*A project report on*

# STABILITY APPROXIMATION OF GEL ELECTROLYTES USING DECISION SUPPORT

*Submitted in partial fulfilment for the award of the degree of*

## Bachelor of Technology

*By*

**LOKESH VAGICHERLA (20BCB7107)**


**SCHOOL OF COMPUTER SCIENCE & ENGINEERING**

May, 2024

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## *DECLARATION*

I here by declare that the thesis entitled "STABILITY APPROXIMATION OF GEL ELECTROLYTES USING DECISION SUPPORT" submitted by me, for the award of the degree of B.Tech. in Computer Science and Engineering is a record of bonafide work carried out by me under the supervision of Prof. Shaik Kareemulla

I further declare that the work reported in this thesis has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.


Place: Amaravati

Signature of the Candidate

Date: 23/May/2024

LOKESH VAGICHERLA
20BCB7107

# *Internship Completion Certificate*

Shia#sh
Focus on Deliverables

**04th May 2024**

**INTERNSHIP COMPLETION CERTIFICATE**

This is to certify that **Mr. Lokesh Vagicherla (Reg. No. 20BCB7107)** Student of **B.Tech.,(Computer Science Engineering) VIT-AP University, Amaravati** has successfully completed the Internship in **Java** platform from **January 2024 to May 2024** in our company.

During the period, he had been exposed to different processes and found to be Punctual, Hard Working and Inquisitive.

We wish him every success in life and career.

For **Shiash Info Solutions Private Limited**

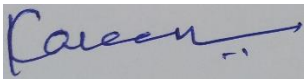
**Ashwini Kanniyappan**

**Manager – Human Resources**

**Shiash Info Solutions Private Limited**
**#51, Level 3, Tower C, Rattha TEK Meadows, Old Mahabalipuram Road,**
**Sholinganallur, Chennai – 600 119, Tamil Nadu, India**

# *CERTIFICATE*

This is to certify that the Internship titled **"STABILITY APPROXIMATION OF GEL ELECTROLYTES USING DECISION SUPPORT"** that is being submitted by LOKESH VAGICHERLA (20BCB7107) is in partial fulfilment of the requirements for the award of Bachelor of Technology, is a record of bonafide work done under my guidance. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.



Prof. Shaik Kareemulla

Guide

*The thesis is satisfactory / unsatisfactory*

**Internal Examiner** **External Examiner**

*Approved by*

**PROGRAM CHAIR** **DEAN**

B. Tech. CSE NETWORK AND SECURITY School of Computer Science & Engineering

## *ABSTRACT*

Electrolytes, integral components of batteries and other energy storage systems, play a crucial role in facilitating the movement of ions between electrodes, enabling the flow of electric current. One of the notable advancements in electrolyte technology is the development of gel electrolytes. Gel electrolytes have gained attention for their unique properties that combine the benefits of traditional liquid electrolytes with enhanced safety and stability. Gel electrolytes represent a significant advancement in energy storage technology with their improved safety, stability, and flexible form factors. Gel electrolytes have attracted interest because of their special qualities, which combine the advantages of conventional liquid electrolytes with improved stability and safety. Gel electrolytes, with their enhanced safety, stability, and adjustable form factors, constitute a substantial improvement in energy storage technology. However, while choosing them for certain applications, it is important to take into account their reduced ionic conductivity and manufacturing challenges. However, their lower ionic conductivity and manufacturing complexities must be carefully considered when selecting them for specific applications. To improve the ionic conductivity of gel electrolytes plays a major role in improving the quality of the gel-based batteries. The quality of products can be increased by adding appropriate number of certain fillers which can be processed by using decision tree algorithm. A decision tree is a supervised learning algorithm that can be used for both classification and regression problems. It is a tree-structured classifier, where internal nodes represent the features of a dataset, branches represent the decision rules and each leaf node represents the outcome. This algorithm helps in changing the decisions that needed to calculate the processing the production data that is needed for gel batteries which will efficiently increase ionic stability, thermal stability and mechanical stability.

## ACKNOWLEDGEMENT

It is my pleasure to express with deep sense of gratitude to, Prof. Shaik Kareemulla, Associate Professor Grade-1, School of Computer Science & Engineering, VIT-AP, for her constant guidance, continual encouragement, understanding; more than all, he taught me patience in my endeavor. My association with her is not confined to academics only, but it is a great opportunity on my part of work with an intellectual and expert in the field of Computer Science.

I would like to express my gratitude to Dr. G. Viswanathan, Dr. Sekar Viswanathan, Mr. Sankar Viswanathan, Dr. G. V. Selvam, Dr. S. V. Kota Reddy, and Prof. Pradeep Reddy CH, School of Computer Science & Engineering, for providing with an environment to work in and for his inspiration during the tenure of the course.

In jubilant mood I express ingeniously my whole-hearted thanks to Dr. Muneeswari G, Head, Dept. of Computer Science and Engineering, all teaching staff and members working as limbs of our university for their not-self-centered enthusiasm coupled with timely encouragements showered on me with zeal, which prompted the acquirement of the requisite knowledge to finalize my course study successfully. I would like to thank my parents for their support.

It is indeed a pleasure to thank my friends who persuaded and encouraged me to take up and complete this task. At last but not least, I express my gratitude and appreciation to all those who have helped me directly or indirectly toward the successful completion of this project.

Lokesh Vagicherla

Place: Amaravati

Date: 23/May/2024

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# LIST OF ACRONYMS

UAT: User acceptance testing
EIS: Electrochemical impedance spectroscopy
PEO: Poly (ethylene oxide)
PVDF: Poly (vinylidene fluoride)
EIS: Electrochemical Impedance Spectroscopy
CV: Cyclic Voltammetry
SEM: Scanning Electron Microscopy
XPS: X-ray Photoelectron Spectroscopy
TGA: Thermogravimetric Analysis
DSC: Differential Scanning Calorimetry

# CHAPTER 1
**Introduction**

## 1.1 Introduction

Gel electrolytes occupy a fascinating middle ground between traditional liquid electrolytes and solid-state alternatives. Gel electrolytes have attracted interest because of their special qualities, which combine the advantages of conventional liquid electrolytes with improved stability and safety. Gel electrolytes, with their enhanced safety, stability, and adjustable form factors, constitute a substantial improvement in energy storage technology. However, while choosing them for certain applications, it is important to take into account their reduced ionic conductivity and manufacturing challenges. Composed of a polymer matrix infused with a liquid electrolyte solution, they combine the high ionic conductivity of liquids with the mechanical stability and leak-proof nature of solids. This unique balance makes them highly attractive for various applications, particularly advanced batteries. Within the polymer scaffold, the liquid electrolyte forms interconnected pathways for ion transport, enabling efficient conductivity comparable to liquid counterparts. Simultaneously, the polymer matrix provides structural integrity, prevents leakage, and suppresses unwanted reactions, addressing major safety concerns associated with liquid electrolytes. However, optimizing gel electrolytes often involves navigating trade-offs. Balancing polymer crystallinity, solvent selection, and ionic species concentration is crucial for maximizing conductivity while maintaining stability and mechanical properties. Understanding these intricate relationships is key to unlocking the full potential of gel electrolytes across various sectors, from energy storage to bioelectronics.

## 1.2 Objective:

1. Processing client requirements can be done efficiently.
2. Immediate authority action is accessible because the action that needs to be performed is transmitted immediately by email with the press of a button, with no communication latency.
3. Reports generation can be done immediately after calculation of number of materials required for processing client data.
4. Testing ionic stability, thermal stability and mechanical stability can be done very easily.
5. Processing data for fillers can be efficiently done in production process which is crucial in the part of production.

6. Very little time needed to go through the information for approval of reports for production.

## 1.3 Scope of The Project*:*

1. Material Selection and Formulation:

   - Polymer Matrix: Explore a variety of polymers, including poly(ethylene oxide) (PEO), poly(vinylidene fluoride) (PVDF), and their copolymers, to identify optimal candidates based on their mechanical properties, electrochemical stability, and compatibility with liquid electrolytes.

   - Liquid Electrolyte: Investigate different solvent combinations and lithium salts to achieve high ionic conductivity, wide electrochemical stability windows, and good interfacial compatibility with electrode materials.

   - Additives: Incorporate fillers, plasticizers, and other additives to enhance specific properties like mechanical strength, thermal stability, and ionic conductivity.

2. Characterization and Performance Evaluation:

   - Ionic Conductivity: Measure ionic conductivity over a wide temperature range using electrochemical impedance spectroscopy (EIS) to assess the efficiency of ion transport within the gel electrolyte.

   - Electrochemical Stability Window: Determine the electrochemical stability window using cyclic voltammetry (CV) to ensure compatibility with the intended battery chemistry and prevent unwanted side reactions.

   - Mechanical Properties: Evaluate mechanical properties like tensile strength, modulus, and elongation at break to ensure the gel electrolyte can withstand the stresses and strains experienced during battery operation.

   - Thermal Stability: Assess thermal stability using thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) to determine the maximum operating temperature and prevent thermal degradation.

- Interfacial Compatibility: Investigate the interfacial properties between the gel electrolyte and electrode materials using techniques like scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS) to ensure good contact and minimize interfacial resistance.

3. Battery Performance Testing:

- Fabricate prototype batteries using the optimized gel electrolyte and evaluate their performance in terms of capacity, rate capability, cycle life, and safety under various operating conditions.

- Compare the performance of gel electrolyte-based batteries with those using traditional liquid electrolytes to quantify the improvements in safety, stability, and overall performance.

4. Scalability and Manufacturing Considerations:

- Develop scalable and cost-effective manufacturing processes for the production of gel electrolytes to ensure their feasibility for commercial applications.

- Investigate the compatibility of gel electrolytes with existing battery manufacturing infrastructure and identify potential challenges or modifications required for their integration.

# CHAPTER 2

## 2.1 Software Development Life Cycle

The System Development Lifecycle framework is designed to outline a complete development and implementation process suitable for developing complex applications. SDLC is a process followed for a software project, within a software organization. It consists of a detailed plan describing how to develop, maintain, replace and alter or enhance specific software. The life cycle defines a methodology for improving the quality of software and the overall development process.

- Business – legislation regulatory requirements, policy, SOP's, guidelines etc.
- Process – how the business is implemented
- Data – the core business data elements collected for the business
- Application – the gate to the business collecting
- Infrastructure- the servers, network, workstations, etc.

## 2.2 Hardware and Software Requirements

| Developing Kit | | | |
|---|---|---|---|
| | **Processor** | **RAM** | **Disk Space** |
| Eclipse | **Computer with a 2.6GHz processor or higher** | **2GB** | **Minimum 20 GB** |
| Database | | | |
| MySQL 5.0 | **Intel Pentium processor at 2.6GHz or faster** | **Minimum 512 MB Physical Memory; 1 GB Recommended** | **Minimum 20 GB** |
| HeidiSQL 8.3 | **Intel Pentium processor at 2.6GHz or faster** | **Minimum 512 MB Physical Memory; 1 GB Recommended** | **Minimum 20 GB** |

## Software Requirements:

- **Front end** : core java, css, js, servlet
- **Web application** : J2ee Frameworks, Hibernate

- **Back end** **:** MySQL 5.1

## 2.3 Input and Output

The major inputs and outputs and major functions of the system are follows:

**Input:**

- The entities such as authority and users must register the account for login. All the user details have been stored the data in our database for the purpose of identifying the entities.
- The E-prospect will upload the requirements for the gel electrolyte like type of battery, quantity, size, etc.

