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Individual Assessment Coversheet

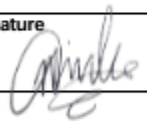
To be attached to the front of the assessment.

Campus: Mbombela
Faculty: IT
Module Code: ITLCA3-12
Group: National
Lecturer's Name: Juliet Maikolo
Student Full Name: Angel Dalila Helen Siwele
Student Number: NS.2022.R4G0J9

Indicate	Yes	No
Plagiarism report attached		

Declaration:

I declare that this assessment is my own original work except for source material explicitly acknowledged. I also declare that this assessment or any other of my original work related to it has not been previously, or is not being simultaneously, submitted for this or any other course. I am aware of the AI policy and acknowledge that I have not used any AI technology to generate or manipulate data, other than as permitted by the assessment instructions. I also declare that I am aware of the institution's policy and regulations on honesty in academic work as set out in the Conditions of Enrolment, and of the disciplinary guidelines applicable to breaches of such policy and regulations.

Signature	Date
	13/06/2025

Lecturer's Comments:

Marks Awarded:	%

Signature	Date

Question 1

1.1. Provide a detailed explanation of an electronic circuit to power DC devices from an AC source including support system diagrams. Provide pictures of each component that would be used in such a design while explaining their respective roles. (10 marks)

To power DC (Direct Current) devices from an AC(Alternating Current) source, you need a wall adapter that converts AC to DC as pictured below.

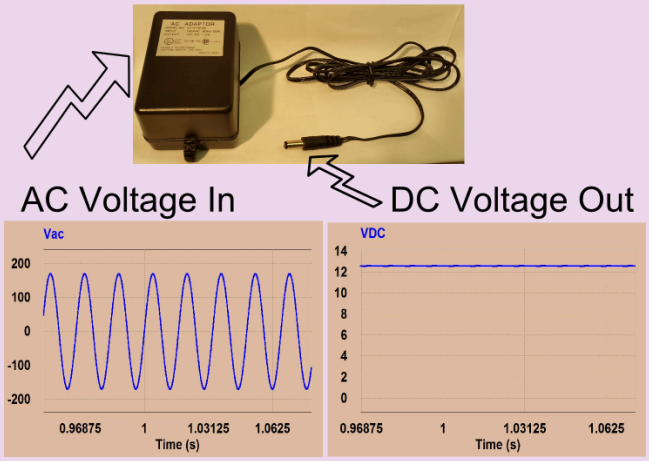


Figure 1. *Input and Output Voltages of AC-DC Adaptor (Williams, 2015)*

This type of adapter is made using the following components:

1. **Transformer:** Steps down AC voltage to a lower level (e.g., from 220V to 12V AC).

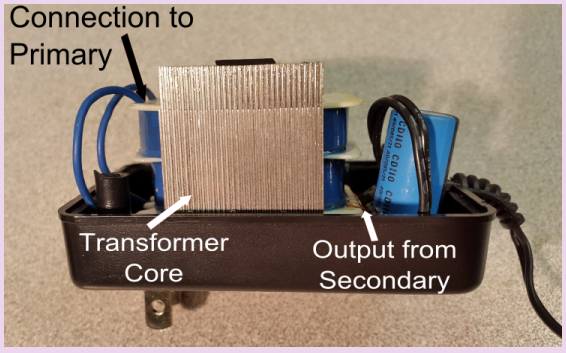


Figure 2. *Side View of AC Adaptor with Transformer Labeled (Williams, 2015)*

2. **Bridge Rectifier:** is a Key part of the circuit for full-wave rectification and Converts AC to Pulsating DC by using an arrangement of diodes that force the current to pass through the load in one direction only.

