

A Simple Computer Code for Result Analysis of University Graduates

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Abstract: In the realm of higher education, efficient and user-friendly tools for result analysis play a pivotal role in evaluating the academic performance of university graduates. A systematic processing of the examination results and their meaningful representation requires enormous labor when attempted manually. The students are generally unaware of the computational metrics of semester grade point average (SGPA) and cumulative grade point average (CGPA) though they like to get updated on their performance periodically. In this study, a straightforward computer code is developed in C++ language to enable the students to calculate their academic progress (in terms of SGPA and CGPA) using the input data of marks and credits of individual subjects. The code is designed with simplicity and practicality in mind, to enable the students, parents, teachers and administrators with a versatile tool for comprehensively assessing the academic outcomes. The validity of the software program is verified by comparing the computational performance for three Indian universities, namely, Anna University,

University of Madras and Indraprastha University in estimating the SGPA and CGPA on a 10-point scale. The results suggest that the code provides an accurate and time-saving solution compared to manual calculation. The results demonstrate the code's ability to verify the grades by the students as well as their mentors to keep track of the performance. This user-friendly tool will be highly beneficial for streamlining the result analysis process, providing valuable insights for the academicians towards decision-making and strategic planning.

Keywords: Computer code; Grade point average; Result analysis; University results.

1. Introduction

The measures of academic performance set forth by any educational institution play a vital role in producing quality graduates who will become the leaders and workforce in any organization in the future, which indirectly contributes to the social and economic growth of the nation. Various measures of academic performance of students followed in the academic institutions under the general guidelines of the higher education authority of the state attract the attention of potential recruiters from industries, in addition to enable them to grasp good opportunities for higher studies or government services. In general, the overall development of an individual is

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quantitatively measured through various academic ranking systems set forth by the universities under the general purview of state authorities (York et al., 2015). Several methods are being adopted to evaluate the academic performance of the students such as cumulative grade point average (CGPA) and integrated CGPA (Mutalib et al., 2019). For a university system, the CGPA is the most commonly used tool for measuring the performance of a student as a whole since the calculation is based on the grades of all the courses, considering all the semesters of their study (Ali et al., 2009).

As of now, most of the result processing and analysis steps require huge computational facilities as being carried out through automated systems by the universities. However, the use of Microsoft excel spreadsheet rarely fulfill the meaning of “computerization” to process the results as only a few of the capabilities of excel spreadsheet are generally being put to use (Ekpenyong and Moses, 2008). As a matter of concern, many of the undergraduate students are generally unaware of the intricacies involved in deriving their semester grade point average (SGPA) and CGPA without attempting self-verification. Even if a student be aware of processing the semester grades, it still remains a tedious and cumbersome task to verify the same manually. Moreover, the students do not generally extend their time and patience to calculate the grades for each semester, even though they do pay attention to the credits for their chosen courses. In a few exceptional cases, the students may inadvertently miss the opportunity for requesting re-valuation or recheck of the results within the stipulated period notified by the university. Furthermore, some of the non-engineering undergraduates may not be well-versed with the excel spreadsheet to perform such tedious calculations.

Very limited studies have reported about the means and impacts of these computational tasks on the students in order to propose some simple solutions. Sultana et al. (2007) developed a software application called as Android Academic Assistant to aid the students in their CGPA calculation. Later, Ukem and Onoyom-Ita (2011) from the University of Calabar, Nigeria developed a software application for the processing the results of their students. Matemilayo et al. (2017) developed a software application to facilitate the automated computation of GPA and CGPA based on the uploaded examination scores. In an academic research, Emmanuel et al. (2021) developed a model to understand the effect of failing a

course (carryovers), low grade point and probation on the overall academic progress (CGPA) of students. Ojeyinka and Olusegun (2020) developed a database for processing academic results without any human intervention. Recently, Ismail et al. (2021) developed a web application system to calculate and display the forecasted GPA and CGPA based on the earlier credit hour, CGPA and expected grades of the subjects.

Although some of these applications developed by various institutions are quite powerful to calculate the CGPA, it was one among many other applications catering to the needs of the academicians, especially the faculty and staff members. Furthermore, the mobile apps and software developed for this application are university-specific and cannot be used for a different grading system. The main objective of the present study is to develop a simple computer code based on C++ programming language that can be used to calculate the SGPA as well as CGPA for universities with a difference in their grading schemes. Further, the developed code is used for three India universities namely, Anna university from Tamil Nadu, University of Madras from Tamil Nadu and Guru Gobind Singh Indraprastha University from Delhi to compare the academic results for different grading systems, thus illustrating the robustness of the developed code. The paper discusses the methodology adopted in computing the SGPA and CGPA, and further compares the grade point system adopted by the three universities. Four different scenarios are considered for the sequential (semester-wise) computation of SGPA and CGPA for each university and the results are verified for their accuracy and computational efficiency.

