

**Electrical Engineering Department**

**College of Engineering**

**Najran University**

**Project Title……**

**By**

|  |  |  |
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**Supervisor:**

**Dr. ....**

**Submitted in Partial Fulfillment of The Requirements for the Bachelor's Degree in Electrical Engineering, College Of Engineering, Najran University, Najran, KSA**

**December 2025**

DEDICATION

Write your dedication here

Example:

To

My father, xxx

My mother, xxx

….

APPROVAL SHEET

This project report entitled "**Project title"** was prepared and submitted by (**student name 1, student name 2 and student name 3**) as the fulfillment of the requirement for the Bachelor of Engineering (**Electrical Engineering**) is hereby accepted.

Approved by:

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Date Approved: xx/xx/1438 H - xx/xx/2016 M

DECLARATION

This report was written by (**student name 1, student name 2 and student name 3**) a student in the Department of Electrical Engineering at Najran University. It has not been altered or corrected as a result of assessment and it may contain errors and omissions. The views expressed in it together with any recommendations are those of the student(s).

|  |  |  |  |
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ACKNOWLEDGMENT

Write your acknowledgment here.

Example:

First and foremost, I express my deepest gratitude to Allah (God) for His countless blessings and guidance throughout my life. I am truly thankful for all that I am and all that I have. I would like to extend my sincere appreciation to my supervisor, Dr. [Name], for his invaluable guidance, unwavering support, and continuous encouragement throughout the development of this project. His constructive feedback and dedicated supervision have been instrumental in shaping the outcome of this work. I am also profoundly grateful to my beloved family and friends for their unconditional love, compassion, and steadfast support, which provided me with the strength and motivation to complete this project.

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LIST OF ABBREVIATIONS

ACMSA Aperture-Coupled Microstrip Antenna

ADS Advanced Design Software

A-GPS Assisted- Global Positioning System

AOA Angle-Of-Arrival

AWGN Additive White Gaussian Noise

CCS Code Composer Studio

CRLB Cramer-Rao Lower Bound

DOA Direction Of Arrival

DSSS Direct Sequence Spread Spectrum

E-911 Enhanced 911 Service System

EVD Eigen Value Decomposition

FCM Forward Correlation Matrix

FFT Fast Fourier Transform

GPS Global Positioning System

IFFT Inverse Fast Fourier Transform

ISI Inter-Symbol Interference

LHCP Left-Hand Circular Polarization

LNA Low Noise Amplifier

LOS Line Of Sight

LIST OF SYMBOLS

 Amplitude coefficient of (*m*, *n*) mode in *x*-direction inside the cavity

 Amplitude coefficient of (*m*, *n*) mode in *y*-direction inside the cavity

 Permittivity of free space

 Relative dielectric constant

 Elevation angle

 Angle of arrival between tag and reader 1

 Angle of arrival between tag and reader 2

 Angle of arrival

 Error in the angle of arrival

 Magnetic permeability

Σ Diagonal eigenvalues matrix

 Normalized diagonal eigenvalues matrix

 Variance of the additive white Gaussian noise

 Noise power of any received snapshot

 Signal power of any received snapshot

 Minimum variance of the successive TOA samples

*τ* Minimum time difference between two successive paths of the channel

 power delay profile

**pROJECT tILTE (20 WORDS MAX.)**

ABSTRACT

* Write the Abstract AFTER you finish your report and results.
* The abstract is a summary of the entire report and should be given the same careful attention as the main text.
* It should not include any reference.
* An abstract should be between **150** and **300** words.
* It includes a brief statement of the problems and objectives of the study, a concise description of the research method and design, a summary of the major findings including their significance, and conclusions.

Example:

Najran City experiences flooding annually due to heavy rainfall and climatic disturbances. These floods result not only in financial losses but also in the loss of lives, damage to property, and destruction of agriculture and livestock. To address this issue, the current project proposes a conceptual framework comprising three main phases: monitoring water levels within the dam and in the upstream and downstream water streams, controlling the opening and closing of the dam gate, and measuring water pressure at the dam barrier. In the event of rising water levels, sensors placed at the top of the dam detect the changes and provide input to a stepper motor, which then controls the dam gate accordingly. Experimental results demonstrate that the proposed system can effectively manage floodwater. It accurately measures water levels and automatically adjusts the dam gate when critical thresholds are reached, while also monitoring water pressure at the barrier through dedicated sensors. The developed real-time monitoring system for the Najran Dam will assist authorities in taking timely preventive measures to mitigate the impact of flood disasters.