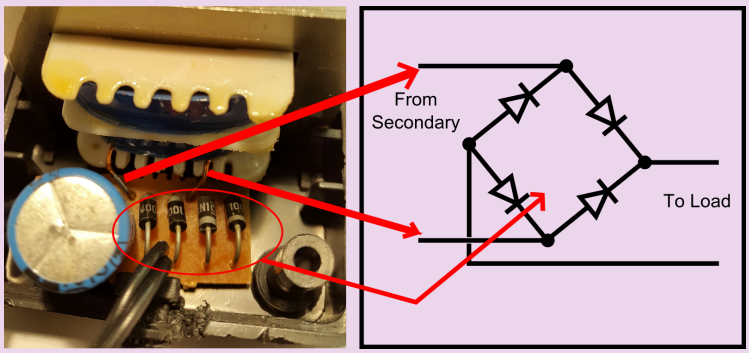


Figure 3. *Full Bridge Rectifier Circuit and Schematic (Williams, 2015)*

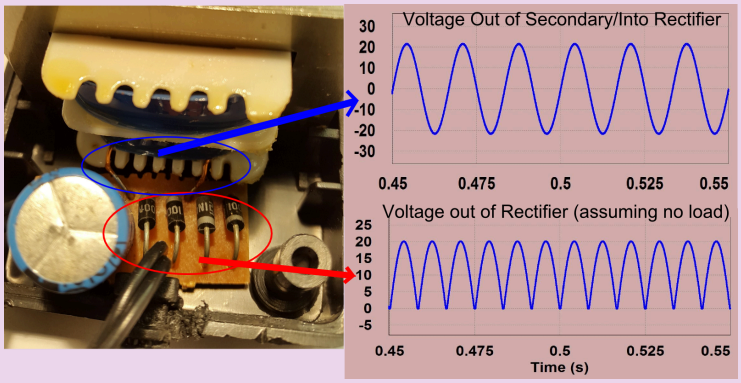


Figure 4. *Rectifier Circuit Showing Input and Output Voltages (Williams, 2015)*

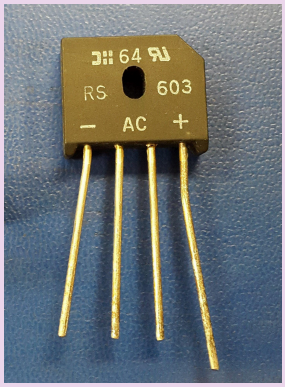


Figure 5. *Bridge Rectifier (Williams, 2015)*

3. **Capacitor (Filter):** Smooths out the pulsating DC from the rectifier.The capacitor is the tall blue cylindrical component in figure 11 below

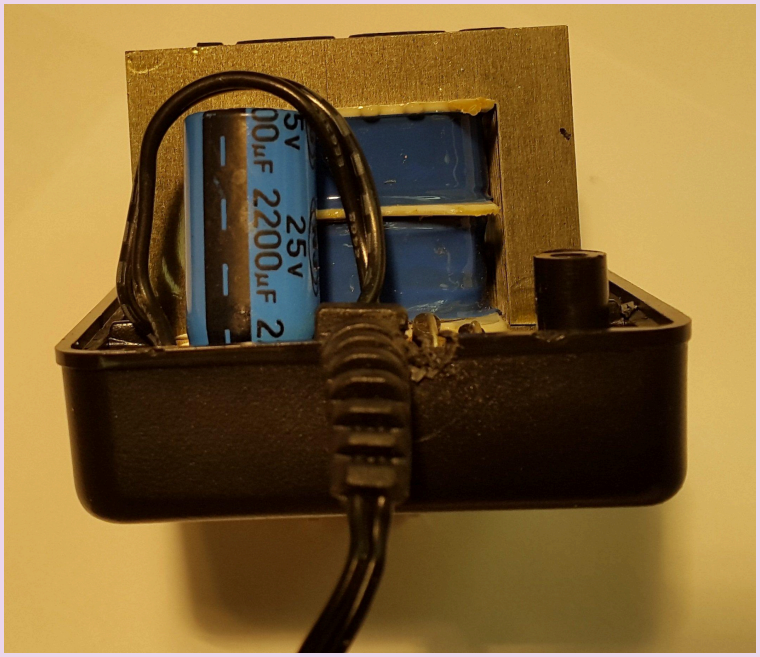


Figure 6. *Capacitor in AC Adaptor (Williams, 2015)*

4. **Voltage Regulator:** Maintains a constant DC output voltage.

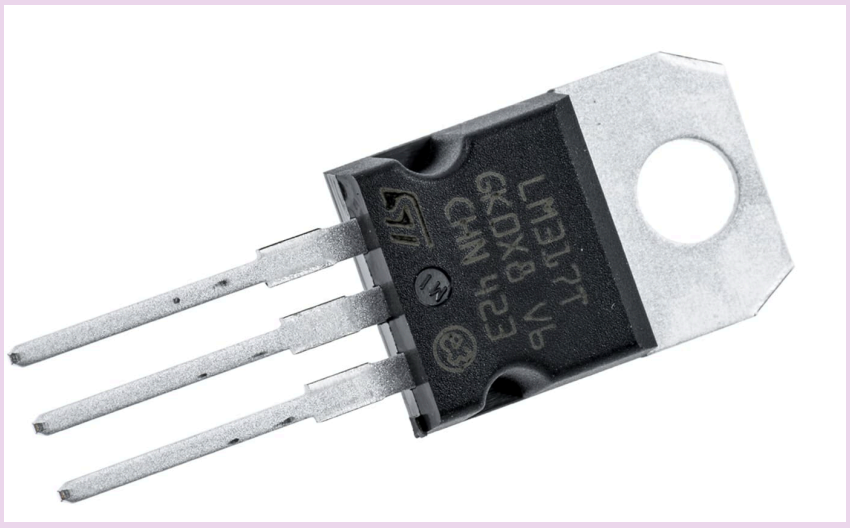


Figure 7. *Voltage Regulator (Williams, 2015)*

1.2. Give a brief report of potential hardware (sensors, indicators, actuators, and power sources) that could be used for the current system as a mini-proof of concept project. Include support pictures and justification. (10 marks)

