

**Laboratory Equipment Borrowing System for Physics Instrument Room.**

An IT Project Proposal  
Presented to  
Faculty of the School of Accountancy, Management,  
Computing and Information Studies

In Partial Fulfillment  
of the Requirements for the Course  
IT 411

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## **Abstract**

The School of Engineering and Architecture (SEA) of Saint Louis University. Every student of SEA are required to take ENGGPHYSL Physics for Engineers (laboratory) including BSMath of School of Accounting, Management, Computing, and Information Studies (SAMCIS) and also, the course Electronics and Communication Engineering(ECE) is the only one that is required to take ECE 1212L Physics 2 (LAB) which is a corequisite of ENGGPHYSL.

The custodian of the Physics Instrument Room is responsible for managing all the apparatuses that are used in every experiment for ENGGPHYSL and ECE 1212L. The work of the custodian is to issue laboratory apparatus to the students and ensures that the condition of the laboratory apparatus is not damaged when returned by the students.

The group proposes a system that will lessen the paper that is used by borrowing and returning processes and saving all the data electronically so that the consistency of data is maintained, if not improved. The system will help the custodian in a way that he wouldn't handle that much paper anymore. The class schedule, faculty, and students data is also included in the system so that the custodian could oversee and confirm that the processes are logical as possible. Lastly, the system could count and check the availability of all the laboratory apparatus so that the custodian could monitor the sending out and receiving of all items and if ever an item is damaged upon return the custodian could easily update the system on that particular item's availability if it is in need of repair or replacement.

## **Chapter 1: Introduction**

### **1.1 Context of the Study**

Laboratory Equipment Borrowing System is an automated borrowing system. This provides equipment that you can borrow or temporarily use, ranging from specific equipment or whole laboratory equipment. This system project contains all of the current information about the equipment, listed alphabetically by name.

[<https://studymoose.com/laboratory-equipment-borrowing-system-of-lorma-colleges-skills-development-institute-essay>]

Borrowing procedure of the equipment in the university is time consuming wherein a representative from each group in the class may only borrow equipment for an experiment by filling up a borrower's slip and listing down the apparatuses that would be borrowed that they must copy from the manual. The slip will be given to the personnel in the counter in order for the personnel to lend on the apparatuses to the students.

Returning procedure is wherein the student will return the borrowed laboratory apparatus by returning the borrower's slip and to check all of the laboratory apparatus that will be returned.

The system will be designed and developed to solve certain problems that are associated with the handling of the apparatuses and laboratory equipment. This study targets to develop an effective and efficient system. The system will basically monitors the equipment that have been taken out of the department and was use by borrower, provides a complete list of equipment that are available inside the Laboratory, creates a daily, weekly, monthly, semesterly and yearly report of personnel who borrows the equipment, creates an interface or form for the users/borrowers and admins to work on with.

## **1.2 Background of the Study**

In Saint Louis University, engineering physics laboratory classes for ENGGPHYS 1 and ENGGPHYS 2 are held on the second floor of the Konrad Adenauer Building - Main Campus which is under the School of Engineering and Architecture. The facilities on this floor include 6 laboratory classrooms and one Physics Instrument Room where instruments are issued. Inside the Physics Instrument Room, there is only one custodian who manages at least 138 different types of laboratory apparatus which students borrow for their experiments.

There are 10 courses required to take Physics. See table 1 (List of courses required to take the subject)

Students who are taking ENGGPHYSL 1 and ENGGPHYSL 2 are required to have a copy of the laboratory manual “Physics for Engineers 1” and “Physics for Engineers 2” respectively. Each manual contains 12 experiments that students need to accomplish. On average, each class can have at most 6 groups composed of 7 to 8 members. There are at most 1 to 2 classes per day during the regular semester and approximately 6 classes per day during the short term. In a single meeting, the students conduct 1 to 3 experiments depending on the lesson they are having.

For every class in the said subject, it consists of a duration of 3 hours once a week in all the subjects of Physics Laboratory Subject of SEA(School of Engineering and Architecture) including other courses.

Every time an experiment is conducted, the students will write the instruments that they need on a borrower slip. Students must follow the borrowing, returning, and issuing process of the instruments. The following sections will discuss these processes.

### **1.2.1 Borrowing Process of Student**

Instructors are the ones who will get the borrower’s slips (See figure 2) from the custodian that will be given for each group in their scheduled class. Each group has 1 borrower’s slip.







# NON-AVAILABILITY OF ITEM

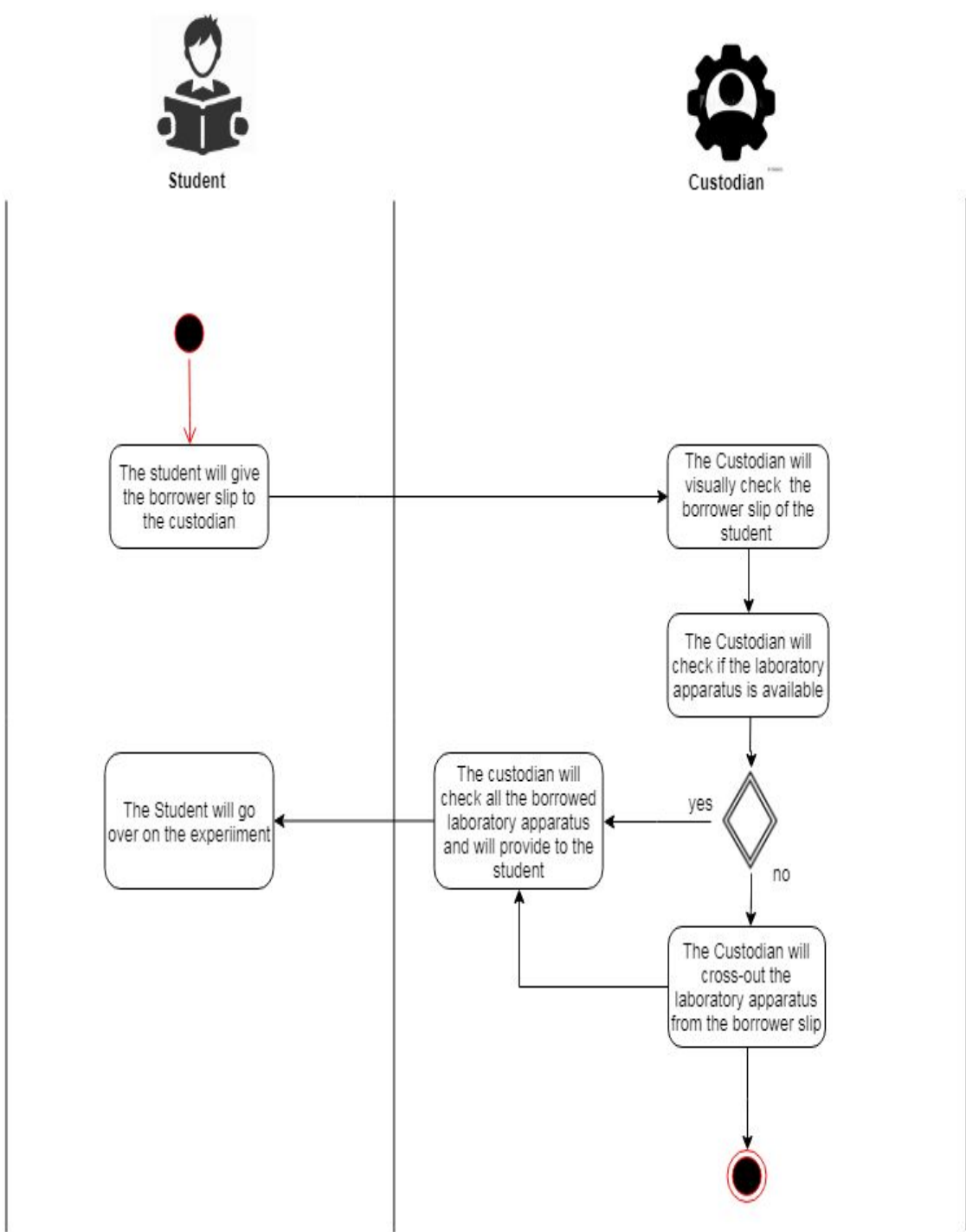


Figure 5 Diagram of availability process

### **1.2.2 Returning Process of Student**

The student will present a borrower slip that he/she filled out and then the custodian will visually check its validity. Each apparatus that has been borrowed by the students must be returned 15 minutes before the end of the subject. Then that would be the time wherein the custodian will check all of those listed on the slip if they are well cleaned and complete before leaving the counter. (See figure 6) If in case there are damaged or lost apparatus the custodian will ask the group to replace or pay for it. (see figure 8).