#

 INTRODUCTION

## Background

The background section of a graduation project provides context and justification for your study. It helps readers understand the problem you're addressing, why it is important, and how your project fits into the broader field.

##  Problem Statement and Motivation

The **Problem Statement** clearly defines the issue your project aims to solve. It should be specific, concise, and focused.

**Identify the Core Problem:**

* + Describe the main issue or gap in current systems, methods, or technologies.
	+ Use clear, factual language to present the problem.

**Explain the Impact:**

* + Highlight why this problem matters (e.g., its effect on people, systems, environment, etc.).
	+ Use real-world examples or data to support the need for a solution.

Example:

Traffic congestion is a major problem in cities of all sizes. As the population grows, the number of vehicles on streets and roads continues to rise [1], [2]. This increase leads to overcrowded streets, particularly at traffic lights during peak hours, resulting in significant economic issues such as wasted time, excessive fuel consumption, and increased environmental harm due to pollutants emitted by idling vehicles [3]. To address these challenges, this project aims to implement an efficient and well-suited traffic light management system.

## Project Objectives

* Objectives are **measurable, achievable, and time-bound** steps that support the aim.
* They should follow the **SMART criteria**:
	+ **S**pecific
	+ **M**easurable
	+ **A**chievable
	+ **R**elevant
	+ **T**ime-bound

**Example:**

1. To analyze current traffic light systems and identify inefficiencies.
2. To design an adaptive algorithm that adjusts signal timing based on real-time traffic data.
3. To simulate the proposed system using traffic modeling software.
4. To evaluate the system’s effectiveness in reducing average vehicle waiting time by at least 20% compared to conventional systems.

## Scope of Project

The scope defines the boundaries of your project, what it will cover (inclusions) and what it will not cover (exclusions). It ensures clarity and prevents unnecessary deviations.

**Example:**

This project aims to develop a machine learning-based traffic light optimization system. The scope includes algorithm design, simulation testing, and performance evaluation using real-world traffic data. However, it excludes physical deployment due to budget constraints. The expected deliverables are a working simulation model and a comparative analysis report. The project will be completed within one academic semester using Arduino microcontroller and MATALB simulation tools.

## Project Organization

**Chapter 1: Introduction**

This chapter introduces the project by outlining the background, problem statement, objectives, and scope. It also explains how the report is organized and what each chapter will cover.

**Chapter 2: Literature Review**

This chapter reviews related previous work, categorizes existing solutions, and identifies gaps in the literature. It shows how the current project builds on and improves earlier studies.

**Chapter 3: Methodology**

This chapter describes the design and development process of the system, including hardware, software, tools, and techniques. It also discusses applicable standards, constraints, and expected results.

**Chapter 4: Results and Discussion**

This chapter presents and analyzes the simulation and experimental results. It compares the outcomes, validates the system’s performance, and highlights potential applications.

**Chapter 5: Conclusion and Future Work**

This chapter summarizes the project’s key achievements, outlines its limitations, and provides recommendations for future improvements and development.

#

LITERATURE REVIEW

## Introduction

Provide a brief description of this chapter and a concise explanation of each subheading.

## Related Pervious Work

In this section, summarize and analyze existing research, technologies, or solutions related to your topic. Follow this structure:

1. **Scope**: Focus on studies/systems directly relevant to your project’s goals.
2. **Organization**: Group works by themes (e.g., "IoT-Based Solutions," "Machine Learning Approaches").
3. **Comparison**: Highlight strengths/weaknesses of each method (use tables if needed).
4. **Gap Identification**: Explain how your project improves upon or differs from prior work.
5. **Citations**: Use credible sources (IEEE, ScienceDirect, patents, etc.).

**Example**:

Previous studies like [4] used RFID for inventory tracking but lacked real-time analytics. [5], [6] proposed a CNN-based system with 95% accuracy but required high computational power. Our project bridges these gaps by combining low-cost sensors with edge computing for efficient real-time processing.



