

Test Driven Software Engineering for Automated Course Scheduler

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DECLARATION

We, hereby, declare that the work presented in this thesis is the outcome of the investigation performed by me under the supervision of Dr. Mumit Khan, Associate Professor, Department of Computer Science and Engineering, BRAC University, Dhaka, Bangladesh. I also declare that no part of this thesis and thereof has been or is being submitted elsewhere for the award of any degree or Diploma.

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ABSTRACT

In this thesis paper, I present details about the scheduling problem of BRAC University and make software for solving these problems. The scheduling problems are essentially the problems that deal with effective distribution of resources. During the scheduling process many constraints have to be considered. Resources are usually limited for most of the scheduling problems it has been shown that they are NP-hard, and that they can not be solved in polynomial time using a deterministic algorithm.

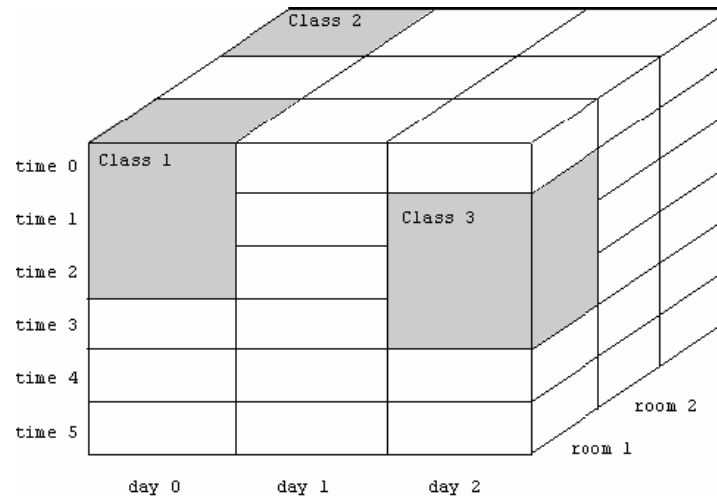


Fig. Timetable presented with 3D structure

Scheduling a timetable could also be represented like special class of 3D cutting problems. The timetable could be presented as a 3D structure. The dimensions of 3D timetables are: days (x-axis), timeslots (y-axis) and rooms (z-axis). The classes are shown as cubes, which should be placed in a 3D timetable structure. The scheduling is a process of placing those cubes into a timetable, in the way that no conflicting classes (which allocate the same resource, a student group or an instructor) are placed in the same time slot.

The BUACS (BRAC University Automated Course Scheduler) is a specialized program that can also be modified to be used as a generic Time-Table Generator to produce timetable output for a certain set of applicable system constraint. The basic requirement is to place the inputted courses in a time by room table maintaining the pre-defined constraint list for each of the courses. The document will explain the detail requirement and underlying system architecture to achieve the primary goal.

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CHAPTER 1: Introduction

1 Introduction

In BRAC University, Every semester the students have to register for different courses. At the time of registration student need to know about courses schedule and exam schedule. In the course schedule class time, lab time and tutorial class time of each course are given with teacher name and room information. In exam schedule the exam time and date of each course are given. Using these two schedule students registers four or five courses in every semester depending on class time, day, exam time and exam day. So it is very important to allocate class time, Lab time room, exam time and exam day properly so that students don't face any problem at time of attending class and final exam. But it is very hard to make a course scheduler for all the courses without clashing. And this whole process is done manually by a teacher of BRAC University which is very hard to do. He has to face many constraints at the time of making the course scheduler. And another person allocates the room for all courses manually depending on the multimedia system and room size. So I make software which can solve these entire problems automatically in very short time.

1.1 Goals and objectives

My goal is to make complete professional software which can solve all problems automatically in short time and generate course schedule and exam schedule. This software can be used by both administrator and student to find out their necessary information regarding scheduling. Currently I am making this software for BRAC University. But this software can use for making scheduling of other universities. At that time this software needs very minor update.

1.2 Problem Definition

There are many problem arise at the time of making a good course schedule. The problems faced by the schedule maker are listed below,

- **Course Clash:**

During registering many courses, two courses overlap in same time in same level of courses. This is the one of the major problem for the student. But there will be no clash on each level of courses.

- **Teacher:**

Sometimes a teacher wants to take class at the morning in a fixed time slot. Or a teacher will come to teach for a semester for a special course who wants to give time only in a fixed time slot. This is another constraint.

- **Time of making schedule:**

Designer needs many days to make a good scheduler. But it is hard to make a clash-free scheduler on minimum time.

- **Section Open:**

During making the scheduler Designer have to consider that how many sections will be opened for a particular courses depending on the all the student can take the courses. A number can be finding out by researching the previously registered student list.

- **Lab Allocation:**

Because of minimum Lab, allocating lab for all lab related course, is very hard to do.

- **Room:**

One other major problem is allocating room for all the courses depending on multimedia system. Besides Designer try to place the CSE related course in CSE building or in few particular class.

- **Others:**

Many constraints will come at the time of design of the software. And when I will go for collecting information about scheduling, then many new problem may occur.

1.3 Naming and Version Convention

The name I use to identify the system is BUACS. The version name will consist of three parts in the xx.xx.xxx format. The first number indicates major version change, the second part identifies minor version change and the last part indicates fixes, updates and minor additions. Moreover any odd number in the second part indicates evaluation or testing version and even numbers indicate stable final versions.

1.4 Previous Work

The detail project documentation of a similar system for Bilkent University at the URL “<http://www.csulb.edu/~obenli/Research/benli-botsali.pdf>” can be used to get a better understanding of how a rather similar systems development process works. Moreover it includes the basic concept on constraint programming, an integral part of representing any such problem. The document is rather well organized, containing general description along with mathematical models. To learn about the possible algorithms, one should search for “Timetable Scheduling Algorithm”. I however primarily use a simple algorithm of my choice and handle the optimization.

1.5 Outline

The remaining part of the thesis follows this outline:

Chapter 2 reviews Requirement Specification of the software

Chapter 3 will give software overview.

Chapter 4 discusses about the technology used in the software.

Chapter 4 discusses about details software design and algorithms.

Chapter 6 gives details of software making process.

Chapter 7 gives conclusion.

Chapter 8 gives references.

CHAPTER 2: Requirement Specification

2 Requirement Specification

First of all, the system stores and manipulates information relating to all courses, Room number, number of teacher and others necessary information. Then the system will place the courses into a satisfactory slot on the basis of the pre-defined constraints. Extensive search algorithms will be applied to do so. After processing the data my goal is to find the optimal solution.

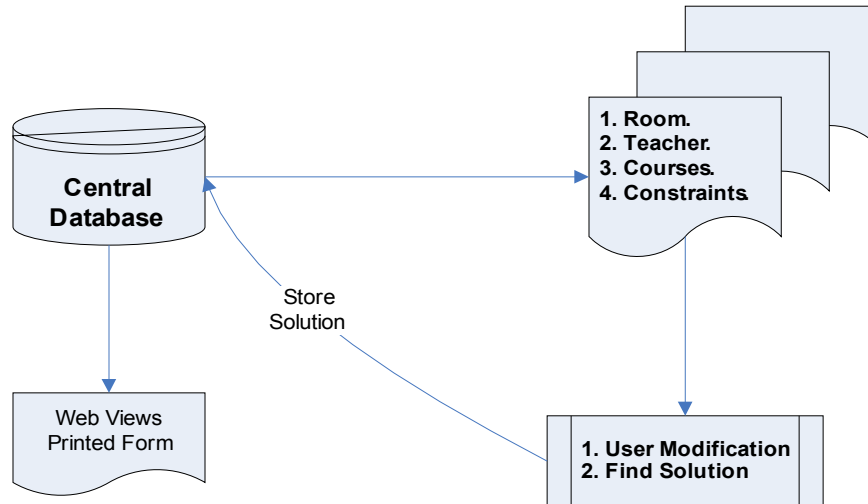


Fig. 2-1: Basic System Architecture.

After reaching my goal, a web version of the solution will give the common users a chance to view it and the administrative body can have printed output in different forms.

2.1 Functional Requirement

Functional requirements are basically the functions the system must be able to perform in order to meet the higher level user requirements. For the BUACS, the functional requirements are as follows,

2.1.1 Administration

2.1.1.1 Defining Department List

Input:

- Department ID
- Department Name

Output:

- Sorted output by Department ID or Department Name
- Update Department Name
- Delete Department
- Summary of all the Departments.

2.1.1.2 Defining Offered Courses List

Input:

- Course ID
- Course Name
- Credit
- Prerequisite
- Class
- Tutorial
- Lab

Output:

- Sorted output by Course ID, Name, Tutorial etc
- Delete or Update Course information.
- Summary of all the courses.