**Output:**

- Only the authorized data users can able to access the data.
- Gel electrolyte ionic conductivity, thermal stability, mechanical stability will be calculated at the given time.

**INPUT DESIGN**

- Input design is a part of overall system design. The main objective during the input design as given below.
- Input States: User can maintain a database in MySQL server or sql server for his/her business requirement.
- Input Media:

  At this stage choice has to be made about the input media. To conclude about the input media consideration has to be given to:
- In this section user can give the input for storage location and get the output from admin side.

## 2.4 Limitations

- ✓ Gel batteries have a lower energy density than traditional lead-acid batteries. This means that they can store less energy for a given volume or weight.
- ✓ Gel batteries are less efficient than traditional lead-acid batteries. This means that they lose more energy during charging and discharging.
- ✓ Gel batteries are more difficult to repair than traditional lead-acid batteries. This is because the gel electrolyte is difficult to remove and replace.

- ✓ Gel batteries are not as versatile as traditional lead-acid batteries. They are not as well-suited for applications that require deep discharge or high-current charging.
- ✓ Gel batteries require special chargers that can deliver a slow charging rate and a constant voltage.

## 2.5 Problems in Existing System:

One of the significant advancements in electrolyte science is the invention of gel electrolytes. Due to their unique characteristics, gel electrolytes have gained attention because they combine the benefits of traditional liquid electrolytes with increased stability and safety. Gel electrolytes represent a significant advancement in energy storage technology because of its improved safety, stability, and adaptable form factors. However, it is crucial to consider their decreased ionic conductivity and manufacturing difficulties when selecting them for certain applications. For gel-based batteries to operate better, gel electrolyte ionic conductivity must be increased. Prior to the emergence of gel electrolytes, two primary electrolyte systems dominated the landscape: liquid electrolytes and solid-state electrolytes. Liquid electrolytes, typically consisting of dissolved lithium salts in organic solvents, offered high ionic conductivity, crucial for efficient battery operation. However, their inherent fluidity posed safety risks like leakage and flammability, limiting their applicability in demanding environments. Additionally, their interaction with electrodes could trigger unwanted side reactions, impacting battery life and performance.

## 2.6 Proposed System

The quality of products may be raised by employing the proper quantity of certain fillers, which may be processed using a decision tree algorithm. Classification and regression problems may be addressed using a supervised learning strategy called a decision tree. It is a tree-structured classifier, where each leaf node represents the classification outcome and inside nodes represent the features of a dataset. By changing the calculations needed to compute the production data needed for gel batteries, this technique helps to increase the mechanical, thermal, and ionic stability of the batteries. Integrating phase-change materials can manage heat dissipation within the battery by absorbing and releasing heat at specific temperatures. Introducing additives like ionic liquids or plasticizers can enhance thermal stability without compromising conductivity. Implementing techniques like polymer crosslinking or nanofiber integration can enhance mechanical robustness without significantly

impacting conductivity. Designing gels that exhibit reduced viscosity under shear stress can facilitate better electrode contact and ion transport during battery operation.

**Advantage of Proposed System:**

- ✓ Processing client requirements can be done efficiently.
- ✓ Immediate authority action is accessible because the action that needs to be performed is transmitted immediately by email with the press of a button, with no communication latency.
- ✓ Reports generation can be done immediately after calculation of number of materials required for processing client data.
- ✓ Testing ionic stability, thermal stability and mechanical stability can be done very easily.
- ✓ Processing data for fillers can be efficiently done in production process which is crucial in the part of production.
- ✓ Very little time needed to go through the information for approval of reports for production.

# CHAPTER 3
**Methodology**

## 3. Methodology:

The development of gel electrolytes for advanced batteries involves a multi-faceted approach, encompassing material selection, formulation optimization, characterization, and performance evaluation.

Material Selection: The process begins with a comprehensive review of potential polymer matrices, liquid electrolytes, and additives. The selection criteria prioritize properties such as high ionic conductivity, wide electrochemical stability window, good mechanical properties, and thermal stability. Polymers like PEO, PVDF, and their copolymers are commonly considered due to their established compatibility with lithium-ion battery chemistries.

Formulation Optimization: Once the materials are chosen, the formulation process involves careful optimization of the polymer-to-liquid electrolyte ratio, additive concentrations, and processing conditions. This step aims to achieve a homogeneous gel with the desired balance of ionic conductivity, mechanical strength, and electrochemical stability.

Characterization: The gel electrolyte is then subjected to a battery of characterization techniques to evaluate its properties. Electrochemical impedance spectroscopy (EIS) measures ionic conductivity, cyclic voltammetry (CV) determines the electrochemical stability window, and mechanical testing assesses tensile strength and modulus. Thermal analysis techniques like thermogravimetric analysis (TGA) and differential scanning calorimetry (DSC) are employed to investigate thermal stability.

Performance Evaluation: The optimized gel electrolyte is incorporated into prototype battery cells and tested under various conditions. Key performance metrics include capacity, rate capability, cycle life, and safety. The battery's performance is compared with that of cells using traditional liquid electrolytes to quantify the improvements achieved by the gel electrolyte.

Iterative Refinement: The results from characterization and performance evaluation are used to iteratively refine the gel electrolyte formulation. This iterative process continues until the desired performance targets are met.

Scalability and Manufacturing: In parallel to formulation optimization, researchers also consider the scalability and manufacturability of the gel electrolyte. This involves developing cost-effective production methods that can be readily adapted for large-scale manufacturing.

By following this systematic methodology, researchers can develop gel electrolytes that offer superior performance, safety, and stability compared to conventional liquid electrolytes, paving

the way for the next generation of high-performance batteries.

## 3.1 Introduction to Java:

## About Java:

Initially the language was called as “oak” but it was renamed as “Java” in 1995.The primary motivation of this language was the need for a platform-independent (i.e. Architecture neutral) language that could be used to create software to be embedded in various consumer electronic devices.

- Java is a programmer’s language
- Java is cohesive and consistent
- Except for those constraints imposed by the Internet environment. Java gives the programmer, full control

Finally, Java is for Internet Programming where c was to System Programming.

## Importance of Java to the Internet

Java has had a profound effect on the Internet. This is because; Java expands the Universe of objects that can move about freely in Cyberspace. In a network, two categories of objects are transmitted between the server and the personal computer. They are passive information and Dynamic active programs. In the areas of Security and probability. But Java addresses these concerns and by doing so, have opened the door to an exciting new form of program called the Applet.

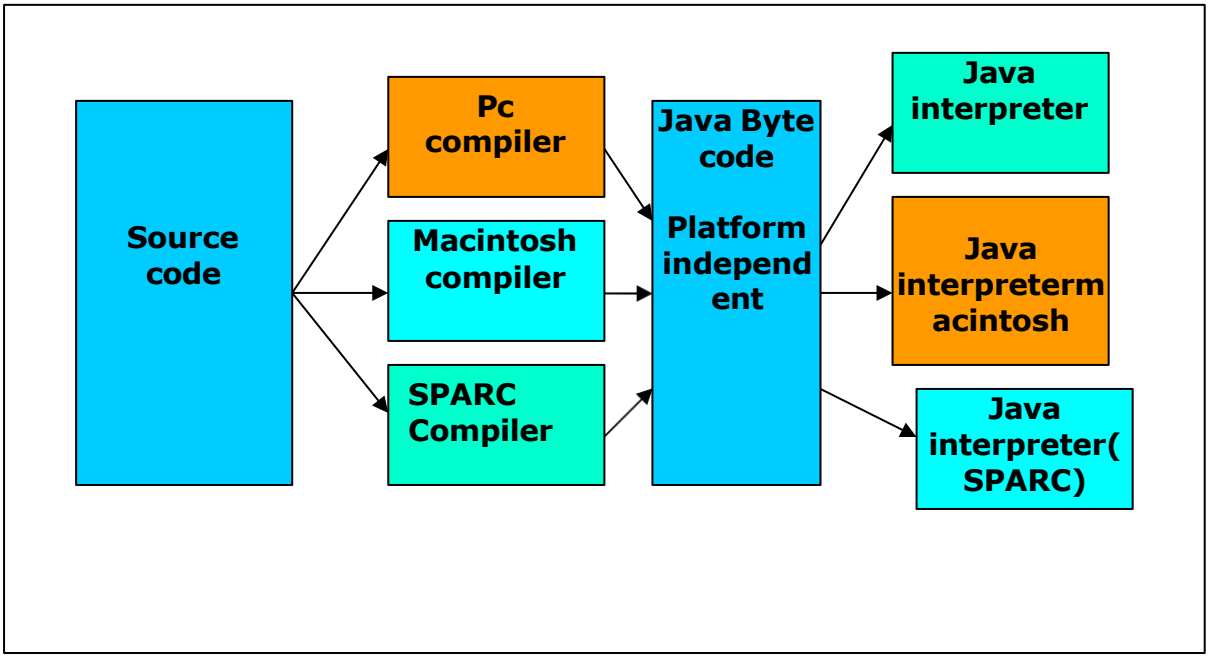
Applications and applets. An application is a program that runs on our Computer under the operating system on that computer. It is more or less like one creating, using C or C++.Java’s ability to create Applets makes it important. An Applet I son application, designed to be transmitted over the Internet and executed by a Java-compatible web browser. An applet I actually a tiny Java program, dynamically downloaded across the network, just like an image. But the difference is, it is an intelligent program, not just a media file. It can be reacted to the user input and dynamically change.

## Java Architecture

Java architecture provides a portable, robust, high performing environment for development. Java provides portability by compiling the byte codes for the Java Virtual Machine, which is then interpreted on each platform by the run-time environment. Java is a dynamic system, able to load code when needed for a machine in the same room or across the planet.

When you compile the code, the Java compiler creates machine code (called byte code) for a hypothetical machine called a Java Virtual Machine (JVM). The JVM is supposed to be executed the byte code. The JVM is created for the overcoming the issue of probability. The code is written and compiled for one machine and interpreted on all machines.Thismachine is called a Java Virtual Machine.

Compiling and interpreting Java source code.




During run-time the Java interpreter tricks the byte code file into thinking that it is running on a Java Virtual Machine. In reality this could be an Intel Pentium windows 95 or

Sun SPARCstation running Solaris or Apple Macintosh running system and all could receive code from any computer through the internet and run the Applets.

## Simple:

Java was designed to be easy for the Professional programmer to learn and to use effectively. If you are an experienced C++ Programmer. Learning Java will oriented features of C++. Most of the confusing concepts from C++ are either left out of Java or implemented in a cleaner, more approachable manner. In Java there are a small number of clearly defined ways to accomplish a given task.

## Object oriented

Java was not designed to be source-code compatible with any other language. This allowed the Java team the freedom to design with a blank state. One outcome of this was a clean, usable,

pragmatic approach to objects. The object model in Java is simple and easy to extend, while simple types, such as integers, are kept as high-performance non-objects.

## 3.2 Servlets/Jsp

A Servlet is a generic server extension. Java classes that can be loaded dynamically to expand the functionality of a server. Servlets are commonly used with web servers. Where they can take the place CGI scripts.

A Servlet is similar to proprietary server extension, except that it runs inside a Java Virtual Machine (JVM) on the server, so it is safe and portable Servlets operate solely within the domain of the server.

Unlike CGI and Fast CGI, which use multiple processes to handle separate program or separate requests, separate threads within the web server process handle all servlets. This means that servlets are all efficient and scalable.

