

Development And Implementation Of An Online Examination System: A Case Study At Information And Communications University-Zambia

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ABSTRACT

In late December 2019, Chinese health authorities in Wuhan, Hubei Province reported an outbreak of a virus of unknown origin. The virus was named as Coronavirus disease 2019 (COVID-19). On January 30, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a global health emergency and the virus has since affected many countries around the world. The severity of this virus has led to many countries shutting down most of their economic activities, including the educational sector. It is because of this pandemic that has led to many learning institutions to find ways and means of offering their services to students during the COVID-19 period.

To achieve continued offer of services to students, the information and communications university has opted to develop and implement an online examination system that will facilitate for students to write their examinations online. The online examination system will allow the institution, through the examinations department, to schedule online examinations. The examinations department will be able to administer examinations online by simply scheduling each running examination, on each day, through the system. The students will be able to access the scheduled examination by simply logging into the system using their login credentials. They will be able to have access to the scheduled examinations. The accessed examination will be based on the courses they are doing in that particular semes-

ter. The student can access the examination paper by selecting the course from the scheduled examination. **Key Words:**

I) CHAPTER ONE: INTRODUCTION

1.1 Problem Statement

Traditional methods of academic learning which involve people being in a single venue at a specific time for learning to occur has been the traditionally accepted form of content delivery to students. The majority of learning that is done in Zambia has been where a lecturer stands in front of students in a classroom and delivers his/her learning content to students. This form of learning has been widely accepted because the lecturer can interact with the students and the students can interact and ask questions. The Ministry of Higher Education, Zambia has given a directive to all higher learning institutions in Zambia that they are required to have some form of face to face interaction with the student before the student can be deemed ready to sit for an examination.

However, after the recent outbreak of the COVID-19 virus, the Government of Zambia has given a directive to close down (lockdown) most of the major economic activities that involve mass gathering in the country. This is to try and reduce the spread of the virus. The lockdown includes closing down all learning institutions around the country. During this lockdown period, no learning institution is sup-

posed to hold any form of Face to Face learning with students. This closer has impacted many learning institutions and has disturbed the learning curriculum. To mitigate this challenge, many learning institutions, including the information and communications university, have decided to develop systems that will enable them to hold virtual classes and virtual examinations. The information and communications university has decided to develop and implement an online examinations system. The proposed system will take advantage of and integrate the already existing technologies to come up with a robust online examinations system that will enable students to write their end of semester examinations online. The system will enable the examinations department to schedule examinations for each examination day. With the scheduled examinations, the department will be able to set the day when each examination will be written. They will also be able to set the time when the examination will start and end. Based on the scheduled examinations, the students will be able to log into the system and have access to the examination questions. The examination questions that the students will be able to access will be based on the courses they are doing in that particular semester. The examination department will be able to administer two types of examination questions; open book questions and short answer question. The student will be able to download the open book question and upload the answers in the system. With the short answer questions, the student will be able to answers the questions directly in the system.

1.2 Research Objectives

The main objective of this research is to develop and implement an online examination system that will allow students at the Information and Communications University to write examinations online. The research aims to achieve the following objectives;

1. Developing a model that will allow students to write examinations online.

2. Developing a model that will allow the examination department to create, schedule, monitor and download online examinations.

3. Developing a model that will enable students to have access to scheduled examinations. The scheduled examination should be based on the semester courses the student is doing.

4. Developing a mechanism that will enable online examinations to uphold examination ethics.

1.3 Research Questions

The above specific objectives will be implemented based on the following research questions (RQ).

RQ1: How can the examination department be able to conduct online examinations?

RQ2: What mechanisms can be put in place to uphold examination ethics while holding online examinations?

II) CHAPTER TWO: RESEARCH LITERATURE REVIEW

2.1 Introduction

In this chapter, the researcher explains the concepts and technologies used and how they are used. Also, in this chapter, the works of other researchers who have worked on related works are discussed under the review of related literature, to aid the researcher in solving the research objectives.

2.2 Theoretical Background

The technologies that will be used to develop the proposed system are all web-based. The technologies include the laravel framework, Javascript and relational database technology (MySQL).

2.2.1 Laravel Framework

Laravel is the main building technology that is used in the development of the proposed system. Laravel is an Open Source framework that was developed

in 2011 by Taylor Otwell. Its main goal is to try and ease the development process for developers by simplifying the repetitive tasks used in most of today's web applications. Laravel offers a robust set of tools and an application architecture that incorporates many of the best features of frameworks like CodeIgniter, Yii, ASP.NET MVC, Ruby on Rails, Sinatra and others. Laravel is a full-stack framework that employs a "Model-view-controller" (MVC) architecture.

An MVC is a software design pattern that is commonly used for developing user interfaces that divide the related program logic into three interconnected elements. This is done to separate internal representations of information from the ways information is presented to and accepted from the user. Furthermore, it separates the logic of the application from the representation layer of the application and allows the web application to have many different views from a single common model.

A Model is the central component of the pattern. It is the application's dynamic data structure, independent of the user interface. It directly manages the data, logic and rules of the application. It is the mode by which the developer can manipulate the data. It consists of a layer residing between the data and the application. The data itself can be stored in various types of database systems such as MySQL or even simple XML or Excel files.

Views are the visual representation of our web application (presentation layer), they are responsible for presenting the data that the Controller received from the Model (business logic). They can be easily built using the Blade template language that comes with Laravel or simply using plain PHP code. The blade is driven by template inheritance and sections. When Laravel renders these Views it examines first their file extension, and depending on it being either "blade.php" or simply ".php", determines if Laravel treats our View as a Blade template or not.

The primary function of a Controller is to handle

requests and pass data from the Model to the Views. Thus, a Controller can be considered as the link between our Model and Views.

The following features are some of Laravel's key design points.

Bundles have provided a modular packaging system since the release of Laravel 3, with bundled features already available for easy addition to applications. Furthermore, Laravel 4 uses Composer as a dependency manager to add framework-agnostic and Laravel-specific PHP packages available from the Packagist repository.

Application logic is an integral part of developed applications, implemented either by using controllers or as part of the route declarations.

Reverse routing defines a relationship between the links and routes, making it possible for later changes to routes to be automatically propagated into relevant links. When the links are created by using names of existing routes, the appropriate uniform resource identifiers (URIs) are automatically created by Laravel.

Restful controllers provide an optional way for separating the logic behind serving HTTP GET and POST requests.

Class auto loading provides automated loading of PHP classes without the need for manual maintenance of inclusion paths. On-demand loading prevents the inclusion of unnecessary components, so only the used components are loaded.

View composers serve as customizable logical code units that can be executed when a view is loaded.

Blade Template Engine: Laravel framework is known for its inbuilt lightweight templates that help in creating amazing layouts using dynamic content seeding. It has multiple widgets incorporating CSS and JS code with solid structures. The blade also provides a set of its control structures such as conditional statements and loops, which are

internally mapped to their PHP counterparts. Furthermore, Laravel services may be called from Blade templates, and the template engine itself can be extended with custom directives.

Eloquent ORM (object-relational mapping) is an advanced PHP implementation of the active record pattern, providing at the same time internal methods for enforcing constraints on the relationships between database objects. Following the active record pattern, Eloquent ORM presents database tables as classes, with their object instances tied to single table rows. The Eloquent ORM provided with Laravel includes a simple PHP Active Record implementation which lets the developer issue database queries with a PHP syntax where instead of writing SQL code, methods are simply chained. Every table in the database possesses a corresponding Model through which the developer interacts with the said table.

Query builder provides a more direct database access alternative to the Eloquent ORM. Instead of requiring SQL queries to be written directly, Laravel's query builder provides a set of classes and methods capable of building queries programmatically. It also allows selectable caching of the results of executed queries.

Schema class provides a database-agnostic way of managing all database related work such as creating or deleting tables and adding fields to an existing table. It works with a multitude of database systems supported by Laravel and MySQL being the default one. The Schema class has the same API across all of these database systems.

Migrations provide a version control system for database schemas, making it possible to associate changes in the application's codebase and required changes in the database layout. They allow us to change the database schema and describe and record all those specific changes in a migration file. Each Migration is usually associated with a Schema Builder to effortlessly manage our application's database. Migration can also be reverted or “rolled

back” using the same said file.

Database Seeder class provides a way to populate database tables with selected default data that can be used for application testing or be performed as part of the initial application setup.

Unit testing is provided as an integral part of Laravel, which itself contains unit tests that detect and prevent regressions in the framework. This feature enables Laravel to run many tests to ensure that new changes done by programmers do not unexpectedly break anything in the web application. Unit tests can be run through the provided artisan command-line utility.

Automatic pagination simplifies the task of implementing pagination, replacing the usual manual implementation approaches with automated methods integrated into Laravel.

Form request is a feature of Laravel that serves as the base for form input validation by internally binding event listeners, resulting in automated invoking of the form validation methods and generation of the actual form.

Homestead - a Vagrant virtual machine that provides Laravel developers with all the tools necessary to develop Laravel straight out of the box, including, Ubuntu, Gulp, Bower and other development tools that are useful in developing full-scale web applications.

Artisan: Allow performing the majority of those tedious and repetitive programming tasks that many developers avoid performing manually. Artisan even helps developers to create their commands and do convenient things with it. These artisans can also be utilized to create the database structure, a skeleton code, and build their migration that becomes pretty easy-to-manage the database system.

Libraries & Modular: Laravel is also popular due to its Object-oriented libraries, as well as many other pre-installed libraries, and these libraries are not found in other PHP frameworks. This framework is

divided into individual modules that adopt modern PHP principles allowing developers to build responsive, modular, and handy web apps.

Security: Laravel takes care of web application security within its framework. It uses hashed and salted password that means the password would never save as the plain text in a database. Additionally, this PHP website development framework uses prepared SQL statements that make injection attacks unimaginable.

2.2.2 JavaScript

JavaScript is combined with HTML and CSS to create dynamic HTML pages. JavaScript is commonly used on the internet to create web pages that respond to user actions, like when the user moves a mouse pointer over an image or clicks a form button. JavaScript was used for the client-side scripting and security, it was also integrated with jQuery and ajax to create Modal Windows used in the application like:

- i. Generating Print preview display
- ii. To ensure the registrant does not submit empty forms
- iii. To ensure that the information requested is what the user enters using the JAVASCRIPT regular expression to match the data submitted.