2. Methodology

A. SGPA

The academic performance of an individual student at the end of each semester shall be indicated in terms of SGPA. The overall grading of the class is done based on the SGPA levels and the students will be awarded with particular grades in each subject they passed. The SGPA is awarded only to those students who pass all the courses in a semester. The SGPA shall be calculated as shown in Eq. (1):

$$\text{SGPA} = \frac{\text{Total earned weightage grade points in a semester}}{\text{Total credits in a semester}}$$

$$SGPA = \frac{\sum_{i=1}^N C_i G_i}{C_i} \quad (1)$$

Where C_i = Number of credits allotted to a particular subject 'i', G_i = Grade point corresponding to the letter grade awarded to the subject 'i', and $i = 1, 2, \dots, N$ indicates the number of subjects in a particular semester.

B. CGPA

The CGPA is a much broader term to bring out the overall performance evaluation of a students in a progressive manner. Though the SGPA gives specific output of a semester, the CGPA provides the cumulative effect of the student's academic growth.

The CGPA is generally awarded only to those students who pass all the courses in the entire programme. The CGPA of a student for the entire programme is calculated as given in Eq. (2):

CGPA = (Total earned weightage grade points for the entire programme) / (Total credits for the entire programme)

$$CGPA = \frac{\sum_{j=1}^M C_j G_j}{C_j} \quad (2)$$

Where C_j = Number of credits allotted to a semester j and G_j = SGPA of semester j, and $j = 1, 2, \dots, N$ indicates the number of semesters in a particular programme. In general, the grade card awarded to a student contains the following information:

- The credits of each course offered in that semester
- The letter grade for each course and grade points corresponding to each letter

Table 1: Grade Point System of Anna University

Score	Grade	Grade point
91-100	O	10
81-90	A+	9
71-80	A	8
61-70	B+	7
51-60	B	6
<50	RA	0
Short of attendance	SA	0
Withdrew from exam	W	0

c. The published values of SGPA and CGPA with decimals

d. Total number of credits earned by the student up to the end of that semester.

As we have chosen three Indian universities for the demonstration, the grading system adopted by the chosen universities has been provided in Tables 1-3.

Table 2: Grade Point System of University of Madras

Score	Grade	Grade point
90-100	O	90-100
80-90	D+	80-90
75-79	D	75-79
70-74	A+	70-74
60-69	A	60-69
50-59	B	50-59
40-49	C	40-49
Less than 40	U	0
Absent	AAA	0

Table 3: Grade Point System of Indraprastha University

Score	Grade	Grade point
90-100	O	10
75-89	A+	9
65-74	A	8
55-64	B+	7
50-54	B	6
45-49	C	5
40-44	P	4
Less than 40 or absent	F	0

C. Computational Algorithm

A systematic algorithm has been adopted to develop the computer code using C++ language for the calculation of SGPA and CGPA (Fig. 1). For the extensive futuristic benefit of the scientific community, we have provided the C++ code developed for this study in the Appendix I. It is verified that the developed C++ code can be compiled using many of the compilers which are now available online (For e.g. www.replit.com). It is further ensured that a minimum number of logically sequenced inputs are required from the users to compute the results in an easy and time saving manner. Thus, the calculation of CGPA is made extremely simple for an undergraduate student by using this code even through a simple mobile phone with internet access.

2. Results and Discussion

A. Scenario #1

In order to facilitate the propagative sequence of result comparison, the distribution of subject-wise credits and the grading scale are essential to be fed to the model. The effectiveness of the proposed model is verified by simulating a few scenarios by considering the subject grade proportions followed by the universities. For the first scenario, we develop the code for enabling the student to compute the SGPA based on the first semester grades from Anna University. Details of the courses, credits and grade points, as well as the computed values of SGPA and CGPA are provided in Table 4. A screenshot of the C++ code showing the input commands and output values from code is shown in Figure 2. It is observed from the results that the calculation is straightforward