Servlets are portable; both across operating systems and also across web servers. Java Servlets offer the best possible platform for web application development.

Servlets are used as a replacement for CGI scripts on a web server; they can extend any sort of server, such as a mail server that allows servlets extend its functionality, perhaps by performing a virus scan on all attached documents or handling mail filtering tasks.

Servlets provide a Java-based solution used to address the problems currently associated with doing server-side programming including inextensible scripting solutions platform-specific API's and incomplete interface.

Servlets are objects that conform to a specific interface that can be plugged into a Java-based server. Servlets are to the server-side what applets are to the server-side what applets are to the client-side-object byte codes that can be dynamically loaded off the net. They differ from applets in than they are faceless objects (without graphics or a GUI component). They serve as platform independent, dynamically loadable, pluggable helper byte code objects on the server side that can be used to dynamically extend server-side functionality.

For example, an HTTP servlet can be used to generate dynamic HTML content when you use servlets to do dynamic content you get the following advantages:

- They're faster and cleaner than CGI scripts
- They use a standard API (the servlet API)
- They provide all the advantages of Java (run on a variety of servers without needing to be rewritten)

## URL Rewriting:

URL rewriting is another way to support anonymous session tracking, With URL rewriting every local URL the user might click on is dynamically modified. Or rewritten, to include extra, information. The extra information can be in the form of extra path information, added parameters, or some custom, server-specific.URL change. Due to the limited space available in rewriting a URL, the extra information is usually limited to a unique session.

Each rewriting technique has its own advantage and disadvantage

Using extra path information works on all servers, and it works as a target for forms that use both the Get and Post methods. It does not work well if the servlet has to use the extra path information as true path information

The advantages and disadvantages of URL. Rewriting closely match those of hidden form fields, The major difference is that URL rewriting works for all dynamically created documents,

such as the Help servlet, not just forms. With the right server support, custom URL rewriting can even work for static documents.

## Persistent Cookies:

A fourth technique to perform session tracking involves persistent cookies. A cookie is a bit of information. Sent by a web server to a browser that can later be read back form that browser. When a browser receives a cookie, it saves the cookie and there after sending the cookie back to the server each time it accesses a page on that server, subject to certain rules. Because a cookie's value can uniquely identify a client, cookies are often used for session tracking.

Persistent cookies offer an elegant, efficient, easy way to implement session tracking. Cookies provide as automatic an introduction for each request, as we could hope for. For each request, a cookie can automatically provide a client's session ID or perhaps a list of clients' performance. The ability to customize cookies gives them extra power and versatility.

The biggest problem with cookies is that browsers don't always accept cookies sometimes this is because the browser doesn't support cookies. More often it's because the browser doesn't support cookies. More often it's because the user has specifically configured the browser to refuse cookies.

## The power of servlets:

The power of servlets is nothing but the advantages of servlets over other approaches, which include portability, power, efficiency, endurance, safety, elegance, integration, extensibility and flexibility.

## Portability:

As servlets are written in Java and conform to a well-defined and widely accepted API. They are highly portable across operating systems and across server implementation

We can develop a servlet on a Windows NT machine running the Java web server and later deploy it effortlessly on a high-end UNIX server running Apache. With servlets we can really "write once, serve everywhere"

Servlet portability is not the stumbling block it so often is with applets, for two reasons

First, Servlet portability is not mandatory, i.e. servlets have to work only on server machines that we are using for development and deployment

Second, servlets avoid the most error-prone and inconstancy implemented portions of the Java languages.

## Power:

Servlets can harness the full power of the core Java. API's: such as Networking and Url access, multithreading, image manipulation, data compression, database connectivity, internationalization, remote method invocation (RMI) CORBA connectivity, and object serialization, among others.

## Efficiency and Endurance:

Servlet invocation is highly efficient, Once a servlet is loaded it generally remains in the server's memory as a single object instance, Thereafter the server invokes the servlet to handle a request using a simple, light weighted method invocation.Unlike the CGI, there's no process to spawn or interpreter to invoke, so the servlet can begin handling the request almost immediately, Multiple, concurrent requests is handled the request almost immediately. Multiple, concurrent requests are handled by separate threads, so servlets are highly scalable.

Servlets in general are enduring objects. Because a servlet stays in the server's memory as a single object instance. It automatically maintains its state and can hold onto external resources, such as database connections.

## 3.3 JDBC
## What is JDBC?

Any relational database. One can write a single program using the JDBC API,and the JDBC is a Java Api for executing SQL,Statements(As a point of interest JDBC are trademarks names and is not an acronym; nevertheless, Jdbc is often thought of as standing for Java Database Connectivity. It consists of a set of classes and interfaces written in the Java Programming language.JDBC provides a standard API for tool/database developers and makes it possible to

write database applications using a pure Java API

Using JDBC, it is easy to send SQL statements to virtually program will be able to send SQL Statements to the appropriate database. The Combination of Java and JDBC lets a programmer writes it once and run it anywhere.

## What Does JDBC Do?

**Simply put, JDBC makes it possible to do three things**

- Establish a connection with a database
- Send SQL statements
- Process the results
- JDBC Driver Types
- The JDBC drivers that we are aware of this time fit into one of four categories
- JDBC-ODBC Bridge plus ODBC driver
- Native-API party-Java driver
- JDBC-Net pure Java driver
- Native-protocol pure Java driver

An individual database system is accessed via a specific JDBC driver that implements the java, sql. Driver interface. Drivers exist for nearly all-popular RDBMS systems, through few are available for free. Sun bundles a free JDBC-ODBC bridge driver with the JDK to allow access to a standard ODBC, data sources, such as a Microsoft Access database, Sun advises against using the bridge driver for anything other than development and very limited development.

JDBC drivers are available for most database platforms, from a number of vendors and in a number of different flavors. There are four driver categories

## 3.4 JAVA SCRIPT

## The Java Script Language

JavaScript is a compact, object-based scripting language for developing client and server internet applications. Netscape Navigator 2.0 interprets JavaScript statements embedded directly in an HTML page. And Livewire enables you to create server-based applications similar to common gateway interface (CGI) programs.

In a client application for Navigator, JavaScript statements embedded in an HTML Page can recognize and respond to user events such as mouse clicks form input, and page navigation. For example, you can write a JavaScript function to verify that users enter valid information

into a form requesting a telephone number or zip code. Without any network transmission, an Html page with embedded Java Script can interpret the entered text and alert the user with a message dialog if the input is invalid or you can use JavaScript to perform an action (such as play an audio file, execute an applet, or communicate with a plug-in) in response to the user opening or exiting a page.

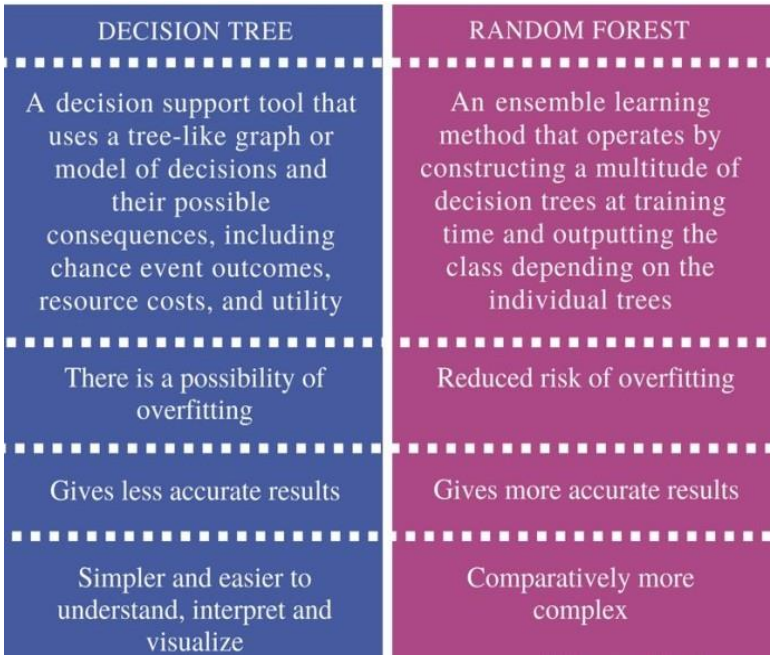
**Decision Tree:**

Structure: A single tree-like model where each node represents a feature, each branch represents a decision rule, and each leaf node represents an outcome.

Interpretability: Easy to understand and visualize. The path from the root to a leaf node explains how a decision is made.

Prone to Overfitting: Can easily memorize the training data, leading to poor generalization on new data.

Suitable For: Smaller datasets, simple relationships between features and targets, and scenarios where interpretability is crucial.




Comparation between Decision Tree and Random Forest

**Random Forest:**

Structure: An ensemble of multiple decision trees. Each tree is trained on a random subset of the data and features. The final prediction is made by aggregating the predictions of all trees (e.g., by majority vote for classification or averaging for regression).

Robustness: Less prone to overfitting than individual decision trees due to the averaging effect of multiple trees.

Higher Accuracy: Typically achieves higher accuracy than a single decision tree.

Less Interpretability: The individual trees can be complex, making it harder to understand the overall decision-making process.

Suitable For: Larger datasets, complex relationships between features and targets, and scenarios where accuracy is prioritized over interpretability.

Role-Based Access Control (RBAC) vs. Discretionary Access Control (DAC): A Comparison

Both RBAC and Discretionary Access Control (DAC) are models used to manage access to resources within a system, but they have fundamental differences in their approach and implementation.

**Discretionary Access Control (DAC)**

Ownership-based: In DAC, the owner of a resource (e.g., a file or folder) has the discretion to decide who can access it and what actions they can perform.

Flexible but less structured: DAC offers flexibility as owners can easily grant or revoke permissions, but it can lead to inconsistent and complex permission structures, especially in large environments.

Potential for errors: DAC relies on the owner's judgment, which can lead to errors, such as granting excessive permissions or overlooking potential security risks.

Suitable for smaller environments: DAC is often used in smaller environments where the number of users and resources is manageable, and the relationships between them are well-defined.

| Feature | DAC | RBAC |
|---|---|---|
| Basis for access | Resource ownership | Role membership |
| Flexibility | High | Moderate |
| Structure | Less structured | More structured |
| Risk of errors | Higher | Lower |
| Scalability | Limited | High |
| Suitable for | Smaller environments | Larger environments |

Image: 2. Comparation of DAC and RBAC

## Role-Based Access Control (RBAC)

Role-based: In RBAC, permissions are assigned to roles, and users are assigned to roles based

on their job responsibilities. Users inherit the permissions associated with their roles.

Structured and scalable: RBAC provides a structured approach to access control, making it easier to manage permissions in large environments with numerous users and complex permission requirements.

Reduced risk of errors: RBAC minimizes the risk of errors by centralizing permission management and ensuring that users only have the necessary permissions to perform their job functions.

Suitable for larger environments: RBAC is well-suited for larger environments where the number of users and resources is significant, and the relationships between them are more dynamic.

# CHAPTER 4
# SYSTEM DESIGN

## 4.1 MODULES:

1. E-Prospect
2. Material Sourcing
3. E-Formulation
4. E-Evaluation
5. Admin

**MODULE 1: E-PROSPECT**

In this module, the clients will register their details in sign up option. Then client will login by using admin allocated password in the sign in page. After that client will upload the requirements in csv format for gel-based batteries. The csv file format includes client id, order id, battery type, quantity, battery size and required date. Then the clients can see their product status in product status sub module. Gel based batteries such as Zinc Carbon Battery, Sodium Nickel Battery, Zinc Bromine Battery…etc. After that payment is done for order id by login with the order id. After that client products gets approved by admin. Then client log out the module.