2.1.1.3 Defining Teacher List

Input:

- Teacher Initial
- Teacher Name
- Teacher Position
- Teacher Email Address

Output:

- Sorted output by Teacher Initial, Name, Tutorial etc
- Delete or Update Teacher information.
- Summary of all the Teacher information.

2.1.1.4 Defining Room List

Input:

- Room ID
- Room Type
- Room Location

Output:

- Sorted output by Room ID etc
- Delete or Update Room information.
- Summary of all the Room information.

2.1.1.5 Defining Constrains

Input:

- Course ID
- Fix time for class, Lab etc.

Output:

- Sorted output by Course ID etc
- Delete or Update Constraints information.
- Summary of all the Constraints information.

2.1.1.6 Allocate Course Teacher

Input:

- Course ID
- Teacher Initial.
- Section

Output:

- Sorted output by Course ID etc
- Delete or Update Allocated teacher information.
- Summary of all the Allocated teacher information.

2.1.1.7 Generating Schedule & Printed Output

Input:

- Search for a courses.
- Search for exam.

Output:

- Sorted schedule by Course ID, Room ID, Teacher ID etc.
- Delete or Update Allocated Schedule information.
- Summary of the entire schedule.
- Printed Schedule.

2.1.2 Student

2.1.2.1 View Schedule

Input:

- Search for a courses.
- Search for exam.

Output:

- Sorted schedule by Course ID, Room ID, Teacher ID etc.
- Delete or Update Allocated Schedule information.
- Summary of all the schedule.

2.1.2.2 Make Routine with Exam Date

Input:

- Course ID.

Output:

- Make Routine of the Week.
- Exam Date.
- Print Routine.

2.2 Non-Functional Requirement

The set of Non Functional requirements are the constraints that the user should know before using a system. Resources are limited and performance requirements are always at the peak. For the BUACS, the functional requirements are as follows:

2.2.1 Response Time

The response time of the system will be questionable in the following steps. They are well addressed below,

- Database Download
- Database Upload
- Processing depending of algorithm
- Report Generation

2.2.2 Throughput

The system is highly algorithm oriented and thus the actual through put will depend on the following factors,

- Total number of rooms.
- Size of the minimum time slot.
- The size of the list of constraint.
- The Hardware and Software used.
- Network connection status.
- Type of database used.

2.2.3 Resource Uses

This system is highly resource hungry. These sort of algorithm-oriented systems are always like this. The only advantage is it does not occupy the network resources for long. Moreover only one computer is needed for the system so a powerful computer should be allocated and that actually less expensive than many light weight systems.

2.2.4 Reliability

The system is supposed to be reliable. During test phase it could be pushed towards its limit, the level of reliability will increase. Actual reliability depends on the following factors,

- The reliability of the used algorithm.
- The network it is operating on.
- The effectiveness and reliability of the RDMS system.

2.2.5 Recovery from failure

The System needs to process for a very long time, so failure is evident. I have planned to use multiple checkpoints where the current state of process will be saved to make sure, in case of a failure I do not need to start from the beginning.

2.2.6 Security

The software will maintain high security. Only administrator can give input for every thing and do necessary changes. And student can only see the output view. So a security system will be maintained in the software.

2.2.7 Maintainability

The system is algorithm based, so it will be a little hard to manage the core without disturbing major components. The rest of the system will be easily maintainable and tunable.

2.2.8 Platform

The system is web based. I developed it on windows .NET Platform.

2.3 Technical Requirement

The BUACS requires various tools and resources to run properly. These resources can be classified in two groups, Hardware and Software.

2.3.1 Hardware Requirements

2.3.1.1 Server Computer

Server computer will be the One.

Database Management System (DBMS) is one of the main components of the system. The DBMS of my choice is SQL Server 2005 Express Edition which is easier to use and install and requires minimum amount of RAM.

And our data will not be so large in size. So I can use SQL Server. The application server must be a fast computer, as this system will need a lot of processing power. The memory requirements are also very high so the system must incorporate large memory modules. A reference client can be as follows,

- P4 with Dual Core 2.66GHz or higher.
- 1GB of RAM (2GB Recommended).
- SATA or SCSI HDD.

2.3.1.2 LAN Connectivity

The network requirement is as simple as high speed LAN connection. Student will use this software so LAN connectivity is needed so that they can access software from any Computer.

2.3.2 Software Requirements

2.3.2.1 Operating System

The OS of Server computer should be Windows 2000/XP/Vista. But client's computer can be anything. Because client computer need only the IP of server computer to access.

2.3.2.2 Microsoft .NET Framework 2.0

BUACS software is written by ASP.NET. ASP.NET runs in .NET Platform of Microsoft. So Microsoft .NET Framework 2.0 must installed in the Server computer.

2.3.2.3 Internet Information Services (IIS)

BUACS software is written by ASP.NET. ASP.NET use page extension .aspx. So to run aspx page, IIS of windows must be installed and enable.

2.3.2.4 SQL Server 2005 Express Edition

BUACS use SQL server 2005 Express Edition to store data. So this must be installed in the server computer.

CHAPTER 3: System Overview

3 System Overview

BUACS is BRAC University specific software for generating the class and exam schedule automatically under the given constraints. It can also be modified for any kind of scheduling problem. Another user input will be there for resource management. Additional constraints could be there to handle teacher's wishes and course allocation to the teachers. Finally a schedule generator algorithm will be there to finalize our actual purpose. Visual outputs along with printing option, in two formats will be available to meet the need of BRAC Mohakhali Campus.

3.1 Administration Section

This is the main part of BUACS Software. Only top level user of administration section can use this part of the software. In this part administrators are allowed to do the following activities:

- **Data Entry to Database:**
At first, there will no data in the database. So Administrator has to provide necessary data for all the table of the database.
- **Data View & Update:**
Administrator can view all data of the database and schedule after generate. He has the full access over software and he is able change or deletes data of any table of the database.
- **Generating Schedule:**
After giving all the necessary information to the tables. Administrators have to give command to generate schedule. After generating schedule, he can change schedule if he find any problem in scheduling or he can give command to re-generate after the changes.
- **View Schedule:**
Administrator is allowed to see the entire generated schedule.
- **Query:**
In very table, there is the facility for sorting, editing, deleting data. And administrator will get the facilities of query of data.

3.1.1 Database Tables

In the software, a SQL Server database is used named BUACS_DB.mdf. There are 13 tables in Database. All the table is listed below with details,

<u>Serial</u>	<u>Table Name</u>	<u>Table Name In Database</u>	<u>Table Type</u>
1	Department	P1_Department	Permanent
2	Course	P2_Course	Permanent
3	Teacher Table	P5_Teacher	Permanent
4	Room Type	P6_RoomType	Permanent
5	Building Table	P7_BuildingLocation	Permanent
6	Room	P8_Room	Permanent
7	Semester	C0_Semester	Changeable
8	Course Section	C3_CourseSection	Changeable

9	Constraints	C4_Constraints	Changeable
10	Teacher Schedule	Schedule1_Teacher	Changeable
11	Course Schedule	Schedule2_Course	Restricted
12	Exam Schedule	Schedule3_Exam	Restricted
13	Security	SecurityTable	Permanent

- **Permanent table(P.T.)** doesn't need to change in every semester.
- **Changeable table(C.T.)** need to change in every semester.
- **Restricted table(R.T.)** only used by Software to store data.


3.1.1.1 Department Table (P.T.)

In this table, administrators are allowed to store some basic information of all the department of BRAC University. This information will be used in the other table of BUACS. The fields are as follows.

P1_Department	
	DepartmentID
	DepartmentName


3.1.1.2 Course Table (P.T.)

In this table, administrators are allowed to store information of all the courses of all the department of BRAC University. This information will be used to know prerequisite course, class, lab and tutorial of each course. The fields are as follows,

P2_Course	
	CourseID
	CourseName
	Credit
	DepartmentID
	PreRequisite1
	PreRequisite2
	Class
	Lab
	Tutorial


3.1.1.3 Teacher Table (P.T.)

In this table, administrators are allowed to store some basic information of all the teacher of all the department of BRAC University. The fields are as follows,

P5_Teacher	
	Initial
	FullName
	DepartmentID
	Position
	EmailAddress

3.1.1.4 Room Type Table (P.T.)

In this table, administrators are allowed to store some basic information of different type of room in BRAC University. The fields are as follows,

P6_RoomType	
	TypeID
	TypeName


3.1.1.5 Building Location Table (P.T.)

In this table, administrators are allowed to store information of all the building location of BRAC University where the class is going on. The fields are as follows,

P7_BuildingLocation	
	BuildingID
	BuildingName
	BuildingAddress


3.1.1.6 Room Table (P.T.)

In this table, administrators are allowed to store information of all the room of BRAC University. Basically this table will use the information of previous two tables. The fields are as follows,

P8_Room	
	RoomID
	TypeID
	BuildingID

3.1.1.7 Semester Table (P.T.)

In this table, administrators are allowed to store information of semester whose schedule is Generating. The fields are as follows,

C0_Semester	
	Semester
	SemesterName
	Year

3.1.1.8 Course Section Table (C.T.)

In this table, administrators are allowed to store information of all the courses that BRAC has to offer with number of Section. The fields are as follows.

