A Minor Project Report on

Smart Solar-Powered IoT Irrigation System with Rain Detection

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BONAFIDE CERTIFICATE

Certified that this Report titled **“Smart Solar-Powered IoT Irrigation System with Rain Detection”**is the Bonafide work of **MADHANKUMAR.D(927622BEE064), MADHAVAN.K(927622BEE065),SANGEETHA.P(927622BEE093) ,SUDHARSHAN.D.S(927622BEE117)** who carried out the work during the academic year (2024-2025) under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other project report.

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Submitted for Minor Project III (18EEP203L) viva-voce Examination held at M.Kumarasamy College of Engineering, Karur-639113 on ………………..

DECLARATION

We affirm that the Minor Project III report titled "**SMART SOLAR-POWERED IOT IRRIGATION SYSTEM WITH RAIN DETECTION"** being submitted in partial fulfillment for the award of **Bachelor of Engineering in Electrical and Electronics Engineering** is the original work carried out by us.

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VISION AND MISSION OF THE INSTITUTION

VISION

- ✓ To emerge as a leader among the top institutions in the field of technical education

MISSION

- ✓ Produce smart technocrats with empirical knowledge who can surmount the global Challenges.
- ✓ Create a diverse, fully engaged, learner - centric campus environment toprovide Quality education to the students.
- ✓ Maintain mutually beneficial partnerships with our alumni, industry and Professional associations.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION

To produce smart and dynamic professionals with profound theoretical and practical knowledge comparable with the best in the field.

MISSION

- ✓ Produce hi-tech professionals in the field of Electrical and Electronics Engineering by inculcating core knowledge.
- ✓ Produce highly competent professionals with thrust on research.
- ✓ Provide personalized training to the students for enriching their skills.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

- ✓ **PEO1:** Graduates will have flourishing career in the core areas of Electrical Engineering and also allied disciplines.
- ✓ **PEO2:** Graduates will pursue higher studies and succeed in academic/research careers
- ✓ **PEO3:** Graduates will be a successful entrepreneur in creating jobs related to Electrical and Electronics Engineering /allied disciplines.
- ✓ **PEO4:** Graduates will practice ethics and have habit of continuous learning for their success in the chosen career.

PROGRAMME OUTCOMES (POs)

After the successful completion of the B.E. Electrical and Electronics Engineering degree program, the students will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/Development of solutions:

Design solutions for Complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety,and the cultural, societal and environmental considerations.

PO4: Conduct Investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning in formed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9: Individual and Team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

The following are the Program Specific Outcomes of Engineering Students:

- **PSO1:** Apply the basic concepts of mathematics and science to analyze and design circuits, controls, Electrical machines and drives to solve complex problems.
- **PSO2:** Apply relevant models, resources and emerging tools and techniques to provide solutions to power and energy related issues & challenges.
- **PSO3:** Design, Develop and implement methods and concepts to facilitate solutions for electrical and electronics engineering related real world problems.

Abstract (Key Words)	Mapping of POs and PSOs
Smart Irrigation System, IoT (Internet of Things), ESP32 Microcontroller, Rain Detection, Blynk Platform.	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9, PO10, PO11, PSO1, PSO2, PSO3

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ABSTRACT

An innovative development in agricultural technology, the Smart Solar-Powered IoT Irrigation System with Rain Detection aims to maximize crop output and water management. Effective irrigation techniques are essential for sustainable farming as water scarcity becomes a greater worldwide concern. By using renewable solar energy, this device ensures environmentally beneficial operation even in isolated locations without consistent access to electricity. A network of linked sensors at the centre of the system keeps an eye on important environmental factors like soil moisture and precipitation levels. Real-time data on crop water requirements is provided by the soil moisture sensors, enabling precise irrigation based on those needs. In order to minimize water waste and avoid overwatering, which can damage crops and degrade soil, rain detection sensors automatically stop irrigation when rain is detected. Through an easy-to-use online interface or mobile application, users may remotely control the system, setting irrigation schedules and getting status updates. In addition to being convenient, this distant link enables farmers to base their decisions on past trends and current weather projections. The data analytics features of the system offer insights into irrigation performance, which improves crop management tactics and operational effectiveness even more. By reducing reliance on traditional energy sources and operational costs associated with water use, the incorporation of solar electricity into the irrigation system also helps to save money. Farmers may enhance their water conservation efforts and ensure sustainable farming practices that benefit the environment and their crops by implementing this technology. In summary, an innovative solution that encourages effective water management and aids sustainable agriculture is the Smart Solar-Powered IoT Irrigation System with Rain Detection. Its creative design gives farmers the resources they need to increase output and safeguard the environment, in addition to addressing the problems caused by water scarcity. Such intelligent irrigation systems will be essential to attaining food security and sustainable farming methods as agricultural demands continue to rise.