1. Ultrasonic Sensor to detects car arrival/departure.

*Figure 8 Ultra Sonic Sensor (*RMSOnline*, no date)*

2. **LEDs (Green for Free Space, Red for Full, Yellow for Doors) to show system status visually.**

Figure 9. *Red LED (DigiKey, no date)*

Figure 10 GREEN LED (DigiKey, no date)

Figure 11 Yellow LED WP7113YD5V

3. **DC Motors with Limit Switches to roll the doors up/down. Easy to control with PLC using relay outputs or H-bridges.**

Figure 12 Metal DC Motor (DIY Electronics, no date)

1. **7-Segment Display / HMI to display shows occupancy count and max level.**

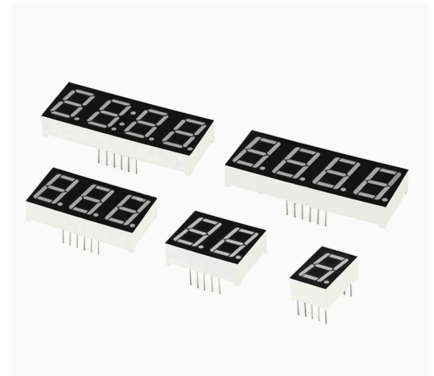


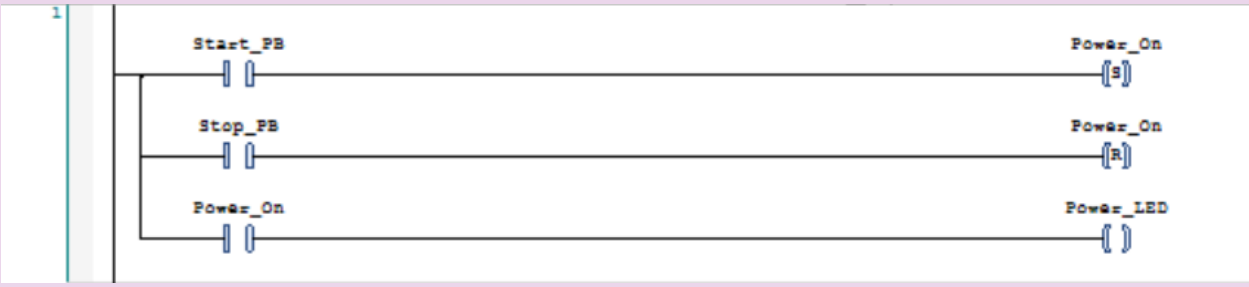
Figure 13 7 Segment Display (stelltron, no date)

