Salesian College

Sonada | Siliguri

# Additional documents for Metric 1.1.1

## Contents

# MEETING MINUTES

| | | |
|---|---|---|
| Cell | : | IQAC |
| Date | : | 4th July '2022 |
| Start Time | : | 10:30 am |
| End Time | : | 11:30 am |

**Facilitator:** Mr. Subhajit Bose & Mr. Rupam Majumdar

**Minutes Keepers:** Mr. Dhiren Newar

The Meeting of IQAC Core Members was held on 4th July 2022 in the Sonada Campus at Research Centre from 10:30 am. The following points was discussed.

1. The lowest NAAC Score was Criteria 3 and Criteria 5. Each sub criteria was discussed in detail and also its solution was also discussed.

2. The next topic discussed was in regard to Student Mentoring. It was decided that Mr. Dhiren would prepare the Student Mentoring Form incorporating the NAAC Criterias and once finalized both the Siliguri Campus and Sonada Campus would follow the same Mentoring Form.

3. It was discussed and also finalized in regard to the Best Faculty Awards to be given and the following Category was finalized: (a) Best Mentor (b) Best Teacher (c) Best Student Support (d) Best Researcher & (e) Best Community Service.

4. It was also agreed that in the Website, the IQAC tab would consist of its Introduction, Scope, Objectives, Functions, Vision & Mission and Composition.

5. This academic year, the Departments should conducted Student Exchange Program with other Institute & Colleges which will carry NAAC Weightage.

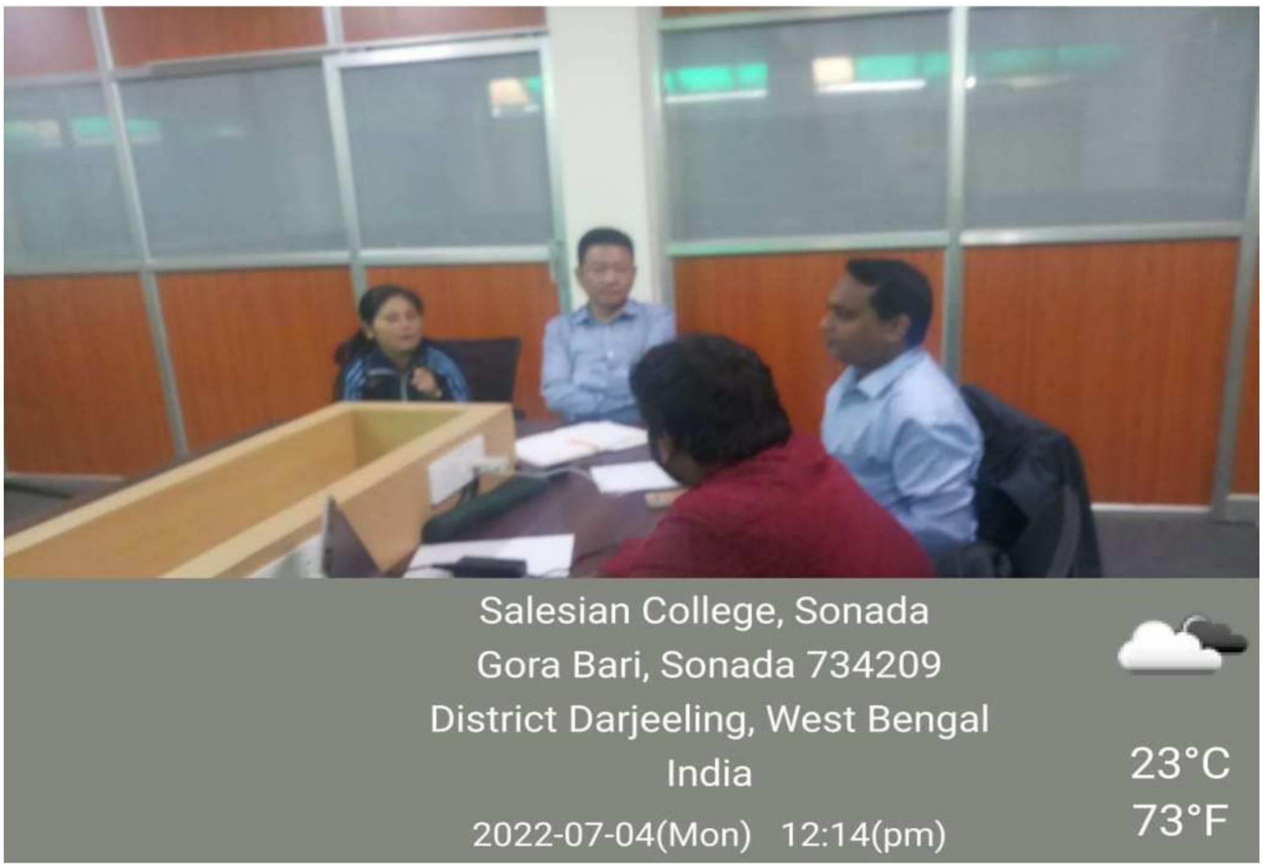
6. It was also agreed that faculty members will fill up the certain NAAC Parameters as a part of their Checklist at the end of each month.