After all of the apparatus has been returned, the custodian will collect the borrower slip of every group who borrowed an apparatus and keep it inside the storage room.

# RETURNING PROCESS

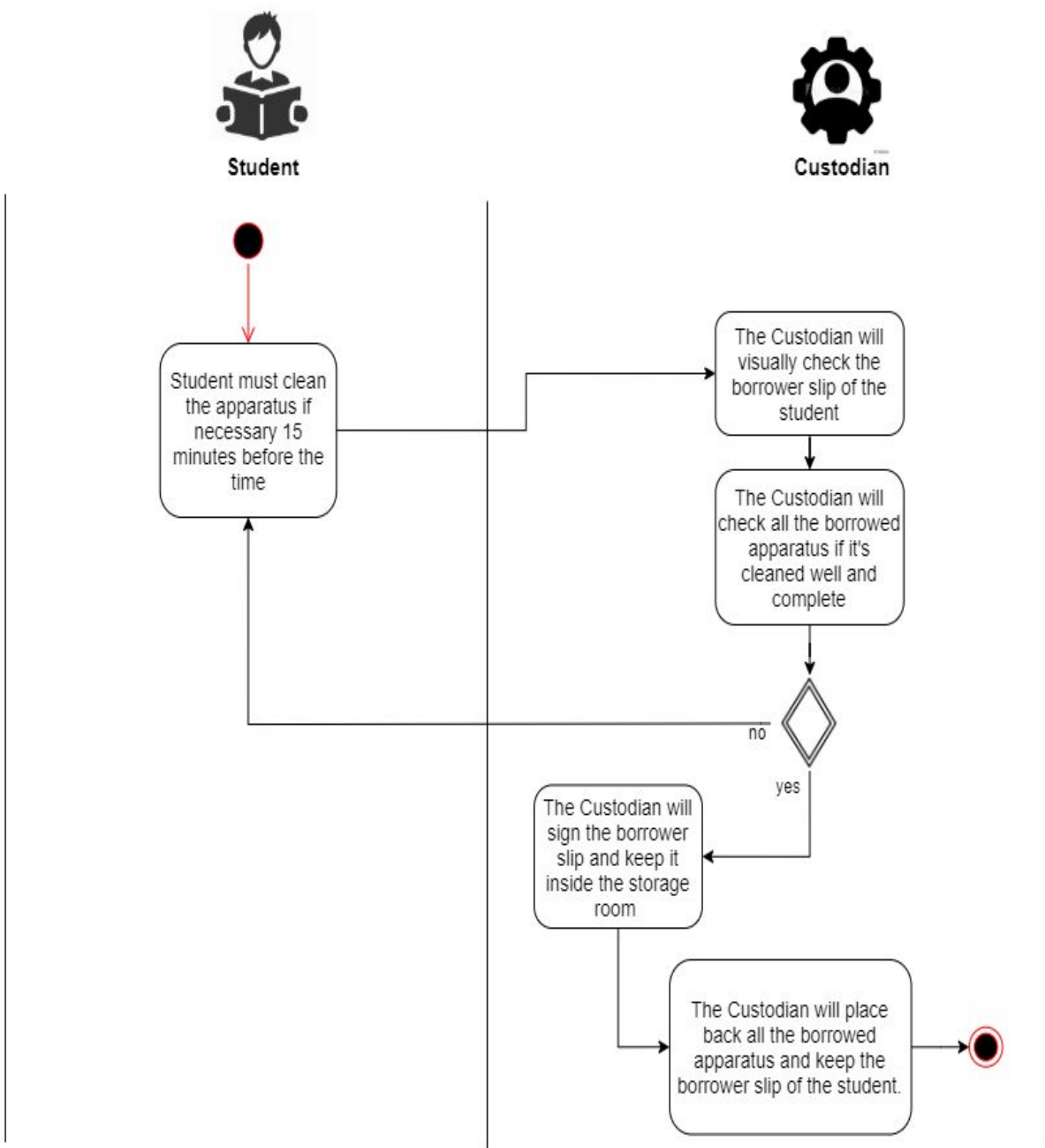


Figure 6 Diagram of Returning Process

DAMAGED APPARATUS

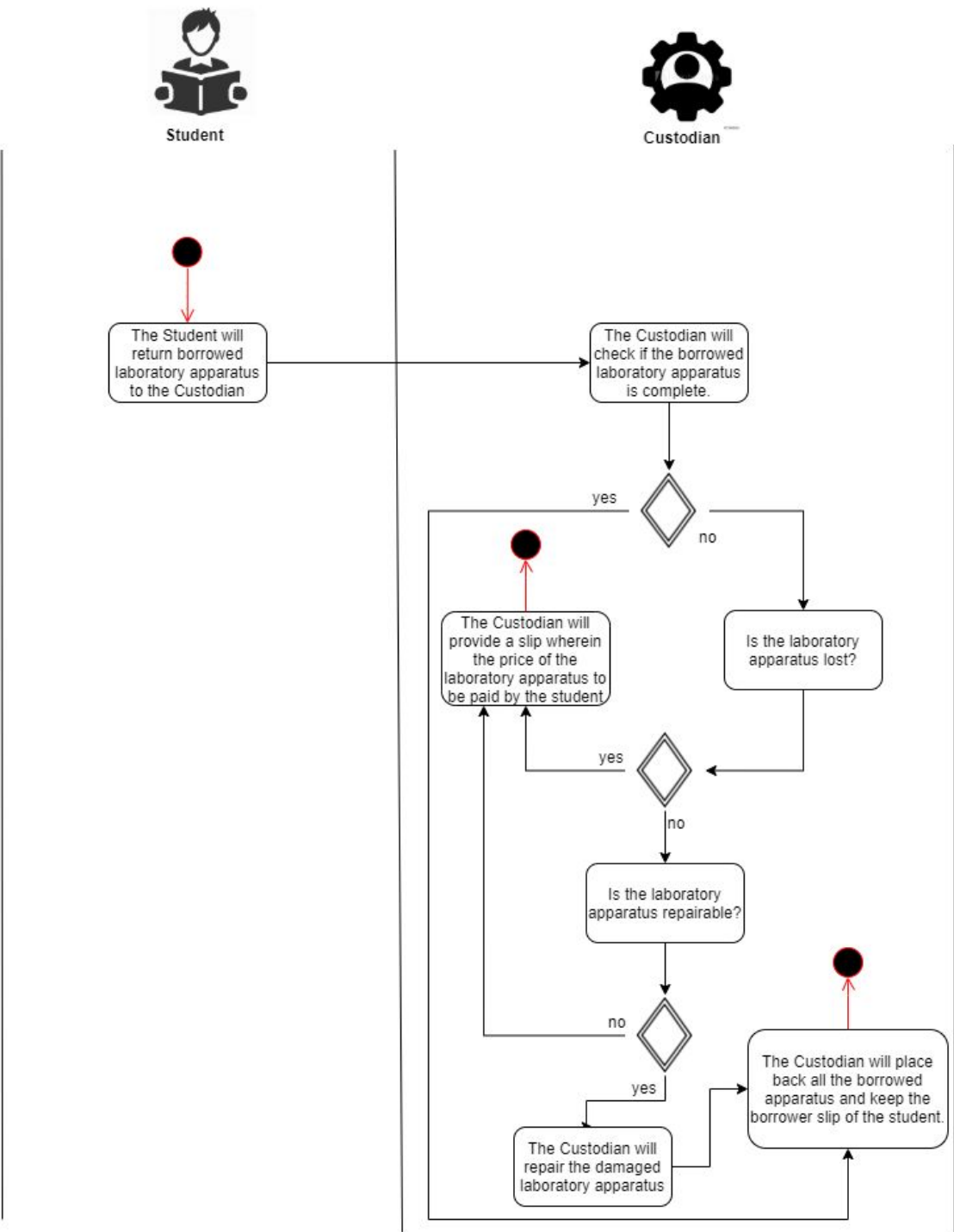
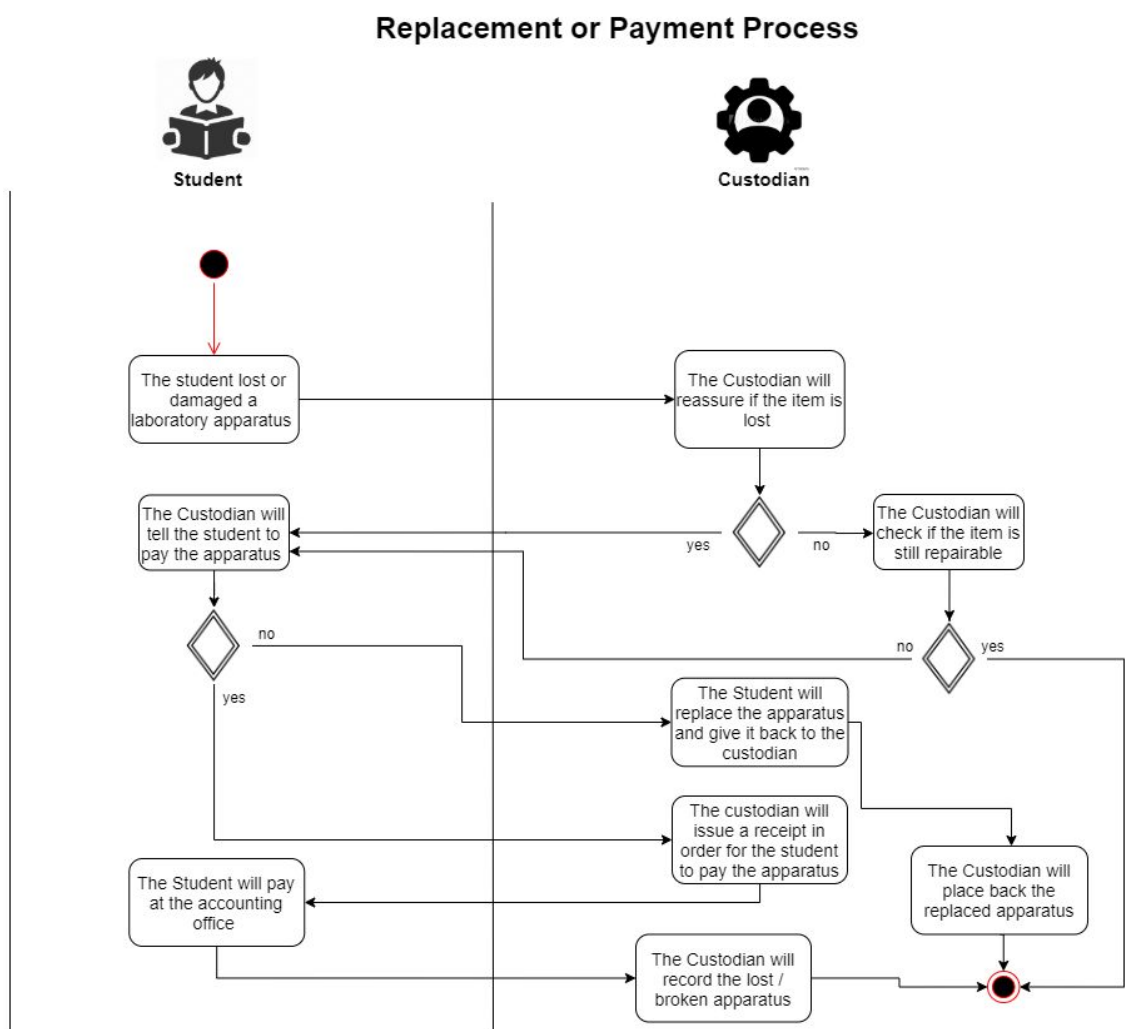


Figure 7 Diagram of damaged apparatus process



*Figure 8 Diagram of Replacement or Payment Process*

### 1.2.3 The List of courses required to take physics subject

These are the list of courses from the School of Engineering and Architecture(SEA) and School of Accountancy, Management, Computing & Information Studies (SAMCIS) necessary to take the physics laboratory subject. The first row indicates the list of courses from Saint Louis University. The second and third-row indicates if the list of courses is required to take the subject Physics 1 and Physics 2.

List of Courses	Physics for Engineers	Physics 2 (Laboratory)
Bachelor of Science in Chemical Engineering (BSChE)	Required	Not Required
Bachelor of Science in Civil Engineering (BSCE)	Required	Not Required
Bachelor of Science in Electrical Engineering (BSEE)	Required	Not Required

Bachelor of Science in Electronics Engineering (BSECE)	Required	Required
Bachelor of Science in Geodetic Engineering (BSGE)	Required	Not Required
Bachelor of Science in Industrial Engineering (BSIE)	Required	Not Required
Bachelor of Science in Mechanical Engineering (BSME)	Required	Not Required
Bachelor of Science in Mechatronics Engineering (BSMeCE)	Required	Not Required
Bachelor of Science in Mining Engineering (BSEM)	Required	Not Required
Bachelor of Science in Mathematics (BSMATH)	Required	Not Required

Table 1 List of courses required to take the subject

1.2.4 Problems Encountered