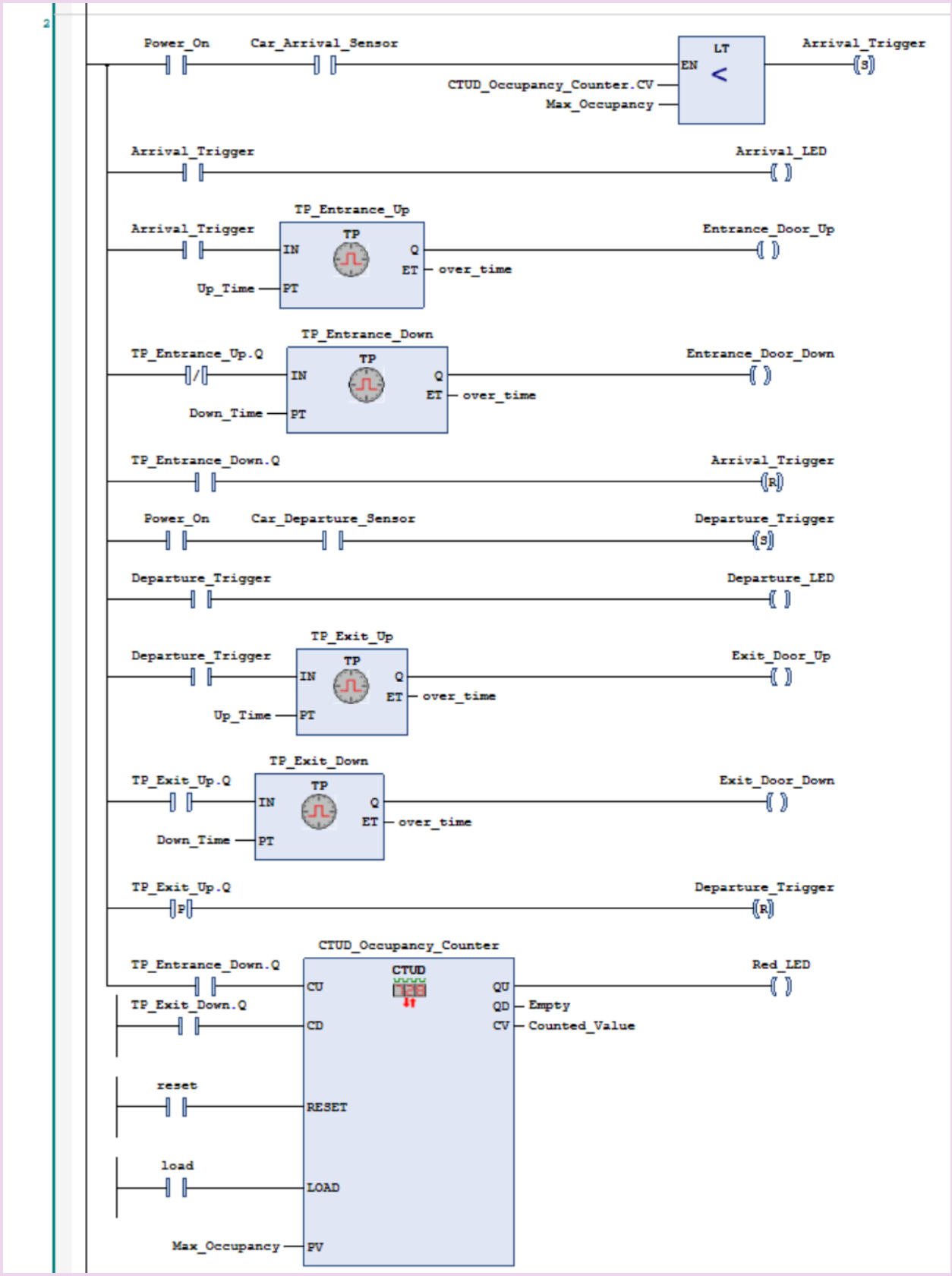
2. **12V DC Power Supply / Transformer + Rectifier**

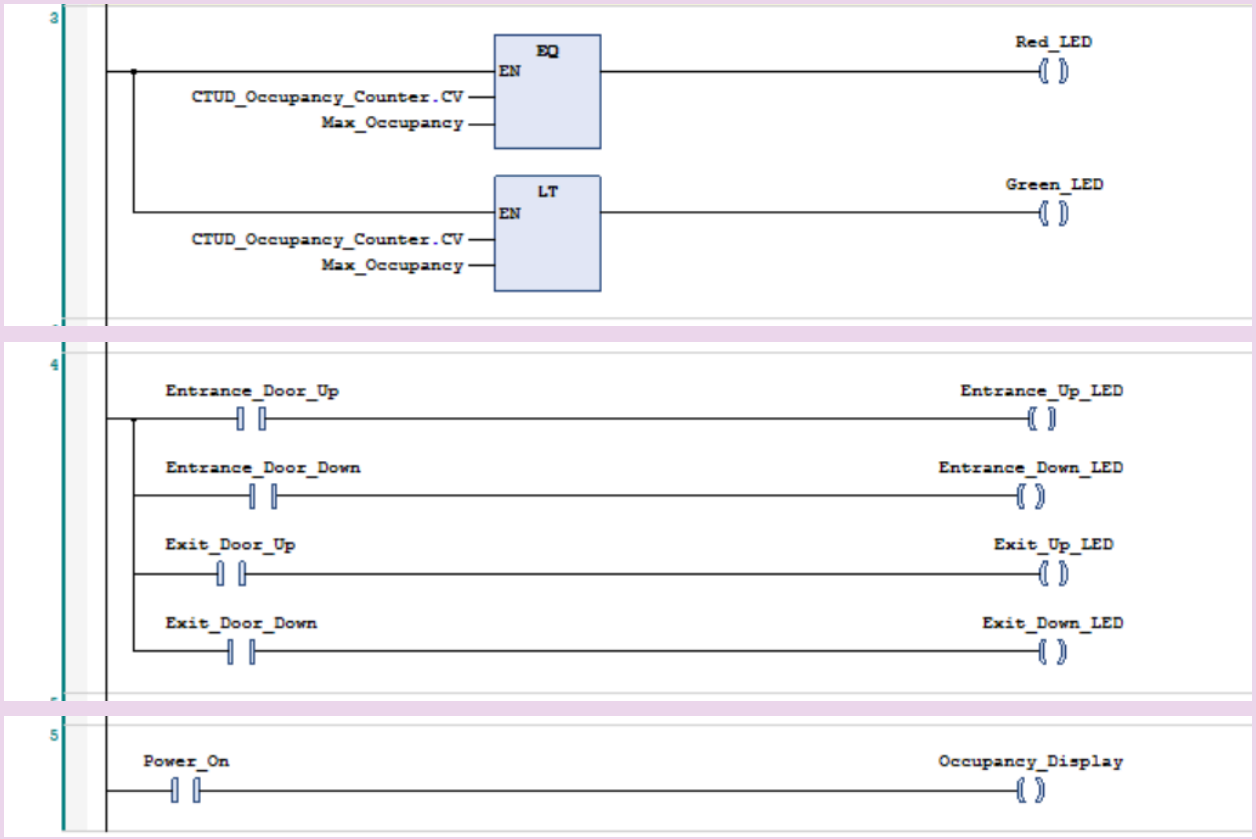
Figure 14 Stainless Steel LEd Driver 120W 12V (Takealot, no date)