2.2.3 Relational Database

The database used for storing information in this project application is MySQL. MySQL is the most widely used open-source relational database management system (RDBMS). The SQL phrase stands for Structured Query Language. MySQL is a popular choice of a database for use in web applications and is a central component of the widely used LAMP open-source web application software stack (and other 'AMP' stacks). LAMP is an acronym for Linux, Apache, MySQL, Perl/PHP/Python.

2.3 Review of Related Literature

There is a growing number of researches that is being done focusing on developing better ways to manage online examinations systems and online learning systems. The majority of these researches are focused on different parts of the system. Some of these researches include;

The Online Examination System is a software solution, which allows any industry or institute to arrange, conduct and manage examinations via an online environment (Deepankar Vishwas Kotwal et al, 2016). It can be done through the Internet/Intranet and/Local Area Network environments. Some of the problems faced during manual examination systems are the delays that occur in result processing. The chance of losing records is high, as well as record searching is difficult. Maintenance of the system is also very difficult and takes a lot of time and effort. Online examination is one of the crucial parts of the online education system. It is efficient, fast enough and reduces a large amount of material resource. An examination system is developed based on the web. This paper describes the principle of the system, presents the main functions of the system, analyzes the auto-generating test paper algorithm, and discusses the security of the system.

Online Education became far too popular in the last few decades serving as a powerful platform for sharing knowledge among international groups and individuals (Aakash Trivedi, 2010). The motive of Online Education is to utilize the potential of the World Wide Web to extend education far beyond its present limits. But the full potential of www is not utilized as there is no relevant technique implemented by which we can examine the knowledge of candidates on a mass level. As a result, we are unable to appreciate hidden talents from different parts of the world. Here we are proposing a new approach for online examinations which counters almost all the drawbacks noticed in the traditional online examination techniques. The

examination model provides a relevant scheme for question presentation and tackles all major challenges faced by online examination systems.

Karadeniz (2009) studied the impact of paper-based, web-based, and mobile-based assessments on students' achievement. A group of 38 students experimented for 3 weeks. Significant differences were found between the scores achieved by the students in the second week but not in the first week. The paper revealed that students had a positive attitude towards web-based and mobile-based assessments due to ease of use, comprehensive and instant feedback. Moreover, most favoured tests were web-based and the least favoured were paper-based.

Gary et al (2008) at the University of New South Wales; Sydney studied the effect of online formative assessment on learning. The outcomes support the contention that integrated well designed online formative assessments can have significant positive effects on learning. Web-based formative assessments also support equity and inclusiveness by allowing students to attempt each assessment anonymously on multiple occasions at any time.

Another paper by LIU Na et al (2007) discusses the designing and application process for an online examination system. Online examination system, a new type of examination forms, which includes online examination, online marking, paper evaluation, online checking and so on, implements standardized tests in a fair, reasonable, and large-scale manner. The system design process is based on the design and application of university online-examination system. It conforms to the criterion of digital campus teaching system application software. It adopts the combination of PHP+MySQL which is believed to be the best tool to design the system according to the teaching features of its school. The network structure it applies is the B/S structure mode. This article also instructs design concept, method and process. The

system is stable and reliable based on feedback on its application in several colleges.

Web-based Examination System is an effective solution for mass education evaluation (Zhen Ming et al, 2003.). They developed a novel online examination system based on a Browser/Server framework which carries out the examination and auto-grading for objective questions and operating questions, such as programming, operating Microsoft Windows, editing Microsoft Word, Excel and PowerPoint, etc. It has been successfully applied to the distance evaluation of basic operating skills of computer science, such as the course of computer skills in Universities and the nationwide examination for the high school graduates in Zhejiang Province, China.

Another paper proposed a web-based online examination system (Rashid et al, 2002.). The system carries out the examination and auto-grading for students' exams. The system facilitates conducting exams, collecting answers, auto-marking the submissions and production of reports for the test. It supports many kinds of questions. It was used via the Internet and is therefore suitable for both local and remote examination. The system could help lecturers, instructors, teachers, and others who are willing to create new exams or edit existing ones as well as students participating in the exams. The system was built using various open-source technologies AJAX, PHP, HTML, and MYSQL database.

III) CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

To address the key research objectives, the researcher used a qualitative method and a combination of primary and secondary sources. The study area, data sources, sampling techniques, data collection methods and ethical considerations are discussed under this section.

3.2 The Study Area

According to Fraenkel and Warren studies, population refers to the comprehensive set of individuals (subjects or events) possessing familiar characteristics in which the researcher is interested. The population of the study was determined based on the need requirement at the Information and Communications University. This data collection was conducted from January 03, 2020, to June 03, 2020, from selected members of staff and student union representatives at the information and communication university.

3.3 Data Sources

3.3.1 Primary Data Sources

The primary data source represents information that is obtained from the source of information. The information that was obtained through the primary data sources was more reliable and has more confidence level of decision-making. The primary data sources that were used include observations, interviews and brainstorming.

3.3.2 Secondary Data Sources

Desk review has been conducted to collect data from various secondary data sources. This includes system reports and project documents available at information and communication university. Reputable academic research papers, journals, books, various articles, magazines, newsletters, newspapers, websites, and other sources were considered in the design and implementation of the online examination systems. In general, for this research study, the desk review has been completed to this end, and it had been worked on and modified upon manuals and documents obtained from the selected sources

3.4 Population and Sample Size

The study population consisted of selected members of staff from the information and communication university and selected student union representatives. The members of staff that were selected came from the examinations depart-

ment, systems engineer's office, quality assurance committee and student union representatives. A total of 15 representatives was selected and put in one room to brainstorm and come up with ideas. The sample size for the brainstorm has been considered based on the role they play at the institution.

3.5 Data Collection Methods

Data collection methods were focused on secondary and primary data collections, which mostly focused on qualitative data as defined in the previous section.

3.5.1 Primary Data Collection Methods

Primary data sources are qualitative and quantitative. The researcher adopted the approach of the qualitative primary data collection method. The qualitative sources are brainstorming, discussions, field observation, interview, and informal discussions. The researcher only utilized the observation, interview and brainstorming sources to come up with the system requirement. The subsequent sections elaborate on how the data were obtained from the primary sources.

3.5.1.1 Data Collection Through Brainstorming

Brainstorming provides a broad environment of discussion, where users are free to give their requirement and expectation of the system. The data (ideas) collected after this process is then discussed and analyzed. The researcher utilized the brainstorming technique to come up with ideas and functionalities for the online examinations system. The brainstorming session employed four general rules to elicit requirements for the system;

i. Quantity is more desired than quality: Group members were encouraged to contribute as many ideas as they can think of. The greater the number of ideas generated, the more likely it is that there will be several useful ideas. The assumption is that the greater the number of ideas generated, the

greater the chance of producing a radical and effective solution.

ii. No criticism, evaluation, judgment, or defense of ideas: The purpose of brainstorming is to generate as many ideas related to the topic as possible in the time allowed. During the brainstorming sessions, criticism of the ideas generated needs to be put 'on hold'. Instead of criticism, participants should focus on adding to ideas and reserve criticism for a later 'critical stage' of the process. By suspending judgment, participants will feel free to generate unusual ideas.

iii. Welcome Unusual Ideas and encouraged informal association: Group members are asked to voice any solutions they can imagine of, no matter how outrageous or impractical they seem. Every idea is to be expressed. It is more straightforward to tone down an idea and to select out later than it is to think up new and creative possibilities. To obtain an accurate and extensive list of ideas, unusual ideas are embraced. They can be generated by looking from contemporary perspectives and suspending assumptions. These creative ways of thinking may provide better solutions.

iv. Combine and Improve Ideas: Good ideas may be combined to construct a unique more brilliant idea. Members can suggest improvements, variations, or combinations of previous ideas. It is believed to stimulate the building of ideas by a process of association.

Employing the formulated rules outlined above, the group members were able to generate diverse ideas. The brainstorming session lasted for five days, in which several ideas were collected from the participants. The last day of the session, the collected ideas were subjected to critics and analysis. Before the ideas were subjected to critics and analysis, the group members formulated a criterion by which the ideas were examined. In addition to the questions highlighted in the research

objective, the criteria by which the ideas were subjected to include;

- How feasibility is the idea?
- How complex is the idea?
- How long will it take to implement the idea?
- What is the cost of implementing the idea?
- Does the idea consider the human factor?
- What resources are available or needed to implement the ideas?

From this process, some ideas were dropped, and some were adopted for implementation. The adopted ideas include;

Creation of a system that is robust and secure: that is why the laravel framework was chosen to be used in the development of the online examination system.

The student should only be capable to view examination papers for the courses they are doing in that semester.

The examination paper should only be available to students at the specified time and date.

The system should allow a student to log in in to the system from one device only.

There should be instructions provided to students about examination paper before they access the paper.

The system should start to count the time based on the set start time and end based on the end time.

The system should allow a student to write a maximum of six courses in that examination session.

The system should give a provision of two types of examinations questions to be set; open book questions and Short answer questions. (Open-book questions should allow the student to download the question paper and submit the answers in the system once done with answering. The short answer questions should allow the student to answer questions in the system by typing their answer into an input box.)

The system should log out the student and not allow them to submit their answers when the set end time elapses.

The system should only allow employees from the examination department to have access to the examination questions and students' answers.

The system should give a provision for the examination department to download the answers submitted by the students. Once the answers are downloaded, the examination department will print and give the lecturers to mark the answer scripts.

The new system should work on top of the current database and compliment the current running systems.

The system should be friendly and easy to use.

3.5.1.2 Data Collection Through Observation

Data collection through observation is an important aspect of science and data collection. There are different sources for data collection through observation. Some of the sources that were employed by the researcher include documentation, archival records, interviews, direct observations, and participant observations. Observational research findings are considered strong invalidity because the researcher can collect in-depth information about a particular behavior. In this dissertation, the researcher used observation method as one tool for collecting information and data.