Figure . Xxx

## Summary

Table 3.2 Summary of existing studies related to the project

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Reference** | **Method Used** | **Key Findings/Strengths** | **Limitations/Gaps** | **How Our Project Improves** |
| [7] | IoT + Cloud-based sensors | 90% accurate in real-time monitoring | High latency in data processing | Uses **edge computing** to reduce latency |
| [4] | Machine Learning (CNN) | 95% defect detection in manufacturing | Requires high GPU resources | Implement **lightweight ML model** for low-cost devices |

#

Methodology

## Introduction

Provide a brief description of this chapter and a concise explanation of each subheading.

## The Proposed System Design

Explain how the system was designed (create a subtitle for each topic), including:

* Circuit design
* Algorithm development (if applicable)
* PCB design or schematic creation
* Tools and Software

Mention any tools, software, or programming environments used (e.g., MATLAB, Arduino, Multisim, Proteus, LabVIEW).

* Flowchart or diagram (see example in Figure 3.1)
* Hardware configuration
* Working Principles of the project



Figure . Flow chart for partner coupling algorithm

## Realistic Constraints and Standards

The report must include all realistic constraints and standards related to the project.

### Engineering Standards Realted to the Project

The Engineering Standards section highlights the national or international standards your project follows to ensure safety, reliability, compatibility, and quality. It reflects professionalism and alignment with real-world engineering practices.

**Examples:**

**Communication Engineering Standards**

| **No.** | **Standard Code** | **Description** |
| --- | --- | --- |
| 1 | IEEE 802.11 | Wireless LAN (Wi-Fi) |
| 2 | IEEE 802.3 | Ethernet networking |
| 3 | IEEE 802.15.4 | Low-rate wireless personal area networks (ZigBee) |
| 4 | ITU-T G.709 | Optical Transport Network (OTN) standard |
| 5 | ITU-T G.703 | Physical/electrical characteristics of hierarchical digital interfaces |
| 6 | ETSI EN 300 328 | Wideband transmission systems (2.4 GHz band) |
| 7 | IEEE 802.16 | Broadband Wireless Access (WiMAX) |
| 8 | ITU-R SM.1138 | Sharing between mobile and fixed services |
| 9 | ISO/IEC 11801 | Generic cabling for customer premises |
| 10 | IEEE 1901 | Broadband over Power Line (BPL) networks |

**Control Engineering Standards**

| **No.** | **Standard Code** | **Description** |
| --- | --- | --- |
| 1 | IEC 61131-3 | Programmable logic controllers (PLC) – Programming languages |
| 2 | IEEE 1588 | Precision Time Protocol (PTP) |
| 3 | ISO 13849 | Safety of machinery – Safety-related parts of control systems |
| 4 | ISA 5.1 | Instrumentation symbols and identification |
| 5 | IEC 61508 | Functional safety of electrical/electronic systems |
| 6 | ISO 12100 | Risk assessment and risk reduction in control systems |
| 7 | ANSI/ISA-88 | Batch control models and terminology |
| 8 | IEC 62061 | Safety of electrical control systems in machinery |
| 9 | IEEE 1451 | Smart transducer interface for sensors and actuators |
| 10 | ISO 10218 | Robotics safety requirements for industrial robots |

**Electrical Engineering Standards**

| **No.** | **Standard Code** | **Description** |
| --- | --- | --- |
| 1 | NFPA 70 (NEC) | National Electrical Code for wiring and installation safety |
| 2 | IEC 61010 | Safety for electrical equipment in control and lab use |
| 3 | IEEE C37.2 | Standard electrical power system device function numbers |
| 4 | IEC 60204-1 | Safety of machinery – Electrical equipment of machines |
| 5 | IEEE 1159 | Power quality monitoring standards |
| 6 | NEMA MG 1 | Motors and generators standards |
| 7 | UL 508A | Standard for industrial control panels |
| 8 | IEEE 242 | Protection and coordination of industrial and commercial power systems |
| 9 | IEC 60950 | Safety of information technology equipment |
| 10 | IEEE 493 | Design of reliable industrial and commercial power systems (Gold Book) |

