Development of an Automated University Examination Timetabling System

Nathaniel Olufisayo Oluwaniyi, Babajide Olakunle Afeni, Bukola Abimbola Onyekwelu
Joseph Ayo Babalola University, Ikeji Arakeji, Osun State, Nigeria
Email: oluwaniyinathaniel@gmail.com, babajideafeni@gmail.com, baonyekwelu@jabu.edu.ng

ABSTRACT
Timetabling is one of the most important administrative activities that require huge attention of the school authorities in all educational institutions. Part of which has to do with examinations. Examination timetabling is sometimes a serious challenge in most universities. The objective of this work is to design and implement a web-based automated platform for university examination timetabling. The system discussed in this paper was developed using Macromedia Dreamweaver for creating the websites while MySQL serves as the database. The programming languages used consists of HTML (Hypertext Markup Language), PHP (Hypertext Preprocessor), Javascript, CSS (Cascading Style Sheets) and SQL (Structured Query Language). PHP is a scripting language that is embedded in HTML. PHP scripting code is used to connect web pages to MySQL databases to create dynamic web sites. The system was able to successfully schedule the university examination timetable within a few seconds without clashes of invigilators and examination venues. If the system is fully implemented and adopted, it will go a long way to correct the problems encountered during the manual method of examination timetabling in most universities.

Keywords: Examination, Timetabling, Programming, Automated, Web-based.

1. INTRODUCTION

Timetabling is a system of scheduling available time and resources for any operation or activity (Burke and .Newall, 2004). Nevertheless, this system has a lot of challenges which arises from the need to develop one that is effective and efficient. Wren, 1996 also noted that timetabling represented a challenging and important research area for researchers across both operational research and artificial intelligence since early 1960s. There has been a significant increase in the level of research activities in the area of timetabling. This is evidence by the advent of a series of publications and international conferences in the theory and practicality of automated timetabling system. The task of timetabling covers many aspects. There are three major parameters in timetabling. They are; (i) Set of time (T), (ii) Resources such as space i.e venue (R) and (iii) The constraints (C). In this research work, we have developed an automated and user friendly timetabling system for Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria. The system is web based which makes it easily accessible to all staff and students of the university.

1.1 RESEARCH OBJECTIVES

The primarily objective of this is to develop a user friendly and time saving automated university timetabling system for efficient scheduling of examination and allocation of invigilators.

In order to achieve the objectives due to the time constraints, the scope of the examination time table system covers the following features: Exam venues, invigilators, students' numerical strength, exam venue capacity and time slot.

2. REVIEW OF RELATED WORKS

The problem of timetabling entails allotting times and available resources in order to satisfy time scheduling constraints. There are wide range areas where timetabling is required, educational timetabling is one of the most widely studied (Momodu and Omogbhemhe, 2014). Education timetabling (lectures and examinations timetabling) is one of the most crucial and time consuming task which occurs intermittently in all educational institutions. Salwani and Hamdan, 2008 made it clear that the quality and efficiency of the timetabling greatly impacts on a wide range of different stakeholders in the institutions such as including administrators, lecturers, and students. Timetabling scheduled courses or examinations is a fundamental activity in educational institutions, these must be assigned into appropriate timeslots for students, lecturers, and classrooms subject to constraints (Burke et al., 2007). Developing feasible timetables is even more difficult when varieties of constraints are imposed. MirHassani, 2006 made it clear that resolving lectures or examination timetabling issues using the manual means is exceptionally problematic and may require a group of academic staff to work for several days without a reasonable outcome.

Allocating huge numbers of students and courses in educational institutions is a serious challenge. When manually done, clashes and unfairness are unavoidable. Clashes occur when concurrent exams are scheduled for the same student, and unfairness to a student or invigilators refers to uninterrupted exams or more than two exams on the same day. Mansour and Timany, 2007 stated that a good examination or lecture timetable should aim to minimize clashes between four main constraints which are students, lecturers, venues and time.

According to Momodu and Omogbhemhe, 2014, there are several types of timetabling in educational institution and these include master timetabling, lecture timetabling (class teacher scheduling), faculty timetabling, department timetabling, examination timetabling etc. Of all the various kinds, examination and lecture timetabling has more difficulties than others during the timetabling process because of the number of constraint and resources involved. This research work consequently concentrates on the means of planning examination timetable in the university. The objective is to highlighting the new trends in examination timetabling system developing a new automated system with online capabilities of handling the burdensome task of examination timetabling

The university policy is to schedule all examination timetables before the commencement of the examination. This is to ensure that there are no clashes of time, courses, invigilators and examination venues (Ahmadi et al., 2003). Therefore, it is the duty of all students and lecturers to locate the time and venue for all the exams they will be taking for that particular semester. It is thus the duty of the timetable scheduler to reduce to the minimum or better still eliminate the errors that may arise during the timetabling exercise. Landa (2004), explained some of the steps that must be taken in order to create an error-free timetabling in educational institutions. The steps includes:

i. Every college needs to send a request for a certain number of days and time slots to the administrative unit.

ii. The institution timetable officer from the administrative unit will allocate each college a certain number of days and available exam venues for each college is based on the combination of the request number, availability of resources and previous experience. Experience has shown that there are never enough resources to accommodate the demands of all the colleges and departments. The timetable officer also reserves a number of “spare” slots for emergencies.

iii. Each college then come up with a feasible timetable using the resources they have been assigned. Some colleges, further break down these resources to departmental level and produce a assembled timetable for the entire departments in that college.

These cycles of request and allocation continues until all the exams have been suitably and satisfactory scheduled. Although Landa (2004) made it clear that this timetabling system experienced several setbacks like any form of error for a large number of courses. Also the process is time consuming and takes several weeks to resolve which can slow down the academic activities if not well handled.

The intricacies and challenges presented by timetabling issues arises from the fact that lots of constraints some of which contradicts each other need to be satisfied. Consequently, this necessitated the need to develop a system using computer to perform this cumbersome task. A timetabling system for the Department of Electrical and Electronics Engineering, University of Agriculture, Nigeria was developed and implemented by Joseph and Jonathan (2012). The system was a huge success in the department. Yet it was limited because it was just a desktop application and can only schedule lectures for a department but not a college not to talk of the entire university. Likewise, Thatchai and Pupong (2013) developed an ordering for ant colony based timetabling system which was also efficient.

Several works have been done in the approach to solve the timetable problem. Oliveira presents a language for representation of the timetable problem called the UniLang. UniLang intends to be a standard suitable as input language for any timetable system. It enables a clear and natural representation of data, constraints, quality measures and solutions for different timetable (as well as related) problems, such as school timetable, university timetable and examination scheduling. Also Gröbner presents an approach to generalize all the timetable problems, describing the basic structure of this problem. Gröbner proposes a generic language that can be used to describe timetable problems and its constraints. The work of Chan discusses the implementation of two genetic algorithms used to solve class-teacher timetable problem for small schools.