3.5.1.3 Data Collection Through Interview

An interview is a loosely structured qualitative in-depth interview with people who are considered to be particularly knowledgeable about the topic of interest. The semi-structured interview is routinely conducted in a face-to-face setting which permits the researcher to seek further insights, ask questions, and assess phenomena in different perspectives. It lets the researcher know the in-depth of the present working environments' influential factors and consequences. It has provided opportunities for refining data collection efforts and examining specialized systems or processes. It was used when the researcher faces written records or published document limitation or wanted to triangulate the data obtained from other primary and secondary data sources. This dissertation is also conducted with a qualitative approach and conducting interviews. The advantage of using interviews as a method is that it allows respondents to raise issues that the interviewer may not have expected. All interviews with employees, management, and technicians were conducted by the corresponding researcher, on a face-to-face basis at the workplace. All interviews were recorded and transcribed.

3.5.2 Secondary Data Collection Methods

Secondary data refer to data that was collected and analysed by other researchers. This data source gives the researcher insights into the research area being investigated. This secondary data may either be published data or unpublished data. To achieve the dissertation's objectives, the researcher has conducted an extensive document and reports reviews of the online examination systems that have been researched in both online and offline modes.

The researcher obtained secondary data from various database sources. These sources include; Researchgate; Scirp (Scientific Research);

ScienceDirect; ScienceOpen (Research and Publishing Network); Taylor and Francis publications; International Journal of Scientific and Research Publications; Dovepress (Open Access Scientific Journal); and other related materials.

The search strategy was focused on articles or reports that measure one or more of the requirements that were listed after the brainstorming sessions. Based on the formulated requirement, unrelated articles to the research model and objectives were excluded. The researcher had reviewed a sample of more than 900 articles, websites, reports, and guidelines to determine whether they should be included in the next phase of the research for further review or be rejected. Articles that were not in line with the research objectives were thoroughly identified and resolved before the review of the main group of more than 150 articles. After excluding the articles that were not in line with the research objectives, based on the title, keywords, and abstract, the remaining articles were reviewed in detail, and the required information was identified and extracted. A complete list of items was then collated within each research targets or objectives and reviewed to identify any missing elements.

3.6 Ethical Consideration

Ethical clearance was obtained from the Information and Communications University. The purpose of the study was explained to the study subjects. The study subjects were told that the information they provided was kept confidential and that their identities would not be revealed in association with the information they provided. Informed consent was secured from each participant.

IV) CHAPTER FOUR: SYSTEMS ANALYSIS AND DESIGN

4.1 Introduction

System development is classified into two areas: analysis of system and design of the system. System design is defined as the process of planning a business system, it can either be a new system or a system to replace an existing system. Before the design can be done, we must understand the existing system and determine how computers and software can be used to enhance the operation of the existing system or the new system. System analysis refers to the process of examining a business process to improve it through better procedures and methods.

4.2 Description of the Existing System

The existing system that is being utilized to manage student information is the Advanced Information Management System (AIMS). The AIMS system enables students at Information and Communication University to login and access their semester study materials.

The current system allows students to have access to semester study materials, semester assignments, semester projects and semester quiz questions. Students are only given access to the courses they are doing in that particular semester. The system allows students to register for a new semester by simply scanning and submitting their bank deposit slip after they deposited the money in the schools' account. The payment has to be reviewed by the accounts department. If the payment does not meet the standard requirements, the payment is rejected. If the payment does meet the required standards, the payment is approved and the student is given access to the new semester courses. The AIMS system allows the student to view their payment history for each semester. The system also allows students to register for physical examination courses that they want to sit for in a particular semester. Though the AIMS system does not give them the provision to write the registered courses

online. When the student sits for physical examinations, the results of the students are uploaded and the student can view the results from their account.

When a student is logged in, some of the functionalities that they can be able to access include;

1. Read messages on the notice board sent by the institution
2. Access semester courses. They can download study materials, Assignment and Projects for a particular course in a semester.
3. Take Online Quiz for a particular course.
4. Register for semester physical examination
5. Make semester registration by submitting deposit payments.
6. View payment history
7. View semester results

4.3 Problem Associated with the Existing System

The current system has been able to deliver most of the institutions' requirements concerning service delivery to students. But with the current situation of the COVID-19 pandemic, the system does not give provision for the institution to conduct online examinations. With the current system, a student can take an online quiz for a particular course, in a semester. But some of the challenges with the quiz system include;

1. The quiz system only takes into consideration one form of questions. It only gives multiple-choice questions.
2. The quiz system does not take into consideration the malpractice of students while taking the quiz questions.
3. The quiz system does not limit the time in which a student should be able to take the quiz questions.

4. The current system uses an old version of PHP. Old versions of PHP are said to be prone to SQL injections.
5. The AIMS system is not user friendly, in the sense that the system does not adapt to different screen sizes.

4.4 Analysis of the Proposed System

The proposed online examination system is a web-based application that will enable students to write semester examinations online. The new system when designed will enable the institution to conduct semester online examinations taking into considerations examinations ethics. Below are how this can be achieved:

1. The system will be an enhancement of the existing system and will be utilizing the existing database.
2. The system will only allow a student to log into the system from one device. It will not allow multiple logins from one student.
3. Once a student has login into the system, he/she will only be able to view the courses they are doing in that semester and have been scheduled for examination on that particular day.
4. Once a student clicks on a course he/she is supposed to be sitting for, they are taken to a page that gives them instructions for that particular examination.
5. After reading the instructions for that particular examination, they can click on Enter Exam Room and have access to the examination paper.
6. Each examinable course has a stipulated limit number of minutes that it is supposed to be running for. when the stipulated time elapses, the student is logged out of the examination room.
7. The examination will be either open book exam, short answer or both. Open book

examination allows students to download the examination question paper and submit handwritten answers in the system within the stipulated time. Short answer examination allows students to give short answers to questions within the system.

4.5 Methodology

During the development of the system, Object-Oriented Analysis and Design (OOAD) methodology were used. Object-oriented analysis and design is a technical approach that used in the analysis and design of applications or system by applying the object-orientated concepts, and develop a set of graphical system models during the development life cycle of the software. In the OOAD methodology two stages are involved; Object-Oriented Analysis and Object-Oriented Design. In the Object-Oriented Analysis, developers work with users and domain experts to define what the system is supposed to do. The major goal of the analysis stage is to create a model

of the system regardless of the limitations that may exist. The Object-Oriented Design stage refines the Object-Oriented Analysis model and applies the needed technology and other implementation requirements. The design stage focuses on describing the objects, their attributes, behavior, and interactions. The input for object-oriented design is provided by the output of the object-oriented analysis.

Unified Modeling Language (UML) is a standardized general-purpose modelling language in the field of object-oriented software engineering. UML includes a set of graphic notation techniques to create visual models of object-oriented software systems. This notation is the design tool that is being used for modelling in this research. The UML used in the research includes: Use Case diagrams and Class diagrams..

4.5.1 Use Case Diagrams

Use case diagrams are used to describe the sequence of actions a system performs to yield the intended results. The diagrams depict the interaction of components in the system with the outside environment. Use case diagrams focus on the behavior of the system from an external point of view.