- Inefficient monitoring of laboratory apparatus
- Slow borrowing and returning procedures
- Inconsistency of filling up required information through slip
- The storage for the borrower’s slip is unorganized
- Waste of borrower’s slip paper

1.3 Statement of Objectives

The main objective of this project is to be able to develop a Computerized Borrowing and Returning System for Physics Instrument Room that will be used by the custodian.

The key objectives of this study are:

- To determine the initial planning for the proposed system.
- To determine the features and design the modules of the system that would address the functional and non-functional requirements.
- To determine how the system will be designed and implemented.
- To test and evaluate the needs for the proposed system.
- To deploy the proposed system.

## **1.4 Scope of the Project**

The group aims to automate the borrowing and returning process in the physics instrument room when:

- The team will export a copy of the checklist via the database file of students and employees from TMDD to be imported into our system.
- The team will make a module for borrowing and returning of items.
- The team will make a module for inquiry and search capability.
- The team will make a module for inventory and its record.
- The team will illustrate and create diagrams, models and prototypes of the proposed system.

## **1.5 Significance of the Study**

The purpose of this study is to automate the borrowing process of the laboratory equipment for the physics instrument room to solve the problems in handling the physics laboratory apparatuses and to promote a clean working environment. The developed system should be able to effectively and efficiently monitor the borrowed laboratory equipment that will be utilized by the custodian.