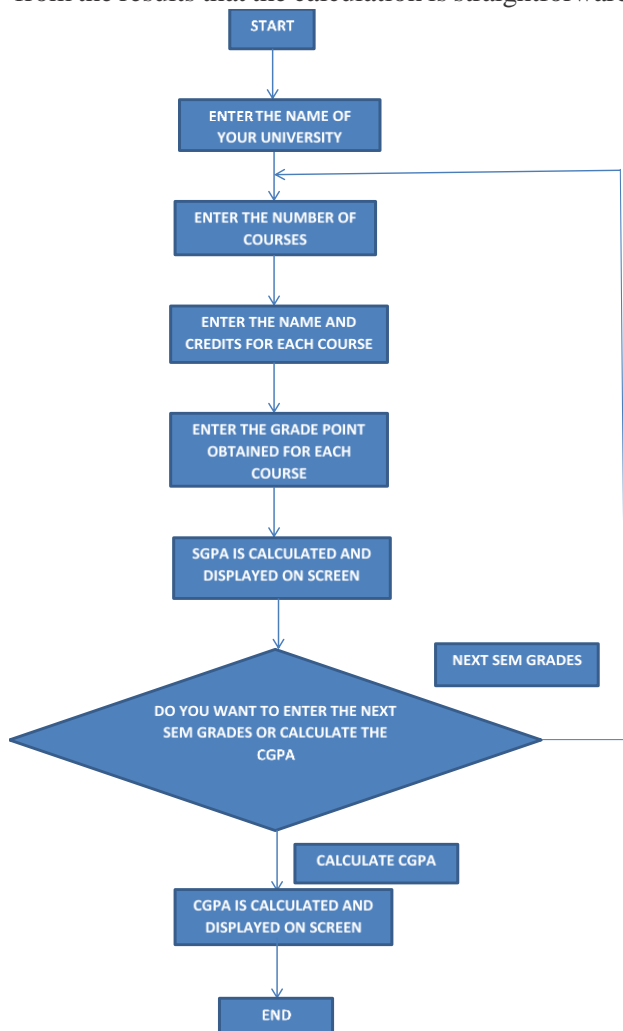


Fig. 1: Flowchart of the algorithm for the developed C++ code

and the result comes with good accuracy. After displaying the results, the code checks further demands from the student based on the suggestions provided as per the computer algorithm. Since the result is of first semester, there is no difference between the CGPA and SGPA. If there is no requirement of further details, the program will end itself by the next command. The execution of the code hardly takes a few seconds on any computer or smartphone with minimum network speed for data transfer.

Table 4: Details of Courses in Semester 1 of Anna University

Courses	Credits	Grade	Grade point	SGPA and CGPA for semester 1
A	3	O	10	9.333
B	3	A+	9	
C	3	A+	9	

```

SGPA Calculator

Choose the grading method
ANNA UNIVERSITY - 1
UNIVERSITY OF MADRAS - 2
INDRAPRASATHA UNIVERSITY - 3
1
Semester 1

Enter the number of courses: 3
Enter the name of course 1[NO SPACES] : A
Enter the credits for A : 3
Enter the name of course 2[NO SPACES] : B
Enter the credits for B : 3
Enter the name of course 3[NO SPACES] : C
Enter the credits for C : 3
Enter the grade for course [O,A+,A,B+,B,RA,SA,W] A : O
Enter the grade for course [O,A+,A,B+,B,RA,SA,W] B : A+
Enter the grade for course [O,A+,A,B+,B,RA,SA,W] C : A+
The grade for course A : O
The credit for course A : 3
The grade value for course A : 10
The grade for course B : A+
The credit for course B : 3
The grade value for course B : 9
The grade for course C : A+
The credit for course C : 3
The grade value for course C : 9

SGPA = 9.33333
In case for new semester type SEM or to Calculate CGPA type CALC :
  
```

Fig. 2: C++ Output for Scenario #1 (Anna University)

B. Scenario #2

This scenario is designed to enable the student to calculate the CGPA based on the grades obtained for the first two semesters as per the subject-credit-grade pattern followed by the University of Madras. The courses, credits and grade points obtained by the student during the first two semesters are provided in Table 5. The screenshot of the results from the C++ code is shown in Figure 3. It is observed that the generated result is fairly accurate and displayed in an easily understandable manner. Once the student is thorough with the sequence of the required input data, there is no ambiguity in the result evaluation, as the SGPA and CGPA values are directed printed on the

screen with high degree of accuracy. It is to be noted that the sequence of selecting the subjects and their respective codes must be correctly followed by the student throughout the data entry steps. However, as the number of subjects are less in this scenario, a hand calculation may also suffice as a necessary test to verify the correctness of the program.