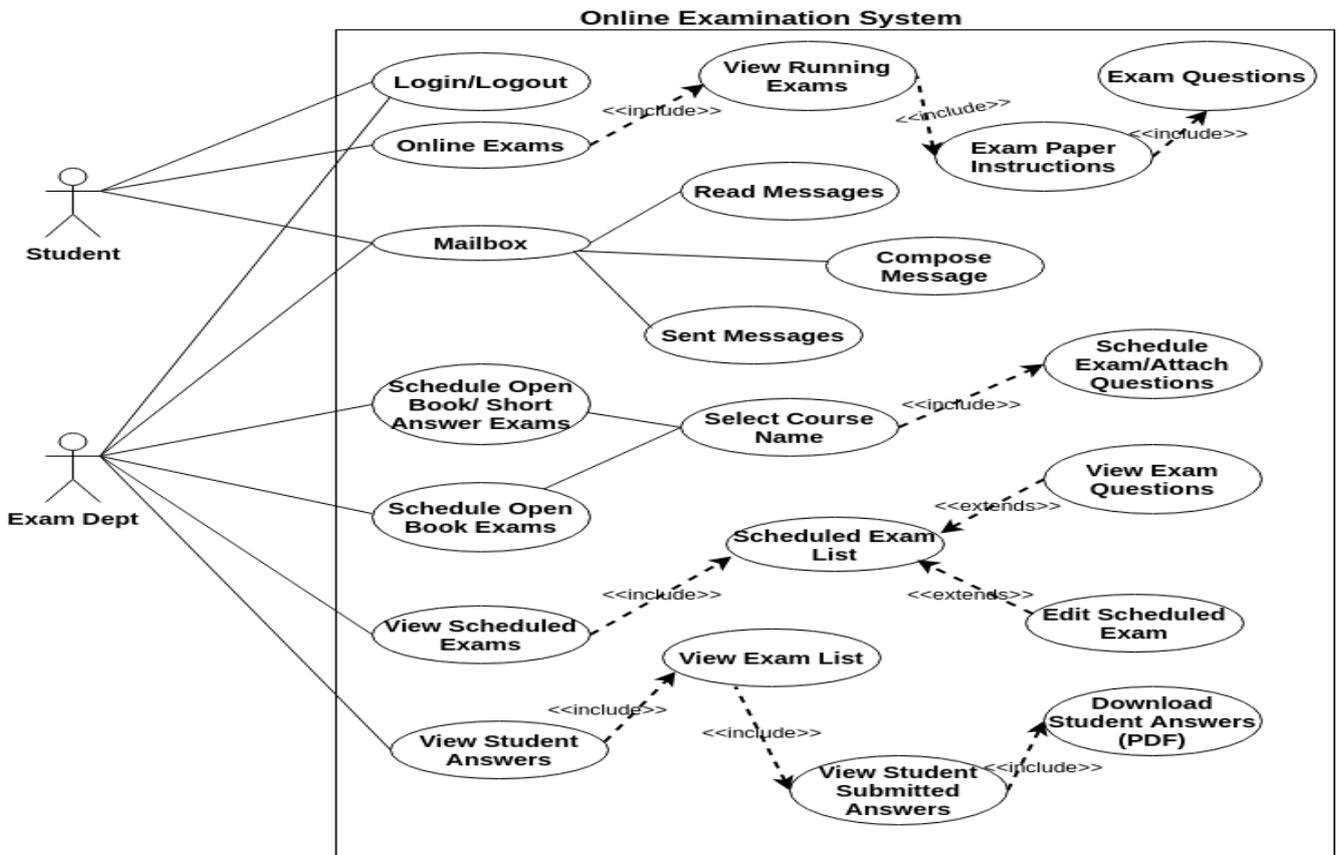


Figure 1 : System Use Case Diagram

4.5.2 Class Diagram

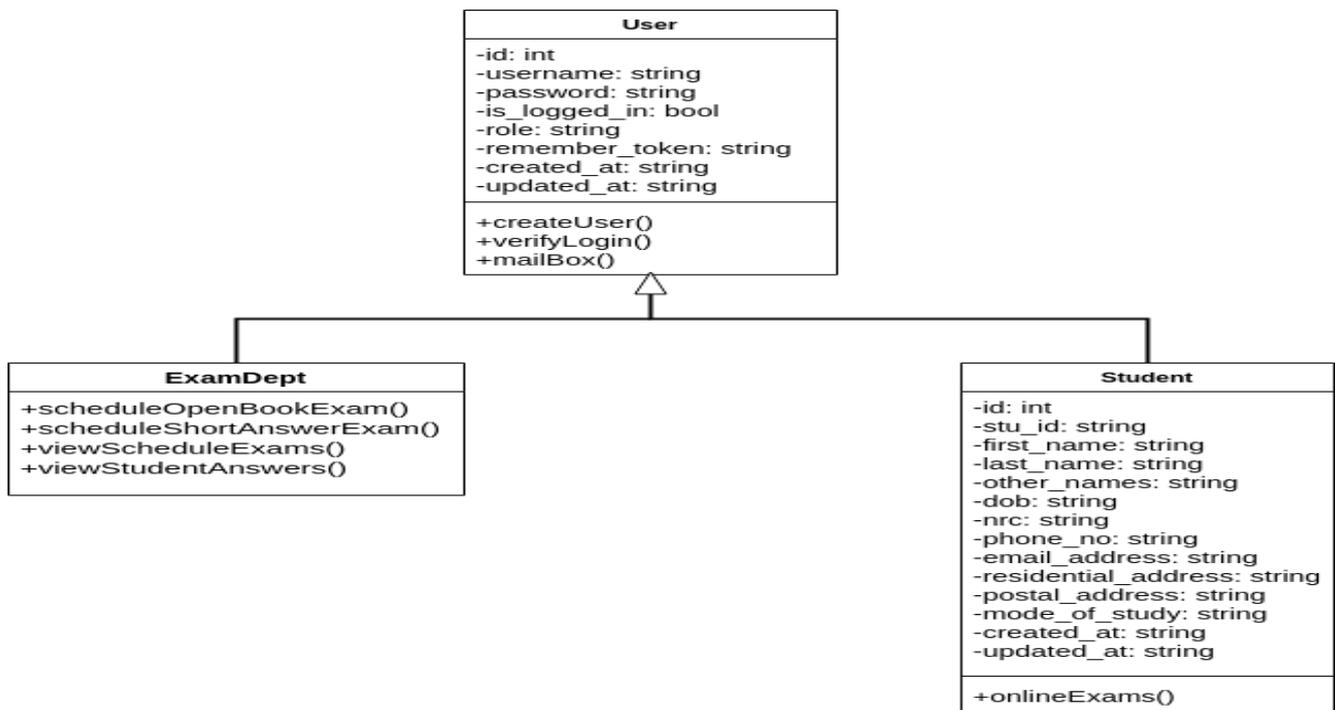


Figure 2: System Class Diagram

4.6 Design of the Proposed System

4.6.1 Database Design

Database Design is a collection of processes that help to facilitate the designing, development, implementation and maintenance of data management systems. The main objectives of database design are to produce logical and physical design models of the proposed system. To design the required database, the researcher used the relational database. The relational database server used to create the database is MySQL.

Table 1: User Table

Field Name	Character Length	Data Type
Id [pk]	10	int
username	15	varchar
password	20	varchar
role	10	varchar
is_logged_in	1	tinyint
remember_token	100	varchar
created_at		timestamp
updated_at		timestamp

Table 2: Students Table

Field Name	Character Length	Data Type
id	15	varchar
Stu_id [pk]	15	int
First_name	50	varchar
Last_name	50	varchar
Other_names	50	varchar
dob		date
gender	'M','F'	enum
nrc	15	varchar
email_address	50	varchar
phone_no	16	varchar
residential_address		text
postal_address	50	varchar

mode_of_study	'Distance','Full Time'	enum
created_at		timestamp
updated_at		timestamp

Table 3: Message Table

Field Name	Character Length	Data Type
Msg_id [pk]	15	int
from	15	varchar
to	15	varchar
subject	30	varchar
message		text
mgfile	100	varchar
created_at		timestamp
updated_at		timestamp

Table 4: Courses Table

Field Name	Character Length	Data Type
Id [pk]	15	int
name	20	varchar
code	10	varchar
description		text
created_at		timestamp
updated_at		timestamp

Table 5: Semester Session Table

Field Name	Character Length	Data Type
Id [pk]	15	int
session	15	int

student_id [f_pk]	15	int
created_at		timestamp
updated_at		timestamp

Table 6: Exam Event Table

Field Name	Character Length	Data Type
Id [pk]	15	int
course_id [f_pk]	15	int
exam_date		date
start_time	20	varchar
end_time	20	varchar
type	1	int
status	2	varchar
created_at		timestamp
updated_at		timestamp

Table 7: Exam Student Answers Table

Field Name	Character Length	Data Type
Id [pk]	15	int
student_id [f_pk]	15	int
exam_event_id [f_pk]	15	int
question_id [f_pk]	15	int
student_answer		text
created_at		timestamp
updated_at		timestamp

Table 8: Questions Table

Field Name	Character Length	Data Type
------------	------------------	-----------

Id [pk]	15	int
exam_events_id [f_pk]	15	int
question_name		text
question_number	15	int
question_type	1	tinyint
created_at		timestamp
updated_at		timestamp

Table 9: Semester Courses Table

Field Name	Character Length	Data Type
c_id [pk]	15	int
program_name	50	varchar
course_id [f_pk]	15	int
semester	15	int
created_at		timestamp
update_at		timestamp

Table 10: Student Programme Assigned Table

Field Name	Character Length	Data Type
p_id [pk]	15	int
student_id [f_pk]	15	int
program_name	50	varchar
completed	5	varchar
created_at		timestamp
updated_at		timestamp

4.6.2 System Architecture

The architectural design that was used in the development of the online examination system is a 3-tier architecture. A 3-tier architecture is a type of software architecture which is composed

of three “tiers” or “layers” of logical computing. The three tiers are Presentation tier, Application tier and Data tier. The presentation tier is the front-end layer in the 3-tier architecture and consists of the user graphical interface. This user interface is accessible through a web browser or a web-based application and is used to display information useful to the end-user. The middle tier connects the presentation tier and the data tier. The middle tier is also called application tier or business logic. The application tier contains the functional business logic of the application system and drives the application’s core capabilities. The application tier of this system is found in the controllers and runs on the server. The data tier is the tier that is responsible for storing the data of the system. It comprises of the database/data storage system and data access layer. The data stored is accessed by the application layer via API calls. The database management system used for developing this system is MySQL database server.

The architecture of the system is shown below.