Keywords: Rain Detection, ESP32 Microcontroller, Internet of Things, Smart Irrigation System, and Blynk Platform.

CHAPTER 1

INTRODUCTION

Due to water scarcity and ineffective irrigation techniques, agriculture—the foundation of food security—faces increasing difficulties. A forward-thinking strategy that strikes a balance between sustainability and innovation is needed to address these problems. A state-of-the-art solution that revolutionizes farming water management by fusing cutting-edge technology with environmentally friendly design is the Smart Solar-Powered IoT Irrigation System with Rain Detection. This system is perfect for off-grid and rural areas since it runs on renewable solar energy without the need for conventional power sources. It incorporates a network of intelligent sensors, such as rain and soil moisture sensors, to track environmental conditions and provide targeted, demand-driven irrigation. It reduces waste and guarantees healthy crop growth by avoiding overwatering and maximizing water distribution. Due to water scarcity and ineffective irrigation techniques, agriculture—the foundation of food security—faces increasing difficulties. A forward-thinking strategy that strikes a balance between sustainability and innovation is needed to address these problems. A state-of-the-art solution that revolutionizes farming water management by fusing cutting-edge technology with environmentally friendly design is the Smart Solar-Powered IoT Irrigation System with Rain Detection. This system is perfect for off-grid and rural areas since it runs on renewable solar energy without the need for conventional power sources. It incorporates a network of intelligent sensors, such as rain and soil moisture sensors, to track environmental conditions and provide targeted, demand-driven irrigation. It reduces waste and guarantees healthy crop growth by avoiding overwatering and maximizing water distribution. The Blynk IoT platform gives farmers access to and control over the system, facilitating data-driven decision-making, real-time warnings, and remote monitoring. In addition to streamlining operations, its user-friendly interface offers insightful data on environmental trends and irrigation effectiveness.

CHAPTER 2

LITERATURE REVIEW

2.1 IoT-Based Smart Irrigation System for Agriculture

Source: Patel, S., & Ramesh, M. (2020). "IoT-Enabled Smart Irrigation System Using Soil Moisture and Temperature Sensors." *International Journal of Innovative Technology and Exploring Engineering*.

Inference: This study investigates the use of IoT technology in automated irrigation systems, focusing on real-time soil moisture and temperature monitoring to control water usage in agricultural fields. Using an ESP8266 microcontroller and Blynk IoT platform, this system provides remote monitoring capabilities and water management based on soil moisture data. The research demonstrates that IoT-based irrigation can reduce water wastage by 30-40% compared to traditional manual methods. Additionally, the system's low power consumption makes it suitable for off-grid rural areas.

2.2 Energy-Efficient Irrigation Using Solar-Powered IoT Systems

Source: Khan, J., & Prasad, S. (2019). "Solar-Powered Smart Irrigation System Based on IoT." *Journal of Renewable Energy Research*.

Inference: This paper presents an IoT-based smart irrigation system powered by solar energy, offering a sustainable solution for water management in agriculture. By combining soil moisture sensors, ESP32 microcontrollers, and a solar energy source, the system is both environmentally friendly and energy-efficient. The research emphasizes the benefit of renewable energy in powering irrigation systems in remote areas with limited access to the electrical grid, ensuring consistent operation even during power outages.

2.3 Automated Irrigation Using Soil Moisture and Rain Detection Sensors

Source: Ali, F., & Ahmad, T. (2018). "Automation in Agriculture: A Low-Cost Irrigation System Using Soil Moisture and Rain Sensors." *International Journal of Agriculture Innovations and Research*.

Inference: This study explores the integration of soil moisture sensors and rain sensors for irrigation control. By utilizing an Arduino microcontroller, the system automatically stops irrigation during rainfall and resumes when dry conditions are detected. The research shows that incorporating rain detection significantly reduces water usage by preventing unnecessary irrigation, allowing for optimal water management without human intervention.

2.4 Remote Monitoring and Control of Irrigation Using Blynk Platform

Source: Mishra, P., & Roy, D. (2021). "Blynk-Based IoT Platform for Remote Irrigation Monitoring and Control." *Journal of Agricultural Sciences and Applications*.

Inference: This paper discusses the use of the Blynk IoT platform to enable farmers to remotely monitor and control irrigation systems. By interfacing with ESP32 and soil moisture sensors, the Blynk application provides real-time data on soil conditions, water usage, and system status. The ability to control irrigation remotely via a smartphone app has proven to be highly beneficial for users in rural areas, reducing the need for frequent on-site visits. The study concludes that Blynk is a user-friendly and effective solution for real-time irrigation management.