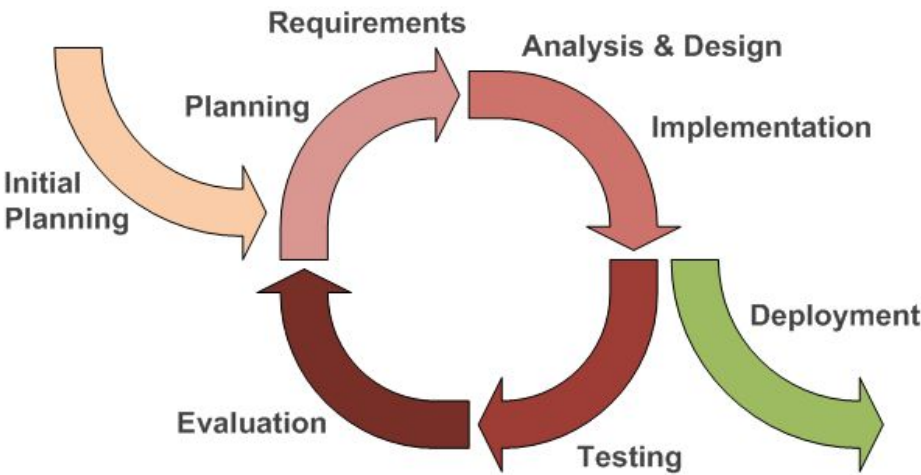
## Chapter 2: Methodology

This chapter shows the methodology that the developers utilize in the creation, implementation, and development of this project. This includes the plans and methods of how all of the objectives for this project will be done and accomplished.

As the development method in creating an Inventory Management System, the project team will be using the Iterative method for it gives more room for changes and this process is repeated in order to come up with a new version of the software up until the specific requirements and the target plan are fulfilled.

### 2.1 Iterative Software Development Model

In conducting this study, the iterative software development approach will be the particular technique used to execute the project. This helps by giving a guide on how to organize, schedule, design and control the process of the project. It also helps in increasing the success of the study with the actual documentation, design, and development of the study. By following this type of approach the team will be able to show the progress to the client referring to any changes that can be and must be made that may help to improve the succeeding versions.



*Figure 9 Iterative Software Development Model*

### 2.2 Identifying the Functional and Non-Functional Requirements

In this phase, the team used different techniques in data gatherings such as interviews, forms analysis, and observations. The functional requirements will be gathered and distinguished through interviews with the custodian of the Physics Instrument Room. As the interviews will be conducted, information will be gathered about the process of the Physics Instrument Room; from requesting of apparatus to be borrowed, checking the availability of the said apparatus, distribution of the apparatus, returning of the apparatus and the process of replacing and paying for damaged or lost laboratory apparatus.

### **2.2.1 Interviews**

In this section, the project team scheduled and managed to be able to conduct an interview with the Dean of the School of Engineering and Architecture to collect business information, regarding the operational process of the day to day basis, and to have an idea regarding the functional and non-functional requirements needed for the system.

### **2.2.2 Document Analysis**

The Physics Instrument Room gave the project team some sample forms that the students used to fill up when borrowing equipment from them. The physics 1 and physics 2 laboratory manual is being studied because it contains the complete equipment as well as their use for each experiment. The project team analyzes these documents in order to find out how they handle the borrowing and returning process for the physics laboratory. This is important for the system's strategy and design success.

## **2.3 Identifying the Modules and Features**

The project team decided the initial modules and features needed to develop the system as requested by the custodian of the Physics Instrument Room. To do this, the team evaluated the functional and nonfunctional requirements of the system.

The specifications given by the custodian of the Physics Instrument Room is used to obtain the modules and features necessary for the proposed system. Additional features and functionalities will be added as the team continues to develop the program and with what the custodian needs or requires, adjustments may occur.

The project team gathered information about the borrowing system with the aid of the knowledge center books, so the team has ideas about the functionality to be added to the system modules and features of the proposed system for the Physics Instrument Room.

### **2.3.1 Tools and Technologies**

To have a basis on how the system will be built, the team searched for existing relevant literature. In addition, the tools and technologies will also be analyzed on the basis of potential technologies associated with the implementation of the system.

## **2.4 Designing the System**

The borrowing system is produced using the various tools with their corresponding features provided by the system for present and future use. The system design has been developed using different design models that include various diagrams in the following chapter, use case diagram and the entity-relationship diagram (ERD) see figure 11. Through interviews and observations, the team must assess and analyze all the requirements specified by the custodian. These requirements will help the team define the system's features and modules.

## **2.5 Implementation**

The team used various tools and technologies to implement the system. The team had to design the system's front-end or interface and design the system's server.

In the construction of the process, the rules for designing the system must be carefully applied. In addition, the actual system design started to create the functionalities or features provided to each system unit. Upon development of the program, the developers will be creating the proposed system method that is provided by the school. In addition, the system interface will be created in order to see the consistency of the proposed system operation. The software architecture will outline the features of the system and will be able to provide information about the system's technology, users or modules.






## **2.6 System Testing**

The team tested the system after the implementation phase and will check if there were any errors or missing system specifications. The team will be searching various testing techniques that will work in the overall analysis of system requirements and specifications. The team will use these various research techniques to make sure there will be no flaw in the system. Furthermore, the system testing will be conducted simultaneously with the other modules to see how it will affect the changes to the entire system.

## **2.7 To deploy the proposed system to SLU**

To deploy the system, the team must meet the custodian's requirements that our proposed system must be able to issue instruments and manage the inventory. The team must configure the software and hardware that the team will use in order to see the flow of the system and to avoid errors.

Development Tools

Tools	Usage
<div>Sublime Text</div> <div></div>	<p>The team will be using the Sublime Text as a code editor for utilizing a such programs</p>
<div>Draw.io</div> <div></div>	<p>The team will be utilizing this application for creating diagrams and charts.</p>
<div>Lucidchart</div> <div></div>	<p>The team will be utilizing the Lucidchart for creating the Entity Relationship Diagram</p>
<div>Creately</div> <div></div>	<p>The team will be utilizing this application with the creation for the use case diagram.</p>
<div>Github</div> <div></div>	<p>The team will be utilizing Github for importing and exporting repositories(codes) which will be held on the creation of our proposed system.</p>

Java 	The team will be utilizing Java for programming the creation of our proposed system.
Mysql 	The team will be utilizing Mysql to manage the database and connect to the software of our proposed system.
Scene Builder 	The team used Scene Builder to create and design the User Interface for front end developers.

Table 2 Development Tools

**Chapter 3: Outcome and Results**

This chapter contains the initial results achieved by following the methodology, as discussed in the previous chapter. Essentially, the results should impart to the readers that the authors (the IT project group) have undergone the requirements analysis and design phase. Prototyping and partial development may have been accomplished.

**3.1 Requirements Specification**

From the requirements analysis phase and through understanding the business process of the Physics Instrument room, the functional and non-functional requirements were thoroughly identified through observation, interviews, research, and form of analysis . The functional

requirements have specified the different features and functionalities of what the system should perform. The non-functional requirements will discuss the system’s behavior once it is deployed.

3.1.1 Functional Requirements

The functional requirements define the function of components of a system. The table below shows the functional requirements and following description.