Carter et al., 1996 introduced various searching methods on constraint satisfaction problems and demonstrated that this technique could be applied to optimization problems. Di Gaspero and Schaerf (2001) carried out a valuable investigation on a family of Tabu Search based techniques whose neighborhoods concerned those which contributed to the violations of hard or soft constraints. Also, Qu et al., (2009) developed a four-stage Tabu Search called OTTABU, where solutions were gradually improved by considering more constraints at each stage, for the exam timetabling problem at the University of Ottawa.

Duong and Lam (2004) employed Simulated Annealing on the initial solutions generated by constraint programming for the exam timetabling problem at HMCM University of Technology. Genetic algorithms have been the most studied Evolutionary Algorithms in terms of timetabling research. In particular, hybridizations of genetic algorithms with local search methods (sometimes called memetic algorithms) have led to some success in the field.

3. SYSTEM DESIGN

Macromedia Dreamweaver tool was used for creating the websites while MySQL software keeps the databases. The programming languages used consists of HTML (Hypertext Markup Language), PHP (Hypertext Preprocessor), Javascript, CSS (Cascading Style Sheets) and SQL (Structured Query Language). PHP is a scripting language that is embedded in HTML. PHP scripting code is used to connect web pages to MySQL databases to create dynamic web sites. SQL, the most common database language was used.

3.1 The System Flowchart

The flow chart depicted below summarizes the overall operation of the system.

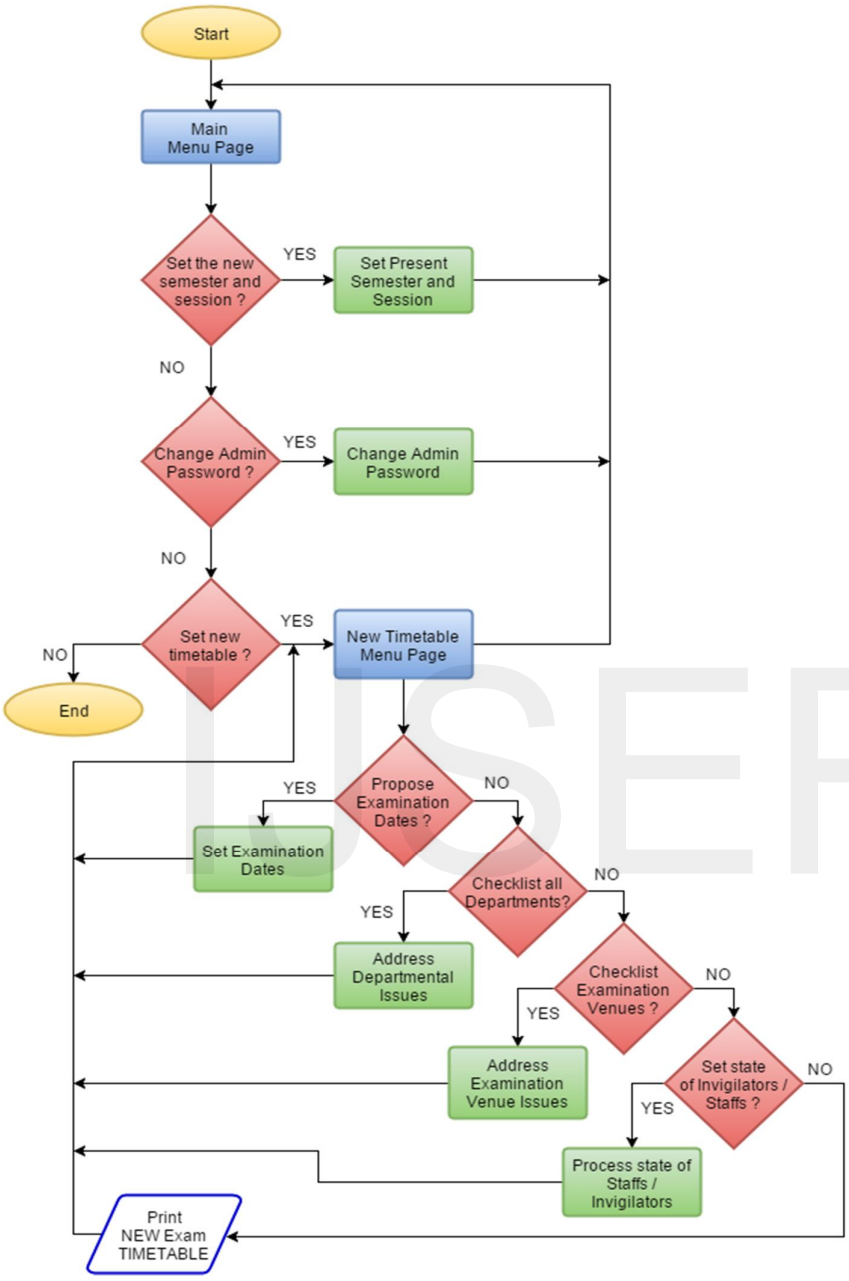


Figure 3.1: Flowchart diagram of the System

3.2 The Database Table Design

A structured collection of records is regarded as a database. During the development of the system using MySQL, two databases were created named *examtimetabledept* and *examtimetable*. *examtimetabledept* database is expected to store tables associated to all the departments in the university. Each of the tables uniquely represents each department and it contains details of courses taken from 100 Level to 700 Level. The number of tables in that database is the same

with the total number of departments in the university. For example, Computer Science, Ecology, Biochemistry, etc.

examtimetable database has limited tables which are named: administratorcheck, staff, timetable, venue, etc.

Below are the table names that were created during the development of the Examination Timetable Management System and their respective attributes.

administratorcheck

This table stores information about the current semester and academic session.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id semester academicsession	Yes	INTEGER VARCHAR(45) VARCHAR(45)	Yes Yes Yes	Yes

Table 3.1: administratorcheck table

controlsub

The controlsub table takes the username, password as well as a securityanswer of the administrator. The securityanswer is used to retrieve the password when it is forgotten.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id username password securityanswer	Yes	INTEGER VARCHAR(450) VARCHAR(450) VARCHAR(4500)	Yes Yes Yes Yes	Yes

Table 3.2: controlsub table

examdate

The table keeps details of the proposed examination dates.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id fromdate todate	Yes	INTEGER VARCHAR(45) VARCHAR(45)	Yes Yes Yes	Yes

Table 3.3: examdate table

staff

One of the functionality of the system is the ability to set state of staff members and invigilators ranging from available to invigilate exam, study leave to other cases. This table takes care of that.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id nameofstaff college department state	Yes	INTEGER VARCHAR(4500) VARCHAR(4500) VARCHAR(4500) VARCHAR(450	Yes Yes Yes Yes Yes	yes

Table 3.4: staff table

studentstrength
This table records the total number of students in each level with respective to each department in the university.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id	Yes	INTEGER	Yes	Yes
department		VARCHAR(4500)	Yes	
level100		VARCHAR(45)	Yes	
level200		VARCHAR(45)	Yes	
level300		VARCHAR(45)	Yes	
level400		VARCHAR(45)	Yes	
level500		VARCHAR(45)	Yes	
level600		VARCHAR(45)	Yes	
level700		VARCHAR(45)	Yes	

Table 3.5: studentstrengthtable

theuniversity
The table stores names of all colleges in the university.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id	Yes	INTEGER	Yes	yes
collegename		VARCHAR(4005)	Yes	

Table 3.6: theuniversity table

theuniversitydept
The table stores names of all colleges as well as the names of all departments in the university.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id	Yes	INTEGER	Yes	Yes
collegename		VARCHAR(4500)	Yes	
department		VARCHAR(4500)	Yes	

Table 3.7: theuniversitydept table

venue
This table records all the list of venues for examination in the university taking note of their capacity and availability status.