Question 2

2.1. Draw the Ladder Diagram representation of the full process. (15 marks)




2
Power_On
Car_Arrival_Sensor
LT
EN
<
CTUD_Occupancy_Counter.CV
Max_Occupancy
Arrival_Trigger
S
Arrival_Trigger
Arrival_LED
TP_Entrance_Up
Arrival_Trigger
TP
IN
Q
ET
over_time
Up_Time
PT
Entrance_Door_Up
TP_Entrance_Down
TP_Entrance_Up.Q
/
Down_Time
Entrance_Door_Down
TP_Entrance_Down.Q
R
Power_On
Car_Departure_Sensor
Departure_Trigger
Departure_Trigger
Departure_LED
TP_Exit_Up
Exit_Door_Up
TP_Exit_Down
TP_Exit_Up.Q
Down_Time
Exit_Door_Down
P
CTUD_Occupancy_Counter
CTUD
CU
CD
RESET
LOAD
PV
QU
QD
CV
Empty
Counted_Value
Red_LED
reset
load
Max_Occupancy

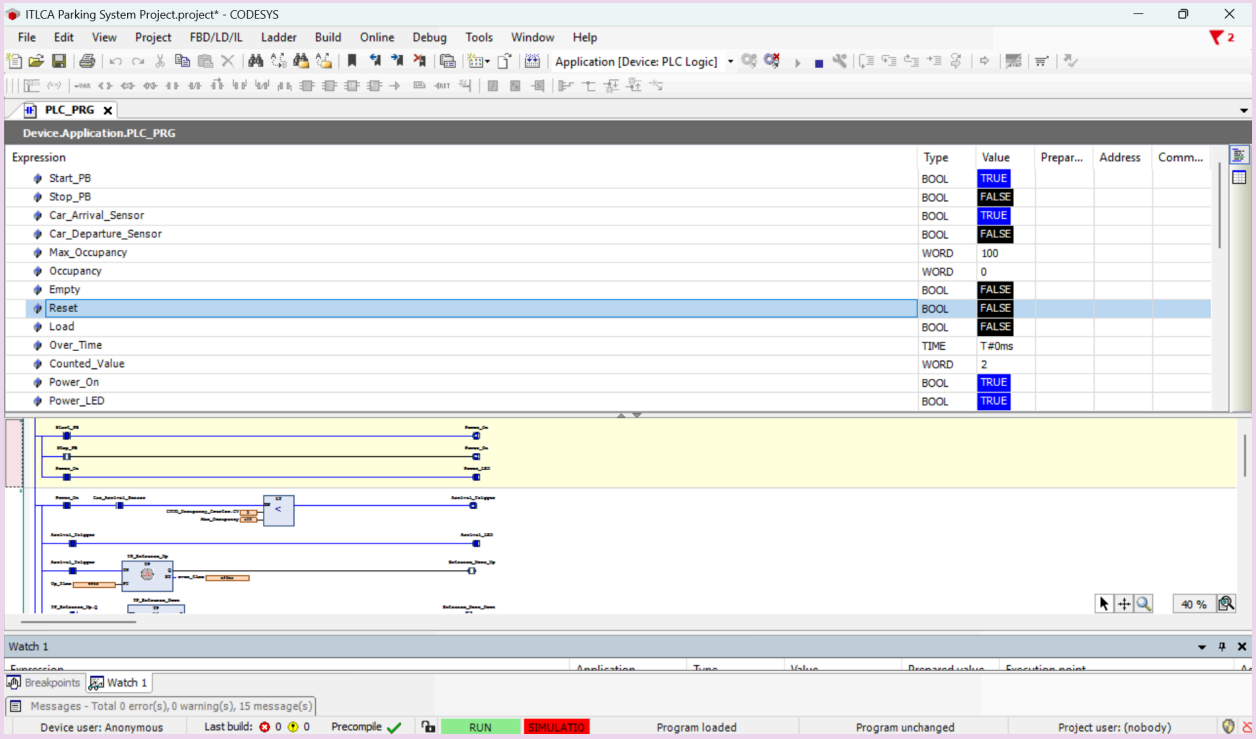

3
EQ
EN
CTUD_Occupancy_Counter.CV
Max_Occupancy
Red_LED
LT
EN
CTUD_Occupancy_Counter.CV
Max_Occupancy
Green_LED
4
Entrance_Door_Up
Entrance_Up_LED
Entrance_Door_Down
Entrance_Down_LED
Exit_Door_Up
Exit_Up_LED
Exit_Door_Down
Exit_Down_LED
5
Power_On
Occupancy_Display

2.2. Explain the functions of each rung (network) in the ladder diagram.(10 marks)

- Network 1: Powers the system ON with Start_PB and OFF with Stop_PB using a Set/Reset latch on Power_On, which turns on Power_LED when active.
- Network 2:
    - Triggers the car arrival sequence (Arrival_Trigger) when Car_Arrival_Sensor is activated and It is determined that the number of cars parked (CTUD_Occupancy_Counter.CV) is less than the Max_Occupancy, then system is powered ON.
    - Activates Arrival_LED and starts TP_Entrance_Up (5-second pulse) to open the entrance door when Arrival_Trigger is TRUE.
    - When TP_Entrance_Up completes, it starts TP_Entrance_Down (8-second pulse) to close the entrance door.
