Student Management System Project

C Programming User Guide

1st Version V1

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1.0 Scope and Delimitations

The main aim of this project is to develop a Student Management System prototype by using Circular Queue or “First in First Out (FIFO)” Data structure algorithm. Such a system was pragmatically employed to insert, delete, organize, update, find, display, and monitor recorded data of students within the created database. The Circular Queue algorithm implementation was assessed in terms of its performance and effectiveness in sorting out the student’s data into and out of the Queue database. The type of memory allocation used for storing the student information throughout the database was statically allocated rather than dynamically for the project first released version V1. During the system design, a user-friendly approach was adhered to optimally enhance the user’s overall experience upon the actual employment of the program.

2.0 System Representation & Overview

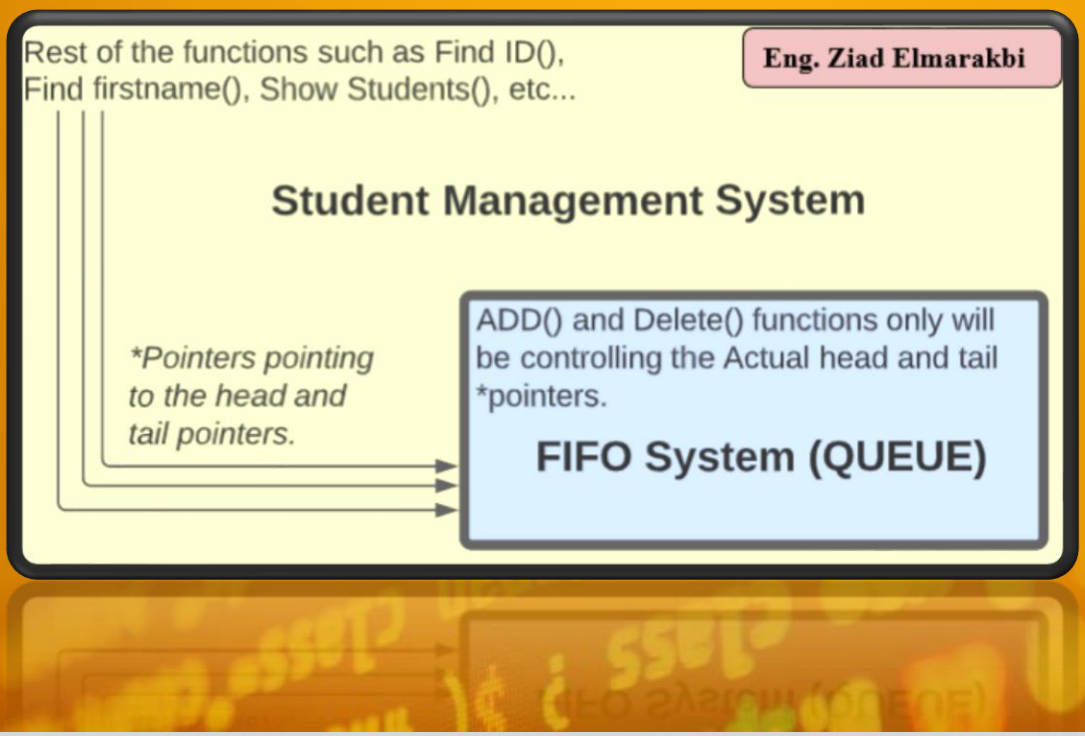
2.1 System Layout

A successfully designed system requires modularity and abstraction. Abstraction simplifies the complexity of the system into a digestible model which can be easily comprehended by other developers or clients. Ideally, dealing with the "Bigger Picture" instead of diving into specifics which might induce vagueness and complete confusion. Subsequently, Modularity implies that the written script at the Operating System layer (OS) can be reusable upon making changes at the Hardware Abstraction Layer (HAL). Thus, the program doesn't have to be completely readjusted to be usable. Which is optimal for future modifications.

In this project, the ideology of Modularity was implemented to structurally organize the code and eliminate any kind of dependencies between a function and the other. Consequently, the student management system was designed in such a way so that the Queue system has its own set of functions for initializing the FIFO elements, as well as enqueuing, and dequeuing into the Queue array. The FIFO elements are the elements which control the operation of the data flowing into and out of the Queue array. Those elements are the head, tail, and base pointers, as well as count, and length integers. During the Queue initialization, all pointers are pointing to the address of the first element of the queue array {&array [0]}. The count variable is set to 0 and the length is set to the maximum size the array can hold. The head pointer will increment to point to the next element of the array upon adding a new element so it's the fundamental player when enqueuing data. The tail pointer will also increment to point to the next element. However, it will lose reference of the first element which will make the first element turn into a garbage data. **i.e.,** deleted data. Thereby, making the tail pointer the main player for tailing out or dequeuing the data.

The third and the most undeniably critical pointer used is the base pointer. Such a pointer is what separates between an ordinary Queue and a circular queue. This pointer acts as an anchored reference for the head and tail pointers to return back to. In a circular queue, when both pointers, “the head and tail” reach to the last element of the array, they have to jump back the first element again to insert any new data. Assuming that at least the first element in the array was dequeued (or the tail moved to the next element). So that when the new data is added, it doesn’t overwrite onto a preexisted data. In comparison with the ordinary Queue, deleting an element requires the rest of the elements in the array to be shifted to fill the void where the deleted data was tailed out.