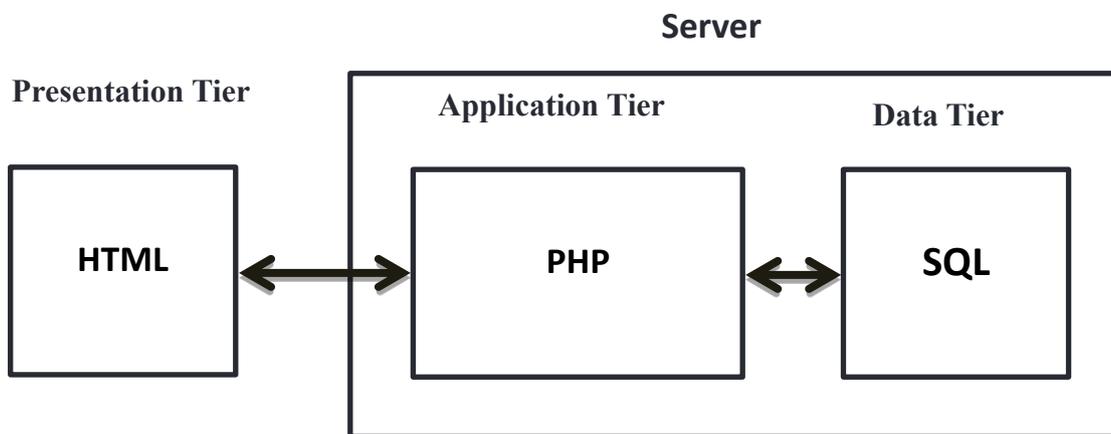


Figure 3: System Architecture

4.6.3 Input Design

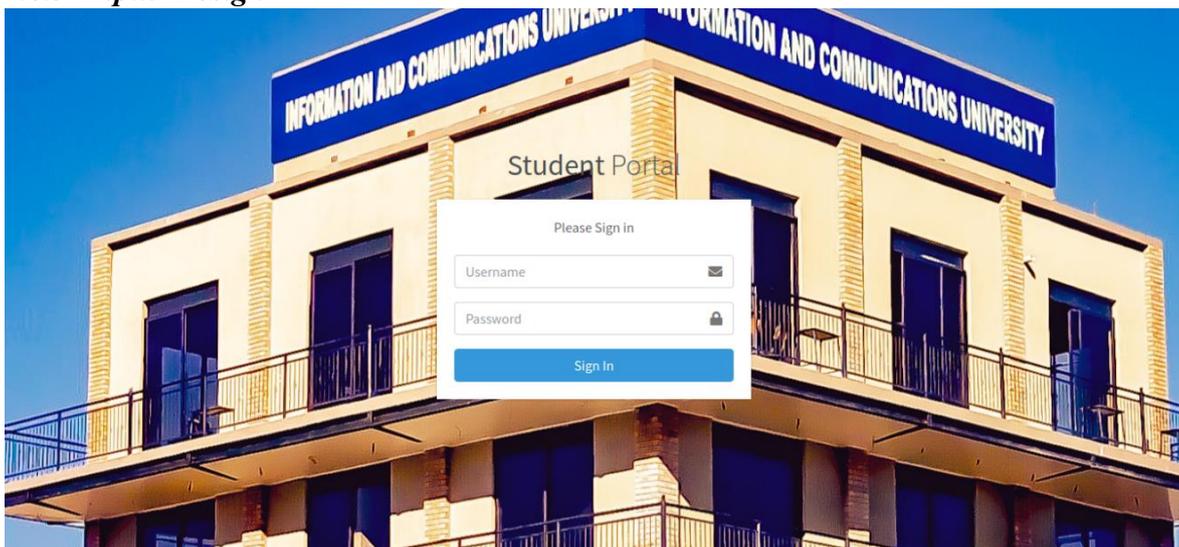
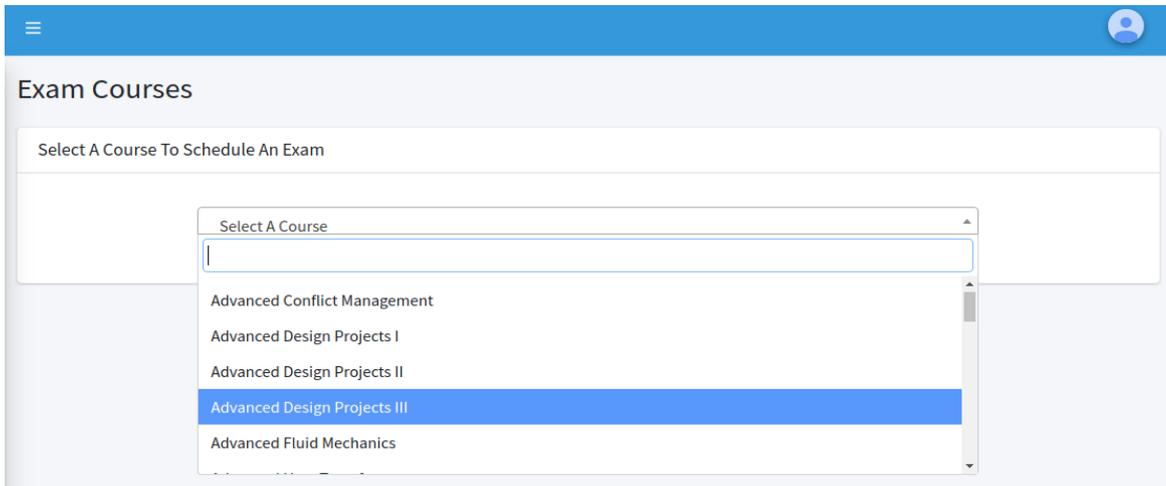


Figure 4: Login Form



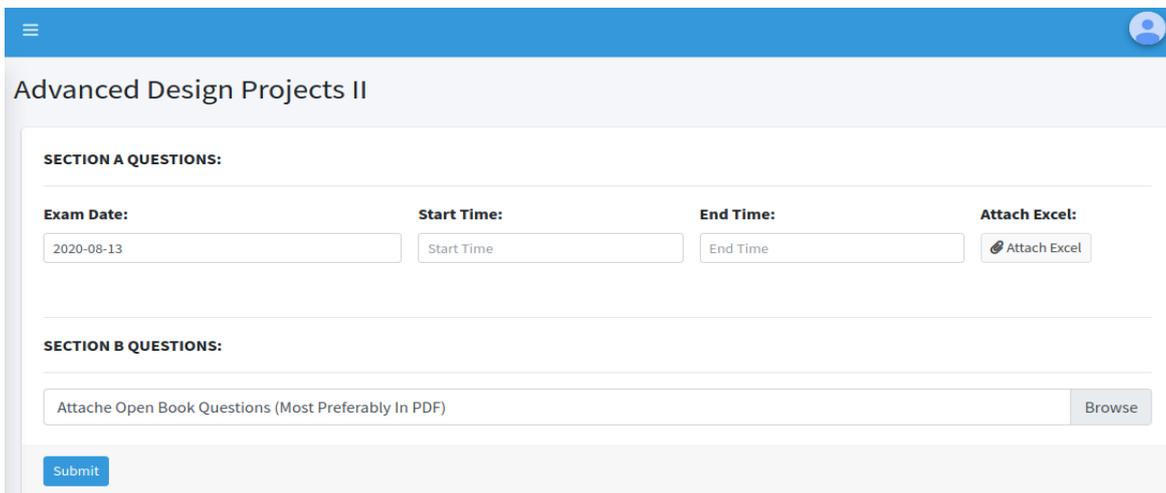
Exam Courses

Select A Course To Schedule An Exam

Select A Course

- Advanced Conflict Management
- Advanced Design Projects I
- Advanced Design Projects II
- Advanced Design Projects III**
- Advanced Fluid Mechanics

Figure 5: Select Course to Schedule Exam Form



Advanced Design Projects II

SECTION A QUESTIONS:

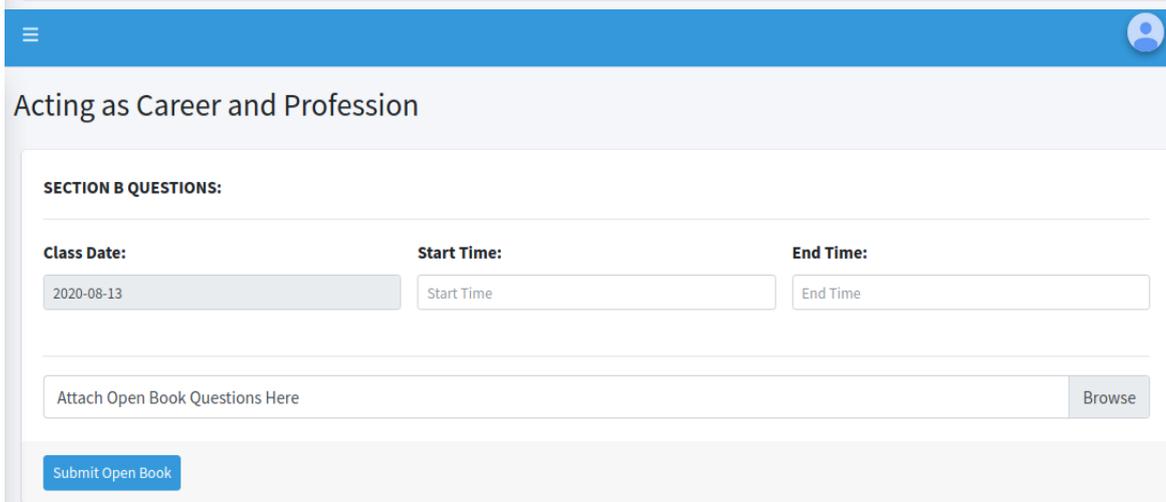
Exam Date: 2020-08-13 Start Time: Start Time End Time: End Time Attach Excel: Attach Excel

SECTION B QUESTIONS:

Attache Open Book Questions (Most Preferably In PDF) Browse

Submit

Figure 6: Schedule Open Book/ Short Answer Exam Form



Acting as Career and Profession

SECTION B QUESTIONS:

Class Date: 2020-08-13 Start Time: Start Time End Time: End Time

Attach Open Book Questions Here Browse

Submit Open Book

Figure 7: Schedule Open Book Exam Form

Menu icon | User profile icon

Edit Exam Event

Exam Event Dates

Exam Date: 2020-08-11 | Start Time: 12:00 | End Time: 15:00

Edit Event

Figure 8:
Edit
Scheduled
Exam
Form

Menu icon | User profile icon

Send Message

Compose New Message

Select Receiver

Enter Subject:

Rich text editor toolbar: Bold, Italic, Underline, Source Sans Pro, Font Color, Background Color, Bulleted List, Numbered List, Indent, Table, Link, Unlink, Image, Video, Code, Help

Attachment
Max. 32MB

Discard | Send

Figure 9:
Compose
New
Message
Form

Figure 10: Add Additional Questions Form

Add Questions To Business Communication/Communication Skills

Upload Questions In Excel Format:

Attach Excel Questions Browse

Project Questions In Image Format:

Question One (Image) Browse Question Two (Image) Browse Question Three (Image) Browse

Question Four (Image) Browse Question Five (Image) Browse Question Six (Image) Browse

Question Seven (Image) Browse Question Eight (Image) Browse Question Nine (Image) Browse

Submit

Figure 11: Reply to Message

Reply Message

Reply Message

RE: EXAM RESULTS

B U Source Sans Pro **A** **☰ ☰ ☰ ☰** **🔗 🖼️ 🎥 📄** **</> ?**

Attachment
Max. 32MB

Discard Send

4.6.4 Output Specification Design

Questions	Question Type
List atleast 4 Major Macromolecules	Short Answer <input type="checkbox"/>
Give two Examples of Carbohydrate	Short Answer <input type="checkbox"/>
Proteins, which are tremendously complex molecules, all use as their basic units or building blocks which are	Short Answer <input type="checkbox"/>
The primary structure of a protein involves	Short Answer <input type="checkbox"/>
The chemical union of the basic units of carbohydrates, lipids, or proteins always produces the biproduct	Short Answer <input type="checkbox"/>
When disaccharides are changed to monosaccharides, the common chemical process involved is	Short Answer <input type="checkbox"/>
Saturated fats have	Short Answer <input type="checkbox"/>
What simple sugar is made during photosynthesis?	Short Answer <input type="checkbox"/>
What category of organic molecule are sugars, starches, and fibers?	Short Answer <input type="checkbox"/>

Figure 12: View All Scheduled Exam

Course Name	Exam Date	Start Time	End Time	Questions	Action
Business Communication/Communication Skills	Aug 11, 2020	12:00	15:00	1	View Edit Del
Higher Mathematics 1	Aug 13, 2020	15:00	18:00	1	View Edit Del
Advanced Chemistry	Jul 3, 2020	12:00	16:00	1	View Edit Del
World Regional Geography	Jun 26, 2020	09:00	13:00	1	View Edit Del
Engineering Drawing 1	Jun 26, 2020	09:00	13:00	1	View Edit Del
Classroom Management for Children with Special Education Needs	Jun 26, 2020	09:00	13:00	1	View Edit Del
Concepts of Biology	Jun 26, 2020	12:00	16:00	1	View Edit Del
Econometrics Theory and Application 2	Jun 26, 2020	09:00	12:00	1	View Edit Del
Econometrics Theory and Application 2	Jun 26, 2020	12:00	16:00	1	View Edit Del
Business Communication/Communication Skills	Aug 13, 2020	12:00	15:00	29	View Edit Del