    - When TP_Entrance_Down completes, it triggers a rising edge to increment the CTUD counter (CU := TRUE) and resets Arrival_Trigger.
    - Triggers the car departure sequence (Departure_Trigger) when Car_Departure_Sensor is activated and system is ON.
    - Activates Departure_LED and starts TP_Exit_Up (5-second pulse) to open the exit door when Departure_Trigger is TRUE.
    - When TP_Exit_Up completes, starts TP_Exit_Down (8-second pulse) to close the exit door.
    - When TP_Exit_Down completes, triggers a rising edge to decrement the CTUD counter (CD := TRUE) and resets Departure_Trigger.
- Network 3: Updates LED indicators for parking status: turns Red_LED ON and Green_LED OFF when the lot is full (CTUD.Q = TRUE), and vice versa when space is available.
- Network 4: updates the door status indicators by linking each motor output to a corresponding LED. When the entrance or exit door is moving up or down, the respective LED (e.g., Entrance_Up_LED, Exit_Down_LED) is turned ON to visually represent the door's motion. This provides real-time feedback on door activity within the parking system.
- Network 5: Updates Occupancy_Display with the current value of the CTUD counter (CV) for visual feedback or display.

Question 3

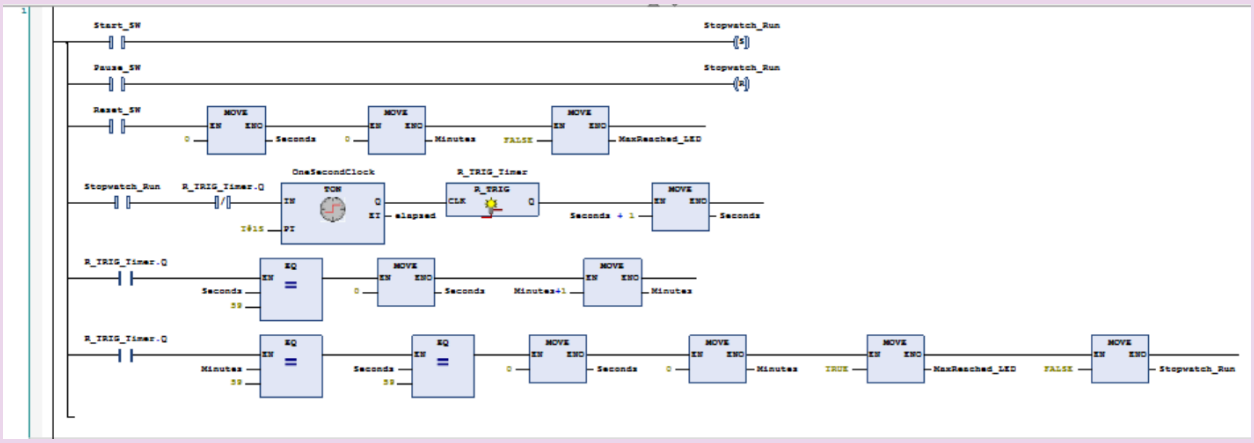
3.1. Simulate the project using CODESYS or any similar PLC simulation software. (15 marks)



3.2. Make a Visualisation to show the operation of your parking system.(15 mark)

Question 4

4.1. Draw the Ladder Diagram representation of the full process and explain the core rungs. (15 marks)



- Rung 1: Starts the stopwatch when Start_SW is pressed and pauses it when Pause_SW is pressed using a Set/Reset latch on Stopwatch_Run.