During the insertion or deletion operations, the count variable keeps on incrementing or decrementing one unit respectively. As long as the count didn’t reach to the maximum length or is still not zero. There will still be accessibility for inserting or deleting from the Queue. Otherwise, the Queue will return FULL or EMPTY status respectively. In coherence with the developed student management system, it was intended that the head or tail are operating into the Queue only when adding or deleting a student. However, when finding, updating, or showing a student or more. Additional set of pointers were created to point out to where the head or tail was currently pointing at. which will prevent changing the state of the head or tail. Thus, optimally enhancing the effectiveness of the system. Since by altering the state of the head or tail pointers by just finding, updating, or showing a student. Monitoring or keeping record of the system state will be a very tedious and complex task specially when the database volume is large. Which will result in a lengthier script with less readability. The figure below shows a clear illustration of the **System Layout**.



2.2 Functions & Header Layouts

Header File Layout:

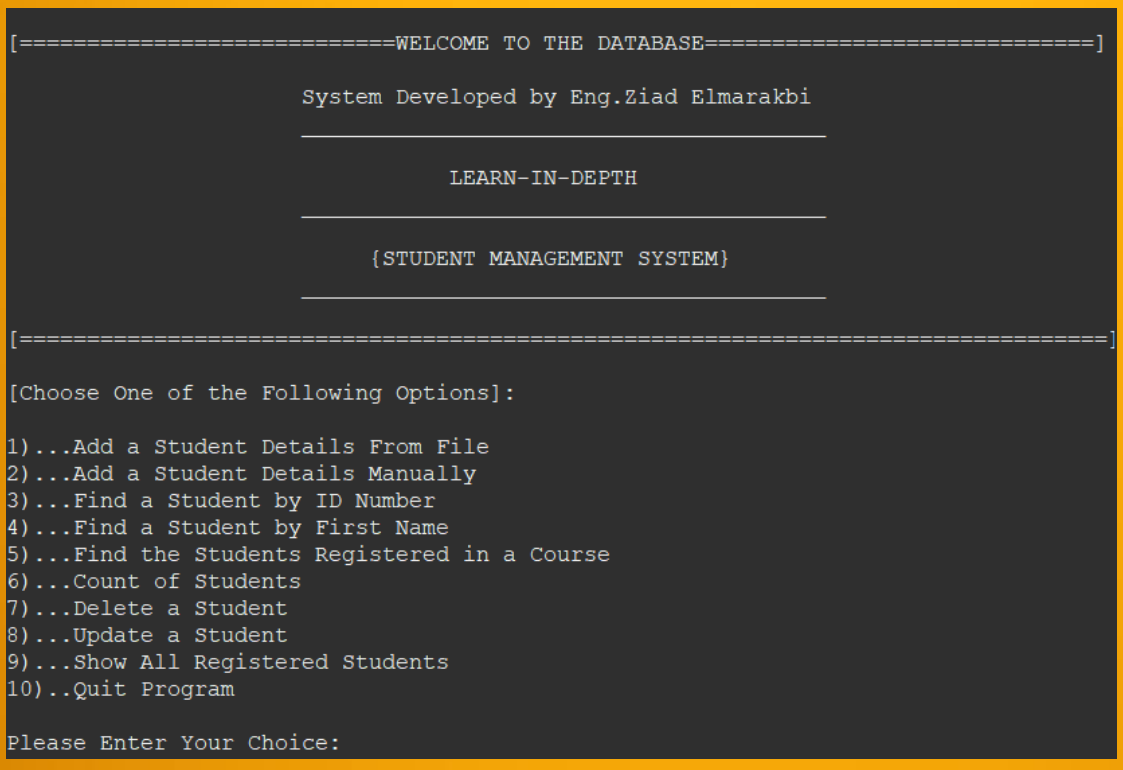
```c
// header Protection
#ifndef SYSTEM_H_
#define SYSTEM_H_

#include "stdio.h"
#include "stdlib.h"
#include "stdint.h"
#include "string.h"
#include "stdbool.h"
#define size_limit 5
#define string_size 15
#define courses_count 5

#define DPRINTF(...) {fflush(stdin); \
        fflush(stdout); \
        printf(__VA_ARGS__);\
        fflush(stdin); \
        fflush(stdout);}

typedef struct{
    char firstname[string_size];
    char lastname[string_size];
    uint32_t rollnum;
    double gpa;
    uint32_t courseId[courses_count];
}Sstudent;

typedef struct {
    Sstudent* base;
    Sstudent* head;
    Sstudent* tail;
    uint32_t count;
    uint32_t length;
}fifo_student;

typedef enum {
    fifo_no_error,
    fifo_null,
    fifo_full,
    fifo_empty
}fifo_status;

typedef enum {
    system_no_error,
    system_has_error
}Function_status;

// --------------------------System APIs--------------------------//
void welcome(void);
Function_status QueueEmptyCheck(fifo_student* fifo_p);
Function_status Add_stud_manually(fifo_student* fifo);
Function_status Reg_studs_bycourseId(fifo_student* fifo_p);
Function_status Update_stud(fifo_student* fifo_p);
Function_status studs_count(fifo_student* fifo_p);
Function_status delete_stud(fifo_student* fifo);
Function_status Find_stud_byId(fifo_student* fifo_p);
Function_status Find_stud_byFirstName(fifo_student* fifo_p);
Function_status Add_stud_fromfile(fifo_student* fifo_p);
void count(uint32_t countstud);
void show_stud(Sstudent* temp, uint32_t i);
void print_all(fifo_student* fifo_p);

// --------------------------FIFO APIs--------------------------//
fifo_status fifo_init(fifo_student* fifo_p, Sstudent* student, uint32_t length);
fifo_status fifo_enqueue(fifo_student* fifo_p, Sstudent* student);
fifo_status fifo_dequeue(fifo_student* fifo_p);

#endif /* SYSTEM_H_ */
```