Column Name	Primary key	Datatype	NOT NULL	AUTO INC
Id	Yes	INTEGER	Yes	Yes
nameofvenue		VARCHAR(4500)	Yes	
available		VARCHAR(45)	Yes	
capacity		VARCHAR(45)	Yes	

Table 3.8: venue table

4.0 SYSTEM IMPLEMENTATION

System Requirements
The system requirements are classified into Hardware requirements and software requirements.
The following are the minimum computer hardware requirements for effective running of the web-application:

- A full computer system (keyboard, mouse and monitor)
- Minimum of 512MB RAM
- Minimum of 50GB hard disk size
- Minimum of 1.60GHz Processor speed

- An Uninterrupted Power Supply (UPS)
- A stabilizer

For this web-application to function efficiently, the following software needs to be running on the computer system:

- A Wamp server / Apache server on the local computer
- A web browser (Mozilla Firefox, Google Chrome, etc)
- Relational Database Management System (RDBMS): MySQL

5 RESULT AND DISCUSSION

5.1 Login page

The first output of this system is the system menu output where a particular user can select his/her operation. If the user is an admin he can use the Admin menu to login. On the login page, the administrator/user can log in to the system by supplying the right username and password. On that same page (the login page) there exists a link to the password retrieval page. The screen output is shown in Fig 4.1 below

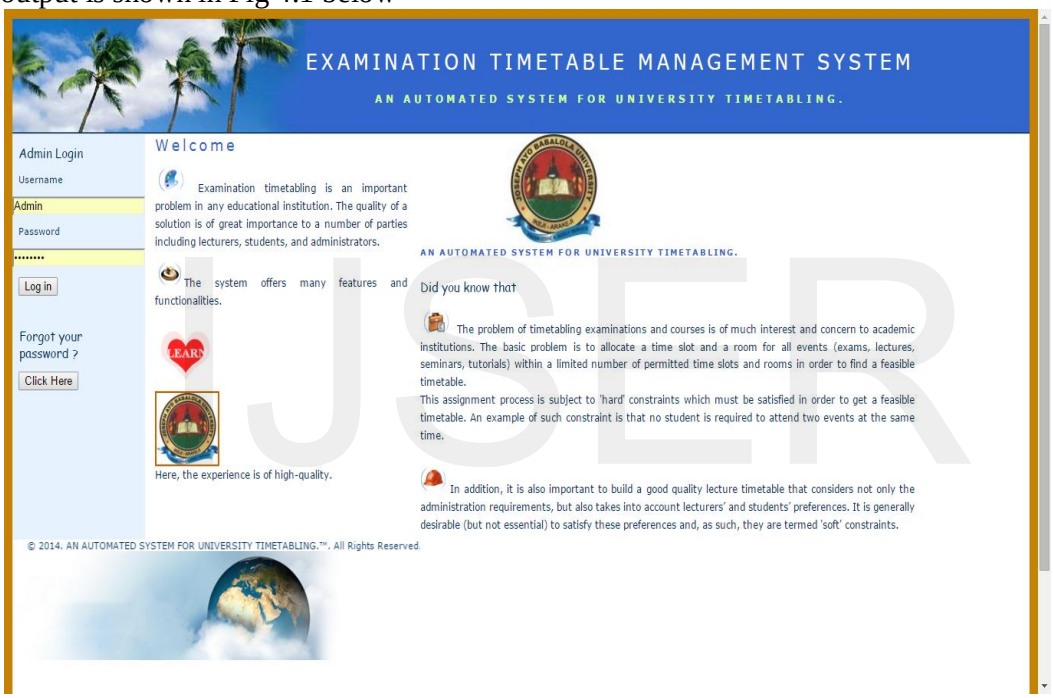


Figure 5.1: Login Page

5.2 Main page

The main page shows the summary of various options and menu available in the system.

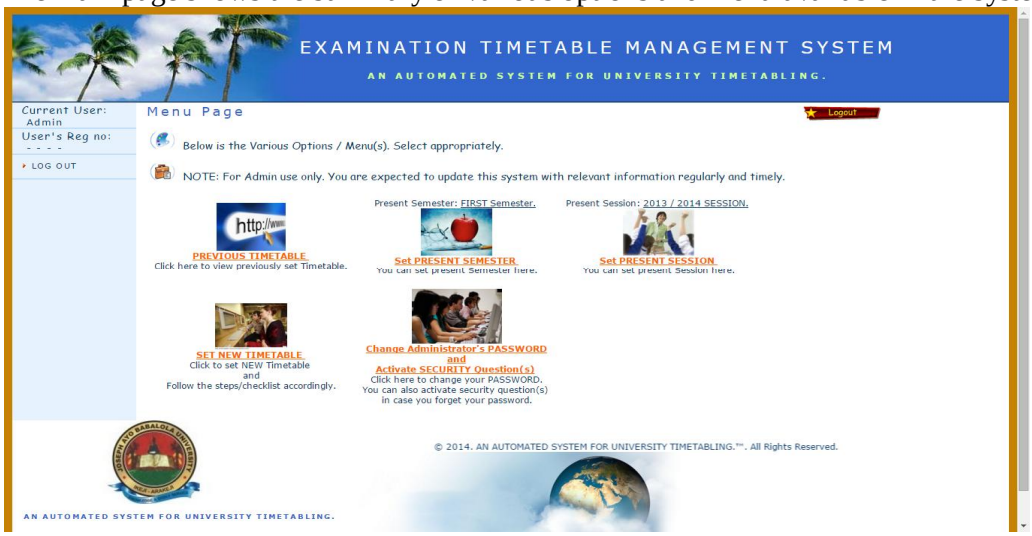


Figure 5.2: Main page

5.3 Academic Session and Semester page

The previously set Semester and Academic Session is displayed on the screen. Nevertheless, the administrator can set the new semester which may be either First or Second Semester and the new academic session from the drop down lists.

Figure 5.3: Academic Session and Semester page

5.4 New Timetable page

The New Timetable page consists of five (5) checklists. The user/administrator is expected to check, verify and update necessary information regarding the Checklist A to Checklist E before clicking on the Set New Exam Timetable button. Each of the Checklists has its own special feature and functionality.

Checklist A is for confirmation of present session, present semester, examination dates and time slots.