Table 5: Details of Courses in Semesters 1 And 2 (University of Madras)

Courses	Credits	Grade	Grade point	SGPA	CGPA
Semester – I					
A	3	O	10	8.0	8.0
B	3	D+	9		
C	3	B	5		
Semester – II					
D	3	A	6	7.0	7.5
E	3	A	6		
F	3	A	6		

C. Scenario #3

In the third scenario, we consider that the student has completed 50% of the academic course works (i.e., the first four semesters) and ready to revisit the overall progress for identifying suitable career options. The courses, credits and grade points obtained by the student for these semesters of Indraprastha University are provided in Table 6. The screenshot of the results from the C++ code is shown in Figure 4. It is observed that despite the increase in the computational steps, the result calculation is spontaneous and the display of SGPA and CGPA is very prompt with high degree of accuracy. As mentioned above, the only critical issue is the careful entry of semester-wise grades for all the subjects. It is, however, taken for granted that the students must be quite aware of the inherent credits associated with each subject he/she opted to study in a particular semester. The code also looks into details of the semester-wise subject counts and the allowed credit-limits so that any mistake in the data entry will be reconciled to the student for making the necessary corrections.

Once the result of first semester is displayed, the student has the freedom to choose any number of semesters for the computation of SGPA and/or CGPA up to a particular semester he/she has completed. There will be a clear indication of the semester up to which CGPA is required to be calculated. This will allow the student (or any user) to progressively monitor the academic performance and make plans to execute suitable corrective or remedial actions.

D. Scenario #4

The next scenario considers that the academic regulations pertaining to Anna university mandates

the students to earn a minimum number of credits for the award of the degree. This is also important for classifying the final grade of the students while completing the academic program. For the purpose of demonstration, we have considered the progress of a student at the end of his/her fourth semester following the credit pattern of Anna University. The details of the courses, credits and grade points during the first four semesters are provided in Table 7.

SGPA Calculator
Choose the grading method
ANNA UNIVERSITY - 1
UNIVERSITY OF MADRAS - 2
INDRAPRASATHA UNIVERSITY - 3
2
Semester 1
Enter the number of courses: 3
Enter the name of course 1[NO SPACES] : A
Enter the credits for A : 3
Enter the name of course 2[NO SPACES] : B
Enter the credits for B : 3
Enter the name of course 3[NO SPACES] : C
Enter the credits for C : 3
Enter the grade for course [O,D+,D,A+,A,B+,B,U,AAA]
A : O
Enter the grade for course [O,D+,D,A+,A,B+,B,U,AAA]
B : D+
Enter the grade for course [O,D+,D,A+,A,B+,B,U,AAA]
C : B
The grade for course A : O
The credit for course A : 3
The grade value for course A : 10
The grade for course B : D+
The credit for course B : 3
The grade value for course B : 9
The grade for course C : B
The credit for course C : 3
The grade value for course C : 5
SGPA = 8
Incase for new semester type SEM or to Calculate CGPA type CALC : SEM
Semester 2
Enter the number of courses: 3
Enter the name of course 1[NO SPACES] : D
Enter the credits for D : 3
Enter the name of course 2[NO SPACES] : E
Enter the credits for E : 3
Enter the name of course 3[NO SPACES] : F
Enter the credits for F : 3
Enter the grade for course [O,D+,D,A+,A,B+,B,U,AAA]
D : A
Enter the grade for course [O,D+,D,A+,A,B+,B,U,AAA]
E : A
Enter the grade for course [O,D+,D,A+,A,B+,B,U,AAA]
F : A
The grade for course D : A
The credit for course D : 3
The grade value for course D : 7
The grade for course E : A
The credit for course E : 3
The grade value for course E : 7
The grade for course F : A
The credit for course F : 3
The grade value for course F : 7
SGPA = 7
Incase for new semester type SEM or to Calculate CGPA type CALC : CALC
CGPA till Semester 2 =7.5

Fig. 3: C++ Output for Scenario #2 (University of Madras)

Table 6: Details of Courses in Semesters 1, 2, 3 and 4 (Indraprastha University)

Courses	Credits	Grade	Grade point	SGPA	CGPA
Semester - I					
A	3	O	10	9.333	9.333
B	3	A+	9		
C	3	A+	9		
Semester - II					
D	3	A	8	8.000	8.667
E	3	A	8		
F	3	A	8		
Semester - III					
G	4	A+	9	7.454	8.207
H	4	B+	7		
I	3	B	6		
Semester - IV					
J	4	O	10	10.000	8.667
K	3	O	10		
L	3	O	10		

Table 7: Details of Courses in Semesters 1, 2, 3 and 4 (Anna University)

Courses	Credits	Grade	Grade point	SGPA	CGPA
Semester - I					
A	3	O	10	3.333	3.333
B	3	RA	0		
C	3	SA	0		
Semester - II					
AA	3	O	10	6.333	4.833
BB	3	A+	9		
CC	3	RA	0		
EVS	PASS				
Semester - III					
AAA	4	A	8	7.666	5.966
BBB	4	A+	9		
CCC	4	B	6		
Semester - IV					
AAAA	3	A	8	8.333	6.512
BBBB	3	O	10		
CCCC	3	B+	7		

In order to illustrate the versatility of the computer program to display the audit courses as well as the list of arrears, we assume that the student might have failed a few courses due to shortage of attendance (SA) or poor performance in the examinations (RA). The proposed computer program is found to be capable of accepting the inputs of arrear subjects while computing the SGPA and CGPA at the end of fourth semester. The output from this case study is shown in Figure 5.