The custodian should be able to:

Functional Requirements	Description
Log in	<ul style="list-style-type: none"><li>● Allows the custodian to log in to the system.</li></ul>
Enter Class Code	<ul style="list-style-type: none"><li>● Allows the Custodian enter the class code of the class</li></ul>
Dashboard	<ul style="list-style-type: none"><li>● The Custodian will be able to view the student’s borrowed apparatus, returned apparatus, breakage apparatus,</li><li>● The Custodian will be able to view the logs of borrowed, pending and returned items.</li></ul>
School year	<ul style="list-style-type: none"><li>● Allows the Custodian to set a School Year</li></ul>
Borrow item/s	<ul style="list-style-type: none"><li>● Allows the Custodian to borrow an item</li></ul>
Return item/s	<ul style="list-style-type: none"><li>● Allows the Custodian to return an item.</li></ul>
Edit item/s	<ul style="list-style-type: none"><li>● Allows the Custodian to edit the items by replacing or adding.</li></ul>
Delete item/s	<ul style="list-style-type: none"><li>● Allows the custodian to delete an item</li></ul>

Notifications	<ul style="list-style-type: none"><li>● Allows the Custodian to check the notification of unreturned items.</li></ul>
Viewing of items	<ul style="list-style-type: none"><li>● The Custodian can add, delete, edit, and view the list of physics laboratory apparatus that will be borrowed by the student.</li></ul>
View student borrowed apparatus	<ul style="list-style-type: none"><li>● The Custodian can view the apparatus that is borrowed by the student.</li></ul>
View student borrowed time	<ul style="list-style-type: none"><li>● The Custodian can view the time in of the apparatus that is borrowed by the student.</li></ul>
View student return time	<ul style="list-style-type: none"><li>● The Custodian can view the time out of the apparatus that is borrowed by the student.</li></ul>
Logs	<ul style="list-style-type: none"><li>● The Custodian can view the logs of the borrowed, returned and damaged apparatus.</li></ul>
Import Module	<ul style="list-style-type: none"><li>● The Custodian can import the checklist database from TMDD</li></ul>
Export Module	<ul style="list-style-type: none"><li>● The custodian can export the history records of the semester for report.</li></ul>
Viewing of schedules	<ul style="list-style-type: none"><li>● The custodian will view the class schedule per adviser.</li></ul>

Payments	<ul style="list-style-type: none"><li>● Allows the custodian to create a note for those students that have damaged or lost an apparatus.</li></ul>
Update items	<ul style="list-style-type: none"><li>● Allows the custodian to update the list of laboratory apparatus</li></ul>
Item status	<ul style="list-style-type: none"><li>● The custodian can edit the status of an item if it is damaged, lost, replaced or pending for payment.</li></ul>
Add information	<ul style="list-style-type: none"><li>● The custodian can add a new curriculum.</li></ul>
History	<ul style="list-style-type: none"><li>● Ensure that all of the borrowed and returned laboratory apparatus every class will be archived.</li></ul>
Generate Reports	<ul style="list-style-type: none"><li>● Allows the custodian to make reports based on the information gathered from each of the borrower slips.</li></ul>

Table 3 Functional Requirements

3.1.1.1 Non-Functional Requirements

The non-functional requirements elaborate on the characteristics and performance of the system and it describes how the system works. Below shows the non-functional requirements.

Non-Functional Requirements	Description
Accessibility	<ul style="list-style-type: none"><li>● The application should be user-friendly and can be easily used by the custodian or the authorized users.</li></ul>
Security	<ul style="list-style-type: none"><li>● The system application can only be viewed by the custodian or the authorized users. Without the credentials,</li></ul>



	no one can view the system, this ensures the security of the application.
Data Integrity	<ul style="list-style-type: none"><li>• The system application should always be available to the custodian or authorized users to access and verify the data in the system.</li></ul>
Performance	<ul style="list-style-type: none"><li>• The items in the inventory system should be accurate and precise to match the physical count of the inventory and perform task searching, retrieving, updating, and adding.</li></ul>
Usability	<ul style="list-style-type: none"><li>• The system application should be effective enough to improve the process and be able to rely on the system.</li></ul>
Scalability	<ul style="list-style-type: none"><li>• The system should be able to function every time there are changes or an increase in the size of the system to meet the needs of the custodian.</li></ul>
Confidentiality	<ul style="list-style-type: none"><li>• The data in the system can only be accessed by the custodian which is controlled by the log in.</li></ul>

Table 4 Non-Functional Requirements

3.2 Features and Modules

Different requirements and design specifications will be used in the development of the project in order to visualize the proposed system an entity-relationship diagram and data scheme was used to define the design of the system.

3.2.1 Administrator Module (The custodian)

In the administrator module, the custodian is required to enter the username and the password then he/she will click the login button. And it has the privileges and the functionality that the custodian can access

3.3 Design and Development

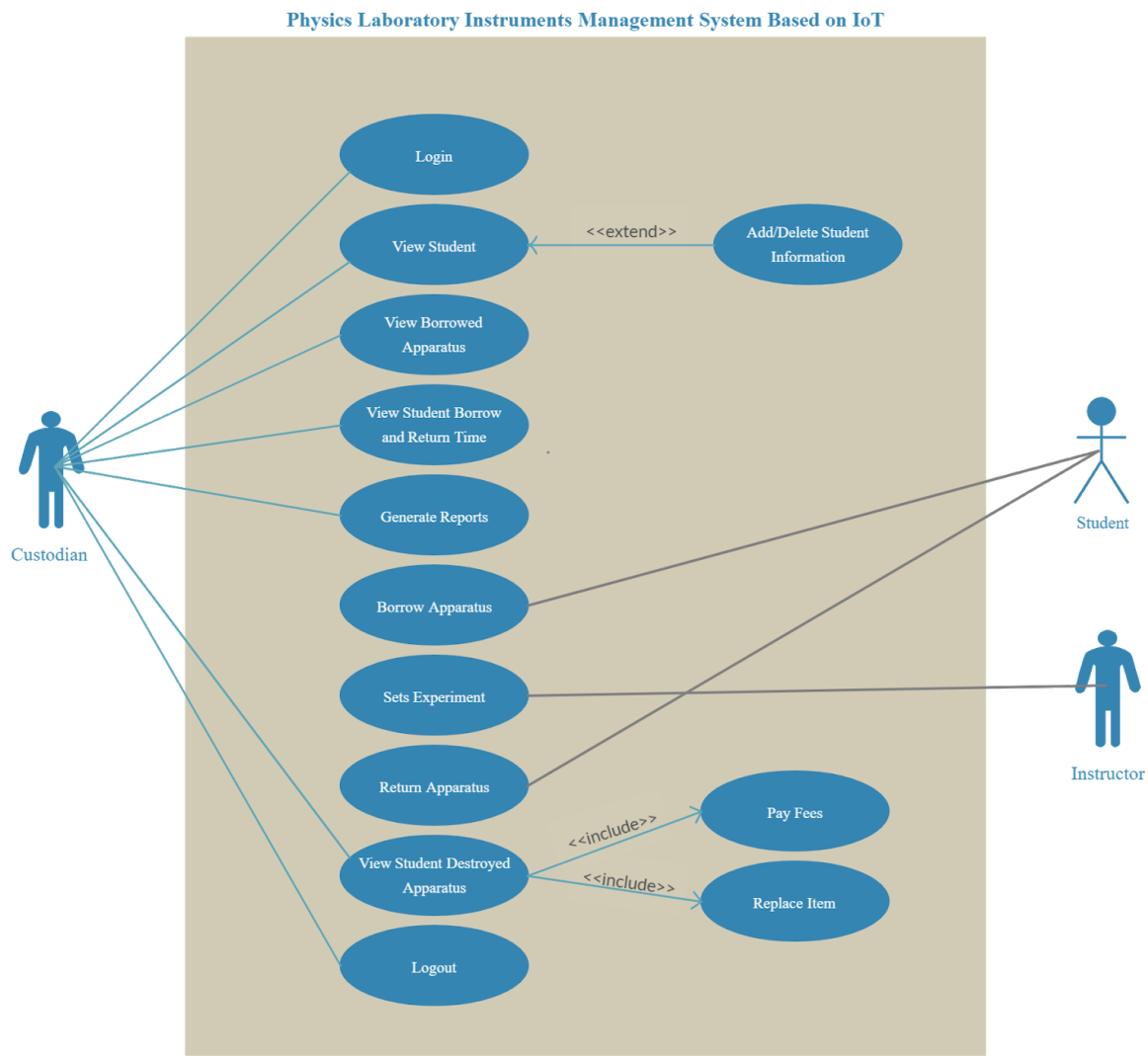
3.3.1 System Architecture

The system architecture is a description of a system that responds to the conceptual and practical difficulties of the description and the design of a complex system. (Boris Golden, n.d.).