Checklist B deals with matters concerning all departments.
Checklist C deals with matters concerning examination venues.
Checklist D addresses the state of staffs and invigilators during the examination period.
And finally, Checklist E takes notes of issues and complains from students i.e. the exam takers. One of the issues may be avoiding a carry-over course clashing with another departmental course.

Figure 5.4: New Timetable page

5.4.1 Checklist A page

Checklist A is for confirmation of present session, present semester, examination dates and time slots. The page allows the user to set a proposed examination dates, though the dates will be subject to final changes.

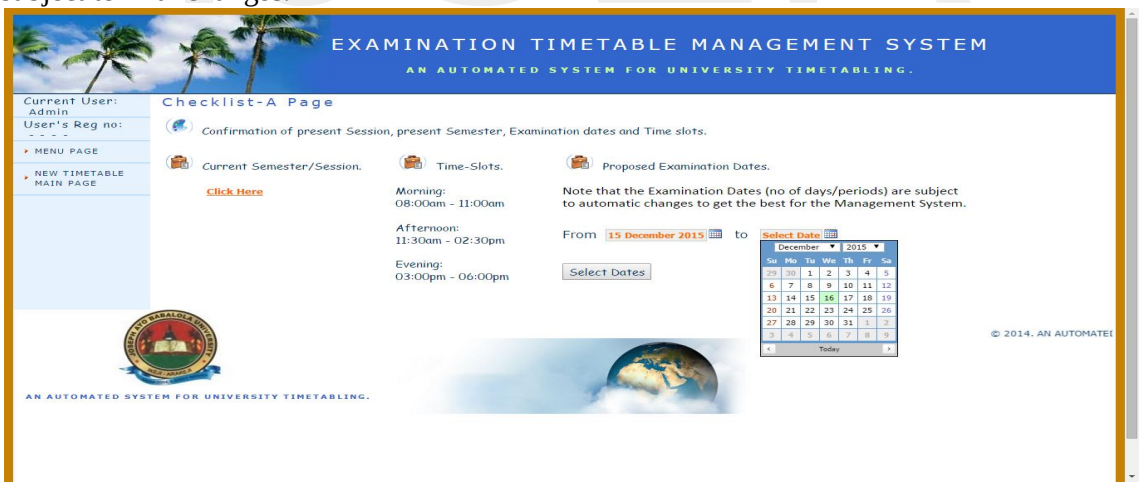
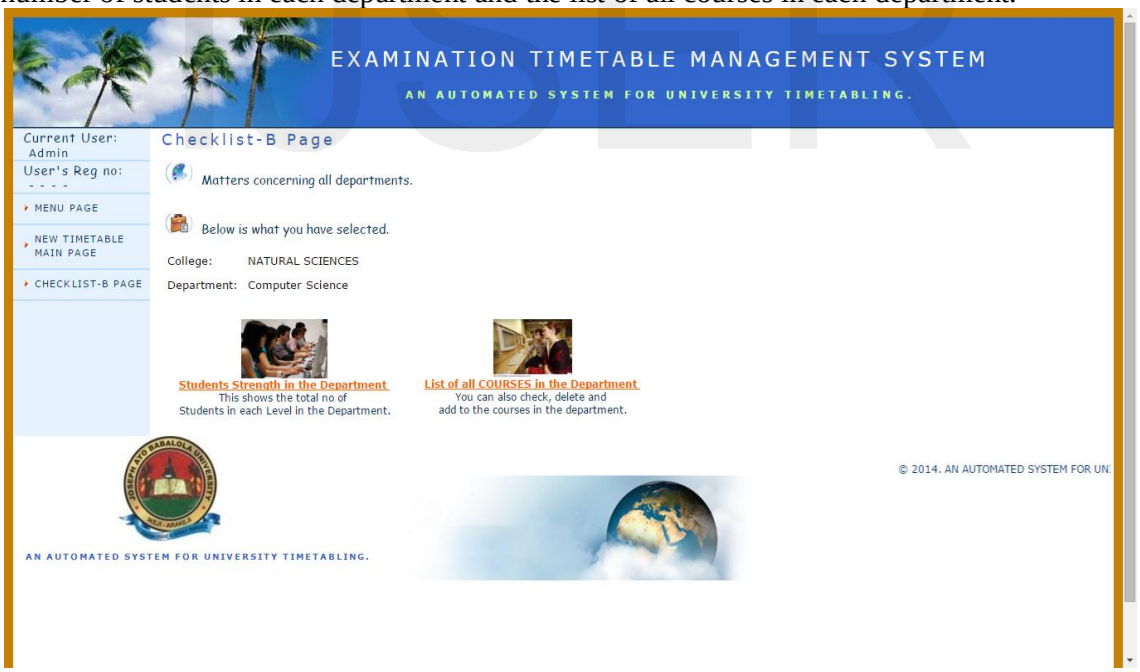


Figure 5.4.1: Checklist A page

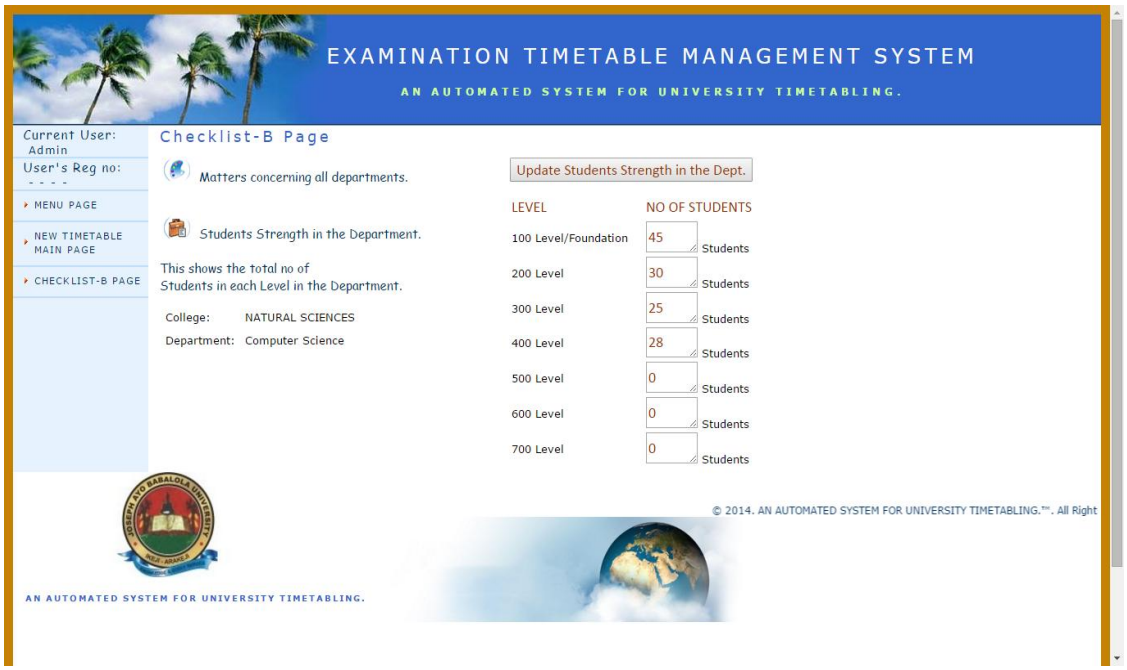
5.4.2 Checklist B page

Checklist B deals with matters concerning all departments.