7. Fr. Principal instructed to involve one faculty assistant to Mr. Dhiren Newar for all the NAAC related activities and would be remunerated for the work and responsibility undertaken.

- **Attendance:**

| No. | Members: | Designation: |
|---|---|---|
| 1 | Fr. George Thadathil | Principal, IQAC Chairperson |
| 2 | Dr. Terence Mukhia | IQAC Coordinator |
| 3 | Mr. Dhiren Newar | IQAC Secretary, SCS |
| 4 | Mr. Sradha Pradhna | IQAC Member |
| 5 | Mr. Subhajit Bose | IQAC Secretary, SCSC |
| 6 | Mr. Rupam Majumdar | IQAC Assistant Coordinator |

**Geo Tagged Photo**




***Minutes Prepared by:***

Secretary (SCS)
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Salesian College
Sonada & Siliguri
*NAAC Accredited 'A' Grade (3rd Cycle) & Twice UGC certified College with Potential for Excellence (CPE)*

**Ref No. SCS/23/IQAC/4** **Date: 03/03/2023**

# NOTICE

**4th IQAC Meeting**

The 4th IQAC meeting of the academic year 2022-23 has been arranged to be held on 11/03/2023 at 2:30 pm in the IQAC Office, Sonada Campus to consider the following agenda. Members are requested to make it convenient to attend the same.

## Agenda:

- **Prayer and Opening note:**
  - *Fr. Nirmal Toppo SDB, Vice Principal, Salesian College, Sonada*

- **Welcome & Address:**
  - *Dr. Terence Mukhia, IQAC Coordinator, Salesian College*

- **Review of Executive Training Programme held at Siloam & Approval of HoDs' Manual:**
  - *Mr Subhajit Bose, IQAC Assistant Coordinator (Siliguri)*
  - *Mr Subhajit Paul, IQAC Secretary & Dean of Sciences (Siliguri)*
  - *Dr. Terence Mukhia, IQAC Coordinator, Salesian College & Dean of Arts & Humanities (Sonada)*

- **AQAR (2021-2022) Review:**
  - *Mr Subhajit Bose, IQAC Assistant Coordinator (Siliguri)*
  - *Mr Subhajit Paul, IQAC Secretary & Dean of Sciences (Siliguri)*
  - *Mr Dhirendra Newar, IQAC Secretary (Sonada)*
  - *Mr. Debajyoti Chakraborty, Educational Engineer (Siliguri)*

- **Review of the performances during the Odd Semester (2022-23):**
  - *Mr. Dhirodutta Subba, Dean of Collaboration & Expansion (Siliguri)*
  - *Ms. Sradha Pradhan, Campus Coordinator (Sonada)*

- **Plan of Action for the next Academic Year 2023-2024:**
  - ***Vice Principals:***
  - *Fr. Nirmal Toppo (Sonada)*
  - *Fr. Babu Joseph (Siliguri)*
  - *Fr. Saju PT. (Siliguri)*
  - *Fr. CM Paul (Siliguri)*

- **Closing Remark:**
  - *Fr. (Prof). George Thadathil, Chairperson (IQAC), Principal / Rector, Salesian College*