Figure 13: View Scheduled Exam Questions

Course Name	Exam Date	Started At	Ended At	Students	Action
Econometrics Theory and Application 1	Jun 22, 2020	11:00	12:00	260	View Students
Farm Management	Jun 22, 2020	11:00	12:00	149	View Students
Environmental Pollution Law	Jun 22, 2020	11:00	12:00	55	View Students
Human Resource Development	Jun 22, 2020	11:00	16:00	1	View Students
Managing Change	Jun 22, 2020	11:00	12:00	1328	View Students
Botany	Jun 22, 2020	11:00	12:00	109	View Students
NGOs and Development	Jun 22, 2020	11:00	12:00	493	View Students
History of Development and Underdevelopment	Jun 22, 2020	11:00	12:00	538	View Students
Biostatistics and Experimental Design	Jun 22, 2020	11:00	12:00	98	View Students

Figure 14: View Written Exams

Student Number	Student Names	Date Written	Questions #	Action
1712246742	Lucky Mudenda	Jun 22, 2020	1	Get Answers
1712199668	FRANCIS KASHWEKA	Jun 22, 2020	3	Get Answers
1712114222	Godfrey Mutemi	Jun 22, 2020	2	Get Answers
1709274949	Danniel Chisenga	Jun 22, 2020	15	Get Answers
1708105165	DERICK WATANUKA	Jun 22, 2020	1	Get Answers
1707545708	Chilombo Mwansa	Jun 22, 2020	21	Get Answers
1706571609	Edward Phiri	Jun 22, 2020	11	Get Answers
1706508324	fadile mtonga	Jun 22, 2020	1	Get Answers
1705254662	Moses Phiri	Jun 22, 2020	16	Get Answers
1705222488	shimooko shimooko	Jun 22, 2020	17	Get Answers

Figure 15: View All Student Answers List



INFORMATION AND COMMUNICATIONS UNIVERSITY
EXAMINATIONS DEPARTMENT
Environmental Pollution Law

Jun 22, 2020
 Gibson Chungu
 1701224756

Question #	Answers
# 1	an act to provide for protection of the environmental and control of pollution
# 2	international law is concerned with the attempt to control pollution and the depletion of nature
# 3	because it is the way to prevent agricultural wastewater pollution
# 4	is to prevent living organisms from being destroyed
# 5	it is difficult to reconcile objectives because of the there so many pollutants
# 6	one of three rio convention the (UNFCCC) one of the three rio conventions the unfccc ultimate objective isto achieve the stabilization of greenhose gas concentration in the atmosphere gas concentrations in the atmospher at a level that would prevent dangerous int

Figure 16: View Single Student Answers List

☰
👤

Running Examination

Select Exam You Want To Seat For

Course Name	Exam Date	Start Time	End Time
Business Communication/Communication Skills	Aug 13, 2020	12:00	15:00