C3_CourseSection	
	CourseID
	NoOfSection

3.1.1.9 Constraints Table (C.T.)

In this table, administrators are allowed to allocate fix time slot for a particular course. For example if a teacher able to take class only Sunday and Tuesday from 9:30am to 11:00am. So we must have to set fix time for him. So this table is used to store this type of constraints. The fields are as follows.

C4_Constrains	
🔑	CourseID
🔑	Section
	FixTime_Class1
	FixTime_Class2
	FixTime_Lab
	FixTime_Tutorial
	FixTime_FinalExam

3.1.1.10 Teacher Schedule Table (C.T.)

In this table, administrators are allowed to allocate teacher for all the courses of each department of BRAC University. The fields are as follows.

Schedule1_Teacher	
🔑	CourseID
🔑	Section
	TeacherInitial_Theory
	TeacherInitial_Lab1
	TeacherInitial_Lab2
	TeacherInitial_Tutorial
🔑	Semester

3.1.1.11 Course Schedule Table (R.T.)

This table is used by Software or System to store the generated course schedule to database for future use. The fields are as follows,

Schedule2_Course	
	CourseID
	Section
	Day
	Time
	RoomID
	Semester

3.1.1.12 Exam Schedule Table (R.T.)

This table is used by Software or System to store the generated exam schedule to database for future use. The fields are as follows,

Schedule3_Exam	
CourseID	
Day	
Time	
RoomID	
Semester	

3.1.1.13 Security Table (P.T.)

This table is used by Software to store the administrator name and password. Using this table the system will understand who is administrator or not. The fields are as follows,

SecurityTable	
Username	
Password	
EmailAddress	

3.1.2 View & Searching

Administrator can see all data at the time of data entry. Although after generating the Schedule, there is five types of views are given in the software which will be very helpful for the administrator. They are listed below,

3.1.2.1 Teacher Schedule View

Administrator able to see details information of allocated teachers:

- for theory class of all the courses offered.
- for Lab class of all the courses offered.(If Lab available)
- for Tutorial class of all the courses offered.(If Tutorial available)

If administrator wants to change teacher for a particular course, he can do necessary change.

CourseID	Section	TeacherInitial_Theory	TeacherInitial_Lab1	TeacherInitial_Lab2	TeacherInitial_Tutorial	Semester
CSE320	1	SKZ				Spring,2007
CSE321	1	RSR	RSR	SKZ		Spring,2007
CSE330	1	MRK				Spring,2007
CSE331	1	AHM				Spring,2007
CSE340	1	MHO				Spring,2007
CSE341	1	SKZ	SKZ	RSR		Spring,2007
CSE350	1	TCH	TCH	MHO		Spring,2007
CSE360	1	SHA	SHA			Spring,2007
CSE370	1	SKZ	SKZ	RSR		Spring,2007

3.1.2.2 Course Schedule View

This is the main schedule table. Here administrator gets information of:

- time slot of Theory class, Lab class and tutorial class of each course.
- allocated Days of Theory class, Lab class and tutorial class of each course.
- allocated Rooms of Theory class, Lab class and tutorial class of each course.

If administrator found any problem in course scheduling, then he has the power to change time or day or Room of any course or re-scheduling is also allowed.

CourseID	Section	Day	Time	RoomID
CSE101	1	TUE	09:30-11:00	ST1001
CSE101	1	MON	02:00-05:00	UB307
CSE101	1	MON	02:00-05:00	UB305
CSE101	1	SUN	09:30-11:00	ST1001
CSE110	2	SUN	11:00-12:30	ST1001
CSE110	1	SUN	08:00-09:30	ST1001
CSE110	1	SUN	02:00-05:00	UB307
CSE110	1	SUN	02:00-05:00	UB305

3.1.2.3 Exam Schedule View

From this view, administrator gets information of:

- exam time of each course.
- allocated day of exam of each course.
- allocated room of exam of each course.

If administrator found any problem in exam scheduling, then he has the power to change the exam day or time or room for any course.

CourseID	Section	Day	Time	RoomID
CSE101	1	TUE	09:30-11:00	ST1001
CSE101	1	MON	02:00-05:00	UB307
CSE101	1	MON	02:00-05:00	UB305
CSE101	1	SUN	09:30-11:00	ST1001
CSE110	2	SUN	11:00-12:30	ST1001
CSE110	1	SUN	08:00-09:30	ST1001
CSE110	1	SUN	02:00-05:00	UB307
CSE110	1	SUN	02:00-05:00	UB305

3.1.2.4 Mix Schedule View

Actually this view is the Mix of Teacher, Course and Exam schedule with high level searching facilities. From this view, administrator gets information of:

- allocated teachers for theory, Lab and tutorial class of each course.
- time slot of Theory class, Lab class and tutorial class of each course.

- allocated Days of Theory class, Lab class and tutorial class of each course.
- allocated Rooms of Theory class, Lab class and tutorial class of each course.
- exam time of each course.
- allocated day of exam of each course.
- allocated room of exam of each course.

Also using searching facilities, administrator can view Mix schedule:

- for a particular Semester by selecting Semester from Dropdown List.
- for a particular course by giving Course ID in the Textbox.
- for a particular Department by giving Department ID in the Textbox.

Semester: Course ID: Department:

Course	Section	Teacher	Day	Time	Room	Exam Day	Exam Time	Exam Room
ARC102	1	TBA	SUN,TUE	08:00-09:30	ST901	DAY1	10.00-01:00	AH602
ARC112	1	TBA	SUN,TUE	11:00-12:30	ST901	DAY2	10.00-01:00	AH602
ARC123	1	TBA	SUN,TUE	12:30-02:00	ST901	DAY3	10.00-01:00	AH602
ARC202	1	TBA	SUN,TUE	11:00-12:30	ST902	DAY1	10.00-01:00	AH603
CSE101	1	MRK	MON	02:00-05:00	UB305,UB307	DAY1	10.00-01:00	AH402
CSE101	1	MRK	SUN,TUE	09:30-11:00	ST1001	DAY1	10.00-01:00	AH402
CSE110	1	MSA	SUN	02:00-05:00	UB305,UB307	DAY2	10.00-01:00	AH402
CSE110	1	MSA	SUN,TUE	08:00-09:30	ST1001	DAY2	10.00-01:00	AH402
CSE110	2	ANH	SUN	11:00-12:30	ST1001	DAY2	10.00-01:00	AH402

3.1.2.5 Day wise Schedule View

This is the very important feature for the administrator. Here administrator has to select a day from Dropdown list. Then he will see:

- How many Rooms are using in the selected day.
- How many Time slot are using for each of the Room in the selected day.
- How many Time slot are not using for each of the Room in the selected day.
- Which course is allocated for each time slot of all the Room in the selected day?

Select Day:

ROOM ID	08:00-09:30	09:30-11:00	11:00-12:30	12:30-02:00	02:00-03:30	03:30-05:00
AH603					CSE421(Sec-1)	CSE421(Sec-1)
ST1001	CSE110(Sec-1)	CSE101(Sec-1)	CSE110(Sec-2)	CSE111(Sec-1)	CSE370(Sec-2)	CSE371(Sec-1)
ST801			CSE220(Sec-1)	CSE221(Sec-1)	CSE230(Sec-1)	CSE251(Sec-1)
ST802	CSE310(Sec-1)	CSE320(Sec-1)			CSE321(Sec-1)	CSE330(Sec-1)
ST803	CSE421(Sec-1)	CSE422(Sec-1)	CSE423(Sec-1)	CSE420(Sec-1)		
ST901	ARC102(Sec-1)	ARC102(Sec-2)	ARC112(Sec-1)	ARC123(Sec-1)		
ST902			ARC202(Sec-1)	ARC202(Sec-2)	ARC224(Sec-1)	ARC225(Sec-1)
UB104	ARC302(Sec-1)	ARC311(Sec-1)			ARC326(Sec-1)	ARC327(Sec-1)
UB204	ARC402(Sec-1)	ARC411(Sec-1)	ARC412(Sec-1)	ARC413(Sec-1)		

3.1.2.6 Room wise Schedule View

This is also the very important feature for the administrator. Here administrator has to select a Room from Dropdown list. Then he will see:

- How many Time slot are using in the Week for the selected Room.
- How many Time slot are not using in the Week for the selected Room.
- Which courses are allocated in the week for the selected Room?
- Which time slots are allocated for those courses?