- Rung 2: Resets the stopwatch by setting Seconds := 0, Minutes := 0, and turning MaxReached_LED := FALSE when Reset_SW is pressed.

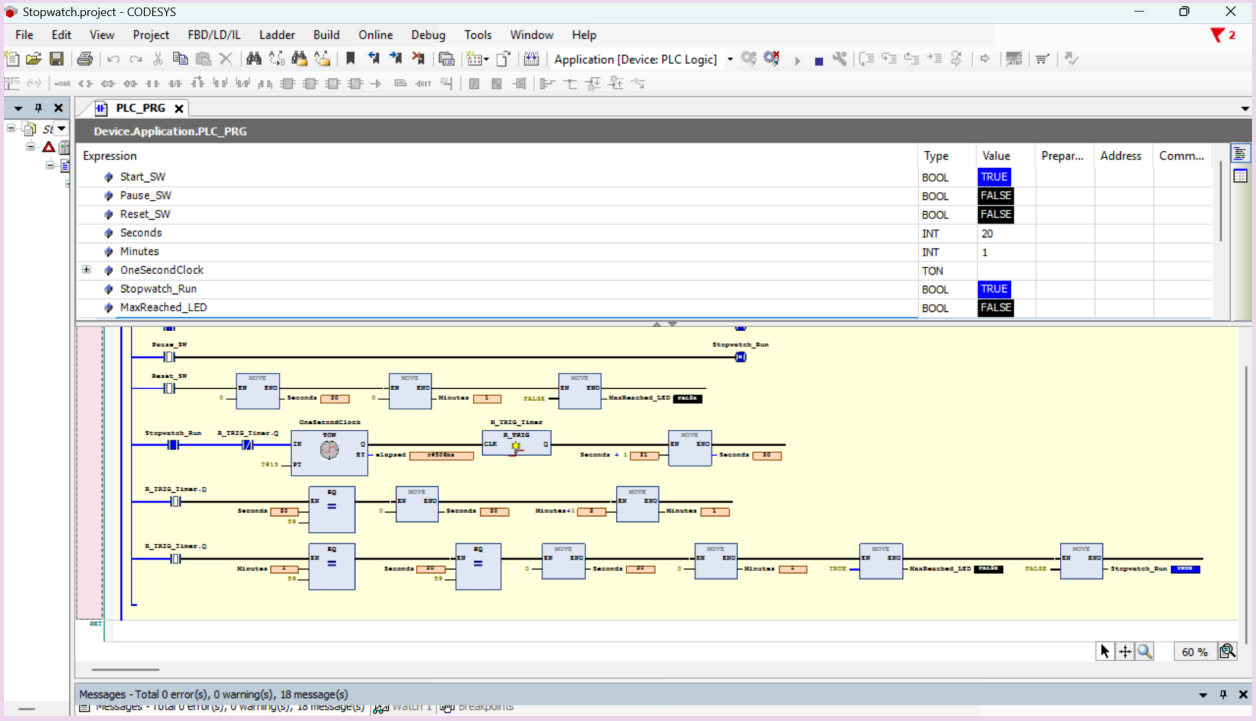
- Rung 3: Activates a 1-second timer (TON) when Stopwatch_Run is TRUE, using PT := T#1s to generate a one-second delay.