**MODULE 2: MATERIAL SOURCING**

In this module, the material manager will register their details in sign up option. Then material manager will login the module by using admin allocated password in the sign in page. Then the manager will upload gel data source which is crucial in machine processing the client requirement data for material calculation and quantity for gel battery requirements like Lead Acid, Lithium Ion, Nickel Cadmium, Zinc Carbon, Sodium Nickel, Zinc Bromine, Zinc Manganese, Gel Alkaline, Sodium Sulphur Battery. The requirements are Electrolyte, Gelling Agent, Solvent, Electrolyte Salt, Additives, Cross Liking Agents, Stabilizers are processed for each battery type with amount needed for number of batteries. Then the manager can view the processed material reports. Then material manager will logout the module.

**MODULE 3: E-FORMULATION**

In this module, the production manager will register their details in sign in option. Then production manager will login the module by using admin allocated password in the sign in page. Then the manager will view the material reports from the material sourcing module. Then the material manager will process fillers for each and every battery type using decision tree algorithm. This decision tree algorithm will process the number of fillers

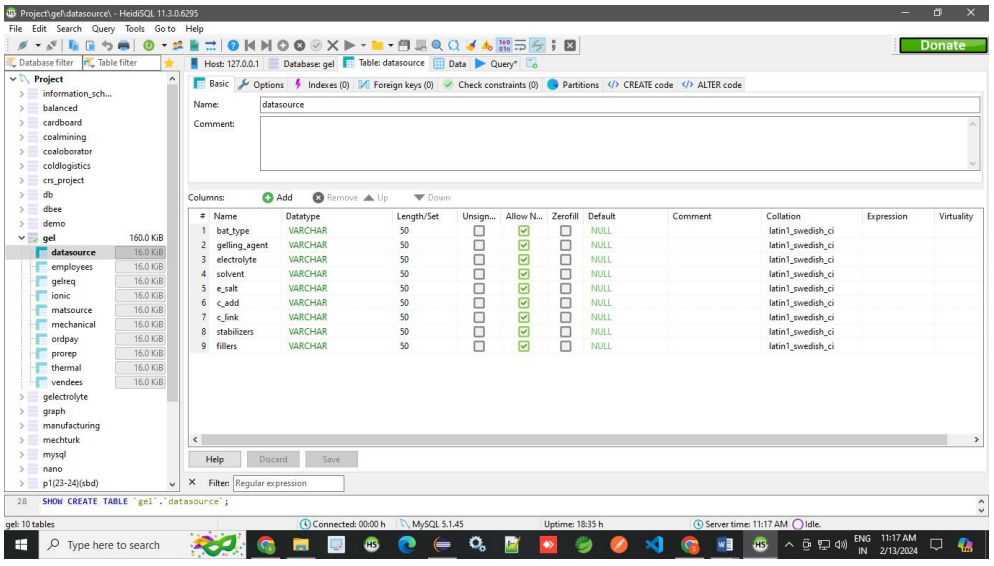
needed for battery type and quantity used. Then total production is done and the reports are viewed in the update manufacture data. In that sub module the manager will submit the production report to the admin for final processing. Then the production manager will logout the module.

**MODULE 4: E-EVALUATION**

In this module, the sample tester will register their details in sign in option. Then the sample tester will login the module with admin allocated password in the sign in page. Then the tester will upload ionic data and process the ionic stability of each type of battery. Then the tester will upload thermal data and process the thermal stability of each type of battery. Then the tester will upload mechanical data and process the mechanical stability of each type of battery. These evaluation reports of mechanical stability, thermal stability, ionic stability all are calculated and sent all reports to admin as total report. Then the tester will logout the module.

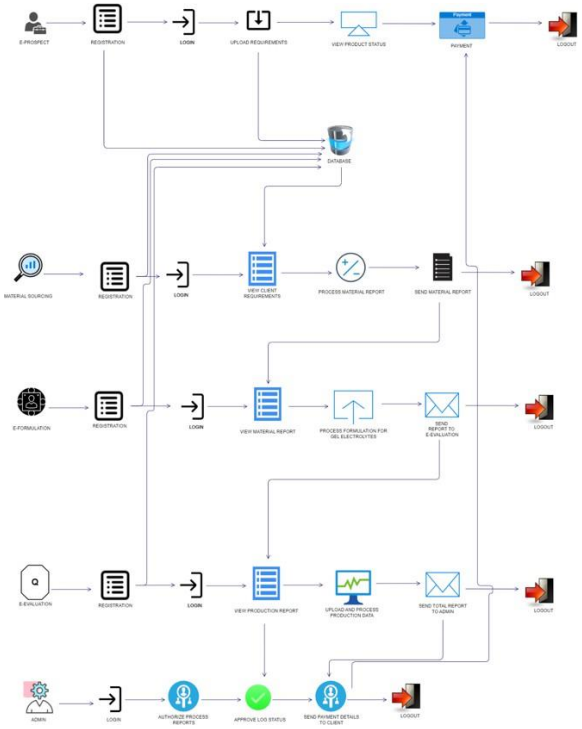
**MODULE 5: ADMIN**

In this module, admin will login the module. Then the admin will process the log status of people who are registering in modules such as E-Prospect, Material Sourcing, E-Evaluator, E-Formulation and Admin. Then the admin will process the details of admitting the people into the modules. After that admin will approve reports of each order of client. Then the admin will generate pay slip for client order. Then after client paying the amount the admin will approve the payment for products. Admin can download the report for each and every battery. The admin can approve the reports.




**Database View after inserting all the data**

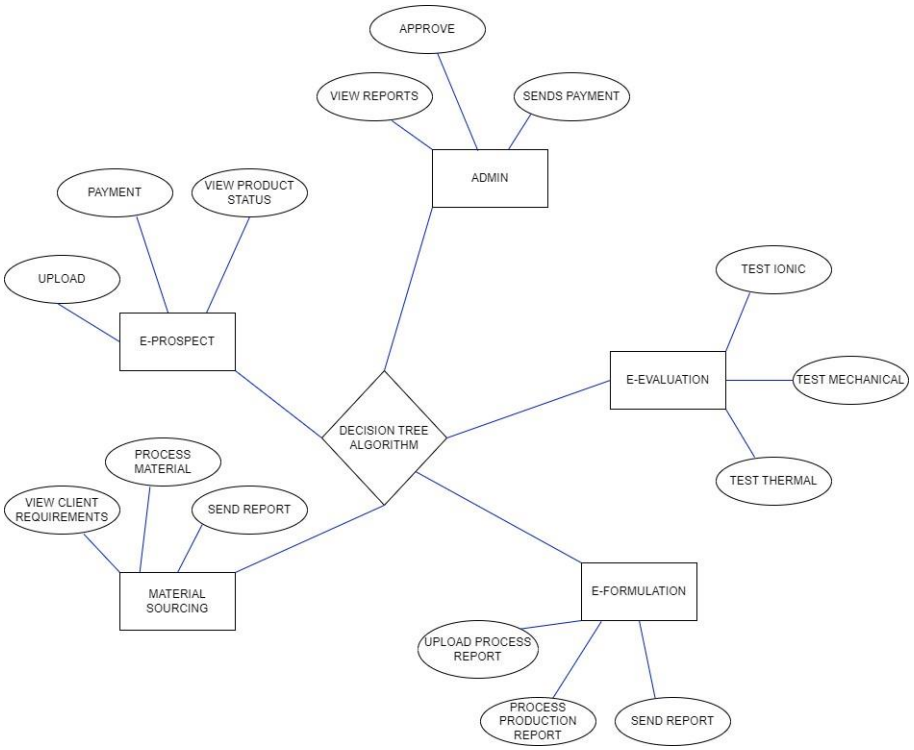
## 4.2 System Architecture:



## 4.3 E – R DIAGRAMS

- The relation upon the system is structured through a conceptual ER-Diagram, which not only specifics the existing entities, but also the standard relations through which the system exists and the cardinalities that are necessary for the system state to continue.
- The Entity Relationship Diagram (ERD) depicts the relationship between the data objects. The ERD is the notation that is used to conduct, the date modeling activity the attributes of each data object noted, is the ERD can be described resign a data object description.
- The set of primary components that are identified by the ERD are
    - Data object
    - Relationships
    - Attributes
    - Various types of indicators.

The primary purpose of the ERD is to represent data objects and their relationships.




## 4.4 FLOW DIAGRAMS

A data flow diagram is a graphical tool used to describe and analyze the movement of data through a system. These are the central tool and the basis from which the other components are developed. The transformation of data from input to output through processing, may be described logically and independently of physical components associated with the system. These are known as the logical data flow diagrams. The physical data flow diagrams show the actual implements and movement of data between people, departments and workstations. A full description of a system actually consists of a set of data flow diagrams. Using two familiar notations Yourdon, Gane and Sarson notation develops the data flow diagrams. Each component in a DFD is labeled with a descriptive name. The process is further identified with a number that will be used for identification purpose. The development of DFD'S is done on several levels. Each process in lower-level diagrams can be broken down into a more detailed DFD in the next level. The lop-level diagram is often called context diagram. It consists a single process bit, which plays a vital role in studying the current system. The process in the context level diagram is exploded into another process at the first level DFD.

The idea behind the explosion of a process into more process is that understanding at one level of detail is exploded into greater detail at the next level. This is done until further explosion is necessary and an adequate amount of detail is described for analysts to understand the process.

Larry Constantine first developed the DFD as a way of expressing system requirements in a graphical form, this lead to the modular design.

A DFD is also known as a "bubble Chart" has the purpose of clarifying system requirements and identifying major transformations that will become programmed in system design. So it is the starting point of the design to the lowest level of detail. A DFD consists of a series of bubbles joined by data flows in the system.

## 4.5 DFD SYMBOLS

In the DFD, there are four symbols

1. A square defines a source (originating) or destination of system data
2. An arrow identifies data flow. It is the pipeline through which the information flows
3. A circle or a bubble represents a process that transforms the incoming data flow into outgoing data flows.
4. An open rectangle is a data store, data at rest or a temporary repository of data

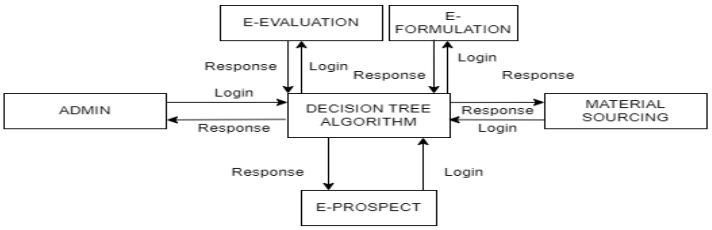
## DATA FLOW

1) A Data Flow has only one direction of flow between symbols. It may flow in both directions between a process and a data store to show a read before an update. The latter is usually indicated, however by two separate arrows since these happen at different type.
2) A join in DFD means that exactly the same data comes from any of two or more different processes data store or sink to a common location.
3) A data flow cannot go directly back to the same process it leads. There must be at least one other process that handles the data flow produce some other data flow returns the original data in the beginning process.
4) A Data flow to a data store means update (delete or change).
5) A data Flow from a data store means retrieve or use.