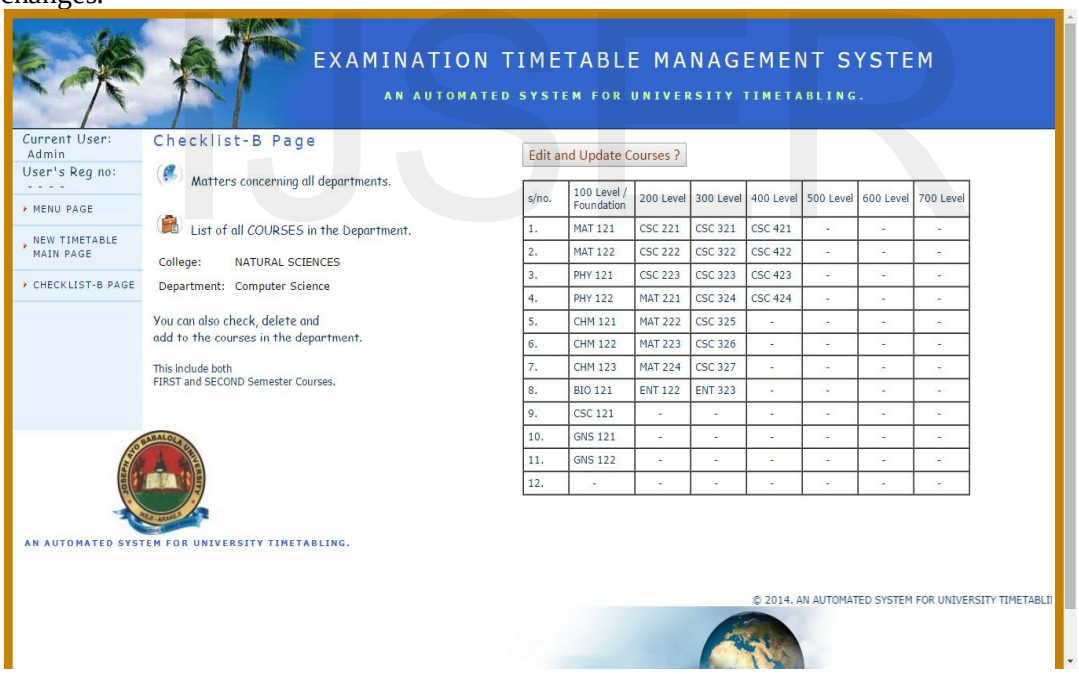
This page provides two options: Student strength in the department which indicates the total number of students in each department and the list of all courses in each department.



Here, the total number of students can be updated by the administrator.



This page shows the list of courses of all level in the department. The list is subject to subsequent changes.

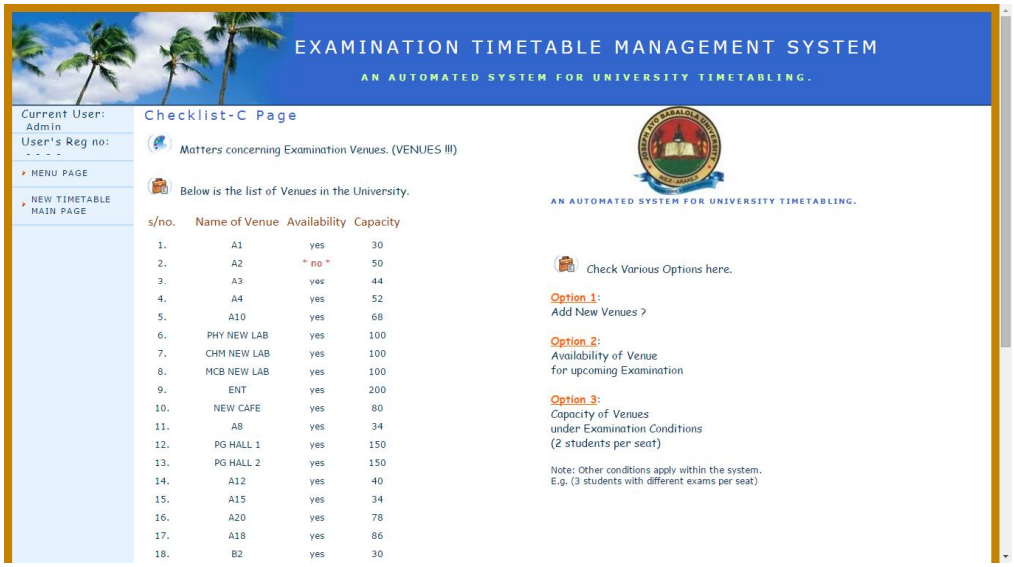


The update of the list of courses can be done here. The proper format is expected to be followed as illustrated on the screen. The courses may include both first and second semester courses. The system will sort out the semester courses accordingly.