Select Room:

DAY	08:00-09:30	09:30-11:00	11:00-12:30	12:30-02:00	02:00-03:30	03:30-05:00
SUN	CSE110(Sec-1)	CSE101(Sec-1)	CSE110(Sec-2)	CSE111(Sec-1)	CSE370(Sec-2)	CSE371(Sec-1)
MON	MAT110(Sec-1)	MAT111(Sec-1)	PHY111(Sec-1)	PHY112(Sec-1)	CSE391(Sec-1)	
TUE	CSE110(Sec-1)	CSE101(Sec-1)	CSE110(Sec-2)	CSE111(Sec-1)	CSE370(Sec-2)	CSE371(Sec-1)
WED	MAT110(Sec-1)	MAT111(Sec-1)	PHY111(Sec-1)	PHY112(Sec-1)	CSE391(Sec-1)	
THU						

3.1.2.7 Teacher wise Schedule View

This is also the very important feature for the administrator. Here administrator has to select a teacher initial name from Dropdown list. Then he will see the class schedule of that particular teacher.

3.2 Student Section

This section provides all necessary information to student about scheduling. In this part users get some following facilities:

- **Data View:**
Students are allowed to see the information related to course, timetable, teacher, rooms and exam which necessary to know before registration.
- **Searching:**
In this software there is some searching facilities with every view which make their life easy.

3.2.1 View & Searching

Students are allowed to view some schedule with searching facilities. They are listed below,

3.2.1.1 Schedule View

Actually this view is same as the Mix Schedule View of Administrator section. From this view, students get information of:

- allocated teachers for theory, Lab and tutorial class of each course.
- time slot of Theory class, Lab class and tutorial class of each course.
- allocated Days of Theory class, Lab class and tutorial class of each course.
- allocated Rooms of Theory class, Lab class and tutorial class of each course.

- exam time of each course.
- allocated day of exam of each course.
- allocated room of exam of each course.

Also using searching facilities, student can see schedule:

- for a particular Semester by selecting Semester from Dropdown List.
- for a particular course by giving Course ID in the Textbox..
- for a particular Department by giving Department ID in the Textbox.

Semester: Course ID: Department:

Course	Section	Teacher	Day	Time	Room	Exam Day	Exam Time	Exam Room
CSE101	1	MRK	MON	02:00-05:00	UB305,UB307	DAY1	10.00-01:00	AH402
CSE101	1	MRK	SUN,TUE	09:30-11:00	ST1001	DAY1	10.00-01:00	AH402
CSE110	1	MSA	SUN	02:00-05:00	UB305,UB307	DAY2	10.00-01:00	AH402
CSE110	1	MSA	SUN,TUE	08:00-09:30	ST1001	DAY2	10.00-01:00	AH402
CSE110	2	ANH	SUN	11:00-12:30	ST1001	DAY2	10.00-01:00	AH402
CSE110	2	ANH	TUE	02:00-05:00	UB305,UB307	DAY2	10.00-01:00	AH402
CSE110	2	ANH	TUE	11:00-12:30	ST1001	DAY2	10.00-01:00	AH402
CSE111	1	MSA	SUN,TUE	12:30-02:00	ST1001	DAY3	10.00-01:00	AH402
CSE111	1	MSA	WED	02:00-05:00	UB305,UB307	DAY3	10.00-01:00	AH402

3.2.1.2 Course Offered List View

Here user can see details information of course offered list of a particular semester with prerequisite courses name and many more.

DepartmentID	CourseID	CourseName	PreRequisite1	PreRequisite2	NoOfSection	Credit
ARC	ARC102	ARC			2	2
ARC	ARC112	ARC			1	2
ARC	ARC123	ARC			1	2
ARC	ARC202	ARC			2	2
ARC	ARC224	ARC			1	2
ARC	ARC225	ARC			1	2
ARC	ARC232	ARC			1	2
ARC	ARC241	ARC			1	2

3.2.1.3 Teacher Details View

Here user can see basic information of all the teacher of BRAC University with their initial, email addresses and many more. Student might need to know about their course teacher information at the time of registration. So I add these facilities.

Initial	FullName	DepartmentID	Position	EmailAddress
AAB	AAB	CSE	LECTURER	
AHM	AHM	CSE	LECTURER	
AKA	Asraf	CSE	LECTURER	
ANH	ANH	CSE	LECTURER	
BTC	BTC	CSE	LECTURER	
MHO	Mushfiqur Rouf	CSE	LECTURER	
MRK	MRK	CSE	LECTURER	
MSA	MSA	CSE	LECTURER	

3.2.1.4 Room Details View

Here user can see basic information of all the Room of BRAC University with room type and Building location. Student might need to know about their room information at the time starting the class. So I add these facilities.

RoomID	TypeID	TypeName	BuildingID	BuildingName	BuildingAddress
AH402	CLASS	This is the Class Room	AH	Arong House	66 Mohakhali
AH403	CLASS	This is the Class Room	AH	Arong House	66 Mohakhali
AH404	CLASS	This is the Class Room	AH	Arong House	66 Mohakhali
AH503	CLASS	This is the Class Room	AH	Arong House	66 Mohakhali
AH602	WINDOWS LAB	This is the Lab	AH	Arong House	66 Mohakhali
AH603	WINDOWS LAB	This is the Lab	AH	Arong House	66 Mohakhali
AH608	CLASS	This is the Class Room	AH	Arong House	66 Mohakhali
AH610	LINUX LAB	LINUX LAB	AH	Arong House	66 Mohakhali

3.2.2 Make Routine

This is very important feature for students. Using this, a student able to make their courses routine for a particular semester. And here a smart printable system is given so that student can easily print their routine in good format. Also student can save a PDF copy of their Routine at the time of printing. Printing system is done by crystal report. So at the time of printing, first system converts the Routine into a PDF document. Then student can save a copy of their routine. And print a PDF document is know to all.

Course 1:	ARC102
Course 2:	ARC112
Course 3:	ARC123
Course 4:	ARC224
Course 5:	
Course 6:	
Course 7:	

DAY	08:00-09:30	09:30-11:00	11:00-12:30	12:30-02:00	02:00-03:30	03:30-05:00
SUN	[ARC102(1) ST901]		[ARC112(1) ST901]	[ARC123(1) ST901]	[ARC224(1) ST902]	
MON						
TUE	[ARC102(1) ST901]		[ARC112(1) ST901]	[ARC123(1) ST901]	[ARC224(1) ST902]	
WED						
THU						

CHAPTER 4: Software Technologies

4 Software Technologies

In BUACS software, I tried to use advanced technology so that it can learn new from those. The technology I used is listed below,

4.1 ASP.NET 2005

ASP.NET is a set of web application development technologies marketed by Microsoft. Programmers can use it to build dynamic website, web applications and XML web services. It is part of Microsoft's .NET Platform and is the successor to Microsoft's Active Server Pages(ASP) technology. ASP.NET is built on the Common Language Runtime, meaning programmers can write ASP.NET code using any Microsoft .NET Language.

Reason for choosing ASP.NET:

- Faster.
- Increase Performance, Stability and Developer Productivity.
- ASP.NET Code Generator is available with Visual Studio 2005. So we can make big project in less time.
- Web programming is important for BUACS types of software. Because there are lot of clients of this software. It's a better way to do that.
- In background, we can use C#. With ASP.NET. So it is very user friendly.
- Now ASP.NET is very popular in Bangladesh.
- ASP.NET programmers are popular in job market in Bangladesh.

4.2 AJAX 1.0 Extension 2.0

AJAX shorthand for "Asynchronous JavaScript and XML" is a web development technique for creating interactive web applications. The intent is to make web pages feel more responsive by exchanging small amounts of data with the server behind the scenes, so that the entire web page does not have to be reloaded each time the user requests a change. This is intended to increase the web page's interactivity, speed and usability. AJAX made popular in 2005 by Google. AJAX is not a new programming language, but a new way to use existing standards. With AJAX we can create better, faster, and more user-friendly web applications.

Reason for choosing AJAX:

- AJAX is very user friendly.
- It's a new valuable tool. And I love to use new tools.
- Using AJAX we can refresh only partial part of the aspx page which save time and become more faster. This is the main reason for using AJAX.
- Now AJAX is becoming very popular in job market in Bangladesh.

4.3 SQL Server 2005 Express Edition

SQL Server 2005 Express Edition is the next version of MSDE and is a free, easy-to-use, lightweight, and embeddable version of SQL Server 2005. Free to download, free to redistribute, free to embed, and easy for new developers to use immediately, SQL Server Express includes powerful features such as SQL Server Management Studio Express, for easily managing a database. Continue reading to learn more about the benefits of SQL Server Express Edition.

Reason for choosing SQL Server 2005 Express Edition:

- Widely used in everywhere in Bangladesh.

- It is built-in with Visual Studio 2005. So easier to use.
- Large capacity.