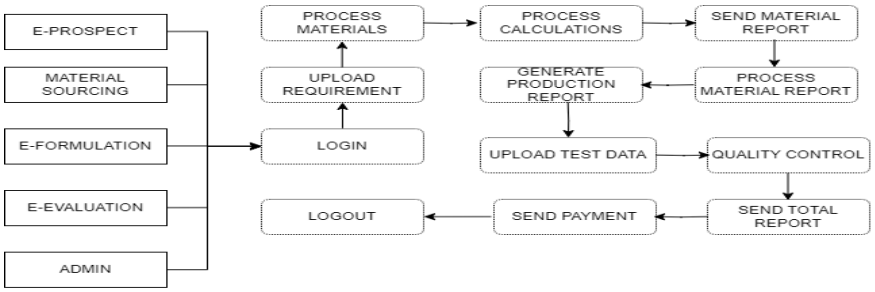
A data flow has a noun phrase label more than one data flow noun phrase can appear on a single arrow as long as all of the flows on the same arrow move together as one package.

**DATA FLOW DIAGRAM**

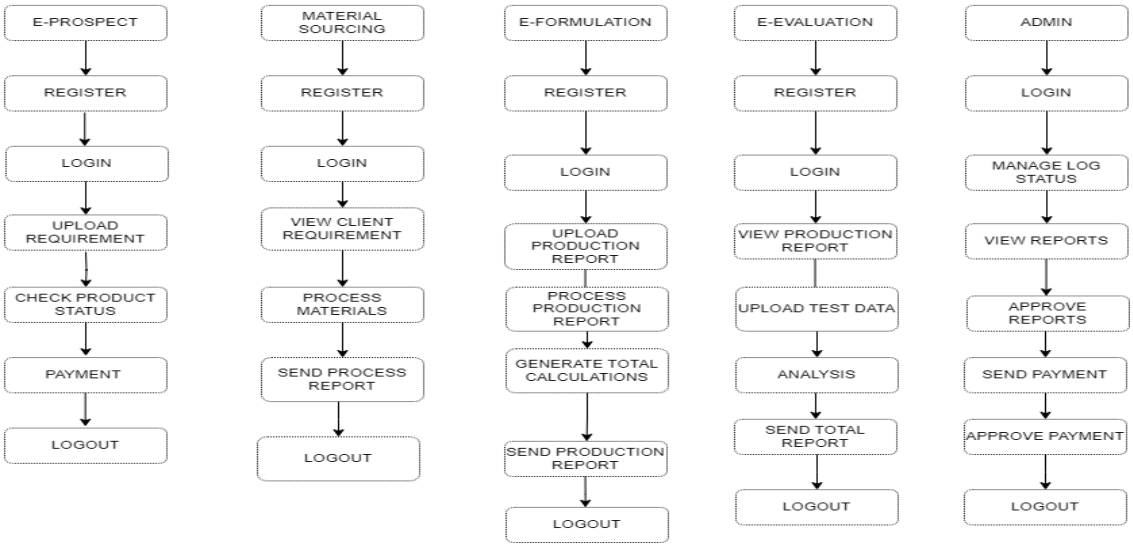
LEVEL 0



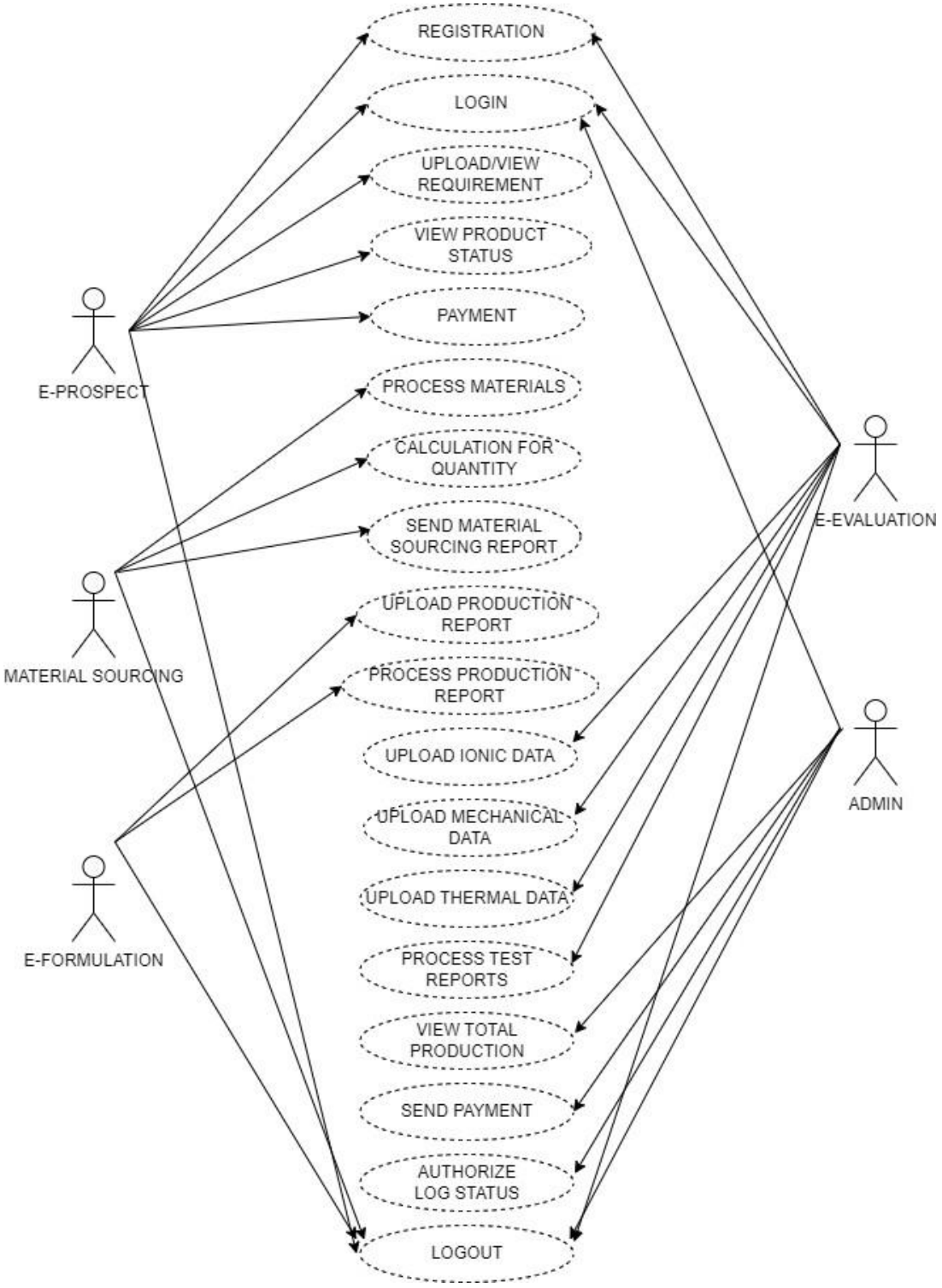

LEVEL 1



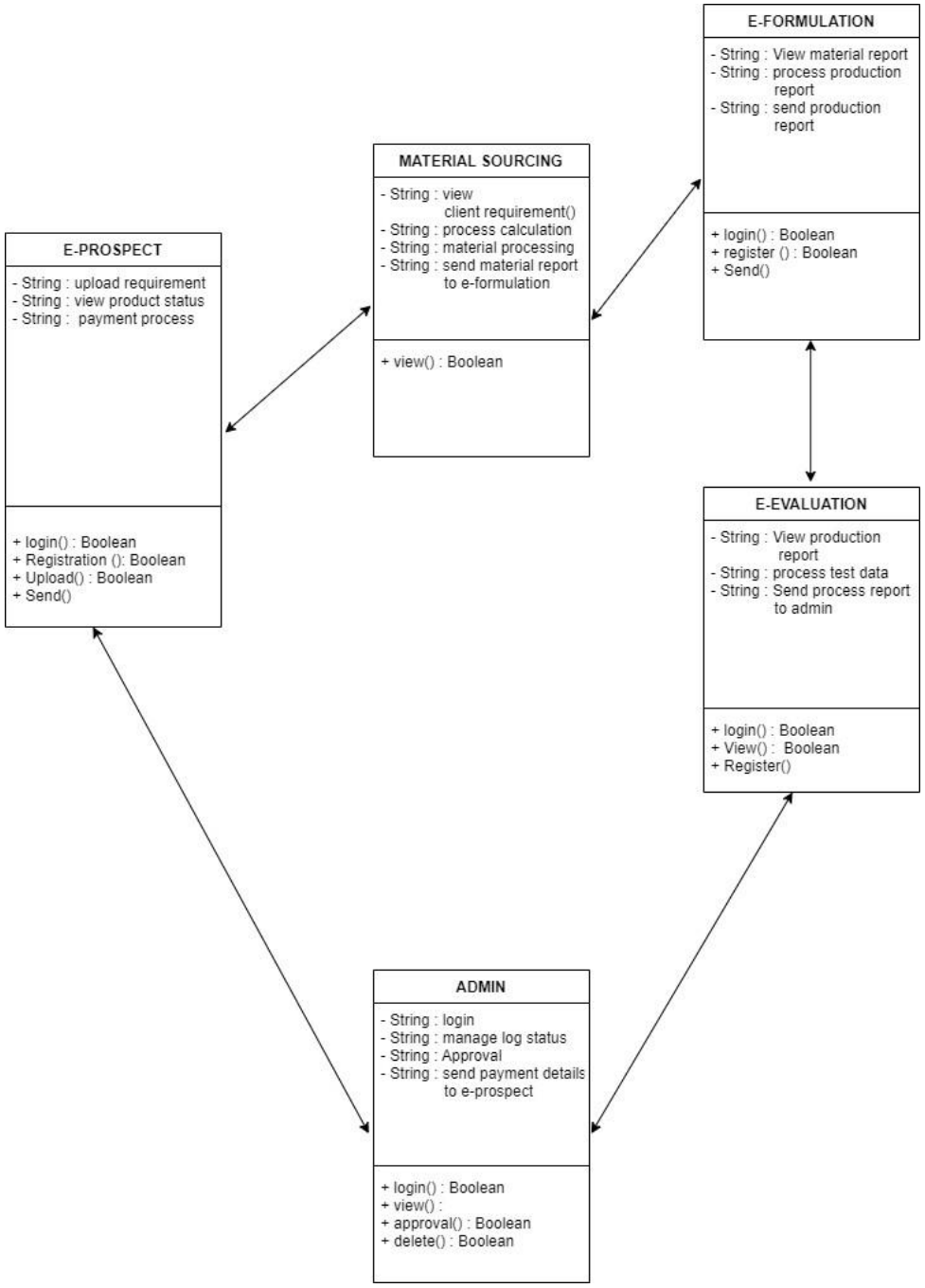

LEVEL 2



## 4.6 USE CASE DIAGRAM



## 4.7 CLASS DIAGRAM



# CHAPTER 5

## Implementation

### HOME PAGE: index.html

```
<!DOCTYPE html>
<html lang="en">
<head>
<title>Gel Electrolytes - Home Page</title>

	<!-- Meta tag Keywords -->
	<meta name="viewport" content="width=device-width, initial-scale=1">
	<meta charset="utf-8">
	<meta name="keywords" content="Indus Fact Responsive web template, Bootstrap
Web Templates, Flat Web Templates, Android Compatible web template,
	Smartphone Compatible web template, free webdesigns for Nokia, Samsung, LG,
SonyEricsson, Motorola web design" />
	<script type="application/x-javascript">
		addEventListener("load", function () {
			setTimeout(hideURLbar, 0);
		}, false);

		function hideURLbar() {
			window.scrollTo(0, 1);
		}
	</script>
	<!--// Meta tag Keywords -->

	<!-- banner slider css file -->
	<link href="home/css/JiSlider.css" rel="stylesheet">
	<!-- //banner slider css file -->

	<!-- gallery-Swipe-box -->
	<link rel="stylesheet" href="home/css/swipebox.css">
	<!-- //gallery-Swipe-box -->

	<!-- testimonials css -->
	<link rel="stylesheet" href="home/css/flexslider.css" type="text/css" media="screen"
property="" /><!-- flexslider css -->
	<!-- //testimonials css -->

	<!-- css files -->
	<link rel="stylesheet" href="home/css/bootstrap.css"> <!-- Bootstrap-Core-CSS -->
	<link rel="stylesheet" href="home/css/style.css" type="text/css" media="all" /> <!--
Style-CSS -->
	<link rel="stylesheet" href="home/css/fontawesome-all.css"> <!-- Font-Awesome-
Icons-CSS -->
	<!-- //css files -->
```

```
	<!-- web-fonts -->
	<link
href="//fonts.googleapis.com/css?family=Montserrat:100,100i,200,200i,300,300i,400,400i,50
0,500i,600,600i,700,700i,800,800i,900,900i&amp;subset=cyrillic,cyrillic-ext,latin-
ext,vietnamese" rel="stylesheet">
	<link
href="//fonts.googleapis.com/css?family=Open+Sans:300,300i,400,400i,600,600i,700,700i,8
00,800i&amp;subset=cyrillic,cyrillic-ext,greek,greek-ext,latin-ext,vietnamese"
rel="stylesheet">
	<!-- //web-fonts -->

</head>

<body>
	<!-- Navigation -->
	<div class="container">
		<!-- header top -->
		<div class="head-wl d-md-flex py-3">
			<div class="headder-w3 text-uppercase p-1 text-center">
				<h1><a href="index.html">GEL ELECTROLYTES</a></h1>
			</div>
		</div>
		<!-- //header top -->

		<!-- Nav bar -->
		<nav class="navbar navbar-expand-lg navbar-light bg-faded">
		  <button class="navbar-toggler mx-auto" type="button" data-
toggle="collapse" data-target="#navbarNavDropdown" aria-controls="navbarNavDropdown"
aria-expanded="false" aria-label="Toggle navigation">
			<span class="navbar-toggler-icon"></span>
		  </button>
		  <div class="collapse navbar-collapse justify-content-center"
id="navbarNavDropdown">
			<ul class="navbar-nav">
			  <li class="nav-item">
				<a class="nav-link" href="ven_lr.jsp">E-Prospect</a>
			  </li>
			  <li class="nav-item">
				<a class="nav-link" href="mat_lr.jsp">Material Sourcing</a>
			  </li>
			  <li class="nav-item">
				<a class="nav-link" href="for_lr.jsp">E-Formulation</a>
			  </li>
			  <li class="nav-item">
				<a class="nav-link" href="eva_lr.jsp">E-Evaluation</a>
			  </li>
			   <li class="nav-item">
				<a class="nav-link" href="adm_lr.jsp">Admin</a>
			  </li>
```

```
                    </ul>
                </div>
            </nav>
        <!-- Nav bar -->
    </div>
        <!-- //Navigation -->

<!-- banner slider-->
<div class="banner-silder">
        <div id="JiSlider" class="jislider">
            <ul>
                <li>
                    <div class="w3layouts-banner-top">
                        <div class="bs-slider-overlay">
                            <div class="container">
                                <!-- Slide Text Layer -->
                                <div class="w3l-slide-text text-center">
                                    <h3 class="text-uppercase pt-4
pb-3">High Quality Materials</h3>
                                    <p class="heading_bottom mb-
4">Nulla pellentesque mi non laoreet eleifend. Integer porttitor mollis lorem, at molestie arcu
pulvinar ut. Proin ac fermentum est. Cras mi ipsum, consectetur ac ipsum in, egestas
vestibulum tellus.</p>
                                </div>
                            </div>
                        </div>
                    </div>
                </li>
            </ul>
        </div>
</div>
<!-- //banner slider -->

<!-- Welcome section -->
<section class="welcome py-5 my-lg-5" id="welcome">
        <h3 class="heading text-center text-uppercase">What is Gel Electrolyte ?</h3>
        <p class="heading-bottom text-center font-italic mb-5"></p>
        <div class="container">
            <div class="row">
                <div class="col-lg-6 welcome_left">
                    <img src="home/images/welcome.jpg" alt="welcome image">
                </div>
                <div class="col-lg-6 welcome_right mt-5 py-5 px-4">
                    <p>Gel electrolyte is a type of electrolyte used in certain types
of batteries, particularly in sealed lead-acid batteries and some types of supercapacitors.
Electrolytes are substances that conduct electrical ions between the positive and negative
electrodes of a battery, allowing the flow of electric current.</p>

                    <div class="row grid1 my-4">
                        <div class="col-md-2 col-sm-2 col-3 icon color1 text-
```

```
center">
                                        <span class="fas fa-info-circle" aria-
hidden="true"></span>
                                    </div>
                                    <div class="col-md-10 col-sm-10 col-9 grid_info">
                                        <h3 class="text-uppercase mb-2">Spill
Resistance</h3>
                                        <p>Since the electrolyte is in a gel form, it won't
spill even if the battery is turned upside down or damaged, making it safer for certain
applications.</p>
                                    </div>
                                </div>
                                <div class="row grid2 my-4">
                                    <div class="col-md-2 col-sm-2 col-3 icon color1 text-
center">
                                        <span class="fas fa-headphones" aria-
hidden="true"></span>
                                    </div>