## In Communication to the Members:

1. Fr (Prof) George Thadathil, Chairperson (IQAC), Principal/Rector, Salesian College
2. Fr (Dr) Tomy Augustine, Rector, Salesian College, Sonada
3. Fr Nirmal Toppo, Vice Principal, Salesian College, Sonada
4. Fr (Dr) Babu Joseph, Vice Principal, Commerce, Management Studies & Vocational Studies (Siliguri)
5. Fr Saju PT, Vice Principal, Arts & Humanities (Siliguri)
6. Fr CM Paul, Vice Principal, Deanery of Sciences (Siliguri)
7. Dr Minakshi Chakraborty (Principal, Kalipada Ghosh Tarai Mahabidyalaya)
8. Mr Eugene Gurung (Industry Representative)
9. Dr Terence Mukhia, Dean of Arts & Humanities Salesian College, Sonada, IQAC Coordinator
10. Mr. Dhirodutta Subba, Dean of Collaboration & Expansion (Siliguri)
11. Fr Raymond Tudu, Bursar (Sonada)
12. Mr Dhirendra Newar, Secretary (Sonada)
13. Mr Subhajit Bose, Assistant Coordinator (Siliguri)
14. Mr Subhajit Paul, IQAC Secretary & Dean of Sciences (Siliguri)
15. Mr Debajyoti Chakraborty, Educational Secretary (Siliguri)
16. Ms Sradha Pradhan, Campus Coordinator (Sonada)
17. Mr. Anirban Ghosh, Internal Auditor (Siliguri)

Fr (Prof) George Thadathil,
Chairperson (IQAC),
Principal/Rector,
Salesian College

Salesian College
Sonada | Siliguri

# Minutes of the 4th IQAC Meeting

IQAC Office, SCS

March 11, 2023

## Contents

# Foreword

The fourth IQAC meeting of the academic year 2022-23 was called on Saturday, March 11, 2023. The meeting was held in the IQAC office of Salesian College, Sonada. The office bearers from the Siliguri campus (SCSC) and the members from the Sonada Campus (SCS) attended the meeting.

## I: (a) Attendees in the meeting

1. Fr (Prof) George Thadathil, Chairperson (IQAC), Principal/Rector, Salesian College
2. Fr (Dr) Tomy Augustine, Rector, Salesian College, Sonada
3. Fr Nirmal Toppo, Vice Principal, Salesian College, Sonada
4. Fr CM Paul, Vice Principal, Deanery of Sciences (Siliguri)
5. Dr Tapu Biswas (Educationist)
6. Dr Terence Mukhia, Dean of Arts & Humanities Salesian College, Sonada, IQAC Coordinator
7. Mr Dhirodutta Subba, Dean of Collaboration & Expansion (Siliguri)
8. Mr Dhirendra Newar, Secretary (Sonada)
9. Mr Subhajit Bose, Assistant Coordinator (Siliguri)
10. Mr Subhajit Paul, IQAC Secretary & Dean of Sciences (Siliguri)
11. Ms Sradha Pradhan, Campus Coordinator (Sonada)
12. Mr Anirban Ghosh, Internal Auditor (Siliguri)

## I: (b) Special Invitees in the meeting

1. Fr Raymond Tudu, Bursar (Sonada)
2. Mr Debajyoti Chakraborty, Educational Secretary (Siliguri)
3. Ms Edna Chettri, Minutes keeper (Sonada)

## Minutes of the Meeting

The minutes have been recorded as it proceeded.

## II: Invocation

The meeting started at 2:30 pm with a prayer by Fr (Dr) Tomy Augustine, the Rector (SCS). Dr. Terence Mukhia, IQAC Coordinator, welcomed all the members present at the meeting. He expressed the blessedness of miracles happening in Salesian College with the efforts and hard work of the team from C++ accreditation to A and now towards autonomy.

## III: Confirm the proceedings of the previous IQAC meeting

Mr Subhajit Bose read the minutes of the IQAC meeting held on the $10^{th}$ of October 2022 which was followed by Mr. Subhajit Paul who read and proposed the minutes of $3^{rd}$ IQAC meeting for the academic year 2021-22 held on June 18, 2022, which was approved by Ms. Sradha Pradhan.

# IV: Agenda

**1. Review of IQAC Action Plan for 2022-23 and 2023-24**

Dr. Terence Mukhia presented the IQAC Action Plan (2022-23) drafted in the previous IQAC meeting held on the 18th of June 2022 and discussed the status of the plan and how much of it has been achieved. He stated that most of the planned action has been implemented.