4.4 Crystal Report 10

Crystal Reports is a Business Intelligence application used to design and generate reports from a wide range of data sources. Its popular reporting and analysis software for Windows from Business Objects that is used to retrieve data from more than 30 types of databases. Using various Web options, queries and reports can be made via a Web browser. Crystal Reports functionality can also be added to proprietary programs written in languages such as C, C++, C#, J++, Delphi and Visual Basic.

Supported data sources:

- Database such as IBM DB2, Microsoft Access, Alpha Five, Microsoft SQL Server, MySQL and Oracle.
- Spreadsheets such as Microsoft Excel.
- Text files.
- XML files.
- Any other data source accessible through a web service, ODBC, JDBC or OLAP.

Reason for choosing Crystal Report 10:

- Best way to print data in a standard format.

4.5 CSV Output

The comma-separated values (or CSV; also known as a comma-separated list or Comma-Separated Variable) file format is a file type that stores Tabular Data. The format dates back to the days of mainframe computing. For this reason, CSV files are common on all computer platforms.

CSV is one implementation of a delimited text file, which uses a comma to separate values. However CSV differs from other delimiter separated file formats in using a "(double quote) character around fields that contain reserved characters (such as commas or new line). Most other delimiter formats either use an escape character such as a backlash, or have no support for reserved characters.

In computer science terms, this type of format is called a "Flat File" because only one table can be stored in a CSV file. Most systems use a series of tables to store their information, which must be "flattened" into a single table, often with information repeated over several rows, to create a delimited text file.

Reason for choosing CSV output:

- Microsoft Excel is popular to use and Save data. So CSV file can be open in Microsoft' Excel.

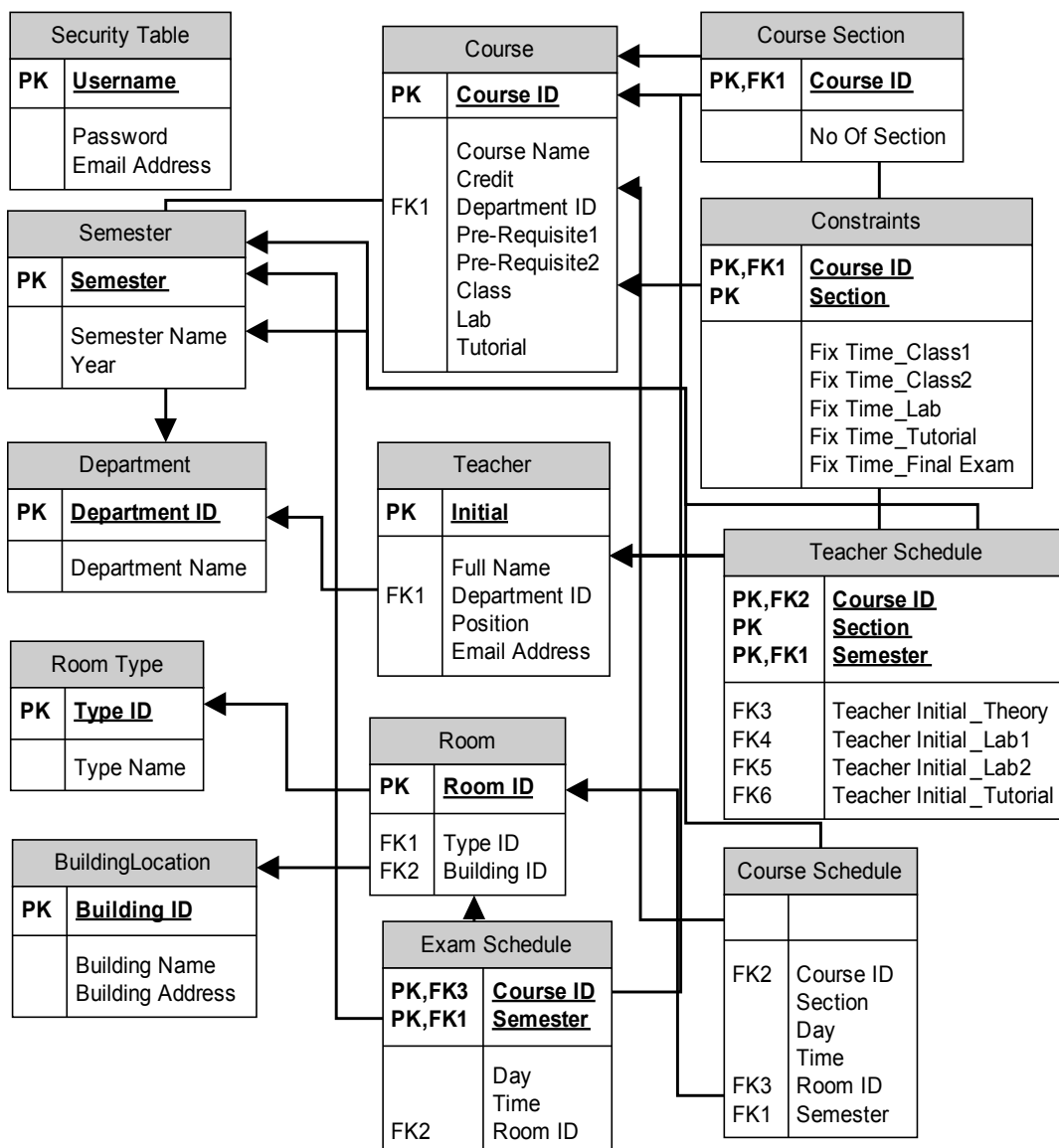
CHAPTER 5: Details Software Design

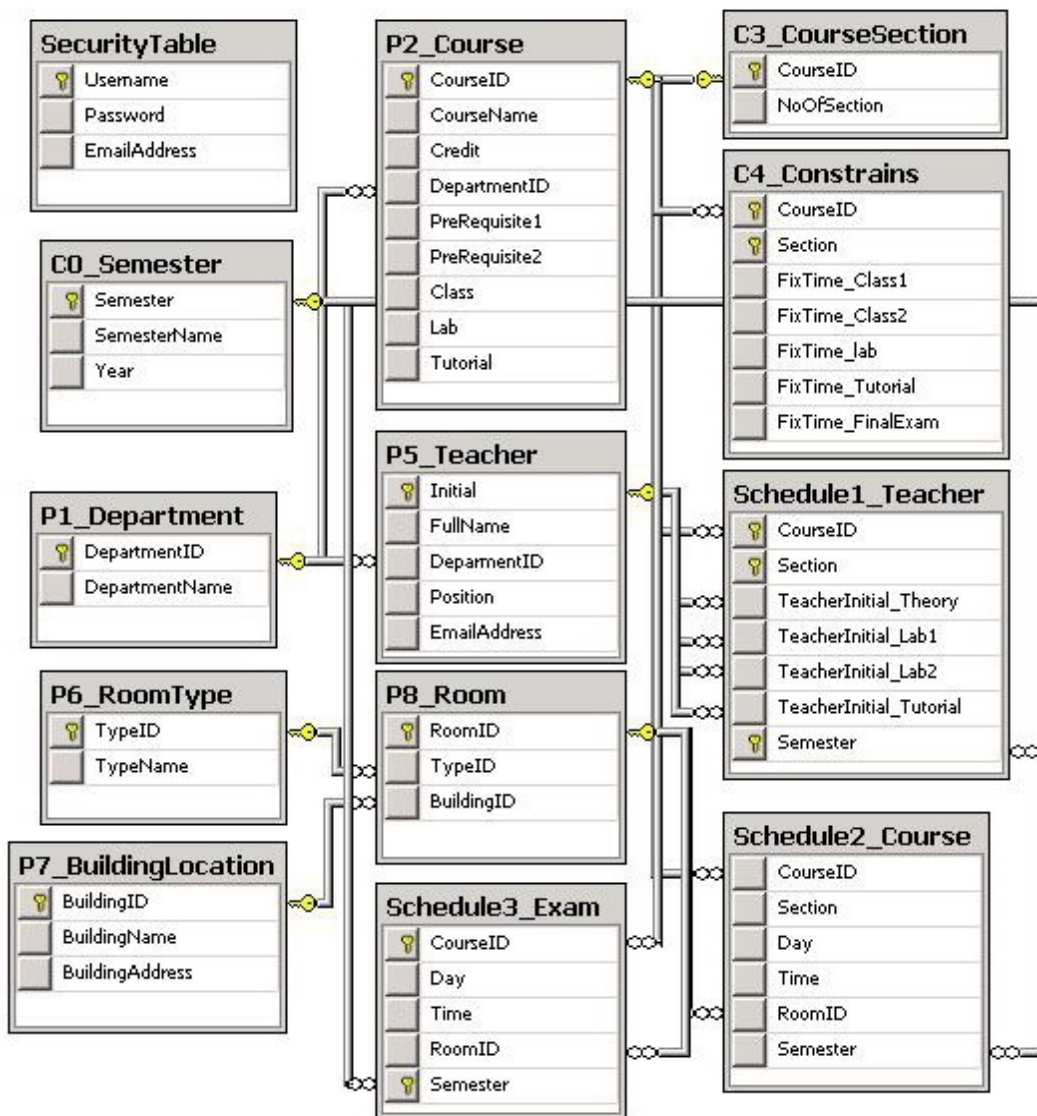
5 Details Software Design

In this chapter I will give overview on details system design of BUACS with diagram. Design processes are listed below,

5.1 Entity-Relation Diagram

The ER Diagram of BUACS is given below. I have already given the details overview on all the table of the Database in chapter 3.1.1. And in this ER diagram, the relation of all the table is given.