                                    <div class="col-md-10 col-sm-10 col-9 grid_info">
                                        <h3 class="text-uppercase mb-2">Maintenance-
Free</h3>
                                        <p>Gel batteries are often referred to as
maintenance-free batteries because they don't require periodic topping up of electrolyte
levels, as is the case with traditional flooded lead-acid batteries.</p>
                                    </div>
                                </div>
                                <div class="row grid3">
                                    <div class="col-md-2 col-sm-2 col-3 icon color1 text-
center">
                                        <span class="fas fa-users" aria-
hidden="true"></span>
                                    </div>
                                     <div class="col-md-10 col-sm-10 col-9 grid_info">
                                        <h3 class="text-uppercase mb-2">Vibration
Resistance</h3>
                                        <p>Gel batteries are less susceptible to damage
from vibration and shock, making them suitable for use in applications where the battery may
experience physical stress.</p>
                                    </div>
                                </div>
                            </div>
                        </div>
                    </div>
                </section>
                <!-- //Welcome section -->

                <!-- services -->
                <!-- //services -->

                <!--Gallery -->
```

```
<!-- //Gallery -->

<!-- Clients -->
<!--// Clients -->

<!-- Indus Fact Workers -->
<!-- //Indus Fact Workers -->

<!-- Newsletter  -->
<!-- //Newsletter  -->

<!-- footer -->
<footer>
	<div class="footer-top">
		<div class="container">
			<div class="row py-5">
				<div class="col-lg-3 col-md-6 footer-grid">
					<div class="footer-logo">
						<h3 class="text-uppercase mb-3">About Gel Electrolytes</h3>
						<p>The processing and calculation of fillers is crucial for ionic stability, thermal stability and mechanical stability of gel electrolytes. It is very possible to calculate using machine learning algorithms.</p>

					</div>
				</div>
			</div>

		</div>
	</div>
</footer>
<!-- //footer -->

<!-- Vertically centered Modal -->
<div class="modal fade" id="exampleModalCenter" tabindex="-1" role="dialog" aria-labelledby="exampleModalCenterTitle" aria-hidden="true">
  <div class="modal-dialog modal-dialog-centered" role="document">
    <div class="modal-content">
      <div class="modal-header">
        <h5 class="modal-title text-uppercase" id="exampleModalLongTitle">Indus Fact</h5>
        <button type="button" class="close" data-dismiss="modal" aria-label="Close">
          <span aria-hidden="true">&times;</span>
        </button>
      </div>
      <div class="modal-body">
		<img src="home/images/1.jpg" class="img-fluid mb-3" alt="Modal Image" />
        Vivamus eget est in odio tempor interdum. Mauris maximus fermentum arcu, ac finibus ante. Sed mattis risus at ipsum elementum, ut auctor turpis cursus. Sed sed odio pharetra, aliquet velit cursus, vehicula enim. Mauris porta aliquet magna, eget laoreet ligula.
      </div>
```

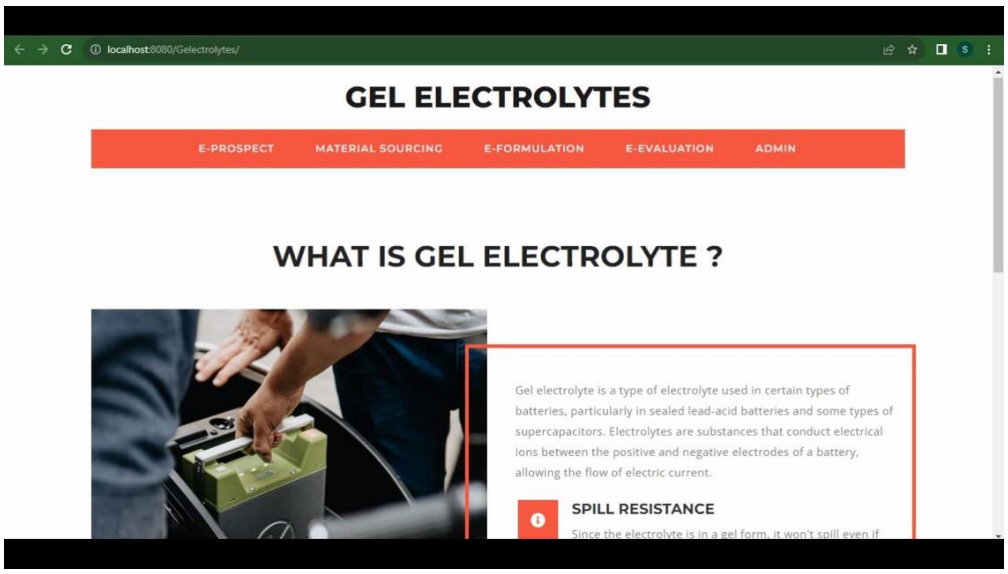
```
      <div class="modal-footer">
        <button type="button" class="btn btn-secondary" data-
dismiss="modal">Close</button>
        <button type="button" class="btn btn-primary">Save changes</button>
      </div>
    </div>
  </div>
</div>
<!-- //Vertically centered Modal -->


<!-- js-scripts -->

        <!-- js -->
        <script type="text/javascript" src="home/js/jquery-2.1.4.min.js"></script>
        <script type="text/javascript" src="home/js/bootstrap.js"></script> <!-- Necessary-
JavaScript-File-For-Bootstrap -->
        <!-- //js -->

        <!-- Banner Slider js script file-->
                <script src="home/js/JiSlider.js"></script>
                <script>
                        $(window).load(function () {
                                $('#JiSlider').JiSlider({
                                        color: '#fff',
                                        start: 3,
                                        reverse: true
                                }).addClass('ff')
                        })
                </script>
                <script>
                        var _gaq = _gaq || [];
                        _gaq.push(['_setAccount', 'UA-36251023-1']);
                        _gaq.push(['_setDomainName', 'jqueryscript.net']);
                        _gaq.push(['_trackPageview']);

                        (function () {
                                var ga = document.createElement('script');
                                ga.type = 'text/javascript';
                                ga.async = true;
                                ga.src = ('https:' == document.location.protocol ? 'https://ssl' :
'http://www') + '.google-analytics.com/ga.js';
                                var s = document.getElementsByTagName('script')[0];
                                s.parentNode.insertBefore(ga, s);
                        })();
                </script
        <script src="home/js/jquery.swipebox.min.js"></script>
        <script type="text/javascript">
                jQuery(function($) {
                        $(".swipebox").swipebox();
```

```
		});
	</script>
	<!-- //script-for-swipebox -->
	<!-- flexSlider --><!-- for testimonials -->
	<script defer src="home/js/jquery.flexslider.js"></script>
	<script type="text/javascript">
		$(window).load(function(){
		  $('.flexslider').flexslider({
			animation: "slide",
			start: function(slider){
			  $('body').removeClass('loading');
			}
		  });
		});
	</script>
	<!-- //flexSlider --><!-- for testimonials -->
	<!-- start-smoth-scrolling -->
	<script src="home/js/SmoothScroll.min.js"></script>
	<script type="text/javascript" src="home/js/move-top.js"></script>
	<script type="text/javascript" src="home/js/easing.js"></script>
	<script type="text/javascript">
		jQuery(document).ready(function($) {
			$(".scroll").click(function(event){
				event.preventDefault();

	$('html,body').animate({scrollTop:$(this.hash).offset().top},1000);
			});
		});
	</script>
	<!-- here stars scrolling icon -->
	<script type="text/javascript">
		$(document).ready(function() {
				var defaults = {
				containerID: 'toTop', // fading element id
				containerHoverID: 'toTopHover', // fading element hover id
				scrollSpeed: 1200,
				easingType: 'linear'
				};
			$().UItoTop({ easingType: 'easeOutQuart' });

			});
	</script>
	<!-- //here ends scrolling icon -->
	<!-- start-smoth-scrolling -->

<!-- //js-scripts -->
</body>
</html>
```