System File Layout:

```c
#include "system.h"

fifo_student fifo_p; // FIFO Object
fifo_status status; // FIFO Status Object
uint32_t countstud1 = 0, add2loop = 0,  Reserved; // Global Counters
Sstudent student[size_limit]; // Array of Structures

//--------------------------------System FUNCTIONS-----------------------------------//

void welcome(){

    // Initializing QUEUE array
    status = fifo_init(&fifo_p, student, size_limit);

    DPRINTF("\n[============================WELCOME TO THE DATABASE============================]\n\n");
    DPRINTF("                      System Developed by Eng.Ziad Elmarakbi\n");
    DPRINTF("                      ______________________________________\n\n");
    DPRINTF("                                LEARN-IN-DEPTH\n");
    DPRINTF("                      ______________________________________\n\n");
    DPRINTF("                           {STUDENT MANAGEMENT SYSTEM}\n");
    DPRINTF("                      ______________________________________\n\n");
    DPRINTF("[================================================================================]\n\n");

}

Function_status QueueEmptyCheck(fifo_student* fifo_p){

Function_status QueueFullCheck(fifo_student* fifo_p){

Function_status Add_stud_manually(fifo_student* fifo){

Function_status Add_stud_fromfile(fifo_student* fifo){

Function_status Find_stud_byId(fifo_student* fifo_p){

Function_status Find_stud_byFirstName(fifo_student* fifo_p){
Function_status Reg_studs_bycourseId(fifo_student* fifo_p){

Function_status studs_count(fifo_student* fifo_p){

Function_status delete_stud(fifo_student* fifo){

Function_status Update_stud(fifo_student* fifo_p){

void show_stud(Sstudent* temp, uint32_t i){

void count(uint32_t countstud){

void print_all(fifo_student* fifo_p){

//--------------------------------FIFO FUNCTIONS-----------------------------------//
fifo_status fifo_init(fifo_student* fifo_p, Sstudent* student, uint32_t length){
fifo_status fifo_enqueue(fifo_student* fifo_p, Sstudent* student){
fifo_status fifo_dequeue(fifo_student* fifo_p){
```

3.0 Program Implementation

The functions created to perform the desired operations were tested with several test cases to check whether the program prototype fulfills the user-friendly approach and is valid for everyday commercial use or not. The set of operations the user can select are shown in the figure below.



3.1 Empty Queue Check

Before the user adds any number of students, the Queue will be empty. Hence, by choosing any of the operations such as finding a student, or updating a student, etc. will give “a Queue is Empty” message at the console as shown in the **figures** below.

```
Please Enter Your Choice:3
QUEUE is Empty.
Please Enter Your Choice:4
QUEUE is Empty.
Please Enter Your Choice:5
QUEUE is Empty.
Please Enter Your Choice:7
QUEUE is Empty.
Please Enter Your Choice:8
QUEUE is Empty.
Please Enter Your Choice:9
QUEUE is Empty.
```

```
Please Enter Your Choice:6
================================
...Total Number of Students = 0
================================
```

3.2 Full Queue Check

In case of the Queue array has reached to its maximum size which it can hold students' data. A message indicating "Queue is Full" will appear at the console stating that the user can't add any other students.

After adding 5 students, which is the defined as the maximum size the Queue array can hold, the user can check how many students have been added.

```
Please Enter Your Choice:6
================================
...Total Number of Students = 5
================================
```

Consequently, if the user wants to add another student to the Queue, either from a file or manually, the console will state that the Queue is full.

```
Please Enter Your Choice:1
QUEUE is Full.
Please Enter Your Choice:2
QUEUE is Full.
```

3.3 Adding a Student Manually

Test Case 1: Adding the very first student details, then deciding to complete the operation for adding more students.

Test Case 2: Adding a student then deciding to terminate the addition operation.

Test Case 3: Adding a new student with a preexisting ID number.

Test Case 4: After adding a student then terminating the operation, return back to add a new student (to check for the counting sequence).

