	10																
		TASK26	Photoresistor Interface with uC and connection of led bar.		Anshul Sharma	Done	7/03/2025	7/04/2025	12								6	6							
		TASK27	DC Motor Interface with uC		Muskan Kumari	Done	10/07/2025	10/7/2025	3														3		
		TASK28	Relay and Bulb Interface with uC																						
Individual Module Development	Software Development	TASK29	Security check Algorithm code development		Ajay Kumar	Done	01/07/2025	1/7/2025	7						7										
		TASK30	Code Development of LCD with DHT11		Ajay Kumar	Done	30/6/2025	1/7/2025	14					7											
		TASK31	LED Flasher Code Development		Akshay Verma	Done	10/07/2025	10/7/2025	2																
		TASK32	DHT11 Sensor Interface and Code Development		Akshay Verma	Done	26/6/2025	26/6/2025	8			4													
		TASK33	Photoresistor Interface and code development		Anshul Sharma	Done	7/01/2025	7/02/2025	14						7	7									
		TASK34	Motor Control Code Development		Ajay Kumar	Done	26/6/2025	26/6/2025	7			6													
		TASK35	Relay and Bulb interface and code Development		Ajay Kumar	Done	07/07/2025	07/07/2025																	
	Hardware Development	TASK36	KeyPad Circuit Connection and managing tracker, Studying about the components.		Anshul Sharma	Done	30/6/2025	30/6/2025	7					6											
		TASK37	DHT11 Circuit Connection, Flow Chart		Ankit Dinkar	Done	30/6/2025	30/6/2025	4					4											
		TASK38	Photoresistor Circuit Connection and helping in hardware setup		Ankit Dinkar	Done	01/07/2025	1/7/2025	6																
		TASK39	Motor with Driver Circuit Connection		Muskan Kumari	Done	30/6/2025	30/6/2025	3					3											
		TASK40	Relay and Bulb Circuit Connection		Muskan Kumari	Done	27/6/2025	27/6/2025	4				3												
		TASK41	KeyPad Circuit Connection ,7 segment ,LED		Muskan Kumari	Done	01/07/2025	02/07/2025	4							3									
		TASK42	Flasher circuit and LED bar connection setup		Muskan Kumari	Done	03/07/2025	03/07/2025	3																
Unit Test	Secirity Unlock algorithm Test	TASK43	LED Flasher Circuit Connection, Working of Led Flasher	Checked the working of Led bar.	Anshul Sharma	Done	27/6/2025	27/6/2025	7				6												
	DHT11 Sensor test	TASK44	Functional Test of Security Check		Ajay Kumar	Done	02/07/2025	3/7/2025	14							7	7								
	Photoresistor code test	TASK45	Functional Test of DHT11		Ajay Kumar	Done	04/07/2025	04/07/2025	7									7	6	6	7				
	Motor Functional Test	TASK46	Functional Test of Photoresistor		Anshul Sharma	Done	7/07/2025	7/07/2025	13										6	6					
	LED Flasher Test	TASK47	Functional Test of Motor		Ajay Kumar	Done	06/07/2025	6/7/2025	8														8		
	Relay Test	TASK48	Functional Test of LED Flashed		Akshay Verma	Done	25/06/2025	25/06/2025	3																

Integration	S/W Integration	TASK49	Functional Test of Relay Working		Akshay Verma	Done	25/06/2025	6/25/2025	2																
		TASK50	Integration of DHT11 sensor Temperature code with DC Motor as per the algorithm		Ajay Kumar	Done	10/07/2025	10/07/2025	8																
		TASK51	Integration of Photoresistor Sensor code with LED Flasher as per the algorithm		Anshul Sharma	Done	7/08/2025	7/09/2025	12													6	6			
		TASK52	Integration of DHT11 Sensor Humidity reading with Relay and Bulb as per the algorithm		Ajay Kumar	Done	11/07/2025		8																
Testing	Secirity Unlock algorithm Test	TASK53	Integration of Complete Module with the security check algorithm		Akshay Verma	Done	07/08/2025	11/7/2025	25											6	7	6			
	DHT11 Sensor test	TASK54	Functional Test of Security Check		Ajay Kumar	Done	09/07/2025	09/07/2025	8																
	Photoresistor code test	TASK55	Functional Test of DHT11 and code improvement, Circuit assembling		Akshay Verma	Done	07/07/2025	7/7/2025	7									6							
	Motor Functional Test	TASK56	Functional Test of Photoresistor		Ajay Kumar	Done	08/07/2025	08/07/2025	7																
	LED Flasher Test	TASK57	Functional Test of Motor		Akshay Verma	Done	25/06/2025	25/06/2025	3																
	Relay Test	TASK58	Functional Test of LED Flashed		Akshay Verma	Done	25/06/2026	25/06/2026	2																
	Functional Test	TASK59	Functional Test of Relay Working		Akshay Verma	Done	25/06/2027	25/06/2027	2																
	Scrum	TASK60	Complete Functional Test		Akshay Verma	Done	14/07/2025	14/07/2025	7																
		TASK61	Daily Scrum		Anshul Sharma	In Progress	24/6/2025	15/07/2025		3	1.5	1	1	1	1	1	1	1	1	1	1	1	1	1	