# CHAPTER 6
## Results

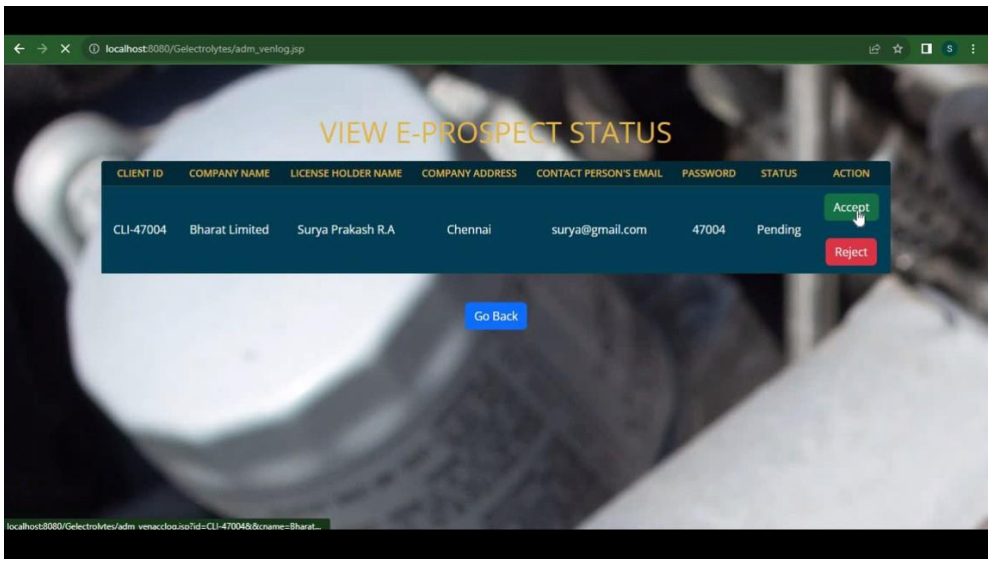
## 6.1 Inputs and Outputs

The main section introduces gel electrolytes, defining them as substances used in batteries like sealed lead-acid and supercapacitors to facilitate the flow of electrical current between electrodes. It highlights a key advantage of gel electrolytes, stating their spill resistance due to their gel form.
A visually prominent image showcases a person holding a battery or similar object, likely symbolizing the application of gel electrolytes in energy storage solutions.




**Dashboard**

In the above image we can see the main dashboard of this project and it we can see the different modules and the main admin page, here role-based authentication was implemented to give access to every user and the sign-up was introduced with admin authentication.

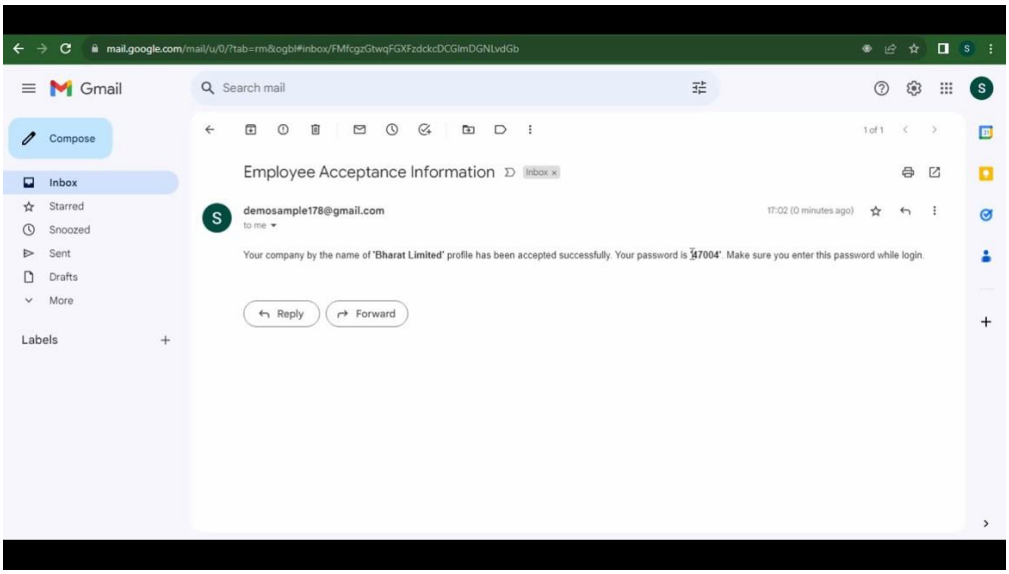



**User Creation**

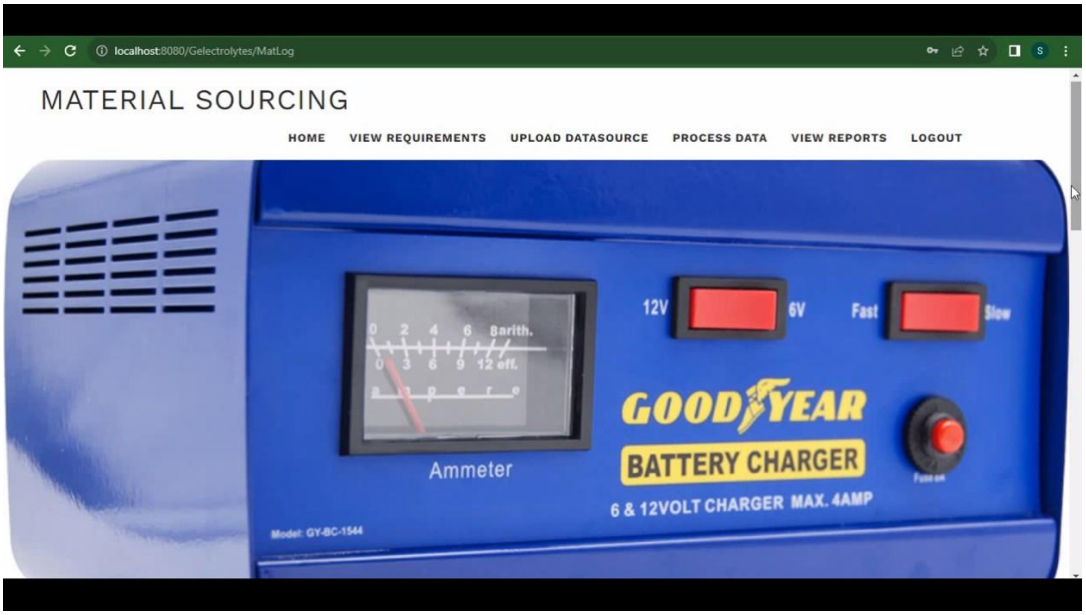
An admin receives an email notification to activate a new user account. This process automatically generates a secure, random password. The admin then securely shares this password with the new user, who is encouraged to change it upon their first login.

This approach ensures:

- Security: The password is not transmitted in plain text within the email, mitigating the risk of interception.
- User Control: The new user can immediately personalize their password to one that they can easily remember.
- Compliance: It adheres to best practices for secure user onboarding and password management.



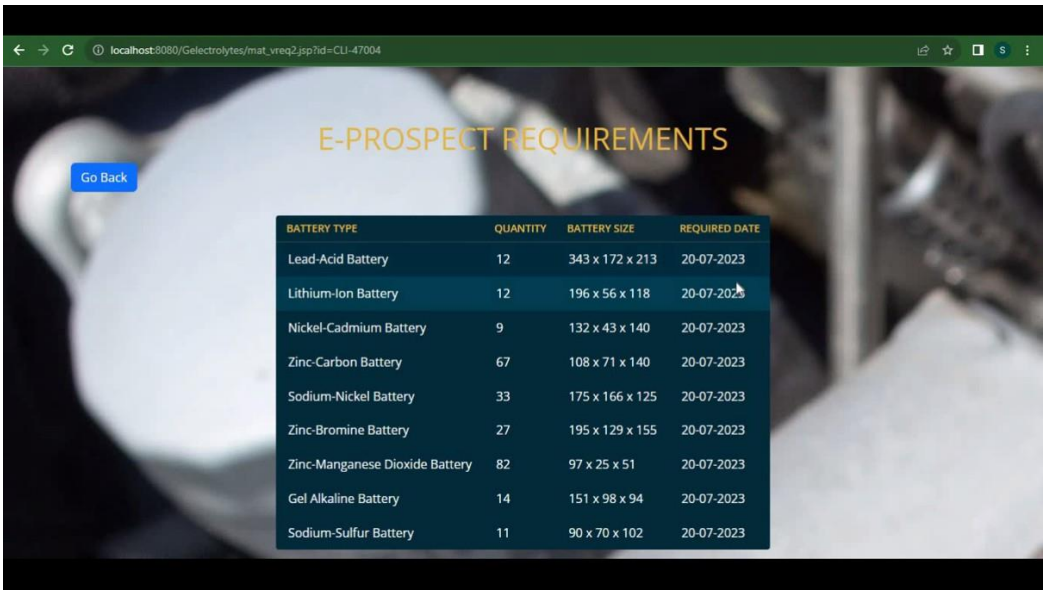

**User Authentication using mail/smtp**



## Material Sourcing Dashboard

The material sourcing dashboard streamlines the collection of requirements and relevant data, consolidating it into a CSV file for further analysis and processing.