Test Case 1:

```
Please Enter Your Choice:2
============================================================
                [REGISTERING STUDENT INFO]
============================================================
Enter Student ID:124986

[INFO] Student ID Added Successfully.
------------------------------------------------------------
Enter Your First Name:Ziad
Enter Your Last Name:Elmarakbi
Enter Your GPA:3.34
----------------Enter Your Course IDs----------------
Course ID 1:201
Course ID 2:202
Course ID 3:203
Course ID 4:204
Course ID 5:205

[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 1 students
[INFO] You can add 4 more students
------------------------------------------------------------
Do you want to add another Student y/n ?
y
============================================================
Enter Student ID:135798

[INFO] Student ID Added Successfully.
------------------------------------------------------------
Enter Your First Name:Ashraf
Enter Your Last Name:Sob7y
Enter Your GPA:4.0
----------------Enter Your Course IDs----------------
Course ID 1:201
Course ID 2:233
Course ID 3:204
Course ID 4:203
Course ID 5:245

[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 2 students
[INFO] You can add 3 more students
------------------------------------------------------------
Do you want to add another Student y/n ?
y
```

Test Case 2:

```
[INFO] Student ID Added Successfully.
-------------------------------------------------------
Enter Your First Name:Ashraf
Enter Your Last Name:Sob7y
Enter Your GPA:4.0
----------------Enter Your Course IDs----------------
Course ID 1:201
Course ID 2:233
Course ID 3:204
Course ID 4:203
Course ID 5:245

[INFO] Student Details has been added Successfully.
-------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 2 students
[INFO] You can add 3 more students
-------------------------------------------------------
Do you want to add another Student y/n ?
n
.........Transferring to MAIN MENU.........

[Choose One of the Following Options]:

1)...Add a Student Details From File
2)...Add a Student Details Manually
3)...Find a Student by ID Number
4)...Find a Student by First Name
5)...Find the Students Registered in a Course
6)...Count of Students
7)...Delete a Student
8)...Update a Student
9)...Show All Registered Students
10)..Quit Program
```

Test Case 3:

```
Please Enter Your Choice:2
=======================================================
                [REGISTERING STUDENT INFO]
=======================================================
Enter Student ID:124986
=======================================================
[ERROR] Student ID Registered Before !
=======================================================

[Choose One of the Following Options]:

1)...Add a Student Details From File
2)...Add a Student Details Manually
3)...Find a Student by ID Number
4)...Find a Student by First Name
5)...Find the Students Registered in a Course
6)...Count of Students
7)...Delete a Student
8)...Update a Student
9)...Show All Registered Students
10)..Quit Program
```

Test Case 4:

```
[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 2 students
[INFO] You can add 3 more students
------------------------------------------------------------
Do you want to add another Student y/n ?
n
.........Transferring to MAIN MENU.........

[Choose One of the Following Options]:

1)...Add a Student Details From File
2)...Add a Student Details Manually
3)...Find a Student by ID Number
4)...Find a Student by First Name
5)...Find the Students Registered in a Course
6)...Count of Students
7)...Delete a Student
8)...Update a Student
9)...Show All Registered Students
10)..Quit Program
Please Enter Your Choice:2
============================================================
                [REGISTERING STUDENT INFO]
============================================================
Enter Student ID:145637

[INFO] Student ID Added Successfully.
------------------------------------------------------------
Enter Your First Name:Mohamed
Enter Your Last Name:Ehab
Enter Your GPA:2.65
---------------Enter Your Course IDs----------------
Course ID 1:203
Course ID 2:204
Course ID 3:245
Course ID 4:233
Course ID 5:201

[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 1 students
[INFO] You can add 2 more students
------------------------------------------------------------
Do you want to add another Student y/n ?
```

3.4 Adding a Student from File

Test Case 1: Adding a number of students from a .txt file.

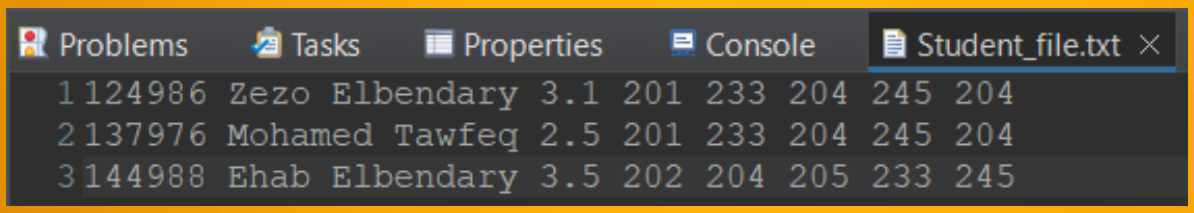
Test Case 2: Adding a number of students from a .txt file but with a repeated ID number.

Test Case 3: Adding a new student manually after adding students from a file then showing all the added students to check if the addition sequence is executing correctly.

Test Case 4: Adding students manually after adding students from file until the queue is full (to check if both adding from a file and manually coexist and integrate properly in the queue).

Test Case 5: Adding students from file but exceeding the maximum size of the Queue.