2.5 Smart Irrigation System Using AI for Predictive Water Management

Source: Suresh, V., & Kumar, P. (2022). "AI-Enhanced Smart Irrigation: Predictive Analysis for Water Conservation." *IEEE Transactions on Agriculture and Technology*.

Inference: This research explores the integration of artificial intelligence (AI) with IoT-based irrigation systems to enable predictive water management. By using machine learning algorithms to analyse soil moisture, temperature, and weather patterns, the system can predict water requirements and adjust irrigation schedules accordingly. The study shows that AI-based predictive irrigation can save up to 50% of water by anticipating crop needs, minimizing over-irrigation, and adapting to environmental changes. The AI-enhanced system demonstrates a significant advancement in automated irrigation technology, though it requires substantial computational resources and data collection.

CHAPTER 3

PROPOSED METHODOLOGY OF SMART SOLAR-POWERED IOT IRRIGATION SYSTEM WITH RAIN DETECTION

3.1 BLOCK DIAGRAM OF SMART SOLAR-POWERED IOT IRRIGATION SYSTEM WITH RAIN DETECTION

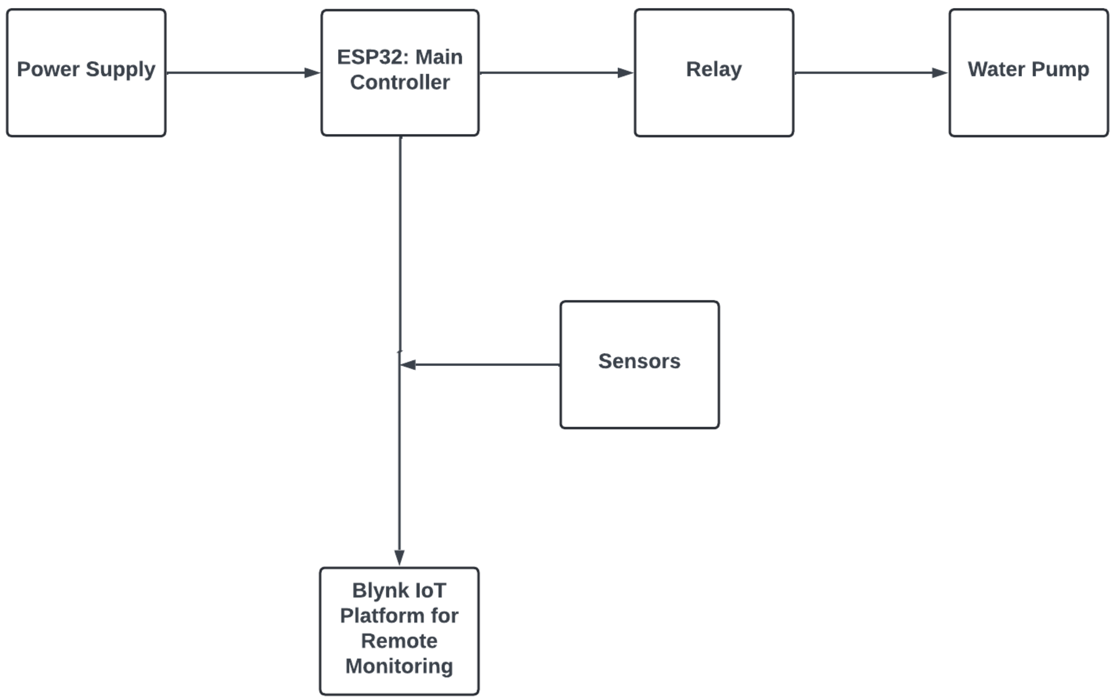

Fig No 3.1 Block diagram of Smart Solar-Powered Iot Irrigation System with Rain Detection

3.2 DESCRIPTION

Through automation and remote monitoring, the Solar-Powered IoT-Based Smart Irrigation System aims to improve agricultural water efficiency. The system collects real-time data from environmental sensors, rain, and soil moisture using an ESP32 microcontroller to regulate irrigation according to the circumstances. The technology automatically turns on a water pump when the soil moisture level is low, but it stops the irrigation operation if rain is detected to avoid overwatering. This real-time modification maximises plant growth, conserves resources, and minimises water waste.The system is appropriate for remote or off-grid locations since it runs on solar energy and uses a solar panel and buck-boost converter to offer a steady power source. With the use of a smartphone app, farmers and gardeners can monitor soil and environmental parameters like temperature and humidity thanks to the Blynk IoT platform's remote monitoring and manual control capabilities. This arrangement saves time and labour by reducing the need for physical supervision. This project provides a sustainable solution to irrigation problems by combining IoT with renewable energy, which makes it perfect for areas with limited access to electricity or water. This technology can increase crop output, manage water better, and support more sustainable farming methods.