The IQAC Action plan for 2023-24 was presented by Dr. Terence Mukhia for approval from the Principal and Office bearers which stated:

**i) Plan of Action:**

a) Academic Action Plan for the forthcoming academic year will be presented at least three months in advance during IQC meeting.

b) Handbook and Academic Calendar will be prepared accordingly.

**ii) SSR submission:**

a) SSR submission will be done in 2024.

b) Data filing to begin from July 2023.

**iii) AQAR Format for Autonomous Colleges:**

An orientation/training programme on the said AQAR format for both faculty and support staff, SCS, will be held on the proposed date 20th May 2023, with Dr. Tapu Biswas as the Resource Person.

**iv) Certificates**

Dr. Terence expressed his concern regarding certificates as the scanned copies are not being submitted to the IQAC Office. He proposed a suggestion that this problem can be solved if distribution of certificates is not permitted in the college unless the scanned certificates are submitted to the IQAC Office.

**v) Feedback on Syllabus (QN 1.4.2):**

He mentioned that a special template will be created for feedback on the syllabus by Students, Teachers, Employers and Alumni. Feedback will be collected, analyzed, action will be taken and the same will be made available on the website as there is no clear-cut data on this and this needs to be made effective.

**vi) Ascertaining Learning Levels (QL 2.2.1):**

Departments will have to devise clear-cut method/s to assess the learning levels of the students and organize special programs for Advanced Learners and Slow Learners. It should be explained clearly so that it is self-explanatory when evaluators view it.

**vii) Research (Q N. 3.3.2):**

a) Faculty will be encouraged to submit research papers in the Journals notified on UGC Carelist/ website, peer reviewed journals and books.

b) Collaborative research will be planned out (QN 3.5.1).

**viii) Mentoring:**

He informed that a new comprehensive mentoring form will be brought into effect from June/July 2023 which has been drafted by Dr. Fr. Tomy Augustine.

**ix) Cross Cutting Issues (PE/GEN/HV/ES) into curriculum (QN 1.3.1):**

List of courses to be prepared not just as co-curricular activities. Presently, only Value Education is shown in the curriculum. He suggested that to get better scores new courses can be prepared.

**x) QN 5.2.3:**

Final year students will be trained and encouraged to sit for state/national/international level examinations (TOEFL/Civil Services/ SET/NET). SCS has Competitive Exam Preparation (CEP) included in the curriculum for which one student in 1st year, two in 2nd year and seven in 3rd year i.e only 10 students of BA Program benefit from it. He suggested that classes be conducted for all 3rd Year students on Saturdays to train them so that everyone can make use of this opportunity.

**xi) QN 5.3.1:**

Students will be sent for participation in Sports and Cultural activities at university level at least. He mentioned that SCS has no data for the last academic year on this criterion.

**xii) Solar Panels:**

Solar panels to be installed at SCS with the approval of the Board members.

**xiii) Environment Concerns (QN 7.1.6):**

Green audit will be done assisted by Dr Tapu Biswas.

**xiv) IQAC Office:**

a) Not all sorts of meetings and programmes will be entertained in the IQAC Office, however

b) DFM HoDs meeting and AQAR Review meeting will be held in the IQAC office. He said that other meetings of academic nature can be organized with prior notice. Dr. Terence Mukhia stated that the reason for presenting this plan of action was to address the issues that concern us as we still have 1 year to go for SSR Submission. Strategies can be implemented to tackle such issues so that we have better chances of scoring during the next SSR evaluation.

Dr. Terence Mukhia stated that the reason for presenting this plan of action was to address the issues that concern us as we still have 1 year to go. Strategies can be implemented to tackle such issues so that we have better chances of scoring during the next SSR evaluation.

Mr. Dhirodutta Subba made the following observations on the proposed Lesson Plan for the Action Plan (2023-24):

Mr. Dhirodutta Subba made the following observations on the proposed Lesson Plan for the Action Plan (2023-24):

i) In Siliguri Campus, a standardized mentoring manual prepared by Dr. Fr. Saju PT has been introduced and the practice of submitting weekly Instructional plan has been implemented wherein the faculty members have to submit their plans for every week every Saturday.

ii) Instead of a lesson plan, a weekly plan must be submitted and that is the only difference between what is being proposed and what is being implemented. Dr. Terence Mukhia responded to the following observations by saying that initially when the idea of a Lesson Plan was being considered in the previous IQAC meeting, a standardized format for both the campuses was proposed; but it was always open to discussion whether both the campuses follow the same method or do it separately.