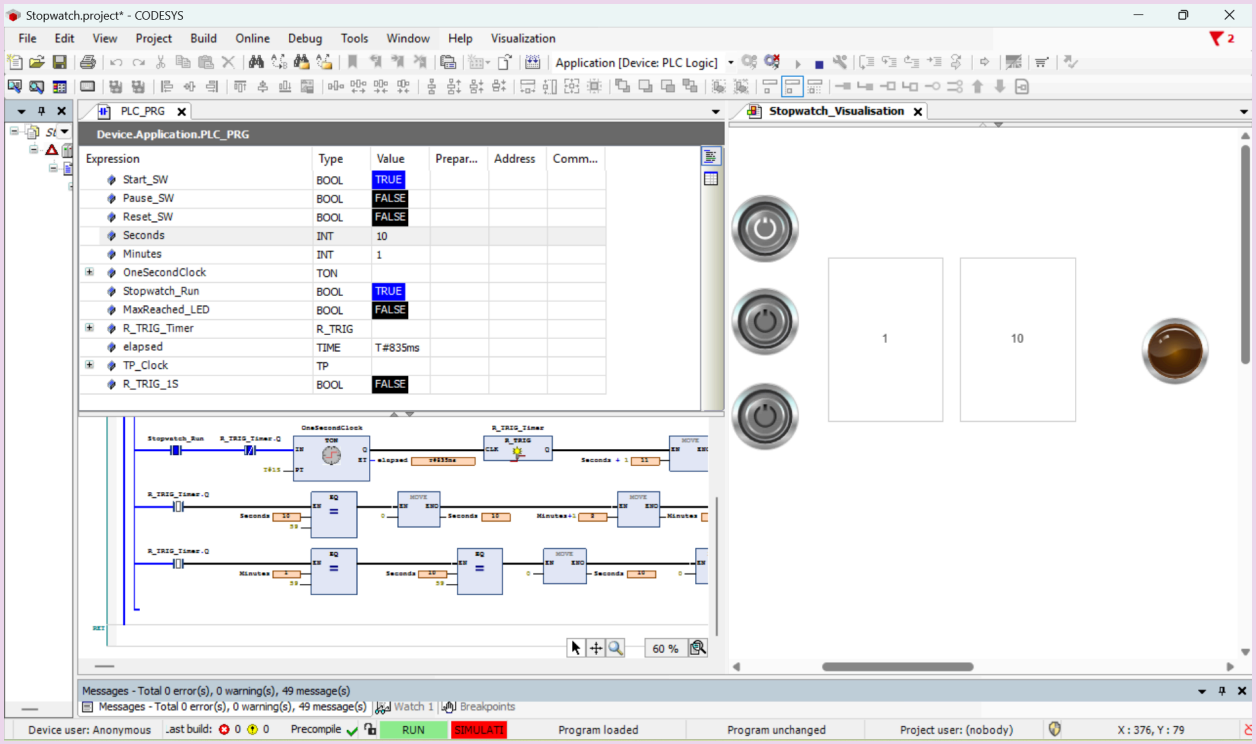
- Rung 4: Uses a rising edge trigger (R_TRIG) on OneSecondClock.Q to ensure Seconds increments exactly once per second.

- Rung 5: When Seconds = 60, resets Seconds := 0 and increments Minutes := Minutes + 1.

- Rung 6: When Minutes = 60, resets both Minutes and Seconds, sets MaxReached_LED := TRUE, and stops the stopwatch by resetting Stopwatch_Run.

4.2. Show your simulation and make use of visualisation to show the operation of your stopwatch system. (10 marks)





References

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- Williams, D. (2015) *Figure 2. Side View of AC Adaptor with Transformer Labeled*. Available at: https://www.allaboutcircuits.com/technical-articles/disassembling-a-rectifier/ (Accessed 10 June 2025).
- Williams, D. (2015) *Figure 3. Full Bridge Rectifier Circuit and Schematic*. Available at: https://www.allaboutcircuits.com/technical-articles/disassembling-a-rectifier/ (Accessed 10 June 2025).
- Williams, D. (2015) *Figure 4. Rectifier Circuit Showing Input and Output Voltages*. Available at: https://www.allaboutcircuits.com/technical-articles/disassembling-a-rectifier/ (Accessed 10 June 2025).
- Williams, D. (2015) *Figure 5. Bridge Rectifier*. Available at: https://www.allaboutcircuits.com/technical-articles/disassembling-a-rectifier/ (Accessed 10 June 2025).
- Williams, D. (2015) *Figure 6. Capacitor in AC Adaptor*. Available at: https://www.allaboutcircuits.com/technical-articles/disassembling-a-rectifier/ (Accessed 10 June 2025).
- Williams, D. (2015) *Figure 7 Voltage Regulator*. Available at: https://www.allaboutcircuits.com/technical-articles/disassembling-a-rectifier/ (Accessed 10 June 2025).
- DigiKey, no date. *Würth Elektronik 151051RS11000 – LED Red Diffused 5mm Round T/H* [online image]. DigiKey Electronics. Available at: https://www.digikey.co.za/en/products/detail/w-rth-elektronik/151051RS11000/4490012 [Accessed 13 Jun. 2025].
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Assessment Name:	Project
Programme:	Information Technology (Robotics)
Student Full Name:	Angel Dalila Helen Siwele
Student Number:	NS.2022.R4G0J9
Date:	13/06/2025

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