Open Book Exam Will Start At 15:00. REFRESH The Page

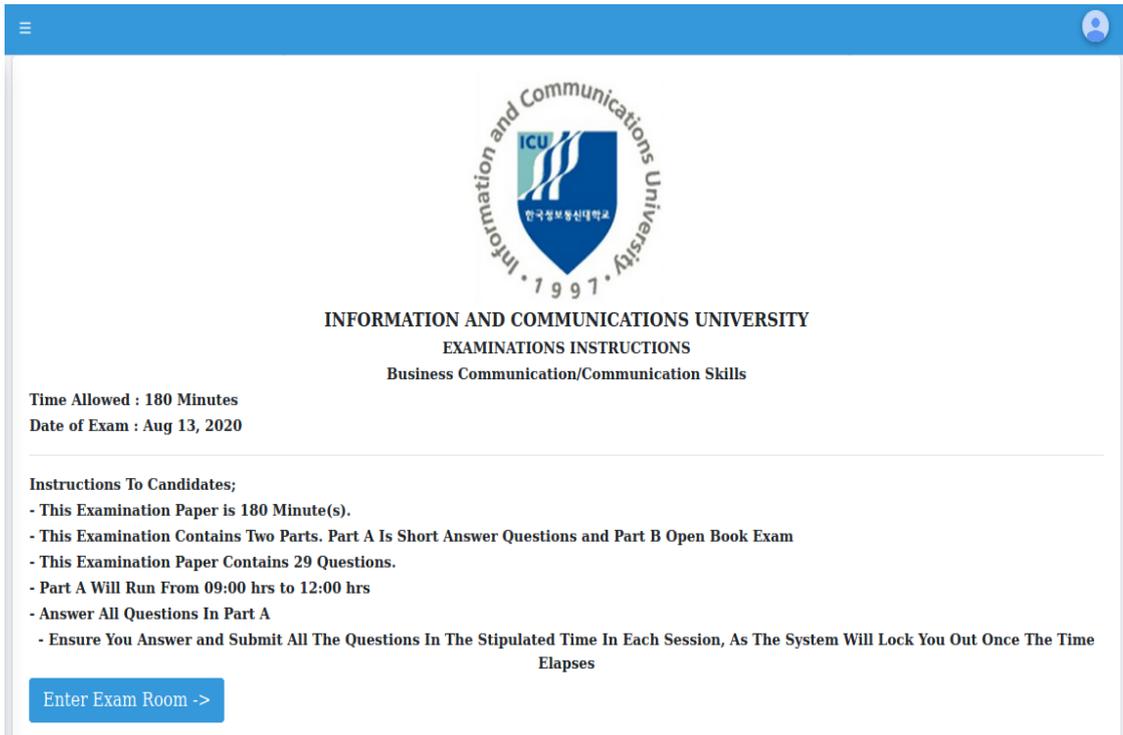


Figure 17: View Today's Running Exams

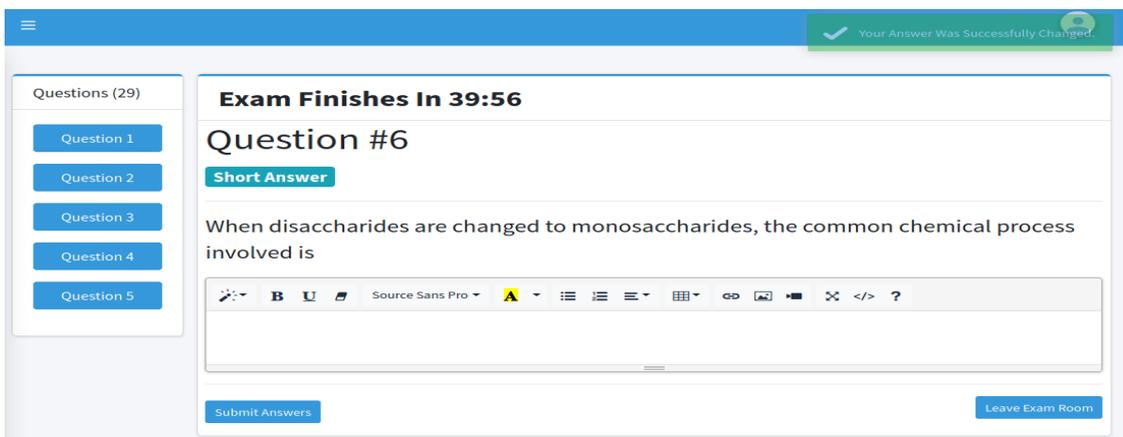


Figure 18: View Exam Paper Instructions

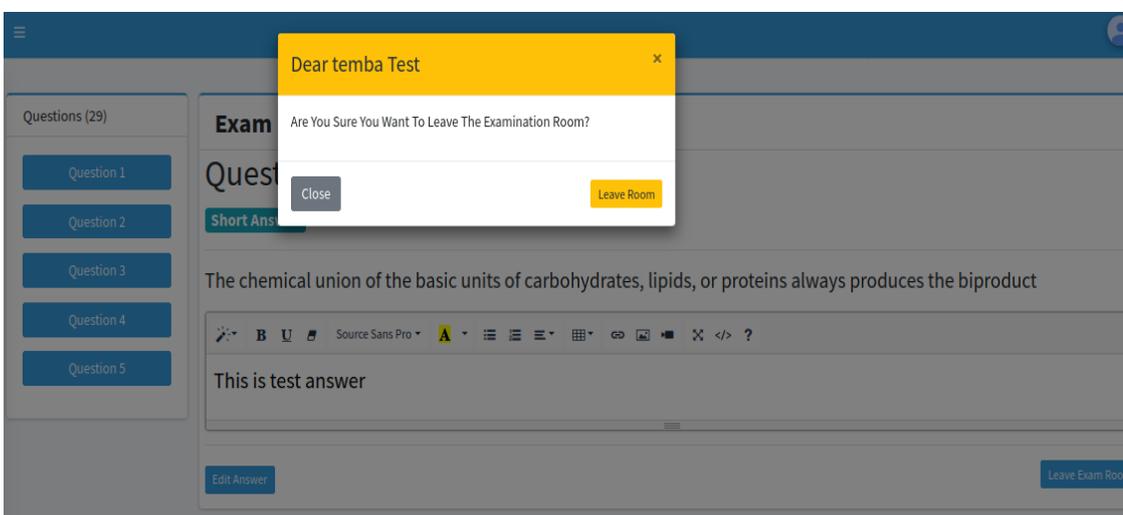


Figure 19: View Exam Paper Questions

Figure 20: Leave Exam Room

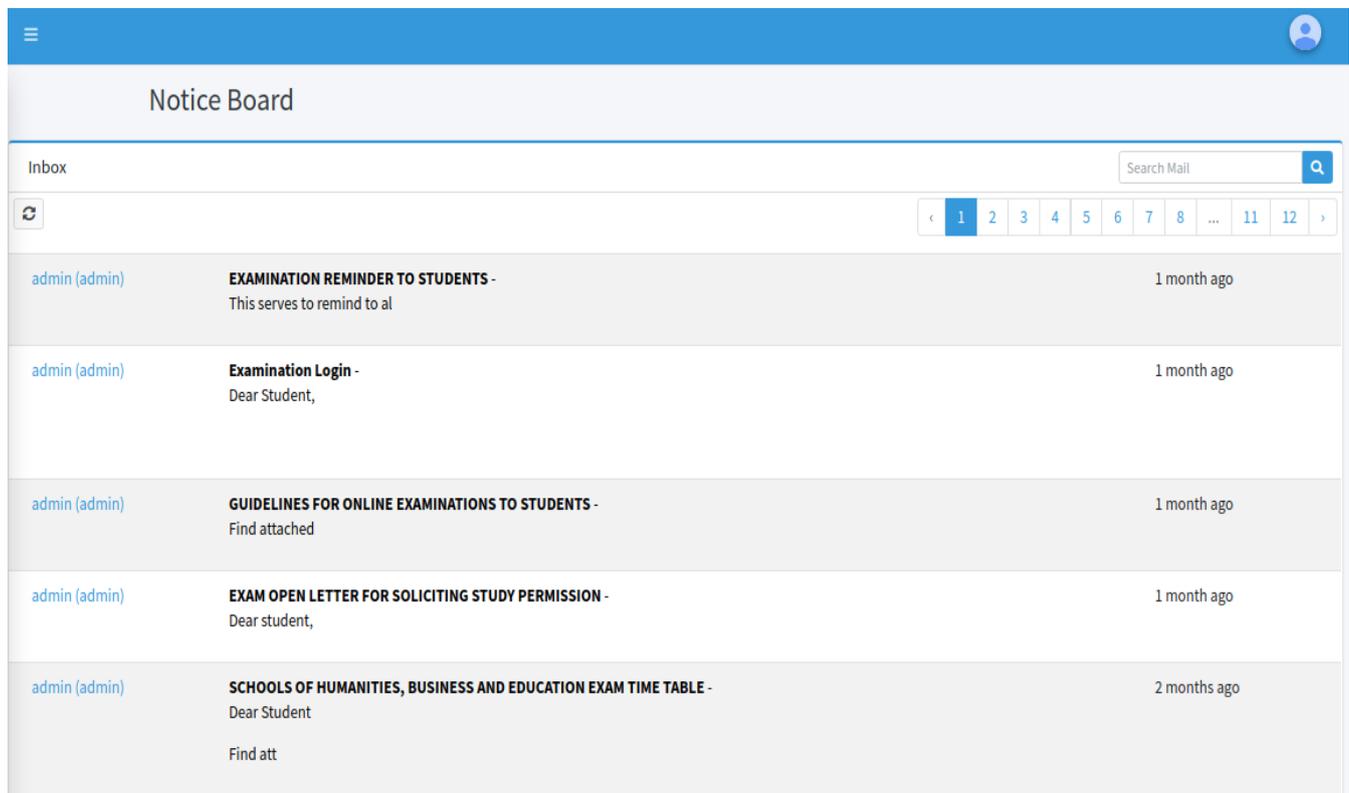


Figure 21: View Messages

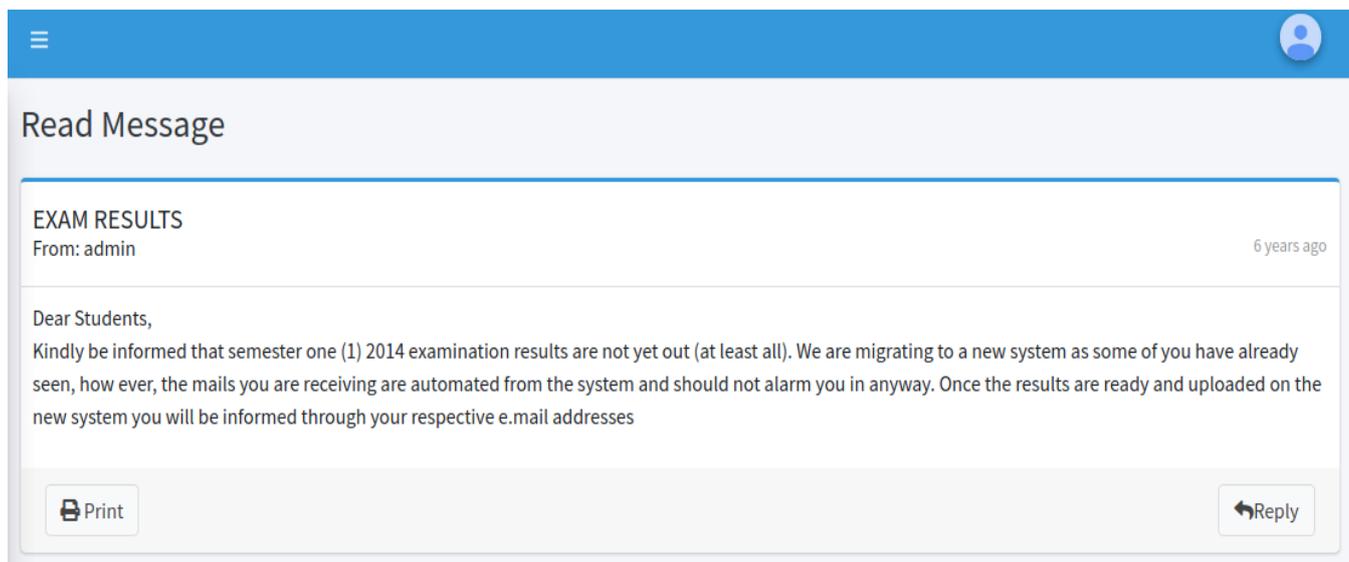


Figure 22: View Message Details

4.6.5 System Design

The online examination system was designed using a top-down approach. The whole system was broken down into separate components and designed in modules.

4.6.5.1 Program Procedure Chart for Examinations Department

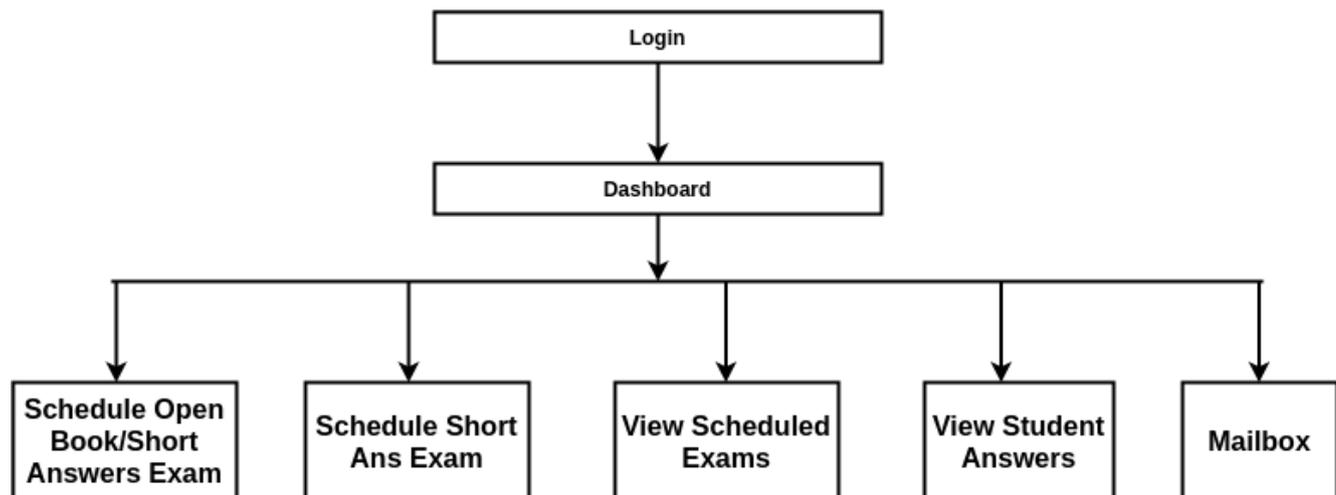


Figure 23: Program Procedure Chart for Examinations Department

4.6.5.2 Program Procedure Chart for Students

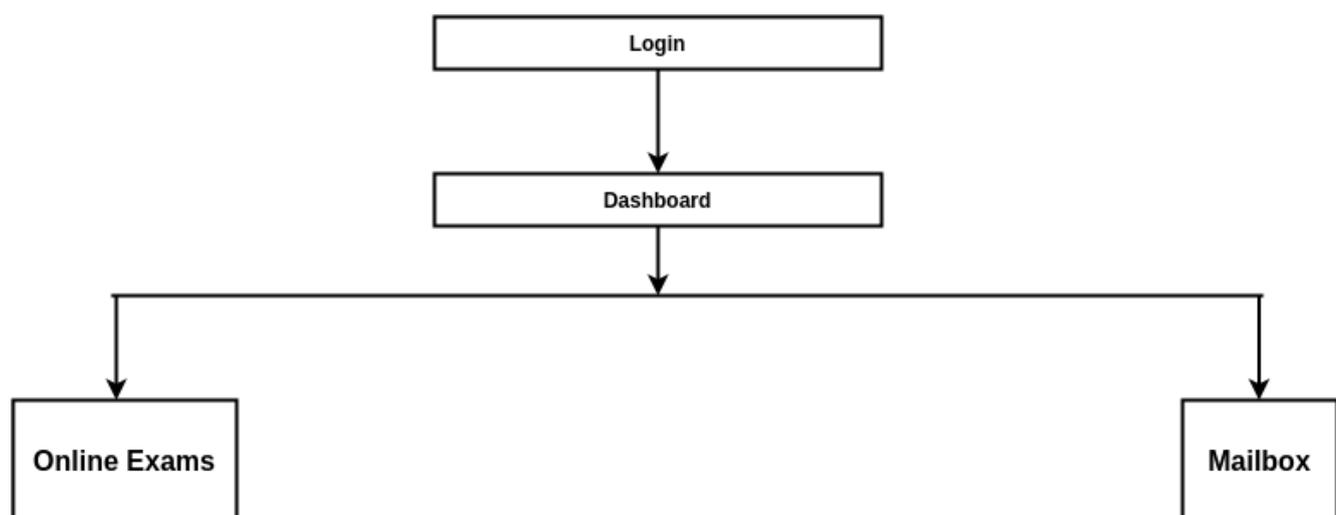


Figure 24: Program Procedure Chart for Students

4.6.6 Program Flow Chart to Gain Access into The System

The online examination system requires all the users that want to access the system to authenticate before they can be granted access. Once the user successfully authenticates, the user will be given access to the online examination system (OES), limiting the user to the access level assigned to them.