**Electronics Engineering Standards**

| **No.** | **Standard Code** | **Description** |
| --- | --- | --- |
| 1 | IPC-A-610 | Acceptability of electronic assemblies |
| 2 | IPC-2221 | Generic standard for PCB design |
| 3 | JEDEC JESD22 | Reliability test methods for electronic components |
| 4 | IEC 60068 | Environmental testing for electronics |
| 5 | IEEE 1149.1 | Standard test access port and boundary-scan architecture (JTAG) |
| 6 | IPC-7711/7721 | Rework, modification, and repair of electronic assemblies |
| 7 | ISO/IEC 17025 | General requirements for testing and calibration labs |
| 8 | UL 94 | Flammability standards for plastic materials in electronics |
| 9 | IEC 60747 | Semiconductor devices – Discrete devices |
| 10 | IEEE 1687 | Access and control of embedded instrumentation in electronic devices |

**Power Engineering Standards**

| **No.** | **Standard Code** | **Description** |
| --- | --- | --- |
| 1 | IEEE 1547 | Interconnection of distributed energy resources with electric power systems |
| 2 | IEEE 519 | Harmonic control in power systems |
| 3 | IEC 60034 | Rotating electrical machines |
| 4 | IEEE 80 | Grounding of substations |
| 5 | IEC 60909 | Short-circuit currents in power systems |
| 6 | IEEE 115 | Test procedures for synchronous machines |
| 7 | IEEE C62.41 | Surge voltages in low-voltage AC power circuits |
| 8 | IEEE 112 | Testing of electric motors and generators |
| 9 | IEC 60529 | Degrees of protection provided by enclosures (IP Code) |
| 10 | IEC 61850 | Communication networks and systems in substations |

**Solar Engineering Standards**

| **No.** | **Standard Code** | **Description** |
| --- | --- | --- |
| 1 | **IEC 61215** | Terrestrial PV modules – Design qualification and type approval |
| 2 | **IEC 61730** | PV module safety qualification (construction and testing requirements) |
| 3 | **IEC 61853** | PV module performance testing and energy rating |
| 4 | **IEC 62109-1/2** | Safety of power converters for PV systems – Part 1 (General) and Part 2 (Inverters) |
| 5 | **UL 1703 / UL 61730** | Safety standard for flat-plate PV modules and panels (North America) |
| 6 | **IEEE 1547** | Interconnection of distributed energy resources with electric power systems |
| 7 | **IEC 62548** | Design requirements for PV arrays |
| 8 | **NFPA 70 (NEC)** | National Electrical Code – Article 690: Solar photovoltaic systems |
| 9 | **IEC 62716** | Ammonia corrosion testing of PV modules |
| 10 | **ISO 9488** | Vocabulary and terminology for solar energy systems |

### Realistic Constraints and Solutions

When writing **Realistic Constraints and Solutions** for an engineering graduation project, the goal is to identify the limitations or challenges that may affect the project and propose practical solutions. Here's a guide on how to approach it:

**1. Identify the Constraints**

* **Technical Constraints**: These refer to limitations related to the technology or equipment you are using. For example, software limitations, hardware compatibility, or specific performance criteria.
	+ Example: "The project must be implemented using an Arduino microcontroller, which limits the processing power and memory for certain complex tasks."
* **Time Constraints**: Consider the time available to complete the project. Be realistic about the phases of development and how much time is allocated for each.
	+ Example: "The timeline is limited to six months, meaning the prototype will need to be developed with a focus on essential features only."
* **Resource Constraints**: This involves availability of materials, financial limitations, and human resources (e.g., team members, mentors, or advisors).
	+ Example: "The budget for the project is restricted to $1000, so we will need to prioritize cost-effective components."
* **Environmental Constraints**: These include physical, social, or regulatory conditions that could affect the project, such as safety standards, environmental impact, or legal requirements.
	+ Example: "The project needs to comply with local safety regulations for electrical systems, requiring specific insulation standards for wiring."
* **Feasibility Constraints**: This covers the practicality of your design, including scalability and long-term implementation.
	+ Example: "The proposed design is intended for small-scale deployment; scaling up for mass production would require further optimization."