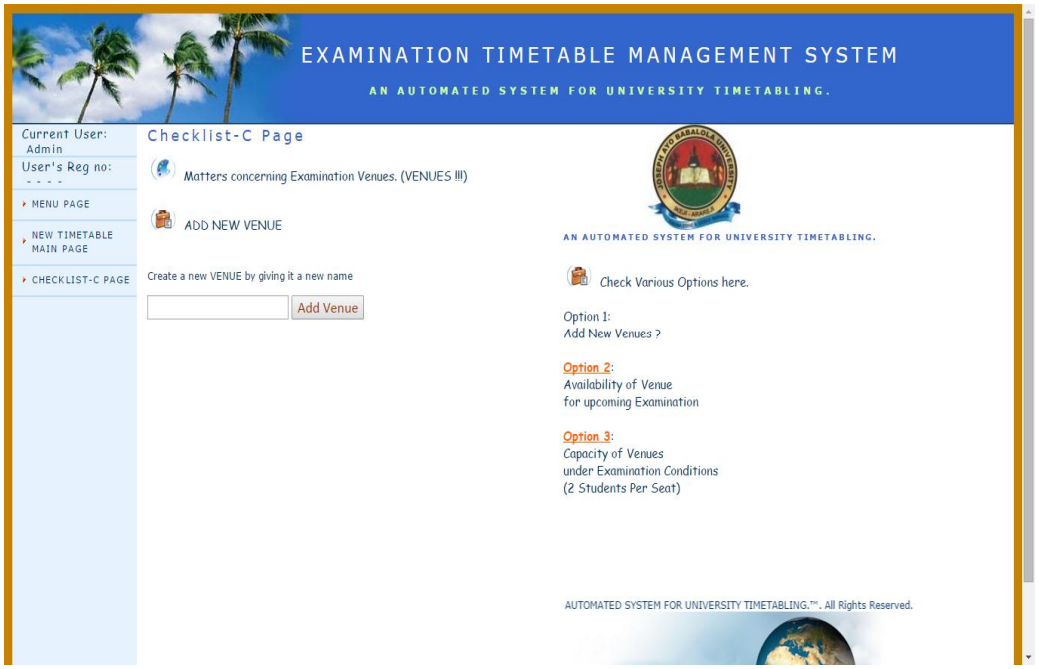
Figure 5.4.2.: Checklist B page

5.4.3 Checklist C page

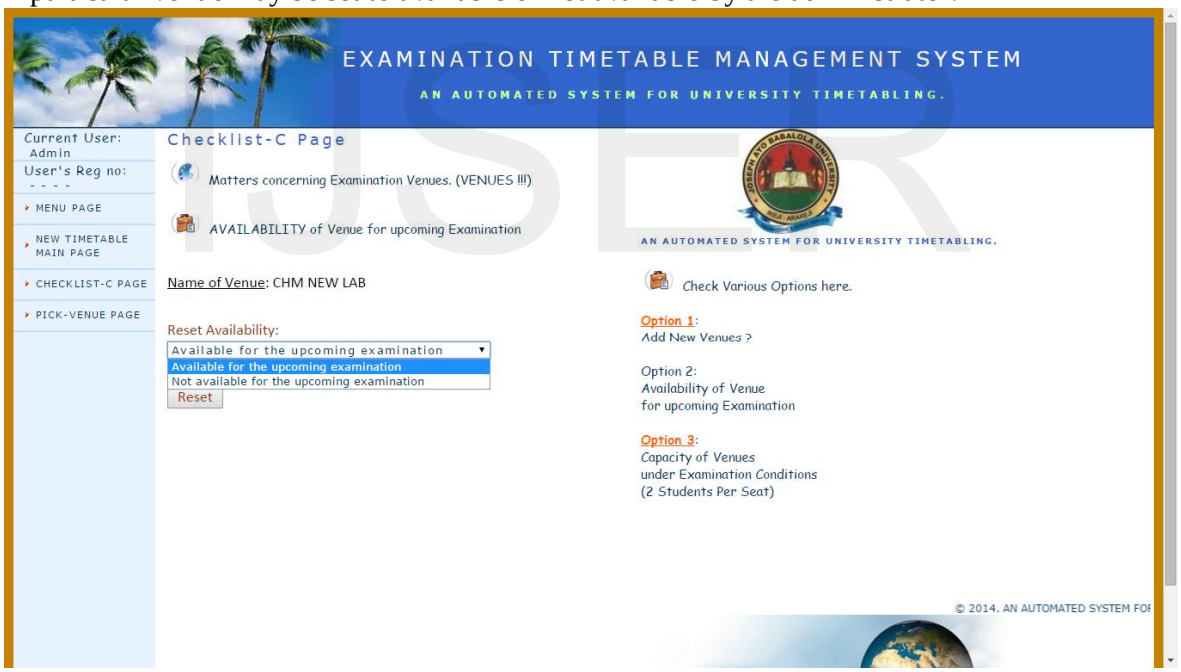
Checklist C deals with matters concerning examination venues. On the screen is a table which shows the list of venues in the university indicating their capacities as well as showing whether they are available to be used during the examination period or not. The page also allows the user to add new venues, reset availability of venue for upcoming examination and updating the capacity of venues by clicking on any of the various options indicated on the right hand side of the page.



A new venue can be created here by giving it a new name.



A particular venue may be set to available or not available by the administrator.



The administrator updates the capacity of each venues taking note of examination condition of 2 students per seat.