3.2.1 ESP32 Microcontroller

- Description: A powerful, low-cost microcontroller with built-in Wi-Fi and Bluetooth capabilities, ideal for IoT applications. It collects data from sensors, processes the information, and communicates with the Blynk IoT platform for remote monitoring and control.
- Role in Project: Central control unit, managing sensor inputs, processing data, and controlling the relay for the water pump.

Fig No 3.2 ESP32 Microcontroller

3.2.2 Rain Sensor

- Description: Detects rain by identifying water droplets on its surface.
- Role in Project: Pauses irrigation if rain is detected, helping prevent water wastage by temporarily disabling the water pump.

Fig No 3.3 Rain Sensor

3.2.3 Motor Driver

A motor driver is a more specialized component designed to drive motors, such as DC motors, stepper motors, or servo motors. It takes a low-power signal from a microcontroller and increases the current to a level that can drive the motor. Some motor drivers also provide features like speed control, direction control, and braking.

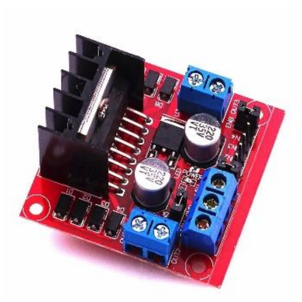

Fig No 3.4 Motor Driver

3.2.4 Water Pump

- Description: A small DC water pump that provides irrigation to the soil when activated.
- Role in Project: Supplies water to the soil when the soil moisture sensor indicates dryness and no rain is detected.

Fig No 3.5 Water Pump

3.2.5 DHT11 or DHT22 Sensor (Temperature and Humidity)

- Description: Measures temperature and humidity in the surrounding environment.
- Role in Project: Provides additional environmental data to monitor the conditions in which plants are growing, which may affect irrigation needs.

3.2.6 Solar Panel (e.g., 10W, 12V)

- Description: A photovoltaic panel that converts sunlight into electrical energy, providing power to the system.
- Role in Project: Supplies renewable power to the system, especially useful for areas with limited access to a constant power supply.

3.2.7 Buck-Boost Converter

- Description: A power converter that steps up or steps down the voltage from the solar panel to match the ESP32's input requirements.
- Role in Project: Ensures a stable output voltage from the solar panel, protecting the ESP32 and other components from voltage fluctuations.

3.2.8 Blynk IoT Platform

- Description: A mobile app platform that provides a user-friendly interface for remotely monitoring and controlling IoT devices.
- Role in Project: Allows users to monitor soil moisture, rain status, temperature, and pump activity in real-time. It also offers manual control of the irrigation system.

3.3 COST ESTIMATION

S.NO	COMPONENTS	ESTIMATED COST (INR)
1	ESP32 Module	500
2	Motor Driver	300
3	Rain Sensor	200
4	Relay Module	50
5	Water Pump	150
6	Solar Panel (6V-12V)	900
7	Miscellaneous (Wires, connectors)	400
8	Total Estimated Cost	2500

Table No 3.3 Cost Estimation of Smart Solar-Powered Iot Irrigation System with Rain Detection

CHAPTER 4

FUTURE SCOPE & ITS IMPLEMENTATION PLAN

FUTURE SCOPE

Integration with Advanced Sensors

- Add temperature and humidity sensors to provide a more comprehensive understanding of environmental conditions.
- Utilize UV and light sensors to monitor sunlight levels, which could influence irrigation schedules for specific crops.

Predictive Analytics and Machine Learning

- Implement machine learning algorithms to analyze historical sensor data and weather forecasts.
- Predict irrigation needs more accurately and optimize water usage based on seasonal trends and crop requirements.

Water Quality Monitoring

- Add sensors to monitor water quality parameters such as pH, turbidity, or salinity, ensuring water suitability for crops.

IMPLEMENTATION PLAN

Phase 1: Adding Sensors and System Testing (1–2 months)

- Procure and integrate additional sensors (temperature, humidity, and UV sensors).
- Test the system's capability to handle new data inputs.
- Validate the accuracy and reliability of multi-sensor data for irrigation decisions.