Fr. Nirmal Toppo, Vice Principal (SCS), explained that the reason for requesting the faculty members to submit their lesson plans for the semester ahead of time was that, while the board members were aware of the number of class days and events that would be held during the semester, the rest of the faculty were not. However, if this information were to be shared with them ahead of time, the lesson plans could be prepared, and the lessons could be distributed accordingly to avoid last minute rush and confusion.

According to Dr. Fr. George Thadathil, IQAC Chairperson/ Principal/ Rector, this was initially conducted as a Course Plan that included an estimated completion time which differed from the Lesson Plan and Instructional Plan.

The mentoring manual, which had been transmitted from the Sonada campus to the Siliguri campus, was not to be printed right away because it was still being tested, according to Dr. Fr. Tomy Augustine. He said that to familiarize the students with the technique, a few departments on the Sonada campus have been conducting dry runs. It has two columns—one for the student and one for the faculty—and after that is completed it will be sent to Siliguri.

Mr. Dhirodutta Subba enquired as to whether there would be another edition of the printed manual that would be utilized by everyone to which Dr. Fr. George Thadathil responded in the affirmative and explained that the previously printed manual is not many in number and would only be used by 200 students out of the total 2000 students.

Mr. Anirban Ghosh answered by stating that it was the original idea when Mr. Subhajit Paul recommended that this may be included in the ERP. Mr. Subhajit Paul also remarked that the students should have access to it where some fields are visible to them, and others are not. According to Mr. Subhajit Bose, the mentoring component of the ERP already exists; it only must be updated with the various fields of evaluation.

Mr. Subhajit Paul stated that faculty training for mentoring is long overdue, to which everyone agreed. According to Dr. Fr. Tomy Augustine, after the student completes his/her self-evaluation, it is submitted to the department, which accesses it and then passes it on to the mentor teacher. The mentor teacher is expected to meet with the student and discuss the areas of improvement for the semester, which will be documented.

Mr. Anirban Ghosh stated that it is similar to the previous reporting system being followed, which was sent to the Deans, who then sent it to the Principal, to which Dr. Terrence Mukhia replied that the reporting system is done every month, whereas this evaluation will be done only once a semester at the end of the semester.

Mr. Dhirodutta Subba announced that the Department of Psychology in the Siliguri campus is conducting a psychometric test for first-year students who have just completed their first semester.

**2. AQAR (2021-22) Review**

Mr. Dhiren Newar presented the second agenda, which detailed the current state of the Sonada campus.

i) <u>Criterion I- Complete, except for 1.4.1 and 1.4.2</u>

Mr. Dhiren Newar expressed his concern about Criteria 1.4.2, stating that it is very difficult to collect feedback, analyze it, take action, and publish it on the website, and strategies are still being considered. Mr. Subhojit Paul provided an example, stating that previously some faculty members expressed some dissatisfaction with the syllabus, so they were asked for suggestions, and those suggestions were made into a formal letter and published on the website. As a result, a similar strategy can be used. He stated that there are no suggestions for the syllabus from the faculty this year. However, it was discovered that one of the letters lacked a date. He then proposed that both campuses collaborate and work on this together.

In this metric, Mr Subhajit Bose observed that some questions in recent examinations were not from the syllabus, and this was communicated to the university. He inquired whether this metric applies to the syllabus, to which it was replied that it does not because it only applies to the feedback of the syllabus and its transactions with the four different categories mentioned, namely Students, Teachers, Employers and Alumni.

Dr. Fr. George Thadathil proposed that there be records of feedback and suggestions from all departments regarding the syllabus for the next academic year in light of the audit that will take place because will be stated that every department will be changing their syllabus by 15%. As a result, if the feedback indicates that the department is pleased with the syllabus, there will be a discrepancy.

Each department must be asked for suggestions, feedback, and comments on how to improve the syllabus or add topics to the syllabus, which must be signed and submitted to the IQAC Office.

Ms. Sradha Pradhan stated that getting feedback from alumni is more difficult in SCS than the other three categories, so Dr. Terence Mukhia suggested to get feedback from the immediate alumni, i.e., the final year students, and collecting their feedback, can be considered which would also provide a record every year.