*Figure 10 Data Architecture*

### **3.3.1 Use Case Diagram**

The use case diagram shows the interaction between the custodian and the system wherein the custodian can access all the functionalities in the system such as adding, deleting, editing of the items that has been borrowed, view history, view transaction and generate report for the inventory he/she can access the login, print laboratory experiments, notification, view items, search items, create schedule, view schedule of students, history.



*Figure 11 Use Case Diagram*

### 3.4 Data Architecture

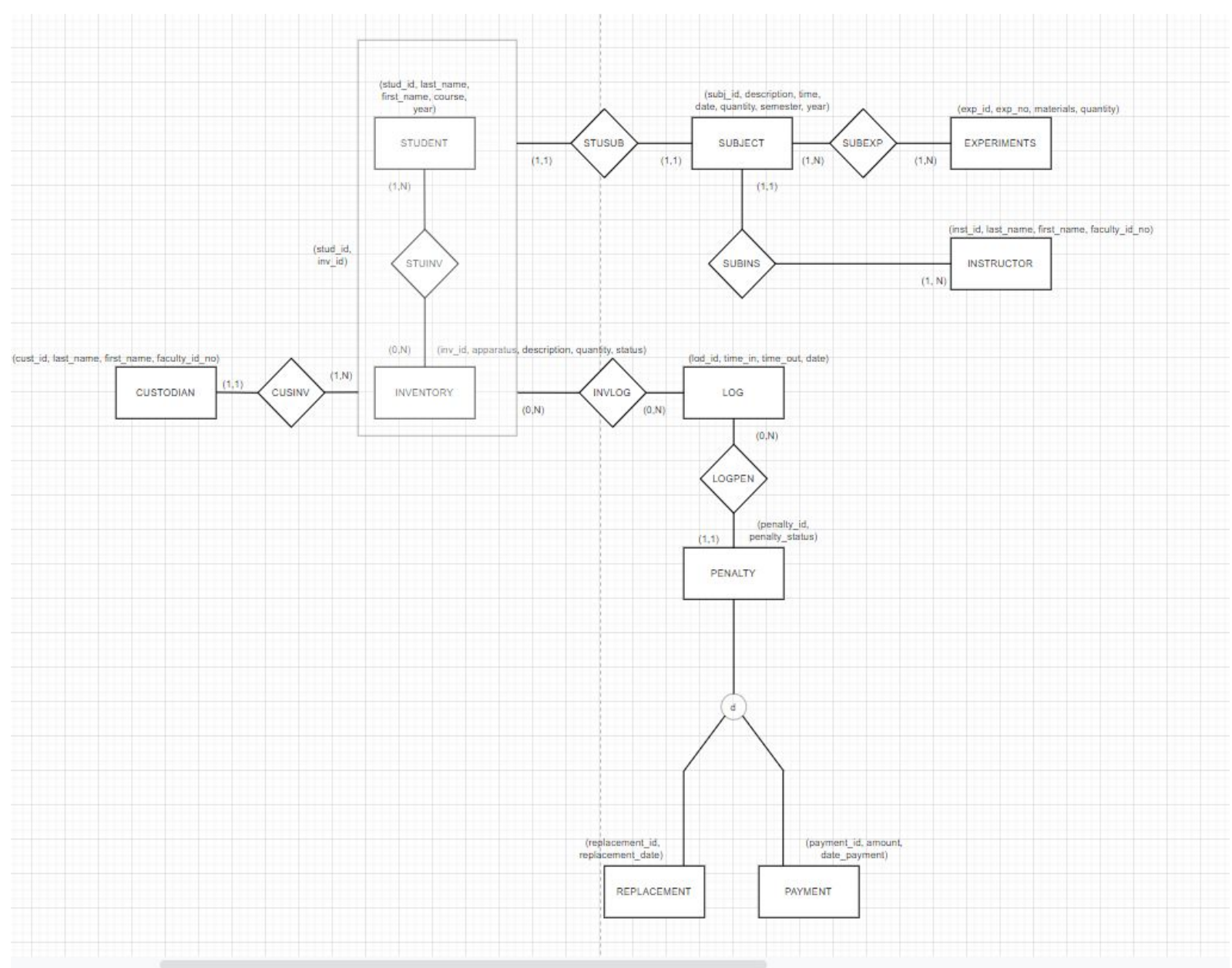


Figure 12 Entity Relationship Diagram

3.5 Prototype

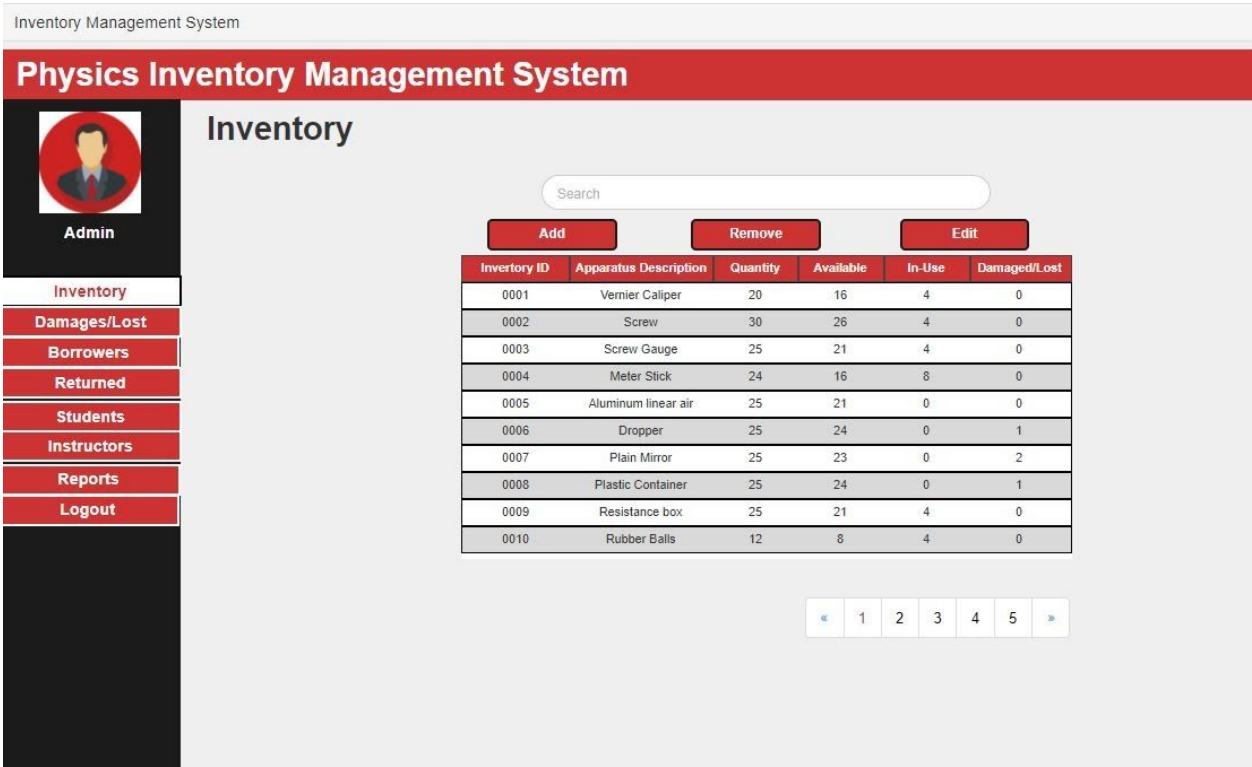


Figure 23 Inventory Interface

INTERFACE ID	11
INTERFACE NAME	INVENTORY INTERFACE
Description	The interface where the custodian can view the whole inventory
Pre-Condition	Must log in to the system with the required credentials
Process Required	<ul style="list-style-type: none"><li>On this page the custodian can view the inventory of the system</li><li>The custodian can add a new apparatus, remove, and edit the details of an existing apparatus.</li><li>The custodian can use the search function to find a certain apparatus</li></ul>
Document/s Produced	N/A