In the case of reappearing a particular subject, those additional subjects will be considered together along with the regular subjects in a particular semester. Similarly, the program also includes a

provision to opt for audit courses which are not strictly recommended in the credit counting, but a “pass” is designated to be sufficient. The same program may be extended for computing the final grades and class of degree program at the end of the stipulated period of study (generally four years under the new academic policy by the UGC).

In summary, the developed program for calculating the semester-wise grade point average marks enables one to easily verify the results and monitor one's academic progress at any point of time during the course. This is also found to be quite useful for the academic mentoring faculty to verify the results and communicate to the guardians regularly. In addition, the computation of success/fail ratio for a batch of students is an important criterion for various academic affiliation and accreditation purposes. Though the program is presented in its virgin form to be used with a compiler, the concept can be further translated to a user-friendly platform such as an Android-based mobile application or an open access software with the help of suitable conversion platforms.

3. Conclusion

Present study deals with an easy and simplified method of calculating the periodic academic performance of a university graduate by using C++ programming. A user-friendly and command-prompted interface was developed to help the students in computing the semester-wise as well as cumulative grade point average values for any number of semesters. The program also enables entry of audit courses (without credit values) and reappearance of arrear subjects without any cumbersomeness and drudgery. The robustness of the code has been demonstrated by implementing the same for three different universities having different grading system. It is anticipated that the students can easily cross-verify the grades issued to them by the university, with a mere input of the credits details for the courses of each semester. The results based on the developed program are found to be accurate, precise and computationally efficient compared to the manual calculation. This tool can be very handy for any undergraduate and even postgraduate student. The user-friendly application of this program can contribute development of a common platform to promote effective communication of educational outcomes with all stakeholders.

SGPA Calculator

Choose the grading method
ANNA UNIVERSITY - 1
UNIVERSITY OF MADRAS - 2
INDRAPRASATHA UNIVERSITY - 3
3

Semester 1

Enter the number of courses: 3

Enter the name of course 1[NO SPACES] : A
Enter the credits for A : 3
Enter the name of course 2[NO SPACES] : B
Enter the credits for B : 3
Enter the name of course 3[NO SPACES] : C
Enter the credits for C : 3
Enter the grade for course [O,A+,A,B+,B,C,P,F] A : O
Enter the grade for course [O,A+,A,B+,B,C,P,F] B : A+
Enter the grade for course [O,A+,A,B+,B,C,P,F] C : A+
The grade for course A : O
The credit for course A : 3
The grade value for course A : 10
The grade for course B : A+
The credit for course B : 3
The grade value for course B : 9
The grade for course C : A+
The credit for course C : 3
The grade value for course C : 9

SGPA = 9.33333
Incase for new semester type SEM or to Calculate CGPA type CALC :SEM

Semester 2

Enter the number of courses: 3
Enter the name of course 1[NO SPACES] : D
Enter the credits for D : 3
Enter the name of course 2[NO SPACES] : E
Enter the credits for E : 3
Enter the name of course 3[NO SPACES] : F
Enter the credits for F : 3
Enter the grade for course [O,A+,A,B+,B,C,P,F] D : A
Enter the grade for course [O,A+,A,B+,B,C,P,F] E : A
Enter the grade for course [O,A+,A,B+,B,C,P,F] F : A
The grade for course D : A
The credit for course D : 3
The grade value for course D : 8
The grade for course E : A
The credit for course E : 3
The grade value for course E : 8
The grade for course F : A
The credit for course F : 3
The grade value for course F : 8

SGPA = 8
Incase for new semester type SEM or to Calculate CGPA type CALC :SEM
Semester 3

Enter the number of courses: 3

Enter the name of course 1[NO SPACES] : G
Enter the credits for G : 4
Enter the name of course 2[NO SPACES] : H
Enter the credits for H : 4
Enter the name of course 3[NO SPACES] : I
Enter the credits for I : 3
Enter the grade for course [O,A+,A,B+,B,C,P,F] G : A+
Enter the grade for course [O,A+,A,B+,B,C,P,F] H : B+
Enter the grade for course [O,A+,A,B+,B,C,P,F] I : B
The grade for course G : A+
The credit for course G : 4
The grade value for course G : 9
The grade for course H : B+
The credit for course H : 4
The grade value for course H : 7
The grade for course I : B
The credit for course I : 3
The grade value for course I : 6