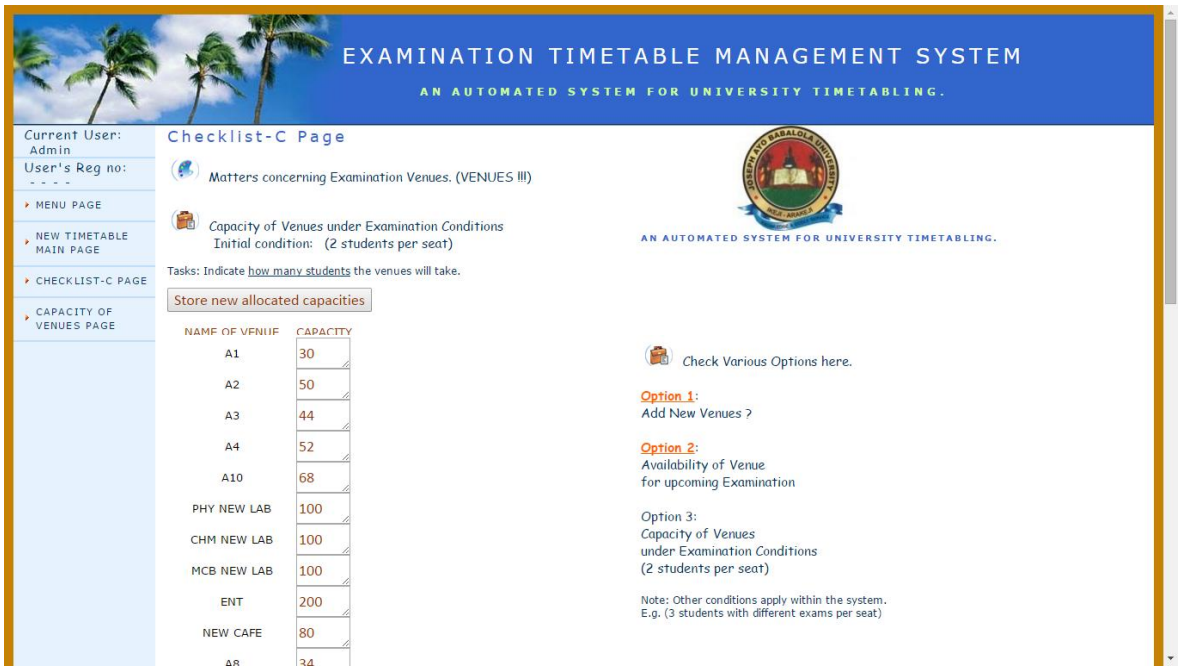
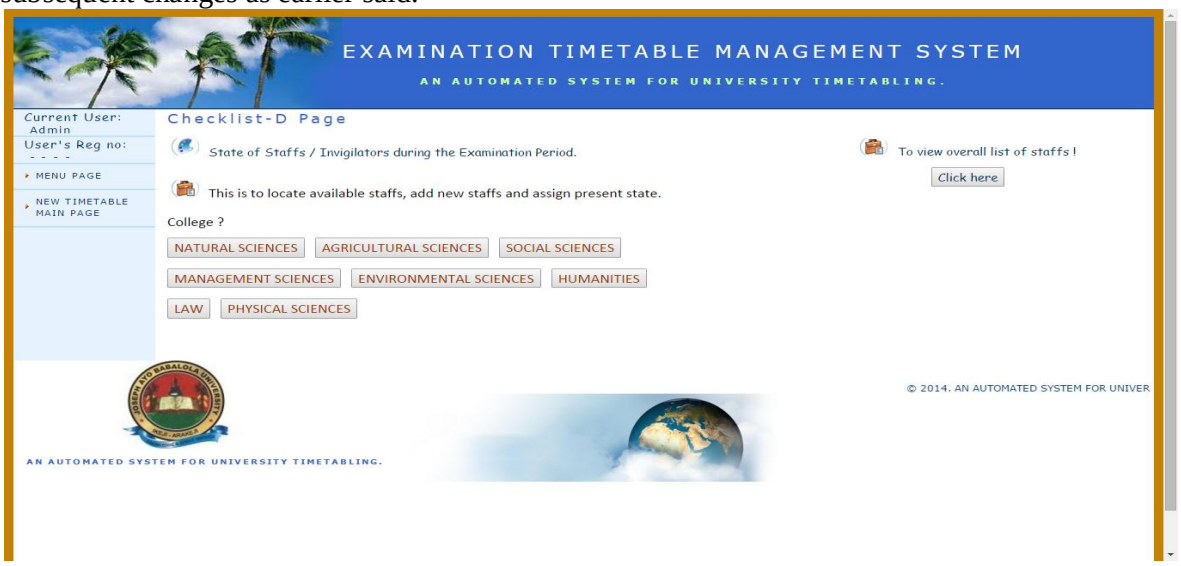
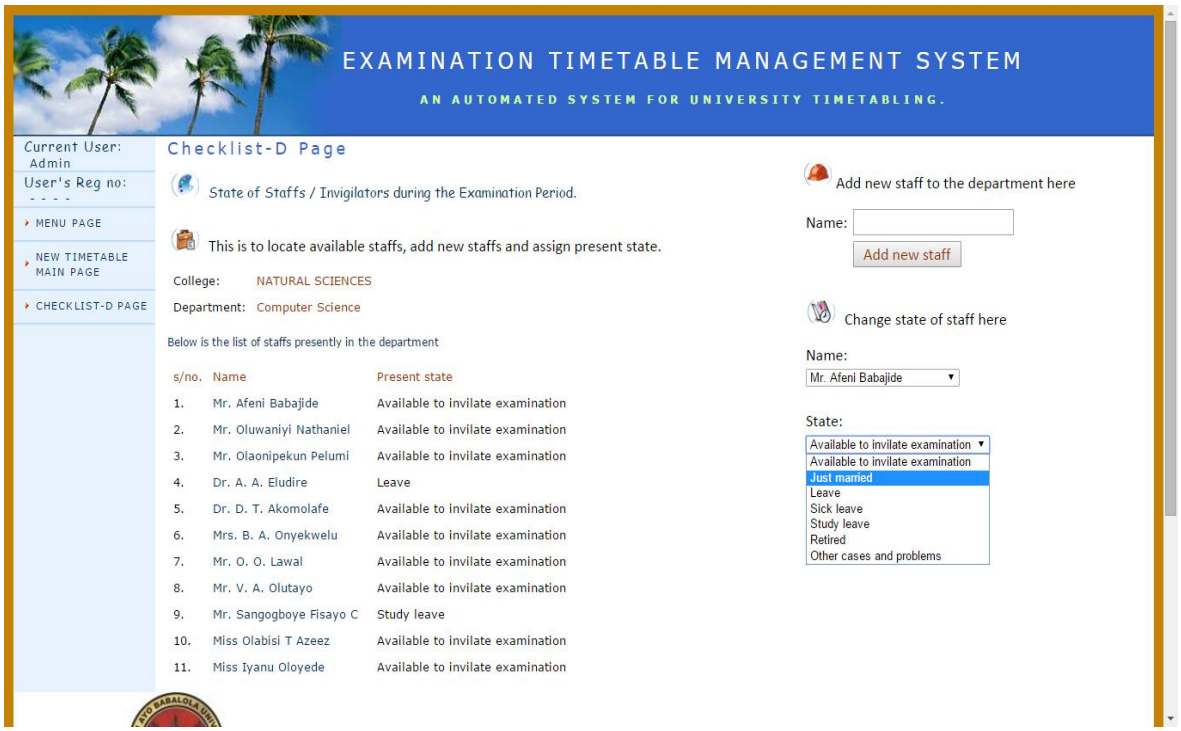


Figure 5.4.3: Checklist C page

5.4.4 Checklist D page

The page recognizes the overall list of staffs in the university. Each staff is located by clicking on the respective college to the department. Then, the state of the staff which includes some options ranging from available to invigilate examination, just married, leave, sick leave, study leave, retired, to other cases may be set. This is to prevent staffs that are on leave being allocated to invigilate examination. Another option is the possibility to add new staff in the system. The college to the department of the staff is located and the name of the staff is supplied. The default state of newly registered staffs is available to invigilate examination which is subject to subsequent changes as earlier said.





This shows the overall list of staffs in the university indicating the Staff Strength of the university.