Mr. Subhajit Paul informed that only a few feedbacks are required because there is no set percentage, to which Dr. Fr. George responded that selected alumni, including faculty, who have graduated from the college, can be considered for this criterion. Mr. Anirban Ghosh added that the senior alumni will be able to point out what can be added in the syllabus. Mr. Subhajit Paul stated that in 2019, he prepared five forms, one for each category, which were filled out, scanned, uploaded, and published on the website.

ii) Criterion II - fully completed

iii) Criterion III - completed as most aspects were not applicable

Mr. Subhajit Bose stated that this criterion should be prioritized because we appear to be losing points due to a lack of data. It is concerned with Research, Innovations and Extension. He suggested that faculties conduct hybrid research with other faculty members to save time. In one year, each department could publish one paper and at least one chapter in a book. Mr. Dhirodutta Subba added that collaborations with other institutions are also possible.

Mr. Anirban Ghosh inquired whether faculty who have completed their PhDs and have been guiding PG students of IGNOU in their dissertations should be considered in criterion 3.1.2

because they are a part of the institution, to which Mr. Debajyoti Chakraborty replied that only faculty guiding PhD students are considered in this criterion.

In response to criteria 3.2.2, Dr. Tapu Biswas suggested that the college host workshops and seminars on research methodology. It was revealed that the Siliguri campus had conducted research, whereas the Sonada campus had data for the years 2022-23 but not 2021-22.

Dr. Fr. Tomy Augustine proposed that the Research Scholars' Workshop be included in this criterion, to which Dr. Terence Mukhia responded that it had already been shown on the other criteria and that if it was shown in multiple places, we would lose points.

Dr. Fr. George Thadathil proposed that this workshop be conducted by final-year students of Sociology, Social Work, Education, Psychology, and other disciplines who have required dissertation papers.

Dr. Terence Mukhia recalled that a research methodology workshop was held for the outgoing batch the previous year, which would be applicable in this criterion.
Dr. Fr. George Thadathil requested that the data provided by the criteria members be cross-checked and tallied with the existing records to ensure that nothing was overlooked.

iv) Criterion IV - complete

v) Criterion V - complete

Regarding criterion 5.4.2, Mr. Debayjyoti Chakraborty informed that the data proof provided must be updated.

vi) Criterion VI – complete

vii) Criterion VII – complete

During the discussion of Criterion 7.2.1, Mr. Debayjyoti Chakraborty stated that he had added Radio Salesian as one of the best practices implemented on the Sonada campus, but that the write-up needed to be changed and updated to the year 2021-22.

Dr. Fr. George Thadathil announced that 'Campus this Week' and 'Elite Talk' from last year will be included for best practices implemented in Siliguri, while 'ERP' and 'Radio Salesian' will be included for Sonada.

For 7.1.6, it was discussed that students could be involved by counting the number of trees for the Green audit. It was suggested that for an Energy audit, hiring someone who is certified in the field and has two years of experience working in an electricity office should be done. A qualified person's signature is required. A signature from the forest department is also required for Green audit.

Mr. Debayjyoti Chakraborty informed that previously, the power usage was calculated on the voltage for the Energy audit had been calculated, but now it has been calculated based on the area of the room to make the data more specific.

Mr. Dhiren Newar informed that Radio Salesian, News Asia Pacific, and Campus This Week are the best practices implemented in SCS for AQAR 2021-22, and that the write-up needs to be updated. Dr. Terence Mukhia advised the person merging data to exercise extreme caution.

**3. NAAC Portal**

The NAAC AQAR upload portal was presented to discuss and make necessary changes before the submissions this month. The process of logging in was demonstrated.
The following points were discussed:

- The previous year's action plan (AQAR 2020-21) for the upcoming year will be converted and should match the implementation action of AQAR 2021-22.
- As a statutory body, IQAC was added.
- Because it is not required that the approval date be of the same session, AQAR 2021-22 can be placed on today's date. It could be the day before the upload, and any of the statutory bodies governing the meeting could be used as the data date.
- NAAC is attempting to integrate AISHE, NIRF, and AQAR submission in the new synchronized mode of upload.
- The areas that need to be updated for collating and merging should be assigned to the members. Since 1 had already been completed by Mr. Subhajit Paul, it was decided that 2, 5, and 7 would be completed by Mr. Debayjyoti Chakraborty and Mr. Satyan, and 3 and 6 could be completed by Mr. Dhiren Newar and Dr. Terence Mukhia. Dr. Fr. George Thadathil will review the five additional answers introduced last year.