Student_file.txt:



Test Case 1:

```
Please Enter Your Choice:1
------------------------------------------------------------
[INFO] ID 124986 added successfully.
------------------------------------------------------------

------------------------------------------------------------
[INFO] ID 137976 added successfully.
------------------------------------------------------------

------------------------------------------------------------
[INFO] ID 144988 added successfully.
------------------------------------------------------------


[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 3 students
[INFO] You can add 2 more students
------------------------------------------------------------
```

Student_file.txt with a Repeated ID Number:

Problems | Tasks | Properties | Console | Student_file.txt

```
1 124986 Zezo Elbendary 3.1 201 233 204 245 204
2 124986 Mohamed Tawfeq 2.5 201 233 204 245 204
3 144988 Ehab Elbendary 3.5 202 204 205 233 245
```

Test Case 2:

```
Please Enter Your Choice:1
------------------------------------------------------------
[INFO] ID 124986 added successfully.
------------------------------------------------------------

------------------------------------------------------------
[ERROR] ID 124986 is already taken.
------------------------------------------------------------

------------------------------------------------------------
[INFO] ID 144988 added successfully.
------------------------------------------------------------


[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 2 students
[INFO] You can add 3 more students
------------------------------------------------------------
```

Test Case 3: Adding a student manually after adding from the file above.

```
Please Enter Your Choice:2
============================================================
                [REGISTERING STUDENT INFO]
============================================================
Enter Student ID:777777

[INFO] Student ID Added Successfully.
------------------------------------------------------------
Enter Your First Name:Keroles
Enter Your Last Name:Elprince
Enter Your GPA:4.0
----------------Enter Your Course IDs----------------
Course ID 1:777
Course ID 2:777
Course ID 3:777
Course ID 4:777
Course ID 5:777

[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 1 students
[INFO] You can add 2 more students
------------------------------------------------------------
Do you want to add another Student y/n ?
n
.........Transferring to MAIN MENU.........
```

Showing all added students:

```
Please Enter Your Choice:9
=========================================================
                [DISPLAYING STUDENT 1 INFO]
=========================================================
Student ID Number: 124986
Student Full Name: Zezo Elbendary
Student GPA: 3.10
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
=========================================================

=========================================================
                [DISPLAYING STUDENT 2 INFO]
=========================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
=========================================================

=========================================================
                [DISPLAYING STUDENT 3 INFO]
=========================================================
Student ID Number: 777777
Student Full Name: Keroles Elprince
Student GPA: 4.00
-----------Student Courses ID-----------
Course ID 1 = 777
Course ID 2 = 777
Course ID 3 = 777
Course ID 4 = 777
Course ID 5 = 777
=========================================================
```

Test Case 4: Adding two more students to overflow Queue.

```
Please Enter Your Choice:2
=========================================================
                [REGISTERING STUDENT INFO]
=========================================================
Enter Student ID:134678

[INFO] Student ID Added Successfully.
---------------------------------------------------------
Enter Your First Name:Student4
Enter Your Last Name:Student4
Enter Your GPA:NULL
----------------Enter Your Course IDs----------------
Course ID 1:4
Course ID 2:4
Course ID 3:4
Course ID 4:4
Course ID 5:4

[INFO] Student Details has been added Successfully.
---------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 1 students
[INFO] You can add 1 more students
---------------------------------------------------------
Do you want to add another Student y/n ?
y
=========================================================
Enter Student ID:156894

[INFO] Student ID Added Successfully.
---------------------------------------------------------
Enter Your First Name:Student5
Enter Your Last Name:Student5
Enter Your GPA:NULL
----------------Enter Your Course IDs----------------
Course ID 1:5
Course ID 2:5
Course ID 3:5
Course ID 4:5
Course ID 5:5

[INFO] Student Details has been added Successfully.
---------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 2 students
[INFO] You can add 0 more students
---------------------------------------------------------
Do you want to add another Student y/n ?
y
=========================================================
QUEUE is Full.
Please Enter Your Choice:1
QUEUE is Full.
```

Student_file.txt with more than the maximum Queue length (more than 5 students):

Problems | Tasks | Properties | Console | Student_file.txt

```
1 124986 Zezo Elbendary 3.1 201 233 204 245 204
2 124987 Mohamed Tawfeq 2.5 201 233 204 245 204
3 144988 Ehab Elbendary 3.5 202 204 205 233 245
4 167898 Student4 Student4 2.5 200 201 202 203 204
5 178954 Student5 Studnet5 2.5 200 201 202 203 204
6 189999 Student6 Student6 2.5 200 201 202 203 204
```

Test Case 5:

```
Please Enter Your Choice:1
------------------------------------------------------------
[INFO] ID 124986 added successfully.
------------------------------------------------------------

------------------------------------------------------------
[INFO] ID 124987 added successfully.
------------------------------------------------------------

------------------------------------------------------------
[INFO] ID 144988 added successfully.
------------------------------------------------------------

------------------------------------------------------------
[INFO] ID 167898 added successfully.
------------------------------------------------------------

------------------------------------------------------------
[INFO] ID 178954 added successfully.
------------------------------------------------------------


[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 5 students
[INFO] You can add 0 more students
------------------------------------------------------------

Please Enter Your Choice:1
QUEUE is Full.

Please Enter Your Choice:2
QUEUE is Full.
```

3.5 Deleting a student (based on ID)

Test Case 1: Deleting the first added student in the Queue.

Test Case 2: Deleting a student from the middle of the Queue.

Test Case 3: Deleting a student then adding another student manually to check for Queue Sequence.

Test Case 4: Deleting students until Queue is Empty.