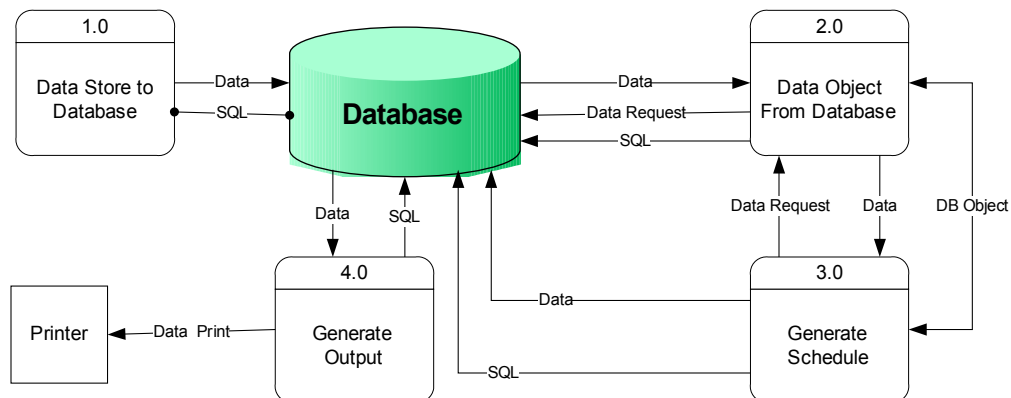




5.2 Data Flow Diagram

Top level view of Data Flow of BUACS is given below. Basically the figure says:

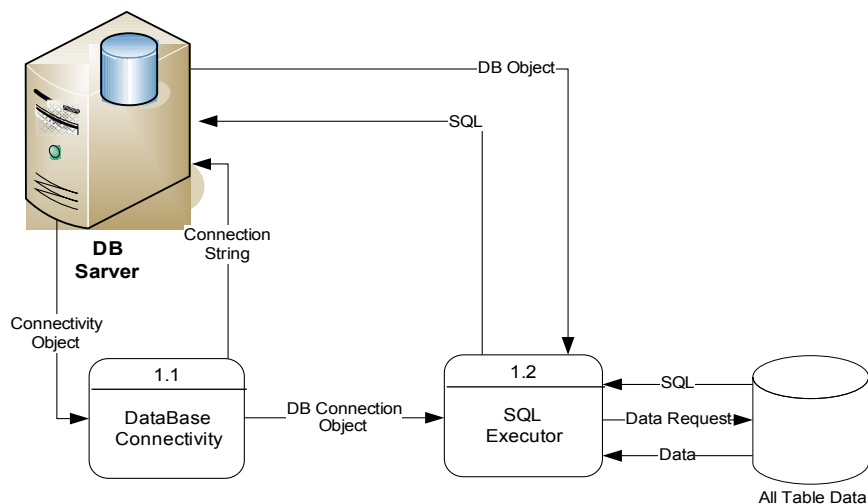
- First the system store data to Database.
- Secondly system read the data from Database to use it.
- Thirdly it generates all the schedule and Store schedule to Database.
- Finally it generate output depend on the user's demand.



5.2.1 Process 1 of DFD

This is the details of Process 1 of Top View of BUACS. This is very simple to understand. The figure says:

- First the Data Connectivity is produced.
- Secondly SQL Command is generated.
- Thirdly Data are stored to the database.

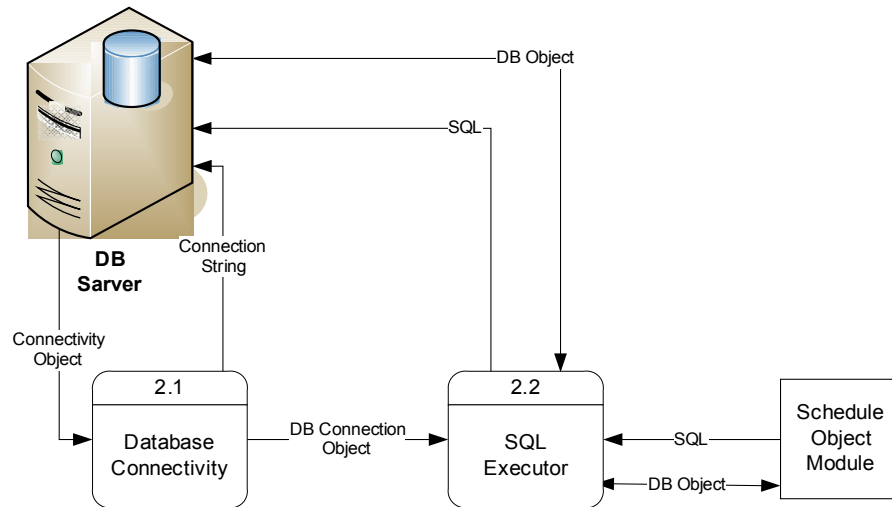


5.2.2 Process 2 of DFD

This is the details of Process 2 of Top View of BUACS. The figure says:

- First the Data Connectivity is produced.
- Secondly SQL Command is generated.
- Thirdly Data are taken by all the related module.

This is very similar to previous process. Only difference is, in process-1 system store data to database and here data is read by System to use.



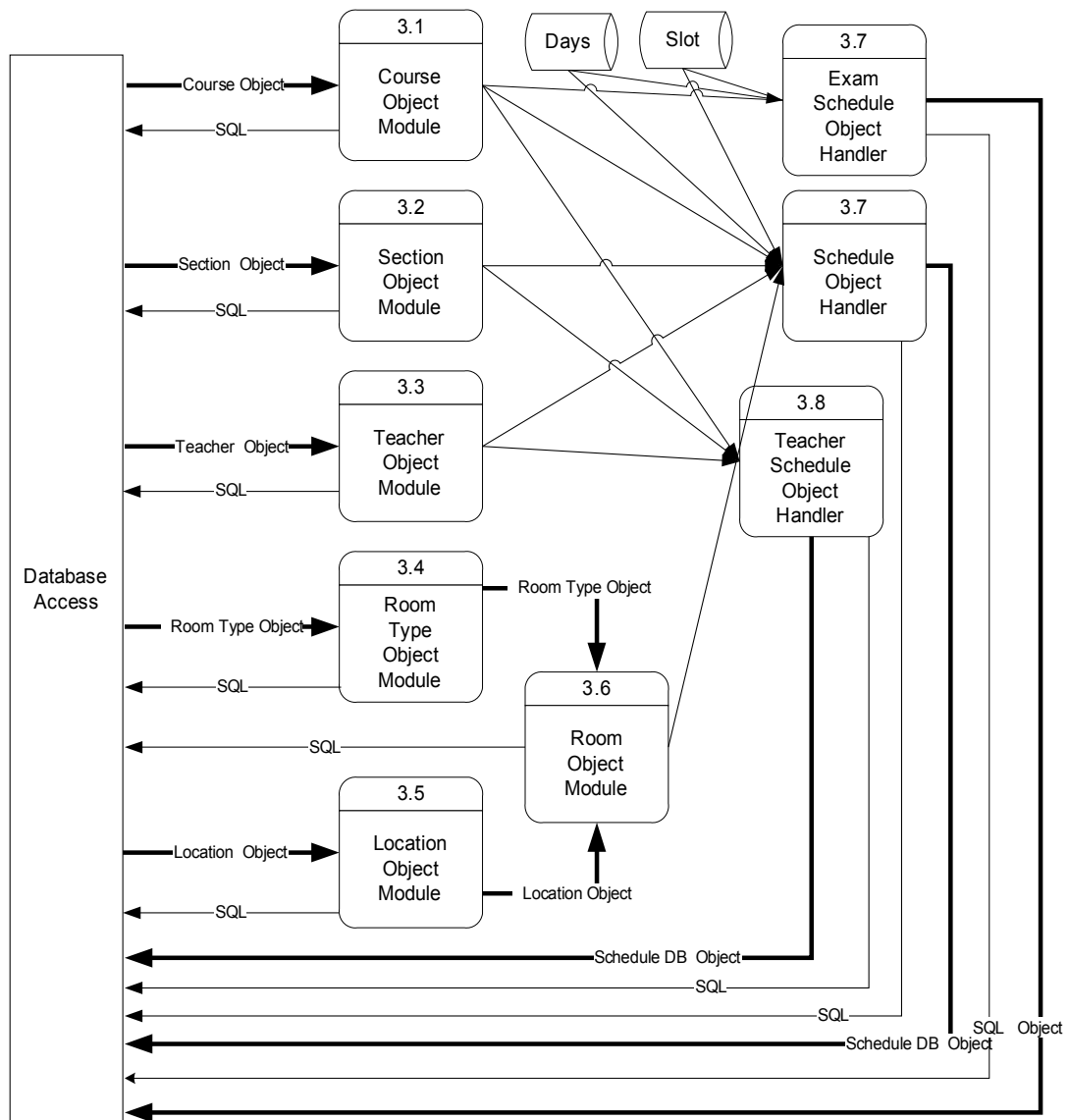
5.2.3 Process 3 of DFD

This is major part of DFD of BUACS. Basically in this part, the entire schedule is generated.