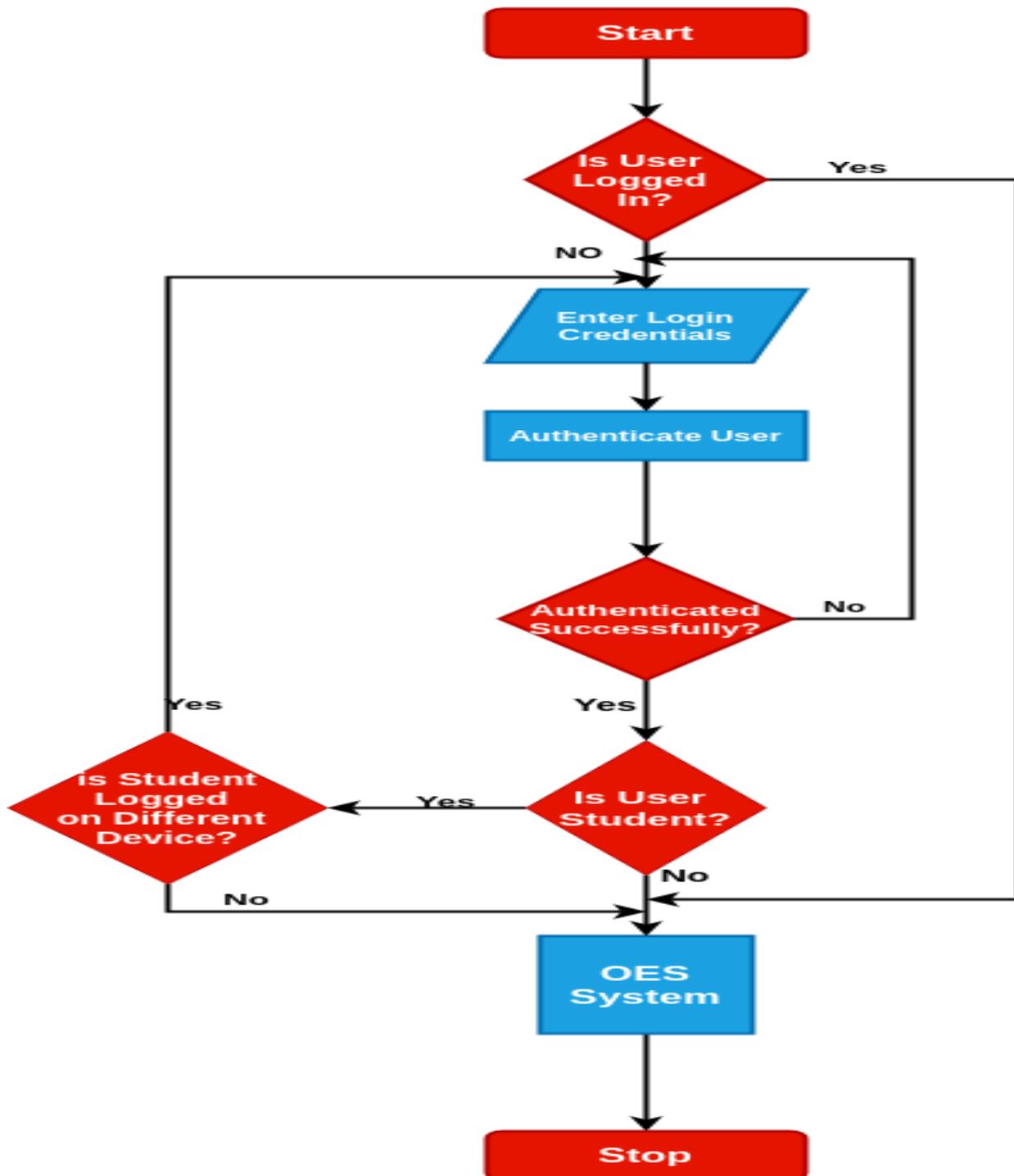


Figure 25: Program Flow Chart to Gain Access into The System

V) CHAPTER FIVE: SYSTEMS IMPLEMENTATION

5.1 Introduction

Implementation of the online examination system is concerned with the preparation of resources, such as hardware and software, that are required for the optimal functionality of the newly designed system. It is also concerned with the evaluation of the performance of the newly designed system by subjecting it to tests and ensuring that the required resources meet the designed objective.

5.2 Choice of Development Environment

The development environment that was used to develop the online examination system was a visual studio code (VS Code). VS Code is an Integrated Development Environment that was developed by Microsoft Company and it is cross-platform. It can be installed on Microsoft Windows operating system, Linux Operating system and Mac Operating System. VS Code is a super-fast, lightweight Source Code text editor that is used to view, edit, run and debug source code for applications. The researcher found using VS Code as the most ideal development environment. The list below gives some reasons why the VS Code was chosen as the development environment.

- i) Visual Studio Code comes with IntelliSense for the programming language. IntelliSense is a term used for a variety of code editing features such as code completion, content assistance and code hinting.
- ii) Visual Studio Code comes with an inbuilt Integrated command line terminal that initially starts at the root folder of the opened project.
- iii) Visual Studio Code has a built-in Git integration. This makes it easy to instantly see any changes that are made in the project. Git can easily be initialized in VS Code and be able to perform Git commands such as commit, pull, push, rebase, publish, and check the changes in the files. Additionally, VS

Code can work with any Git repository either locally or remotely and offers visual symbols to resolve the conflicts before the code commits.

iv) VS Code comes with a built-in debugger helps accelerate code editing, compiling and debugging looping. By default, VS Code comes with the ability to support NodeJS and can debug anything that is transpiled to JavaScript.

v) VS Code provides additional language service features such as Peek Definition, Go to Definition, Find All References, and Rename Symbol. These features are very useful and help the developer to code and debug fast.

5.3 Deployment Platform

The program source code will be deployed on the Linux Operating System that is hosted by a hosting company called Bluehost. The database is going to be deployed on XAMPP. XAMPP contains both Apache server and MySQL relational database server. The system is going to be accessed through the Uniform Resource Locator (URL) <http://sis.icuzambia.net/>

5.4 Implementation Architecture

In the implementation of the proposed system, the architecture is designed using the laravel framework. The laravel framework allows the views of the presentation layer to be designed using HTML as the User Interface, the logic of the application is designed in the controllers. The logic in the controllers handles any backend functionalities of the application. The application can communicate with the MYSQL database through the model. The model is responsible for establishing communication with the database, and in this instance, we are using the MYSQL database server.

5.5 Software Testing

The unit testing approach was adopted in testing the codes written. The procedure adopted for the unit test is;

1. The module interface is tested to ensure that information properly flows into and out of the program unit under test.

2. The local data structure is examined to ensure that data stored temporarily maintained its integrity during all steps in an algorithm's execution.

3. All the statements are executed at least once and error handling paths are tested

5.6 Documentation

Documentation of any system is very important in the development of the software application. This is because documentation makes the software application easier to all users, and if an application is not well documented it becomes difficult to use. The researcher has taken the step to document the system for users that are going to be using the system as either a system user or as a system administrator.

5.7 Hardware Requirements

The software application designed needed the following hardware for the effective operation of the newly designed system:

- i. Any computer that can go to the internet
- ii. At least 500MB of Random-Access Memory (RAM)
- iv. At least 80GB hard disk.
- vi. An Uninterruptible Power Supply (UPS) Units

5.8 Software Requirements

The software requirements for this system include:

- i. Any Linux Operating System.
- ii. Structured Query Language (MySQL)
- iii. PHP version 7
- iv. OpenSSL PHP Extension
- v. PDO PHP Extension
- vi. Mbstring PHP Extension
- vi. Laravel Framework

VI)CHAPTER SIX: SUMMARY AND CONCLUSION

6.1 Summary

In this paper, an online examination system was developed and implemented at the University of Information and Communications University, Zambia. The developed system is an examination system that enables students to write the end of semester examinations online. The examinations are prepared by the lecturers and monitored by the examinations department. The system helps the university to overcome the challenge that most universities are faced with around the country. Universities around the country are not allowed to hold any physical examinations. This is because of the COVID-19 pandemic. The government of Zambia had given a directive to restrict the number of group gatherings to 50 people. To conform to the directives of the government, ICU Zambia has developed the online examination system to enable students to write examinations online. The cost of holding physical examinations will drastically and significantly be reduced as there will be no costs associated with holding physical examinations. The system is designed using the Laravel framework. The top-down approach was adopted as the implementation approach for this project research. This involves breaking the complex system into subsystems and then into modules for easy study and understanding. The system architecture is divided into three basic parts. The first is the front end that shows the user interface designed with PHP, HTML and JavaScript, the back-end model which connects the application to the database server and different tables, at the middle is the controller; which provides the logic of the application and connectivity between the front end and the back end. The user interfaces are interactive, and provisions are made for the security of data stored. The use of the examination system is relatively simple and the I.T knowledge requirement for its usage is also relatively minimal. The system can further be expanded and more features can be added to strengthen and better it .

6.2 Conclusion

Having developed the online examination system, it is subject to modification on its features as time goes on. The developed system will help the institution to save costs that are associated with holding physical examinations. Additionally, students will also be able to save costs as they will not be required to travel just to come and write physical examinations. This is a very creative web-based application that can enforce examination rules duration the online examinations. The system only allows students that have paid for a semester to view the courses they are doing in that semester. Additionally, the student will only be able to view examination courses that have been scheduled for that particular day and at a particular time. Once the student has access to the examination paper, the examination paper will only be available for the

time scheduled. Once the scheduled time elapses for that examination, the system will automatically lock the students out of the examination paper.

6.3 Recommendations

The author wishes to make the following recommendation:

- i. Review the scope to widen the present study to ensure improvement in the existing system.
- ii. Enhance the security of the system concerning student malpractice by integrating the system with tools like a big blue button.
- iii. Other learning institutions can adopt and modify the system since it was found to be cost-effective.

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