SGPA = 7.45455
Incase for new semester type SEM or to Calculate CGPA type CALC :SEM

Semester 4

Enter the number of courses: 3
Enter the name of course 1[NO SPACES] : J
Enter the credits for J : 4
Enter the name of course 2[NO SPACES] : K
Enter the credits for K : 3
Enter the name of course 3[NO SPACES] : L
Enter the credits for L : 3
Enter the grade for course [O,A+,A,B+,B,C,P,F] J : O
Enter the grade for course [O,A+,A,B+,B,C,P,F] K : O
Enter the grade for course [O,A+,A,B+,B,C,P,F] L : O
The grade for course J : O
The credit for course J : 4
The grade value for course J : 10
The grade for course K : O
The credit for course K : 3
The grade value for course K : 10
The grade for course L : O
The credit for course L : 3
The grade value for course L : 10

SGPA = 10
Incase for new semester type SEM or to Calculate CGPA type CALC :CALC

CGPA till Semester 4 =8.66667
Incase for new semester type SEM or to Calculate CGPA type CALC :^C

Fig. 4: C++ Output for scenario 3 (Indraprastha University)

```

SGPA Calculator
~~~~~
Choose the grading system
ANNA UNIVERSITY - 1
UNIVERSITY OF MADRAS - 2
INDRAPRASATHA UNIVERSITY - 3
1
SEMESTER 1
~~~~~
Enter the number of courses      : 3
Enter the number of audit courses : 0
Enter the name of course 1[NO SPACES] : A
Enter the credits for A      : 3
Enter the name of course 2[NO SPACES] : B
Enter the credits for B      : 3
Enter the name of course 3[NO SPACES] : C
Enter the credits for C      : 3
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - A : O
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - B : RA
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - C : SA
The grade for course - A      : O
The credit for course - A      : 3
The grade value for course - A : 10

The grade for course - B      : RA
The credit for course - B      : 3
The grade value for course - B : 0

The grade for course - C      : SA
The credit for course - C      : 3
The grade value for course - C : 0

SGPA = 3.33333
Arrears courses
1. B
2. C
Incase for new semester type SEM or to Calculate CGPA type
CALC :CALC
CGPA till Semester1 =3.33333
Incase for new semester type SEM or to Calculate CGPA type
CALC :SEM

SEMESTER 2
~~~~~
Enter the number of courses      : 3
Enter the number of audit courses : 1
Enter name of the audit course 1 (NO SPACE) : ENVIRONMENTALSCIENCES
Enter the grade for the audit course
ENVIRONMENTALSCIENCES : PASS
Enter the name of course 1[NO SPACES] : AA
Enter the credits for AA      : 3
Enter the name of course 2[NO SPACES] : BB
Enter the credits for BB      : 3
Enter the name of course 3[NO SPACES] : CC
Enter the credits for CC      : 3
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - AA : O
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - BB : A+
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - CC : RA
The grade for course - AA      : O
The credit for course - AA      : 3
The grade value for course - AA : 10
The grade for course - BB      : A+
The credit for course - BB      : 3
The grade value for course - BB : 9
The grade for course - CC      : RA
The credit for course - CC      : 3
The grade value for course - CC : 0

SGPA = 6.33333
Audit courses
Course name : ENVIRONMENTALSCIENCES
Grade : PASS
Arrears courses
1. CC
Incase for new semester type SEM or to Calculate CGPA type
CALC :CALC
CGPA till Semester2 =4.83333
Incase for new semester type SEM or to Calculate CGPA type
CALC :SEM