- Every student's information must be entered into the Government portal.
- Bank account information is being requested in order to track the donations received.
- The files that were uploaded were examined. Some of the uploaded files as proof were not accessible, according to feedback.
- A template for the table of contents has been created, and the files and PDFs must be attached one by one because the page numbers are mentioned in the contents but are not visible on the pages.
- A notification has been issued stating that proof data cannot be uploaded to Google Drive. Only the Institutional machine will have access to it.
- To ensure consistency in the mode of notice display, all IQAC notices should be in a standardized format.
- In the case of qualitative data, the word limit of 200 means that a lot of information is lost. While collating the data, 200 words of data can be provided, but the rest of the information can be added as additional proof that can be posted on the website under the IQAC, and that option is available.
- The file for 2.3.3 was found to be pixelated, and the signature must be added.
- To complete the data that needs to be reviewed, a deadline must be set.
- It was confirmed that students pursuing BEd. after completing their PG could be included in Student's Progression because it is an additional degree.
- The Best Faculty award can be obtained by following a procedure.
- The number of students taking government exams can be increased by having faculty members coach them.
- The Organogram was shown. It was suggested that the addition of HoDs and BOS be made, and that all departments be omitted. A suggestion of creating a unified chart integrating both campuses was made. Dr. Fr. Tomy Augustine questioned how the campuses would be differentiated in terms of management, to which it was stated that the college is the same, with two campuses, and a decision was made to redesign the chart by merging the two campuses. The hierarchy must be adhered to. The number of governing body members and the role functions should be removed from the chart.

- It was asked if any information was left out during submissions, whether it could be included in the SSR because there were a lot of issues when reviewing the data, such as the title of the events and the certificates as points could be lost.
- Except for joint meetings, there is one IQAC core committee that meets whenever it is convenient and keeps separate minutes.
- To ensure consistency, the geo-tagged photos can be taken with the same app. 'Spotlens' is the app recommended. Following verification, the IQAC office can send a notice.
- Sensor lights can be installed to save energy.
- There will be disabled friendly restrooms built.
- Changes to the write-up for Criterion 7.3.2 to be made.

**4. Plan of Action for the next Academic Year 2023-24**

Fr. C.M Paul, Vice Principal (SCSC) stated the following plans for the upcoming academic year other than the daily activities:

Other than daily activities, Fr. C.M Paul, Vice Principal (SCSC), stated the following plans for the upcoming academic year:

- Considering the performance of students in the post-corona examination, preventive action is being tested by conducting an orientation programme for first-year students with the assistance of the Department of Psychology. A total of three tests are being administered by PG Psychology students to profile the students and assess their academic performance. It will be made an annual event for the newly admitted batch to get to know the students better for them to be guided appropriately.
- According to the results of the tests, students will be directed to the Salesian wellness lab for counselling and the wellness studio for testing, which will be administered by PG faculty and MA 4th semester students. It will be hands-on learning for MA students because it includes an outreach programme and a service to the student community.
- The government is promoting a Tinkering lab, which will be run by the Department of Science and Technology, to encourage creativity, innovation, and entrepreneurship. This can be used to introduce new apps or to solve existing problems.

- Students' seminar to be organized which has been tested by Trends in Science and Technology. All students are encouraged to publish and present papers who will be guided by a faculty during their three-year course.

Mr. Dhirodutta Subba informed that the United board had previously sent invitations to send proposals, which was done after which an online interview had been conducted. They would be visiting the campus on April 20th, 2023, to see the infrastructure. Based on that, the plan should be rephrased and resubmitted which they might consider funding.

Dr. Fr. George Thadathil mentioned that the government-funded project can be added as data in the NAAC portal's partake of projects received in the blank column.

Mr. Subhajit Paul asked if we were going to start with autonomy this upcoming semester, to which Dr. Fr. George Thadathil replied that a month ago when it was communicated about the three pending courses, i.e., Masters in Social Work, Bachelors in Tourism & Hospitality, and Department of Music as a regular department, UGC had set up a new framework for approval of courses which had been passed and required information had been sent. The notification should have come by February. Dr. Tapu Biwas said that he would follow up with that.