Test Case 5: Entering a non-existed ID number

Current Students:

```
Please Enter Your Choice:9
=====================================================
                [DISPLAYING STUDENT 1 INFO]
=====================================================
Student ID Number: 124986
Student Full Name: Zezo Elbendary
Student GPA: 3.10
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
=====================================================

=====================================================
                [DISPLAYING STUDENT 2 INFO]
=====================================================
Student ID Number: 124987
Student Full Name: Mohamed Tawfeq
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
=====================================================
                [DISPLAYING STUDENT 3 INFO]
=====================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
=====================================================

=====================================================
                [DISPLAYING STUDENT 4 INFO]
=====================================================
Student ID Number: 167898
Student Full Name: Student4 Student4
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
=====================================================

=====================================================
                [DISPLAYING STUDENT 5 INFO]
=====================================================
Student ID Number: 178954
Student Full Name: Student5 Studnet5
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
=====================================================
```

Test Case 1: deleting the first added student

```
Please Enter Your Choice:7
=========================================================
Enter the ID number you want to delete:124986
=========================================================

[INFO] The ID Number has been deleted Successfully.
---------------------------------------------------------
[INFO] You deleted 1 students
---------------------------------------------------------
```

```
Please Enter Your Choice:9
=========================================================
                [DISPLAYING STUDENT 1 INFO]
=========================================================
Student ID Number: 124987
Student Full Name: Mohamed Tawfeq
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
=========================================================

=========================================================
                [DISPLAYING STUDENT 2 INFO]
=========================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
=========================================================

=========================================================
                [DISPLAYING STUDENT 3 INFO]
=========================================================
Student ID Number: 167898
Student Full Name: Student4 Student4
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
=========================================================

=========================================================
                [DISPLAYING STUDENT 4 INFO]
=========================================================
Student ID Number: 178954
Student Full Name: Student5 Studnet5
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
=========================================================
```

Test Case 2: deleting the 3rd added student

```
Please Enter Your Choice:7
============================================================
Enter the ID number you want to delete:167898
============================================================

[INFO] The ID Number has been deleted Successfully.
------------------------------------------------------------
[INFO] You deleted 1 students
------------------------------------------------------------
```

```
Please Enter Your Choice:9
============================================================
                [DISPLAYING STUDENT 1 INFO]
============================================================
Student ID Number: 124987
Student Full Name: Mohamed Tawfeq
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
============================================================

============================================================
                [DISPLAYING STUDENT 2 INFO]
============================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
============================================================

============================================================
                [DISPLAYING STUDENT 3 INFO]
============================================================
Student ID Number: 178954
Student Full Name: Student5 Studnet5
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
============================================================
```

Test Case 3: deleting the last student then adding a new student

```
Please Enter Your Choice:7
============================================================
Enter the ID number you want to delete:178954
============================================================

[INFO] The ID Number has been deleted Successfully.
------------------------------------------------------------
[INFO] You deleted 1 students
------------------------------------------------------------
Please Enter Your Choice:9
============================================================
                [DISPLAYING STUDENT 1 INFO]
============================================================
Student ID Number: 124987
Student Full Name: Mohamed Tawfeq
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
============================================================

============================================================
                [DISPLAYING STUDENT 2 INFO]
============================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
============================================================
Please Enter Your Choice:2
============================================================
                [REGISTERING STUDENT INFO]
============================================================
Enter Student ID:373737

[INFO] Student ID Added Successfully.
------------------------------------------------------------
Enter Your First Name:TestFirstName
Enter Your Last Name:TestLastName
Enter Your GPA:4.0
----------------Enter Your Course IDs----------------
Course ID 1:233
Course ID 2:245
Course ID 3:201
Course ID 4:205
Course ID 5:203

[INFO] Student Details has been added Successfully.
------------------------------------------------------------
[INFO] The total number of Students is 5
[INFO] You added 1 students
[INFO] You can add 2 more students
------------------------------------------------------------
Do you want to add another Student y/n ?
n
```

```
Please Enter Your Choice:9
============================================================
                [DISPLAYING STUDENT 1 INFO]
============================================================
Student ID Number: 124987
Student Full Name: Mohamed Tawfeq
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
============================================================

============================================================
                [DISPLAYING STUDENT 2 INFO]
============================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
============================================================

============================================================
                [DISPLAYING STUDENT 3 INFO]
============================================================
Student ID Number: 373737
Student Full Name: TestFirstName TestLastName
Student GPA: 4.00
-----------Student Courses ID-----------
Course ID 1 = 233
Course ID 2 = 245
Course ID 3 = 201
Course ID 4 = 205
Course ID 5 = 203
============================================================
```

Test Case 4: deleting all students

```
Please Enter Your Choice:7
============================================================
Enter the ID number you want to delete:124987
============================================================
Please Enter Your Choice:7
============================================================
Enter the ID number you want to delete:144988
============================================================
Please Enter Your Choice:7
============================================================
Enter the ID number you want to delete:373737
============================================================
Please Enter Your Choice:7
QUEUE is Empty.
```

Test Case 5: Entering non-existed ID number

```
Please Enter Your Choice:7
==========================================================
Enter the ID number you want to delete:13579
==========================================================
----------------------------------------------------------
[ERROR] The ID Number you Entered is not found
----------------------------------------------------------
```

3.6 Finding a student by ID number

Test Case 1: Finding details of an existed ID number.