**2. Propose Solutions**

* **Technical Solutions**: Provide realistic alternatives or workarounds for any technical challenges.
	+ Example: "To overcome the processing power limitations of the Arduino, we can use a secondary microcontroller for intensive computations and communicate with the Arduino via I2C."
* **Time Management Solutions**: Suggest how you plan to manage the time constraints and ensure timely completion.
	+ Example: "To stay within the six-month timeline, we will break the project into phases and set milestones for each major component."
* **Resource Optimization**: Show how you plan to make the best use of available resources or acquire necessary resources.
	+ Example: "We will source materials from local suppliers to reduce shipping costs and use open-source software tools to avoid licensing fees."
* **Environmental and Regulatory Compliance**: Explain how you plan to address any external constraints, such as legal or environmental factors.
	+ Example: "We will ensure compliance with safety standards by conducting thorough testing and using certified components for electrical systems."
* **Feasibility and Scalability Solutions**: Address how the project can be made scalable or feasible in the future.
	+ Example: "For scalability, the system will be designed with modular components that can be upgraded without requiring complete redesigns."

The student can make a table to list the realistic constraints and solutions as in Table 3.1.

Table . The realistic constraints and solutions of the project

| **Category** | **Realistic Constraints** | **Proposed Solutions** |
| --- | --- | --- |
| **Technical Constraints** | Limited processing power and memory of the chosen microcontroller (e.g., Arduino). | Use a secondary microcontroller for intensive tasks and communicate with the main microcontroller via I2C. |
| **Time Constraints** | The project must be completed within six months, restricting the scope of work. | Break the project into phases, set milestones for each component, and focus on essential features for the prototype. |
| **Resource Constraints** | Limited budget of $1000 for purchasing materials and equipment. | Source components from local suppliers to minimize shipping costs and prioritize cost-effective solutions. |
| **Environmental Constraints** | Compliance with local safety regulations for electrical systems. | Ensure adherence to safety standards by using certified components and conducting thorough safety tests. |
| **Feasibility Constraints** | The project is intended for small-scale use; mass production may require additional work. | Design with modular components that allow future scaling and upgrading without a complete redesign. |
| **Regulatory Constraints** | Restrictions on usage or installation of certain equipment due to local laws or standards. | Consult with legal experts to ensure all equipment and designs comply with relevant regulations before implementation. |
| **Performance Constraints** | Limited communication range due to hardware capabilities. | Implement low-power, long-range communication modules to extend the operational range of the system. |
| **Human Resource Constraints** | Limited access to technical support or team members. | Organize efficient collaboration with online resources and self-learning, while seeking occasional guidance from mentors. |
| **…** | … | … |

## Expected Results

The Expected Results section outlines the anticipated outcomes of your project based on your design, methodology, and objectives. It helps set clear expectations and provides a benchmark for evaluating the actual results later.

Depending on your project, expected results may include:

* **Functional performance** (e.g., system produces desired output voltage, frequency, speed)
* **Efficiency** (e.g., power conversion efficiency of 90% or higher)
* **Accuracy** (e.g., sensor reading error below 5%)
* **Cost-effectiveness** (e.g., low-cost implementation compared to existing solutions)
* **Improved performance** over traditional methods or systems
* **Successful simulation or hardware prototype**

#

RESULTS AND DISCUSSION

## Introduction

Provide a brief description of this chapter and a concise explanation of each subheading.

##  Simulation and Measurment Results

This section presents and explains the outcomes obtained from simulations and real-world measurements. It is essential to clearly differentiate between simulated data (from software) and measured data (from practical implementation or experiments).

##  Analysis of Results and Discussion

### Simulation Results

* Present outputs from simulation software with clear figures, waveforms, or data tables.
* Label all graphs and explain key points (e.g., voltage levels, signal behavior, frequency response).
* Compare results with theoretical expectations where applicable.
* Mention simulation settings (e.g., time steps, input values).

Example:

Figure 4.1 illustrates the results obtained from the variation of antenna distance, d at 2.5 to 7 GHz. A tumor of 10mm radius is inserted for this process …..



Figure . Simulated return loss with different values of d

### Measurement Results

* Present data collected from physical testing or lab experiments.
* Use photos of test setups, tables of measurements, or oscilloscope captures.
* Discuss accuracy, consistency, and any deviations from expected results.