The entire object module is used to read data from Database using SQL Command. Days and time slot are fixing accordingly to BRAC University rules. And then using those modules, day and time the schedule are generated.

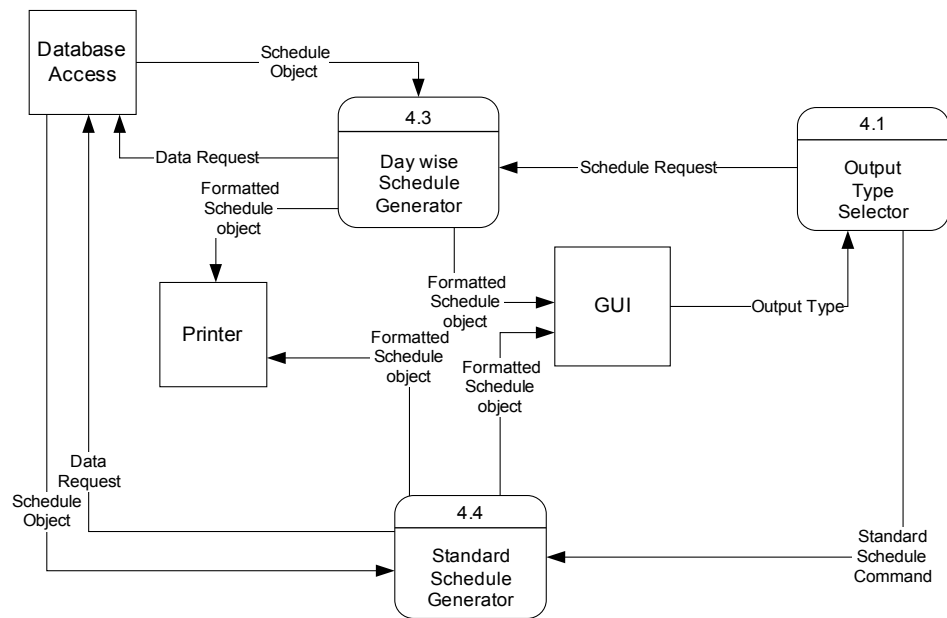
For example:

- Exam table are generated by using day, time slot and course module.
- Course table are generated by using day, time slot, course, section, teacher and room object module.



5.2.4 Process 4 of DFD

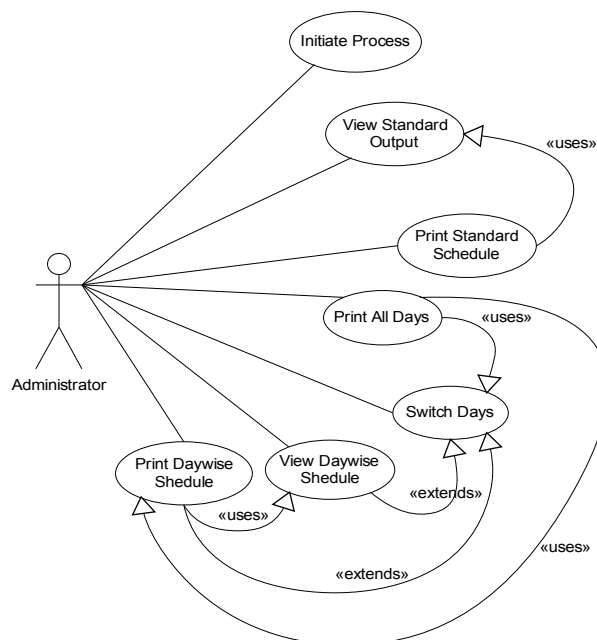
In this part, the schedule is shown to user depending on the particular input from the user. Here day wise, room wise and teacher wise view are allowed for the user and printing facilities are available are done in this process.



5.3 Use Cases

In this chapter I will give details overview on different Use Cases of BUACS. They are listed below,

5.3.1 Administrator Side



Administrator is allowed to do the following activities which are told in the figure of administrator use Cases.

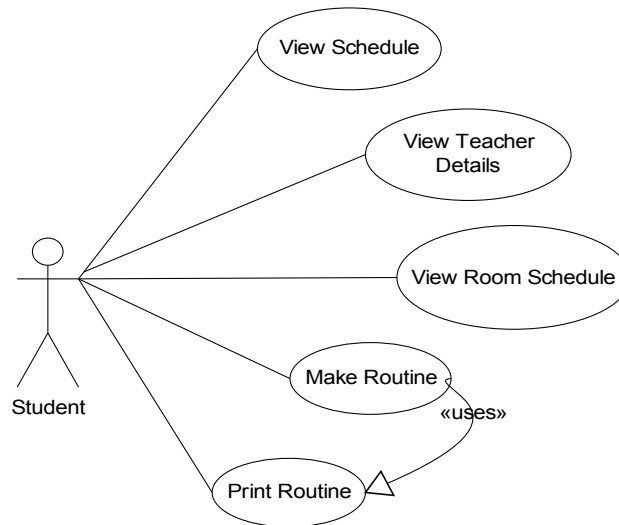
- Administrator has to initiate the processes by giving necessary data to Database.

- After generating scheduling he is allowed to see different type of output depending on the demand.
- Administrator can print output.

5.3.2 Student Side

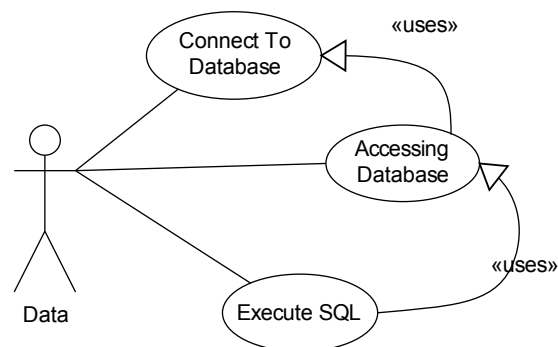
Student is allowed to do the following activities:

- Student can see some schedule.
- Student can make their routine and print it.



5.3.1 Data Side

The simple use cases of Data process given in the Use Case.



5.3 Algorithm of BUACS

This is the main part of this paper. In this type of scheduling software, algorithm plays very important role. I used techniques to solve this scheduling problem.

The step making of the algorithms are given below.

1. Choose a department(D) from Database. ($D \in ND$, where ND=Number of Department.)
2. D has L level of course. ($L \leq 6$ in BU. Where L=Max Level of Course. e.g. CSE has highest 4 level course.
3. Allocate L new Room(R) for D.
 - R1 for first level(L1) of course,
 - R2 for Second level(L2) of course.
 -
 - RL for L level(Ln) of course. [$L_n=L$]

	Day-1	Day-2	Day-3	Day-4	Day-5
Room-1 (R1)	L1	L1	L1	L1	L1
Room-2 (R2)	L2	L2	L2	L2	L2
Room-3 (R3)	L3	L3	L3	L3	L3
Room-4 (R4)	L4	L4	L4	L4	L4

4. Allocate Lab slot(LS) for L level of Course..
 - LS1 for first level(L1) of course.
 - LS2 for Second level(L2) of course.
 -
 - LSL for L level of course.

For example, In BRAC University class going on 8am to 5pm. So total 9 hour. And every class is 1.5 hour. So everyday $9/1.5=6$ slot are available for class & Lab.

In this step, algorithm allocates 2 slot for Lab for each level of Course. For example for first level of course, Lab Slot(LS1)=5 & 6 .That's mean, Labs of first level of course will be in Slot 5 & Slot 6 of any day of the week.

But For each level LS will not be same. Otherwise more labs will be needed. For example LS1=5, 6. LS2=1, 2. LS3=3, 4. LS4=5, 6. But LS4 =LS1. Because all combination is done. I have to give same Lab slot. But on new lab room.

So it is possible to take lab class upto 3rd level of course in same lab room. But for 4th level we new new lab room.