Phase 2: Machine Learning Integration (2–4 months)

- Collect historical data from the system during its operation to train predictive models.
- Implement basic machine learning algorithms (e.g., linear regression or decision trees) for irrigation prediction.
- Test the performance of the predictive model in live conditions.

Phase 3: Power Source Expansion (3–5 months)

- Explore additional renewable energy options (small wind turbines, kinetic systems).
- Design and integrate these energy sources with the existing power management system.
- Monitor and ensure that the combined energy harvesting meets system requirements.

Phase 4: IoT and Cloud Expansion (4–6 months)

- Link the system to cloud platforms for advanced analytics and data storage.
- Develop APIs to connect with various IoT platforms.
- Upgrade the mobile app to include additional features like historical data charts, push notifications, and scheduling.

Phase 5: Scalability and Deployment (6–9 months)

- Design the system to support multiple zones with unique irrigation requirements.
- Conduct field trials on larger farms to evaluate scalability.
- Collect user feedback for further refinement.

Phase 6: Commercialization and Deployment (9–12 months)

- Create user-friendly guides and kits for farmers or gardeners to deploy the system independently.
- Market the system to potential users, emphasizing its water-saving benefits, eco-friendliness, and cost efficiency.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 PROTOTYPE PHOTO:

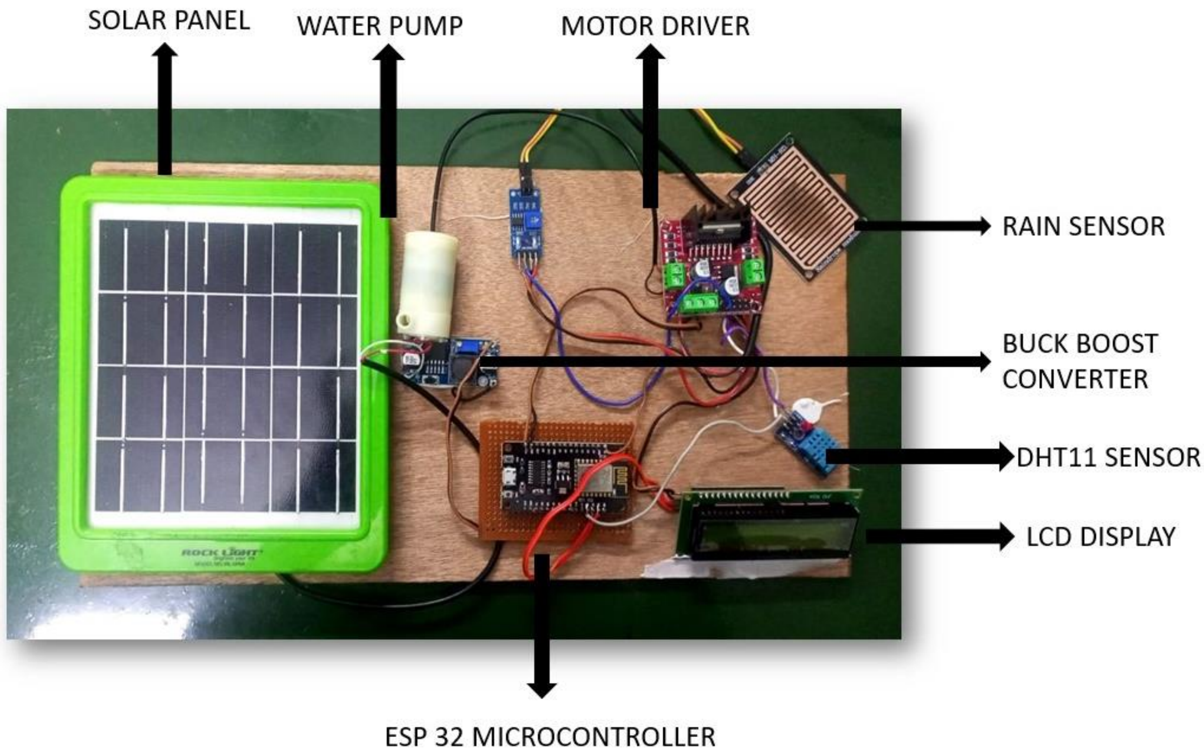

Fig.No 5.1 Prototype of Smart Solar-Powered IoT Irrigation System with Rain Detection

5.2 CONCLUSION

In summary, the Smart Solar-Powered IoT Irrigation System with Rain Detection is a transformative technology that enhances water management in agriculture. By combining renewable energy, IoT capabilities, and intelligent monitoring, this system not only promotes sustainable practices but also supports farmers in achieving higher productivity and environmental stewardship. As agricultural demands continue to rise, such innovative solutions will be crucial in fostering a more sustainable future for farming.

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