Table 15 Inventory Interface Table

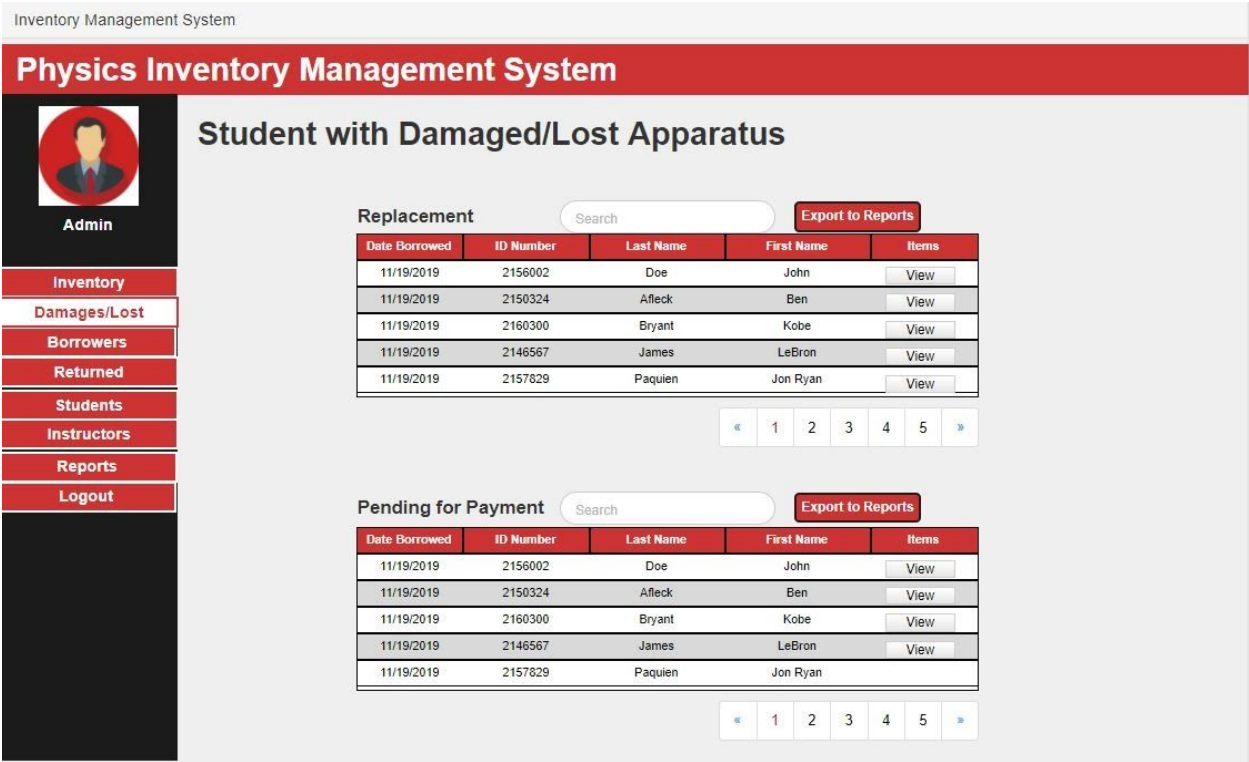


Figure 24 Damaged/Lost Apparatus Interface

INTERFACE ID	12
INTERFACE NAME	DAMAGED/LOST APPARATUS INTERFACE
Description	This is where the custodian can view all of the apparatus that are to be replaced or to be paid by the student
Pre-Condition	Must log in to the system with the required credentials
Process Required	<ul style="list-style-type: none"><li>The custodian can view here the students that have committed a breakage or lost to an apparatus</li><li>The data information gathered here can be exported and be generated into a report</li></ul>
Document/s Produced	N/A

Table 16 Damaged/Lost Interface Table

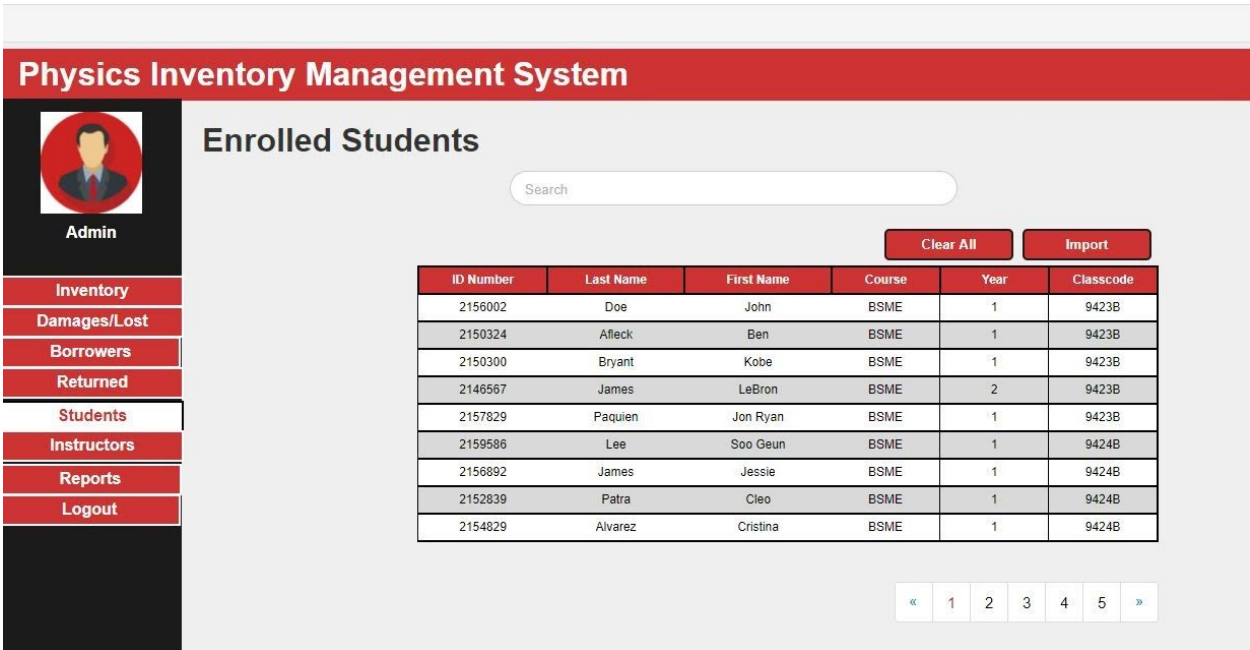


Figure 25 Students Interface

INTERFACE ID	13
INTERFACE NAME	STUDENTS INTERFACE
Description	In this interface, the students that are enrolled to ENGGPHYSL 1 or ENGGPHYSL 2 added into the database and can be viewed here
Pre-Condition	Must log in to the system with the required credentials
Process Required	<ul style="list-style-type: none"><li>• The custodian can use the search engine to find a particular student. This is helpful to see if the a student is really enrolled in any of the said subjects</li><li>• The custodian can click on the Clear All button to clear all data of the student database</li><li>• The custodian can import a checklist of students enrolled of the two physics subjects that is taken from the TMDD</li></ul>
Document/s Produced	N/A