You can visualize by following table,

Lab Room-1: (Allocated for Level 1,2,3)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1 (LS2)	L2	L2	L2	L2	L2
Slot-2 (LS2)	L2	L2	L2	L2	L2
Slot-3 (LS3)	L3	L3	L3	L3	L3
Slot-4 (LS3)	L3	L3	L3	L3	L3
Slot-5 (LS1)	L1	L1	L1	L1	L1
Slot-6 (LS1)	L1	L1	L1	L1	L1

Lab Room-3: (Allocated for Level 4 only)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1					
Slot-2					
Slot-3					
Slot-4					
Slot-5 (LS4)	L4	L4	L4	L4	L4
Slot-6 (LS4)	L4	L4	L4	L4	L4

5. Allocate Class Slot(CS) for each L level of courses. All the slot will use for placing class of each level except the Lab slot (LS) of that level.

For example, for the first level course(L1), class Slot (CS1) will be,

Room-1: (Allocated for Level-1 only)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1	CS1	CS1	CS1	CS1	CS1
Slot-2	CS1	CS1	CS1	CS1	CS1
Slot-3	CS1	CS1	CS1	CS1	CS1
Slot-4	CS1	CS1	CS1	CS1	CS1
Slot-5					
Slot-6					

Room-2: (Allocated for Level-2 only)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1					
Slot-2					
Slot-3	CS2	CS2	CS2	CS2	CS2
Slot-4	CS2	CS2	CS2	CS2	CS2
Slot-5	CS2	CS2	CS2	CS2	CS2
Slot-6	CS2	CS2	CS2	CS2	CS2

And so on.

6. Place all the course of each level depends of the Class Slot(CS) and Lab Slot(LS).

[For example,

Course-1 of Level-1(L1) is denoted as L1_C1

Course-2 of Level-1(L1) is denoted as L1_C2 and so on.

For placing theory class of each level the alternate day will be chosen by algorithm. Showing below,

Room-1: (Allocated for Level-1 only)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1	L1 C1	<i>L1 C5</i>	L1 C1	<i>L1 C5</i>	
Slot-2	L1 C2	<i>L1 C6</i>	L1 C2	<i>L1 C6</i>	
Slot-3	L1 C3	<i>L1 C7</i>	L1 C3	<i>L1 C7</i>	
Slot-4	L1 C4	<i>L1 C8</i>	L1 C4	<i>L1 C8</i>	
Slot-5					
Slot-6					

Lab Room-1: (Allocated for Level 1,2,3)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1 (LS2)					
Slot-2 (LS2)					
Slot-3 (LS3)					
Slot-4 (LS3)					
Slot-5 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8
Slot-6 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8

Lab Room-2: (Allocated for Level 1,2,3)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1 (LS2)					
Slot-2 (LS2)					
Slot-3 (LS3)					
Slot-4 (LS3)					
Slot-5 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8
Slot-6 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8

All the courses of Level-1 don't have Lab. Thus all the lab is not placed. For placing lab slot showing below, in lab room-1, only 20 computers is available. But in every course there will be 40 students. So we need another Lab room for others 20 student. So Lab Room-2 is allocating.

up to this algorithm was placing the first level of course. Let's place Level -2 Courses.

Room-2: (Allocated for Level-2 only)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1					
Slot-2					
Slot-3	L2 C1	<i>L2 C5</i>	L2 C1	<i>L2 C5</i>	
Slot-4	L2 C2	<i>L2 C6</i>	L2 C2	<i>L2 C6</i>	
Slot-5	L2 C3	<i>L2 C7</i>	L2 C3	<i>L2 C7</i>	
Slot-6	L2 C4	<i>L2 C8</i>	L2 C4	<i>L2 C8</i>	

Lab Room-1: (Allocated for Level 1,2,3)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1 (LS2)	L2 C1	L2 C2	L2 C5	L2 C6	L2 C8
Slot-2 (LS2)	L2 C1	L2 C2	L2 C5	L2 C6	L2 C8
Slot-3 (LS3)					
Slot-4 (LS3)					
Slot-5 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8
Slot-6 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8

Lab Room-2: (Allocated for Level 1,2,3)

	Day-1	Day-2	Day-3	Day-4	Day-5
Slot-1 (LS2)	L2 C1	L2 C2	L2 C5	L2 C6	L2 C8
Slot-2 (LS2)	L2 C1	L2 C2	L2 C5	L2 C6	L2 C8
Slot-3 (LS3)					
Slot-4 (LS3)					
Slot-5 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8
Slot-6 (LS1)	L1 C1	L1 C3	L1 C6	L1 C7	L1 C8

And so on.

7. Store the all data in the Database.
8. If there is other department. Go to step-2.
9. End

In this algorithm i have shown only basic steps. There will more step will add. It's a very complex algorithm. It's very hard to explain in step by step. So I give a basic idea of my algorithm.

CHAPTER 6: Details Software Making Process

6 Details Software Making Process

In this chapter I will give short overview on how BUACS is made by me using programming. There are some techniques which are used in making BUACS. They are listed below,

6.1 Use Code Generator

I used Visual Studio 2005(VS2005) for making BUACS. In VS2005 code generator is built-in with VS2005. I used that generator in some cases of BUACS. Because there we don't need to think more about programming.

Advantage of using Code Generator:

- Programmer get very fast progress.
- Programmer doesn't need to think more about Programming.
- Drag and Drop facilities.
- Programming can be done by only mouse click.

Disadvantage of using Code Generator:

- Hard to understand generated Code.
- Change in generated code is difficult.
- Sometime programmer is not allowed to do root level coding.
- Can't fulfill all of programmer demand.

6.2 Writing Own Code

As I told before, Code Generator can't fulfill all my demand. So to fulfill my demand, I do root level coding. Beside I make my code suitable to the generator so that using tools I can use my own code in the generator.

6.3 Use of additional tools

I told about AJAX. This is the important additional tools I used for loading the data faster. It's not built-in with VS2005.I download it from Internet. I read their documentation and see sample software. And then I make AJAX suitable for BUACS.

CHAPTER 7: Conclusion

7 Conclusion

This chapter summarizes the major contributions of BUACS. And then it will say about future plan.

7.1 Major Contribution

At the making this software I spend more time on some part of the software. They are listed below,

7.1.1 Software Design

Before starting coding, it is very important to make a very good design of the whole software. Otherwise developer may face a big problem in the middle. Then may be they have to reconstruct the design again and may have to start coding from beginning. Thus I spend 40% time on designing.

In my case, I also change the database design two or three times. But those problem was smaller, thus I didn't get in great problem.

7.1.2 Graphical Interface

User first sees the interface of the software. So a good graphical interface is very important part of the software. Thus I try to give good interface to this software.

7.1.3 User friendly

I spend more time for making very user friendly software. If designs and algorithms are very good, but if the software is not a user friendly, then people will lose interest from the software.

7.1.4 Use of advance tools

At the time of making this software, I read lot about new tools like AJAX, Atlas and more details about ASP.NET. Also use of SQL Server was the first time for me. Basically I learned A to Z of AJAX during making of this software.

Benefit of using new tools is, we can do more in very less time and gets lot of facilities from new tools. Thus it was the major contribution area of mine.

7.1.5 Algorithm

My software is scheduling software. A very good algorithm is very essential for making this type of scheduling software. Thus I give importance on algorithm part.

7.1.6 Professional Software

I try to make this software like other professional software. Because a software has no value if the software has no professional value.

7.2 Future Update

I want to update this software in future if BRAC University uses this software for solving their scheduling problem. BUACS has the ability to solve all the problem occurs in Scheduling. BUACS can be update by Genetic Algorithm(GA). Using GA scheduling will more efficient.

CHAPTER 8: References

8 References

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APPENDIX

Glossary of Terms

AJAX	Asynchronous JavaScript and XML
ASP	Active Server Pages.
BU	BRAC University
BUACS	BRAC University Automated Course Scheduler
C.T.	Changeable Table
Constraints	A set of rules that should be maintained during timetable generation.
CSV	Comma Separated Values
FK	Foreign Key
Genetic Algorithm	A genetic algorithm (GA) is a search technique used in computer science to find approximate solutions to optimization and search problems. Genetic algorithms are a particular class of evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, natural selection, and recombination (or crossover).
IIS	Internet Information Service
GUI	Graphical User Interface, A mouse and high resolution image and icon based computer desktop environment.
Non-Clash Set	A set of course that need to be placed in the timetable in a manner such that none of them overlap each other no matter what sort of classes you are trying to place.
VS2005	Visual Studio 2005
PK	Primary Key
P.T.	Permanent Table
R.T.	Restricted Table
Timetable Scheduling	Placing one entity on a 2D or 3D space under a given constraint list and if the plane contains time line at any axis it is known as time table scheduling.