SEMESTER 3
~~~~~
Enter the number of courses      : 3
Enter the number of audit courses : 0
Enter the name of course 1[NO SPACES] : AAA
Enter the credits for AAA      : 4
Enter the name of course 2[NO SPACES] : BBB
Enter the credits for BBB      : 4
Enter the name of course 3[NO SPACES] : CCC
Enter the credits for CCC      : 4
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - AAA : A
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - BBB : A+
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - CCC : B
The grade for course - AAA      : A
The credit for course - AAA      : 4
The grade value for course - AAA : 8
The grade for course - BBB      : A+
The credit for course - BBB      : 4
The grade value for course - BBB : 9
The grade for course - CCC      : B
The credit for course - CCC      : 4
The grade value for course - CCC : 6

SGPA = 7.66667
Incase for new semester type SEM or to Calculate CGPA type
CALC :CALC
CGPA till Semester3 =5.96667
Incase for new semester type SEM or to Calculate CGPA type
CALC :SEM

SEMESTER 4
~~~~~
Enter the number of courses      : 3
Enter the number of audit courses : 0
Enter the name of course 1[NO SPACES] : AAAA
Enter the credits for AAAA      : 3
Enter the name of course 2[NO SPACES] : BBBB
Enter the credits for BBBB      : 3
Enter the name of course 3[NO SPACES] : CCCC
Enter the credits for CCCC      : 3
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - AAAA : A
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - BBBB : O
Enter the grade[O,A+,A,B+,B,RA,SA,W] for course - CCCC : B+
The grade for course - AAAA      : A
The credit for course - AAAA      : 3
The grade value for course - AAAA : 8
The grade for course - BBBB      : O
The credit for course - BBBB      : 3
The grade value for course - BBBB : 10
The grade for course - CCCC      : B+
The credit for course - CCCC      : 3
The grade value for course - CCCC : 7

SGPA = 8.33333
Incase for new semester type SEM or to Calculate CGPA type
CALC :CALC
CGPA till Semester4 =6.51282

```

Fig. 5: C++ Output for scenario 4 (Anna University)

APPENDIX

Appendix – I: Developed C++ code for the problem:

```

#include <iostream>
#include <stdio.h>
using namespace std;
int main()
{
    int numCourse, i, numAudit;
    int numSem = 0;
    int gradeSystem;
    float tot = 0, toc = 0;
    float sum1;
    float sgpa[20];
    float scr[20];
    float credit[numCourse];
    float buff, buff2, buff3, buff4, buff5;

    cout << endl;
    cout << "SGPA Calculator" << endl;
    cout << "~~~~~" << endl;
gradeSysreset:
    cout << "Choose the grading system" << endl;
    cout << "ANNA UNIVERSITY - 1" << endl;
    cout << "UNIVERSITY OF MADRAS - 2" <<
endl;
    cout << "INDRAPRASATHA UNIVERSITY - 3 "
<< endl;
    cin >> gradeSystem;
    course:
    int ra = 0;
    numSem = numSem + 1;
    cout << "SEMESTER " << numSem << endl;
    cout << "~~~~~" << endl;
    cout << endl;
    cout << "Enter the number of courses \t\t : ";
    cin >> numCourse;
    cout << "Enter the number of audit courses \t : ";
    cin >> numAudit;
    cout << endl;
    std::string grade[numCourse];
    std::string course[numCourse];
    std::string auditName[numAudit];
    std::string auditGrade[numAudit];
    for (i = 0; i < numAudit; i++) //Audit courses
    {
        cout << "Enter name of the audit course "
<< i + 1 << " (NO SPACE) \t : ";
        cin >> auditName[i];
        cout << "Enter the grade for the audit
course " << auditName[i] << "\t : ";
        cin >> auditGrade[i];
    }
    int gvalue[numCourse];
    float css[numCourse];
    css[0] = 0;
    buff5 = 0;
    for (i = 0; i < numCourse; i++) //Normal Courses
    {
        cout << endl;
        cout << "Enter the name of course " << i + 1 << "[NO
SPACES] \t : ";
        cin >> course[i];
        cout << "Enter the credits for " << course[i] << "\t\t : ";
        cin >> credit[i];
        buff5 = buff5 + credit[i];
    }
    cout << endl;
    scr[numSem] = buff5;
    switch (gradeSystem) //Comperator
    {
    case 1:
    {
        for (i = 0; i < numCourse; i++)
        {
            cout << "Enter the grade[O,A+,A,B+,B,RA,SA,W] for
course - " << course[i] << "\t : ";
            cin >> grade[i];
            cout << endl;
            if (grade[i].compare("O") == 0)
                gvalue[i] = 10;
            else if (grade[i].compare("A+") == 0)
                gvalue[i] = 9;
            else if (grade[i].compare("A") == 0)
                gvalue[i] = 8;
            else if (grade[i].compare("B+") == 0)
                gvalue[i] = 7;
            else if (grade[i].compare("B") == 0)
                gvalue[i] = 6;
            else if (grade[i].compare("RA") == 0)
                gvalue[i] = 0;
            else if (grade[i].compare("SA") == 0)
                gvalue[i] = 0;
            else if (grade[i].compare("W") == 0)
                gvalue[i] = 0;
        }
        break;
    case 2:
    {
        for (i = 0; i < numCourse; i++)
        {
            cout << "Enter the grade[O,D+,D,A+,A,B+,B,U,AAA] for
course - " << course[i] << "\t : " << endl;
            cin >> grade[i];
            cout << endl;
            if (grade[i].compare("O") == 0)
                gvalue[i] = 10;
            else if (grade[i].compare("D+") == 0)
                gvalue[i] = 9;
            else if (grade[i].compare("D") == 0)
                gvalue[i] = 8;
        }
    }
    }
}

```