Table 17 Students Interface Table

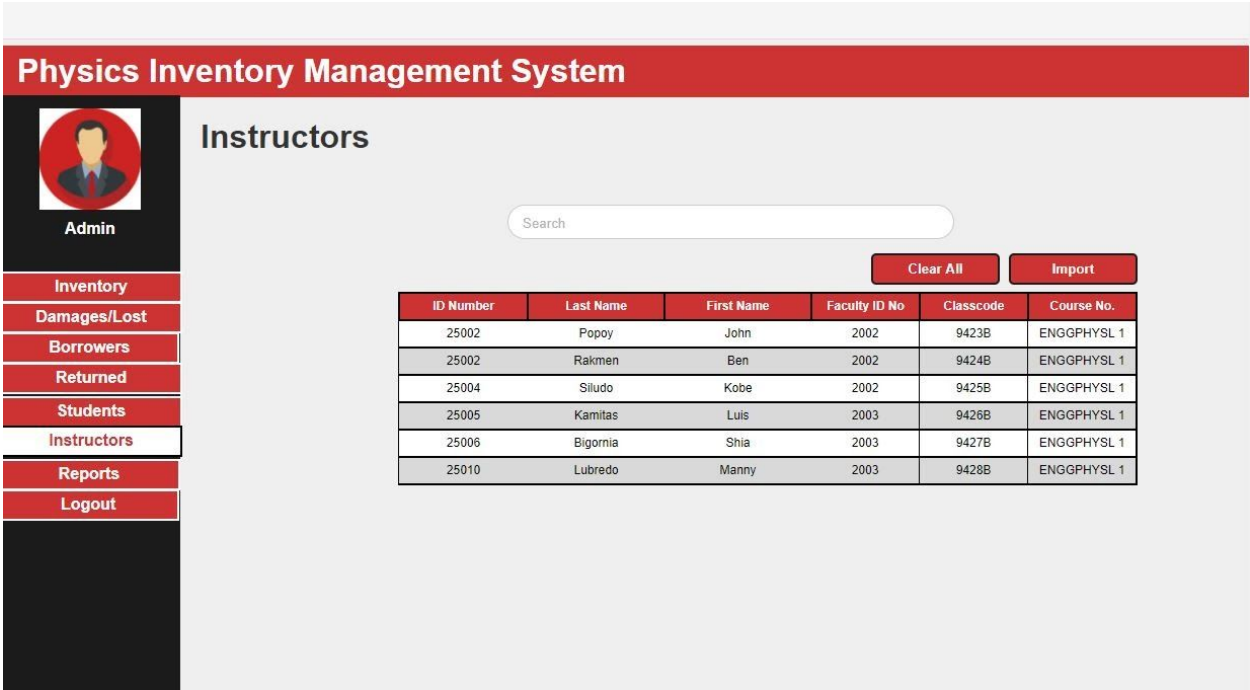


Figure 26 Instructors Interface

INTERFACE ID	14
INTERFACE NAME	INSTRUCTORS INTERFACE
Description	In this interface, the instructors that have been assigned to teach ENGGPHYSL 1 or ENGGPHYSL 2 are added into the database and can be viewed here
Pre-Condition	Must log in to the system with the required credentials
Process Required	<ul style="list-style-type: none"><li>• The custodian can use the search engine to find a particular instructor.</li><li>• The custodian can click on the Clear All button to clear all data of the instructors database</li><li>• The custodian can import a checklist of instructors that would be teaching of the two physics subjects that is taken from the TMDD</li></ul>
Document/s Produced	N/A

Table 18 Instructors Interface Table



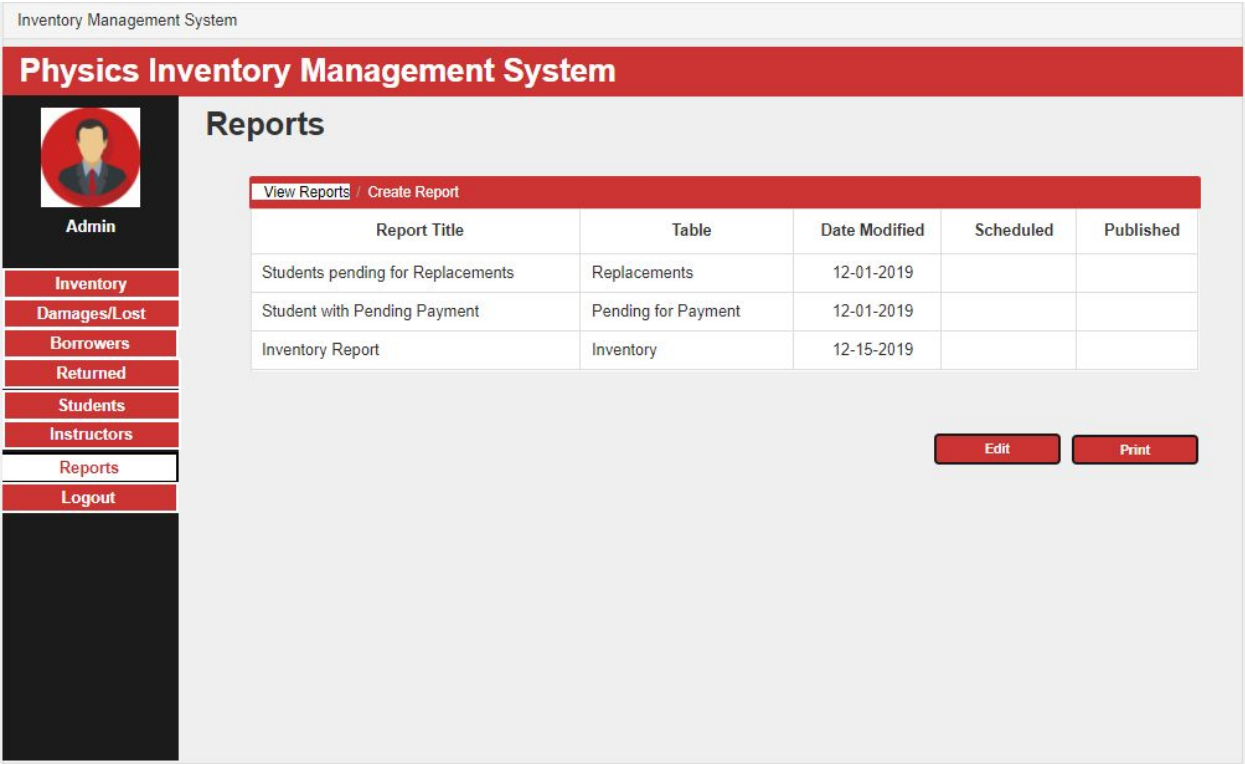


Figure 27 Reports Interface

INTERFACE ID	15
INTERFACE NAME	REPORTS INTERFACE
Description	In this interface, the custodian can view all reports here that are generated. The custodian can also create new reports and can use the data of the other interfaces.
Pre-Condition	Must log in to the system with the required credentials
Process Required	<ul style="list-style-type: none"><li>• The custodian can export data from the other interfaces to produce reports can be generated from</li><li>• The custodian can create a custom report</li></ul>
Document/s Produced	<ul style="list-style-type: none"><li>• Inventory Status Reports</li><li>• Payment Reports</li></ul>

Table 19 Reports Interface Table

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