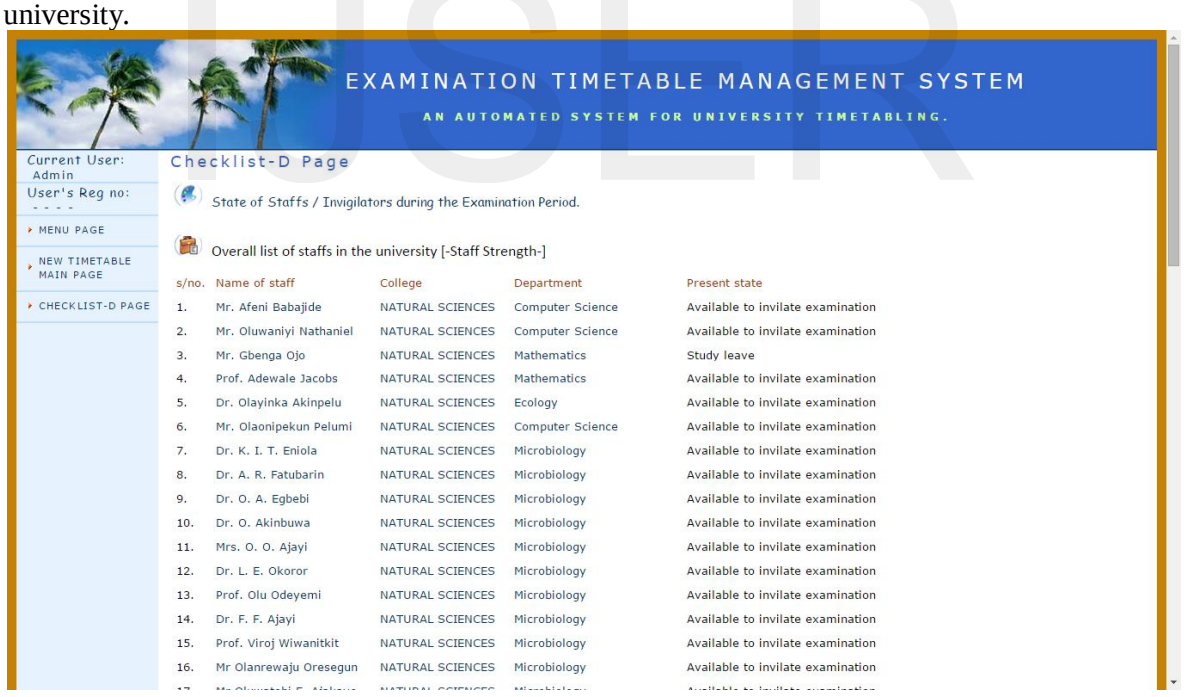
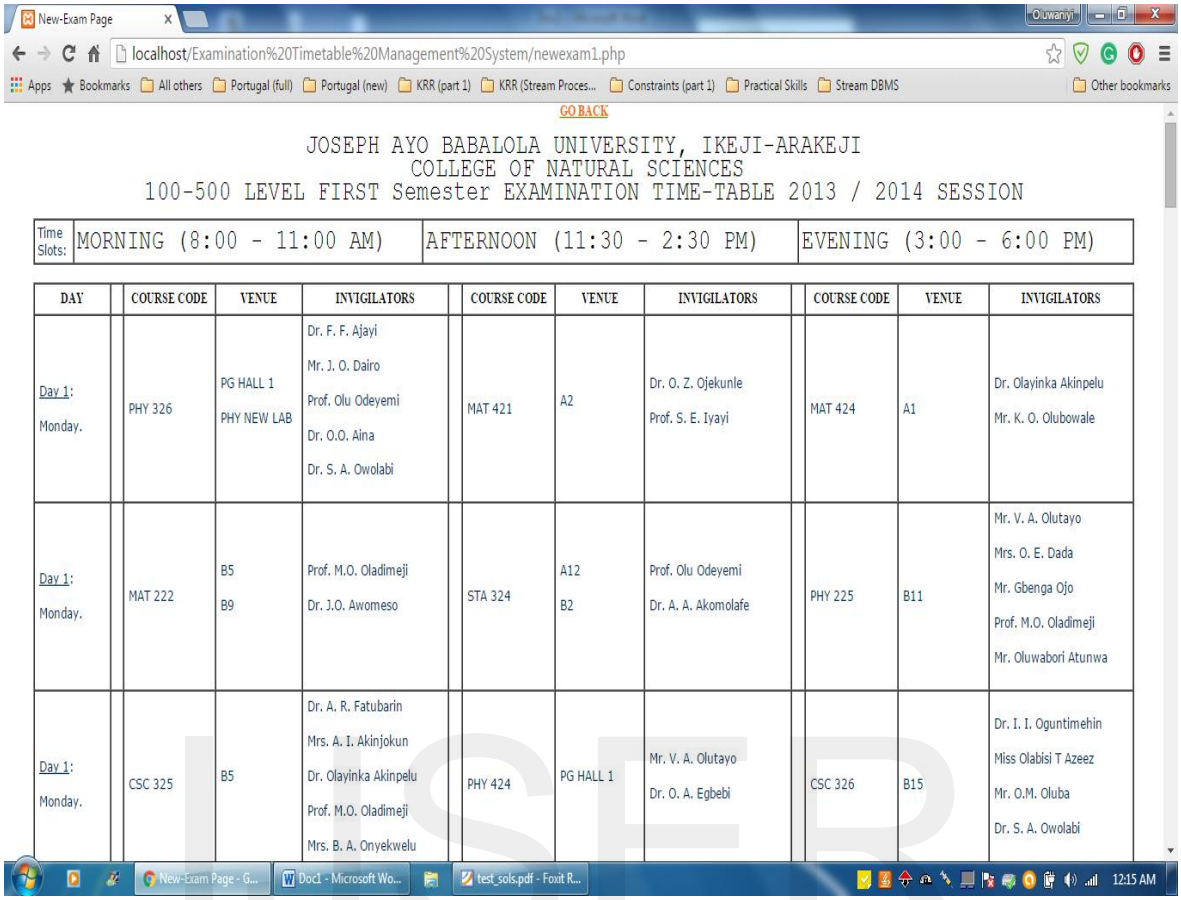


Figure 5.4.4: Checklist D page

5.5 System Output Page

Below is the output of the system which is university examination timetable showing the courses, the time and the respective examination venues obeying all given constraints. It can be printed, distributed and uploaded on the university webpage for easy access.



GO BACK

JOSEPH AYO BABALOLA UNIVERSITY, IKEJI-ARAKEJI
COLLEGE OF NATURAL SCIENCES
100-500 LEVEL FIRST Semester EXAMINATION TIME-TABLE 2013 / 2014 SESSION

Time Slots:	MORNING (8:00 - 11:00 AM)	AFTERNOON (11:30 - 2:30 PM)	EVENING (3:00 - 6:00 PM)

DAY	COURSE CODE	VENUE	INVIGILATORS	COURSE CODE	VENUE	INVIGILATORS	COURSE CODE	VENUE	INVIGILATORS
Day 1: Monday.	PHY 326	PG HALL 1 PHY NEW LAB	Dr. F. F. Ajayi Mr. J. O. Dairo Prof. Olu Odeyemi Dr. O.O. Aina Dr. S. A. Owolabi	MAT 421	A2	Dr. O. Z. Ojekunle Prof. S. E. Iyayi	MAT 424	A1	Dr. Olayinka Akinpelu Mr. K. O. Olubowale
Day 1: Monday.	MAT 222	B5 B9	Prof. M.O. Oladimeji Dr. J.O. Awomeso	STA 324	A12 B2	Prof. Olu Odeyemi Dr. A. A. Akomolafe	PHY 225	B11	Mr. V. A. Olutayo Mrs. O. E. Dada Mr. Gbenga Ojo Prof. M.O. Oladimeji Mr. Oluwabori Atunwa
Day 1: Monday.	CSC 325	B5	Dr. A. R. Fatubarin Mrs. A. I. Akinjokun Dr. Olayinka Akinpelu Prof. M.O. Oladimeji Mrs. B. A. Onyekwelu	PHY 424	PG HALL 1	Mr. V. A. Olutayo Dr. O. A. Egbebi	CSC 326	B15	Dr. I. I. Oguntimehin Miss Olabisi T Azeez Mr. O.M. Oluba Dr. S. A. Owolabi

Figure 5.5: System Generated Exam Timetable Output

6. CONCLUSION

This paper has demonstrated that the full adoption of this system model and its implementation on a large scale will go a long way to correcting the problems encountered during the manual method of university examination timetabling. The work will help reduce the difficulties faced in generating a fair and efficient timetable without any clash. This will in no doubt go a long way to enhance the smooth running of examinations and also facilitate the academic activities in institutions of higher learning.

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