**Example:**

Table 4.1 shows the measured output voltages from the prototype circuit. The results show minor deviations (±3%) from the simulation due to component tolerances.

Table . : Reflection coefficient at different antenna distance

|  |  |
| --- | --- |
| Time (s) | Voltage (V) |
|  |  |
|  |  |

### Comparison and Analysis

* Compare simulation and measurement results if both were performed.
* Discuss similarities and differences.
* Explain reasons for discrepancies (e.g., ideal vs real components, noise, environmental factors).

**Example Table:**

Table . : Comparison between ….

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Parameter** | **Simulated Result** | **Measured Result** | **Theoretical Value** | **Deviation (%)** |
| Output Voltage (V) | 4.95 | 4.92 | 5.00 | -1.6% |

## Result Validation of the Proposed System

The Validation of Results section demonstrates that your project outcomes (simulation, implementation, or analysis) are accurate, reliable, and meet design objectives. It provides evidence that the system performs as intended by comparing results with standards, theoretical models, or previously published work.

## Potentail Applications of Project

Write the marketing application for the project, focus on how the project can be commercialized or meet market needs. Briefly describe the potential users or industries that would benefit from the project. Explain how your solution addresses a specific demand, improves efficiency, reduces cost, or solves a real-world problem. Highlight any competitive advantages, such as innovation, affordability, or ease of use, that make it appealing in the market. Conclude by suggesting how the project could be implemented, scaled, or further developed for broader commercial use.

## Summary

* Summarize the overall performance of the system based on results.
* Highlight whether the design goals were achieved.

#

Conclusion and Future Work

## Conlusion and Achievements

The **Conclusion** summarizes the project’s achievements, key findings, and whether the objectives were met. It should be **concise, clear, and impactful**.

**Key Elements:**
✔ **Restate Objectives** – Briefly recap the project’s goals.
✔ **Summarize Results** – Highlight major outcomes and successes.
✔ **Answer "So What?"** – Explain the significance of the project (e.g., efficiency improvement, cost savings).
✔ **Avoid New Information** – Only discuss what was already presented in the report.

**Example:**

The system successfully measures water levels inside, upstream, and downstream of Najran Dam while automating gate control via a stepper motor. Data is displayed on an LCD, achieving 100% accuracy in water level detection and pressure measurement. Tests confirm the sensors and motor operate flawlessly, enabling effective flood prevention by regulating water discharge autonomously. This automated solution eliminates human intervention, enhances safety, and minimizes flood risks to lives and infrastructure. The integrated pressure sensor further strengthens real-time monitoring, supporting proactive flood warnings before, during, and after heavy rainfall. In conclusion, the system ensures precise, damage-free water management, setting a new standard for dam safety.

## Limitations of Project

In this section, the limitations faced during the project should be identified. It demonstrates critical thinking and transparency about the project’s boundaries.

### Recommendations for Future Work

The **Future Work** section suggests improvements, expansions, or next steps for the project. It should be **realistic and actionable**.

**Key Elements:**
✔ **Suggest Enhancements** – New features, better tools, or scaled testing.
✔ **Industry/Research Applications** – How can this work be extended?

**Example:**

Future work should focus on:

1. Implementing the system on Raspberry Pi for cost-effective hardware deployment.
2. Integrating IoT sensors for real-time weather adaptation.
3. Testing in high-traffic urban intersections for scalability validation.

References

[1] A. H. M. Almawgani, “Design Of Real Time Smart Traffic Light Control System,” *ISER- 318th Int. Conf. Sci. Technol. Eng. Manag.*, vol. 6, no. 4, pp. 51–55, 2018.

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APPENDIX A

ADS Schematics to Design Path 3 and Path 4 of the Planar Microstrip Antenna Array with 4×4 Butler Matrix

Figure A.1 shows the ADS schematic for path 3 which connects between antenna 3 and 4×4 Butler matrix. The ADS schematic to modify the length of path 3 is shown in Figure A.2.



Figure A.1 ADS schematic for path 3



Figure A.2 ADS schematic to modify the length of path 3

APPENDIX B

Title

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