- Clarity: The sentence is more concise and directly states the purpose of the dashboard.
- Focus: The emphasis is on the dashboard's function of collecting requirements and data.
- Accuracy: The mention of CSV files is retained as it's a common format for storing and transferring data.




**After fill the Material Sourcing data**

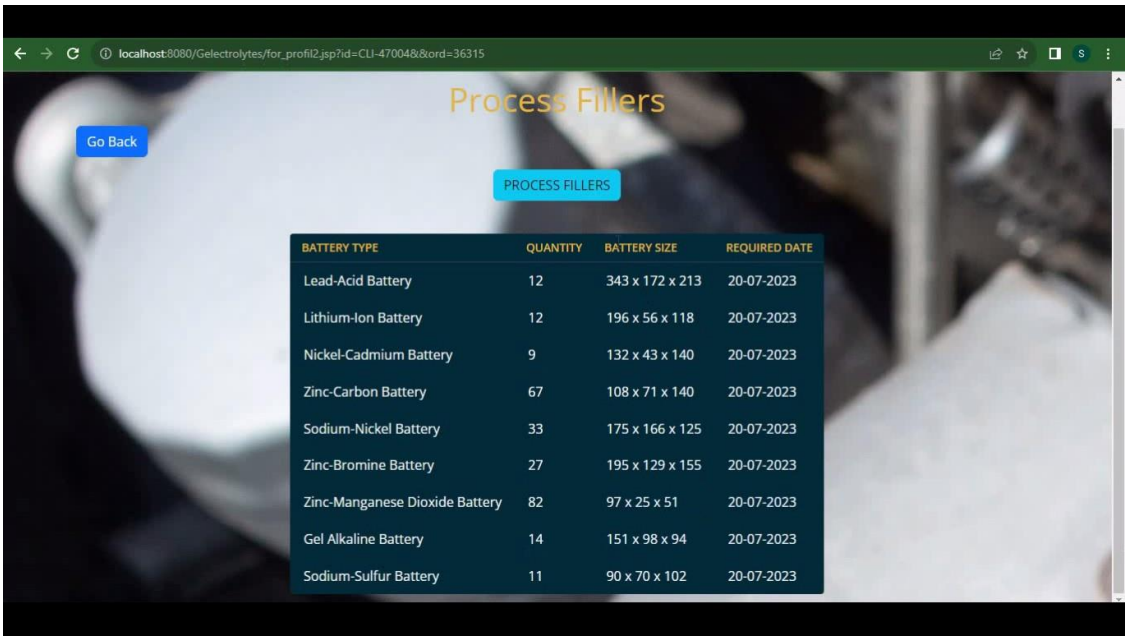

**After submitting the requirements**

In the depicted image, upon submission, the data will be collected, validated, and transmitted to subsequent processes for further processing and storage in a database.

- Validated: Added to emphasize the important step of checking the data for accuracy and completeness before further processing.

- Transmitted: Replaces "send" for a more precise description of how data moves between processes.
- Subsequent processes: Clarifies that there may be multiple steps involved after collection, such as transformation, enrichment, or analysis, before the data is stored.
- "Further processing": Acknowledges that the data may undergo modifications or manipulations before being stored.

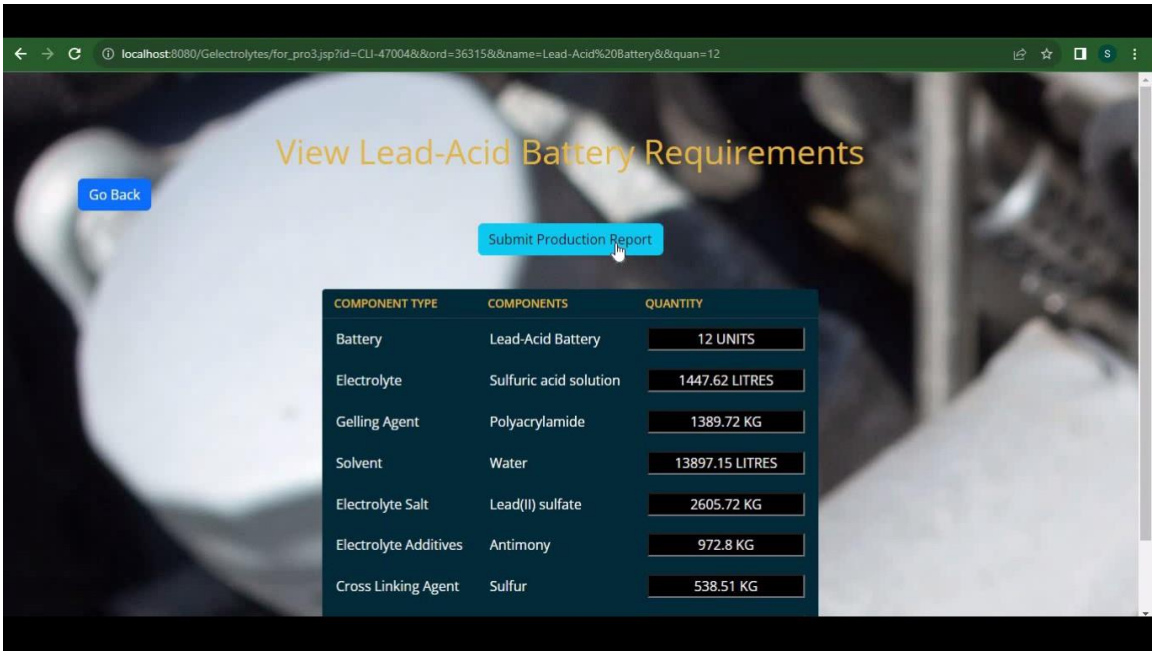

**Nickel Cadmium Battery Requirements**



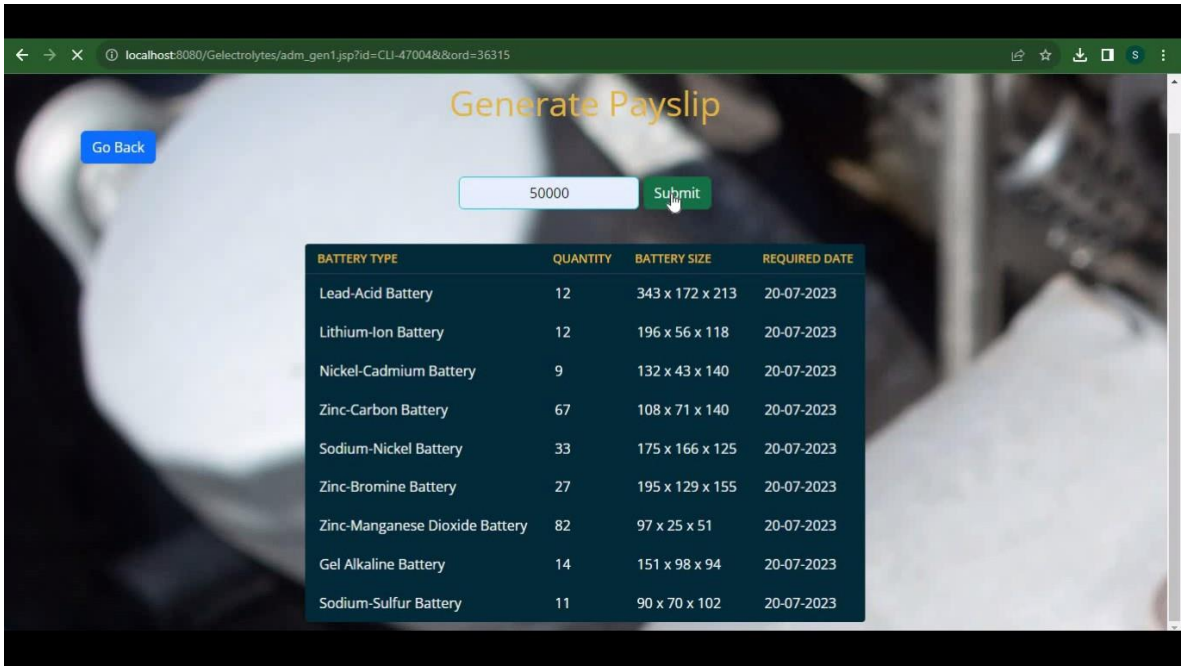

**Processing Page**

In this process, a report generated using a decision tree algorithm is submitted for production by an administrator. Before production, the administrator thoroughly checks all data within the report to ensure accuracy and validity.

- Clearer Sentence Structure: The sentences are simplified for easier understanding.
- Focus on the Process: The description highlights the steps involved (report generation, submission, data checking, production).
- Specifics: The decision tree algorithm is mentioned, as is the administrator's role in data validation.
- Concise: Unnecessary details are removed, keeping the description focused.




**Report Submission**




**Payslip amount submission**

# CHAPTER 7
## Conclusion & Future Work

### 7.1 Conclusion:

The conclusion is that gel batteries are a more versatile and reliable option than traditional lead-acid batteries. They are a good choice for applications where vibration and shock are a concern, such as in solar panels and electric vehicles. There are a number of ways to enhance the performance of gel batteries in the future. One way is to develop new materials for the gel electrolyte. This could improve the battery's performance in terms of capacity, lifespan, and resistance to heat and cold. Another way to enhance gel batteries is to develop new manufacturing processes. This could make the batteries more efficient and less expensive to produce. Finally, research is also being conducted on new types of gel batteries, such as lithium -ion gel batteries. These batteries have the potential to offer even better performance than traditional gel batteries. Overall, the future of gel batteries looks bright. They are a promising technology that has the potential to revolutionize the way we power our devices. Gel electrolytes combine the high conductivity of liquid electrolytes with the leakproofness and stability of solid-state ones, making them highly desirable for various applications, including batteries, sensors, and bioelectronics.

### 7.2 Future Work:

- **Incorporation of Machine Learning:** Explore the integration of advanced machine learning techniques, such as deep learning and neural networks, to further enhance the predictive capabilities of the decision support system. This could involve training models on larger datasets and incorporating more complex feature engineering to capture subtle patterns in gel electrolyte behavior.
- **Real-Time Monitoring and Prediction:** Develop a real-time monitoring system that continuously collects data from gel electrolyte samples under various operating conditions. Combine this real-time data with the decision support system's predictive models to provide dynamic stability assessments and early warnings of potential degradation.

- **Expansion of Database:** Expand the database of gel electrolyte compositions, operating conditions, and stability data to cover a wider range of materials and applications. This will increase the generalizability and robustness of the decision

support system's predictions.

- **Integration with Battery Management Systems:** Integrate the decision support system with battery management systems (BMS) to enable adaptive control strategies based on real-time gel electrolyte stability assessments. This could involve adjusting charging/discharging parameters, temperature management, or other control variables to optimize battery performance and longevity.
- **Validation in Real-World Applications:** Validate the decision support system's predictions in real-world battery applications under diverse operating conditions. This will provide valuable feedback for further refinement and optimization of the system's algorithms and models.
- **Consideration of Environmental Factors:** Investigate the impact of environmental factors, such as temperature, humidity, and mechanical stress, on gel electrolyte stability. Incorporate these factors into the decision support system to provide more comprehensive and accurate stability predictions.
- **Exploration of Novel Gel Electrolyte Materials:** Expand the scope of the decision support system to encompass new and emerging gel electrolyte materials, such as those based on ionic liquids, polymer blends, or nanocomposite structures. This will ensure that the system remains relevant and adaptable to the latest advancements in gel electrolyte technology.

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