```

else if (grade[i].compare("A+") == 0)
    gvalue[i] = 7.5;
else if (grade[i].compare("A") == 0)
    gvalue[i] = 7;
else if (grade[i].compare("B+") == 0)
    gvalue[i] = 6;
else if (grade[i].compare("B") == 0)
    gvalue[i] = 5;
else if (grade[i].compare("U") == 0)
    gvalue[i] = 0;
else if (grade[i].compare("AAA") == 0)
    gvalue[i] = 0;
    }
    }
    break;
    case 3:
    {
for (i = 0; i < numCourse; i++)
    {
cout << "Enter the grade [O,A+,A,B+,B,C,P,F] for course - "
<< course[i] << "\t : " << endl;
cin >> grade[i];
cout << endl;
if (grade[i].compare("O") == 0)
    gvalue[i] = 10;
else if (grade[i].compare("A+") == 0)
    gvalue[i] = 9;
else if (grade[i].compare("A") == 0)
    gvalue[i] = 8;
else if (grade[i].compare("B+") == 0)
    gvalue[i] = 7;
else if (grade[i].compare("B") == 0)
    gvalue[i] = 6;
else if (grade[i].compare("C") == 0)
    gvalue[i] = 5;
else if (grade[i].compare("P") == 0)
    gvalue[i] = 4;
else if (grade[i].compare("F") == 0)
    gvalue[i] = 0;
    }
    }
    break;
    default :
    {
cout << "Grade system is not entered properly";
    goto gradeSysreset;
    }
    }
for (i = 0; i < numCourse; i++) //Per Sem display
    {
cout << "The grade for course - " << course[i] << "\t\t : " <<
right << grade[i] << endl;
cout << "The credit for course - " << course[i] << "\t\t : " <<
right << credit[i] << endl;
cout << "The grade value for course - " << course[i] << "\t :
" << right << gvalue[i] << endl;
//arrears comperator
if (grade[i].compare("RA") == 0 || grade[i].compare("SA") ==
0 || grade[i].compare("W") == 0 || grade[i].compare("F") == 0
|| grade[i].compare("AAA") == 0 || grade[i].compare("U") ==
0)
    ra = ra + 1;
    css[i] = gvalue[i] * credit[i];
    cout << endl;
    }
    int buffra = ra + 2 ;
    int j = 0;
    std::string arrearsName[buffra];
    for (i = 0; i < numCourse; i++)
    {
if (grade[i].compare("RA") == 0 || grade[i].compare("SA") ==
0 || grade[i].compare("W") == 0 || grade[i].compare("F") == 0
|| grade[i].compare("AAA") == 0 || grade[i].compare("U") ==
0)
    {
        arrearsName[j] = course[i];
        j++;
    }
    }
    buff = 0;
    buff2 = 0;
    for (i = 0; i < numCourse; i++) //total calc
    {
        buff = css[i] + buff;
        buff2 = credit[i] + buff2;
    }
    buff3 = buff / buff2;
    cout << "_____ " << endl;
    cout << "SGPA = " << buff3 << endl;
    cout << endl;
    if (numAudit > 0)
    {
cout << "Audit courses" << endl;
for (i = 0; i < numAudit; i++)
    {
cout << "Course name \t : " << auditName[i] << endl;
cout << "Grade \t : " << auditGrade[i] << endl;
cout << endl;
    }
    }
    cout << endl;
    if (ra > 0)
    {
cout << "Arrears courses" << endl;
        for (i = 0; i < ra; i++)
        {
            cout << i + 1 << " . " << arrearsName[i] << endl;
        }
    }
    sgpa[numSem] = buff3;
    std::string reset;
    retry:

```

```

cout << endl;
cout << "Incase for new semester type SEM or to
    Calculate CGPA type CALC :";
cin >> reset;
if (reset.compare("SEM") == 0)
    {
    goto course;
    }
else if (reset.compare("CALC") == 0) //cgpa calculator
    {
    for (i = 1; i < numSem + 1; i++)
        {
        tot = tot + (sgpa[i] * scr[i]);
        toc = toc + scr[i];
        }
    sum1 = (tot / toc);
    cout << endl;
    cout << "CGPA till Semester" << numSem << " =" << sum1
    << endl;
    toc = 0;
    tot = 0;
    goto retry;
    }
cout << "~~~~~ END ~~~~";
}

```

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