Test Case 2: Finding details of a non-existed ID number

Test Case 1:

```
Please Enter Your Choice:3
==========================================================
Enter Student ID Number you want to find:124986
==========================================================

==========================================================
                [DISPLAYING STUDENT 1 INFO]
==========================================================
Student ID Number: 124986
Student Full Name: Zezo Elbendary
Student GPA: 3.10
----------Student Courses ID----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
==========================================================
```

Test Case 2:

```
Please Enter Your Choice:3
==========================================================
Enter Student ID Number you want to find:555777
==========================================================

==========================================================
Student ID Number Not found !
==========================================================
```

3.7 Finding a student by First name

Test Case 1: Finding details of an existed first name.

Test Case 2: Finding details of a non-existed first name.

Test Case 1:

```
Please Enter Your Choice:4
=====================================================
Enter Student First name to check for Info:Zezo
=====================================================

=====================================================
                [DISPLAYING STUDENT 1 INFO]
=====================================================
Student ID Number: 124986
Student Full Name: Zezo Elbendary
Student GPA: 3.10
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
=====================================================
```

Test Case 2:

```
Please Enter Your Choice:4
=====================================================
Enter Student First name to check for Info:Ziad
=====================================================

=====================================================
Student First Name not found !
=====================================================
```

3.7 Registered Students in a specific course

Test Case 1: Checking a common course ID between all the available students who's registered in the same subject.

Test Case 2: Checking registered students but with a non-existed course ID

Current Students (Reuploading Student_file.txt):

```
Please Enter Your Choice:9
=========================================================
                [DISPLAYING STUDENT 1 INFO]
=========================================================
Student ID Number: 124986
Student Full Name: Zezo Elbendary
Student GPA: 3.10
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
=========================================================

=========================================================
                [DISPLAYING STUDENT 2 INFO]
=========================================================
Student ID Number: 124987
Student Full Name: Mohamed Tawfeq
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
=========================================================

=========================================================
                [DISPLAYING STUDENT 3 INFO]
=========================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
=========================================================

=========================================================
                [DISPLAYING STUDENT 4 INFO]
=========================================================
Student ID Number: 167898
Student Full Name: Student4 Student4
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
=========================================================

=========================================================
                [DISPLAYING STUDENT 5 INFO]
=========================================================
Student ID Number: 178954
Student Full Name: Student5 Studnet5
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
=========================================================
```

Test Case 1:

```
Please Enter Your Choice:5
=========================================================
Enter the Course ID:200
=========================================================

                [DISPLAYING STUDENT INFO]
=========================================================
Student ID Number: 167898
Student Full Name: Student4 Student4
Student GPA: 2.50
=========================================================

                [DISPLAYING STUDENT INFO]
=========================================================
Student ID Number: 178954
Student Full Name: Student5 Studnet5
Student GPA: 2.50
=========================================================
```

Test Case 2:

```
Please Enter Your Choice:5
=========================================================
Enter the Course ID:500
=========================================================

=========================================================
Course ID not found !
=========================================================
```

3.9 Updating Student Details

Test Case 1: Checking for student ID existence.

Test Case 2: Updating an existed student info. (first name, last name, ID number, etc.).

Test Case 3: Entering previous ID number after updating the ID of the student.

Test Case 4: Entering a wrong update choice.

Test Case 5: Updating a non-existed Course ID.

Test Case 1: Existing student ID number

```
Please Enter Your Choice:8
------------------------------------------------------------
Enter the Student ID Number you are interested in Updating:124987
------------------------------------------------------------

----------What do you want to update ?----------
1.First Name
2.Last Name
3.Roll No.
4.GPA
5.Courses
```

Non-Existed student ID number:

```
Please Enter Your Choice:8
------------------------------------------------------------
Enter the Student ID Number you are interested in Updating:565656
------------------------------------------------------------

[ERROR] ID Number Not Existed in Database.
------------------------------------------------------------
```

Test Case 2: Updating all information of an existed student ID number

```
Please Enter Your Choice:8
------------------------------------------------------------
Enter the Student ID Number you are interested in Updating:124986
------------------------------------------------------------

----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
1
------------------------------------------------------------
Enter the New first name:Ziad
------------------------------------------------------------
[INFO] First Name of Student has been Updated Successfully.
------------------------------------------------------------
------------------------------------------------------------
Do you Want to Update Any other Info y/n ?y
------------------------------------------------------------

----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
2
------------------------------------------------------------
Enter the New Last name:Elmarakbi
------------------------------------------------------------
[INFO] Last Name of Student has been Updated Successfully.
------------------------------------------------------------
```

```
------------------------------------------------------------
Do you Want to Update Any other Info y/n ?y
------------------------------------------------------------

----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
3
------------------------------------------------------------
Enter the New ID Number:13579
------------------------------------------------------------
[INFO] ID Number of Student has been Updated Successfully.
------------------------------------------------------------
------------------------------------------------------------
Do you Want to Update Any other Info y/n ?y
------------------------------------------------------------

----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
4
------------------------------------------------------------
Enter the New GPA Score:4.0
------------------------------------------------------------
[INFO] GPA of Student has been Updated Successfully.
------------------------------------------------------------
------------------------------------------------------------
Do you Want to Update Any other Info y/n ?y
----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
5
------------------------------------------------------------
Which Course ID You want to Update?201
------------------------------------------------------------
------------------------------------------------------------
Enter New Course ID you want to Update with the Existing One:501
------------------------------------------------------------
[INFO] Course ID has been Updated Successfully.
------------------------------------------------------------
------------------------------------------------------------
Which Course ID You want to Update?245
------------------------------------------------------------
------------------------------------------------------------
Enter New Course ID you want to Update with the Existing One:750
------------------------------------------------------------
[INFO] Course ID has been Updated Successfully.
------------------------------------------------------------
------------------------------------------------------------
Do you Want to Update Any other Info y/n ?n
[Choose One of the Following Options]:
```

Previous Student Info.:

```
Please Enter Your Choice:9
============================================================
                [DISPLAYING STUDENT 1 INFO]
============================================================
Student ID Number: 124986
Student Full Name: Zezo Elbendary
Student GPA: 3.10
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
============================================================
```

Updated Student Info.:

```
Please Enter Your Choice:9
============================================================
                [DISPLAYING STUDENT 1 INFO]
============================================================
Student ID Number: 13579
Student Full Name: Ziad Elmarakbi
Student GPA: 4.00
-----------Student Courses ID-----------
Course ID 1 = 501
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 750
Course ID 5 = 204
============================================================
```

Test Case 3:

```
Please Enter Your Choice:8
------------------------------------------------------------
Enter the Student ID Number you are interested in Updating:124986
------------------------------------------------------------

[ERROR] ID Number Not Existed in Database.
------------------------------------------------------------
Please Enter Your Choice:8
------------------------------------------------------------
Enter the Student ID Number you are interested in Updating:13579
------------------------------------------------------------

----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
```

Test Case 4:

```
----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
6
------------------------------------------------------------
You Entered a Wrong Choice.
------------------------------------------------------------
```

Test Case 5:

```
----------What do you want to update ?----------
1.First Name
2.Last Name
3.ID Number
4.GPA
5.Courses
5
------------------------------------------------------------
Which Course ID You want to Update?653
------------------------------------------------------------
------------------------------------------------------------
[ERROR] Course ID Entered Doesn't Exist.
------------------------------------------------------------
```

3.10 Number of Registered Students

```
Please Enter Your Choice:6
============================================================
...Total Number of Students = 5
============================================================
```

3.11 Showing all Students

```
Please Enter Your Choice:9
============================================================
                [DISPLAYING STUDENT 1 INFO]
============================================================
Student ID Number: 13579
Student Full Name: Ziad Elmarakbi
Student GPA: 4.00
-----------Student Courses ID-----------
Course ID 1 = 501
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 750
Course ID 5 = 204
============================================================

============================================================
                [DISPLAYING STUDENT 2 INFO]
============================================================
Student ID Number: 124987
Student Full Name: Mohamed Tawfeq
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 201
Course ID 2 = 233
Course ID 3 = 204
Course ID 4 = 245
Course ID 5 = 204
============================================================
```

```
============================================================
                [DISPLAYING STUDENT 3 INFO]
============================================================
Student ID Number: 144988
Student Full Name: Ehab Elbendary
Student GPA: 3.50
-----------Student Courses ID-----------
Course ID 1 = 202
Course ID 2 = 204
Course ID 3 = 205
Course ID 4 = 233
Course ID 5 = 245
============================================================

============================================================
                [DISPLAYING STUDENT 4 INFO]
============================================================
Student ID Number: 167898
Student Full Name: Student4 Student4
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
============================================================
```

```
============================================================
                [DISPLAYING STUDENT 5 INFO]
============================================================
Student ID Number: 178954
Student Full Name: Student5 Studnet5
Student GPA: 2.50
-----------Student Courses ID-----------
Course ID 1 = 200
Course ID 2 = 201
Course ID 3 = 202
Course ID 4 = 203
Course ID 5 = 204
============================================================
```

4.0 Limitations & Future Recommendations

As observed in the program implementation section of the project, the system has been excessively validated through several test cases to ensure peak functionality and facilitate user-friendliness. Although, the system checked all the boxes for its effectiveness. It has been observed that there is a slight drawback in the deletion operation of the system. In which deleting a student from the middle of the queue will require shifting the rest of the elements to exploit the empty void as in the case of an actual everyday queue in real-life. When an individual standing in a queue decides to leave, the rest of the people in the queue will move ahead to be inline and re-organized by filling the space of the person who left the queue. Technically, the element stored at a specific location in the queue array is not actually deleted, but instead it's turned into a garbage data after it being tailed out by a tail pointer moving to the next element. Thus, by shifting the rest of the elements in the queue, the tailed-out data will be overwritten. By shifting the rest of the elements, the complexity of the code increases as well as loading more on the processor for multiple switch contexting and more instructions.

Ideally, implementing a single linked list data structure algorithm for this system would be a more optimal alternative as linking the previous node to the node after the deleted node will let the deleted node lose reference from the list. Thus, fixing the problem without unnecessary layer of complexity.