Concerning autonomy, Dr. Fr. George Thadathil stated that the University forwarded it to the UGC and that it has reached the Higher Education Department. Three members were supposed to come for a visit under the old guidelines, but there will be no visit under the new guidelines. The UGC Autonomy section must make that decision. When contacted, they asked for the date of submission, and when told that it had arrived a week ago, they said we needed to wait for the new guidelines to be approved and that they would get back to them.
Mr. Subhajit Paul mentioned that if we gain autonomy in the coming semester, a series of official meetings and resolutions should be held where the Board of Studies, syllabus, course draft, and so on must all be finalized.

Dr. Fr. George Thadathil added that a strategic planning meeting of the institution should be planned, with the agenda being where the institution will be in ten years because autonomy is being handed over for ten years. He stated that the meeting date should be finalized to complete the documentary work that will serve as the framework for strategic planning. He stated that a decision should be made regarding the formation of a committee or small committees to oversee the Finance committee structure, Governing body, and Autonomy Council.

A document will be created, and a strategic planning meeting will be held because of it. He stated that if an institution is granted autonomy, the institution can notify NAAC of the same, and that whatever grade we have will be extended.

Fr. Nirmal Toppo, Vice Principal (SCS), stated the following plans for the Sonada campus for the year:

- There will be Student Exchange Programs. A proper policy and framework must be developed, whether it should be made mandatory for all departments or set a number of such programmes to be held each semester.
- Backlog Mentoring is being implemented, which includes strategizing methods in which mentor teachers communicate with students and parents to obtain feedback on potential actions to be taken.
- Departmental syllabus planning can begin immediately, and faculty members can go paper by paper every Saturday. It would make things easier when the autonomy notice arrives.

Dr. Fr. Tomy Augustine suggested that once autonomy is achieved, the Philosophy department be brought in, and the syllabus revised to include the papers included there as optional courses for students.

Dr. Fr. George Thadathil stated that it was agreed at the previous meeting that each department would have five activities per year. Similarly, MOU-related activities should be integrated into departmental operations. Each department must plan an event with one of the MOU colleges. Within the department, webinars can also be organized. Student exchange programmes that are cost-effective, beginning with inter-campus student exchange, should be encouraged.

Internships for skill-based courses, according to Fr. C.M Paul, should also be implemented. Dr. Fr. George Thadathil added that one of the activities for all students will be CV creation so that when they graduate, they will have a mentoring grade sheet that maps their overall performance. overall performance is mapped and all the activities they've done in 3 years will be shown in their CV.

It was informed that the date of LOP for the outgoing batch must be fixed, and Fr. George suggested that it must be in the month of April because graduation day will be held in the month of May.

**5. Review of the Performance during the Odd Semester (2022-23)**

Mr. Dhirodutta Subba presented the students' performance in the odd semester, highlighting:

For the fifth semester -

Arts Deanery - 22% failed and 78% passed.

The Science Deanery had 15% backlogs and 85% passed.

30% of the Commerce and Management BVoc Deanery had backlogs, while 70% passed.

Overall, 25% had problems, while 75% performed admirably.

For the third semester -

Arts Deanery - 23% failed while 77% excelled.

66% of Science Deanery students had backlogs, while 34% passed.

73% failed and 27% passed the in Commerce and Management BVoc Deanery.

Mr. Dhirodutta mentioned that there was a visible issue with Bcom, BCA, and BBA, and that when the issue was investigated, the reason discovered was that in BCA, the majority of the students were not from science backgrounds and had backlogs in Maths and Statistics, and the students were also careless. With Commerce and Management, it was discovered that the students performed well in the qualitative answers, but the paper that required regular practise was not completed diligently by the students.

Ms. Sradha Pradhan presented the students' performance from the Sonada campus, stating that:

In the third semester, out of a total of 107 students, 70 passed and 37 failed, with the majority of the defaulters coming from the Department of Political Science.

Overall, 34% failed, while 74% passed.

In the fifth semester, 126 students passed the exam and 33 students failed out of a total of 159 students.

In total, 20% of the students failed and 80% passed.

According to Ms. Sradha, the main issue is with the third-semester students.

The following were mentioned during the discussion of the action taken for the same:

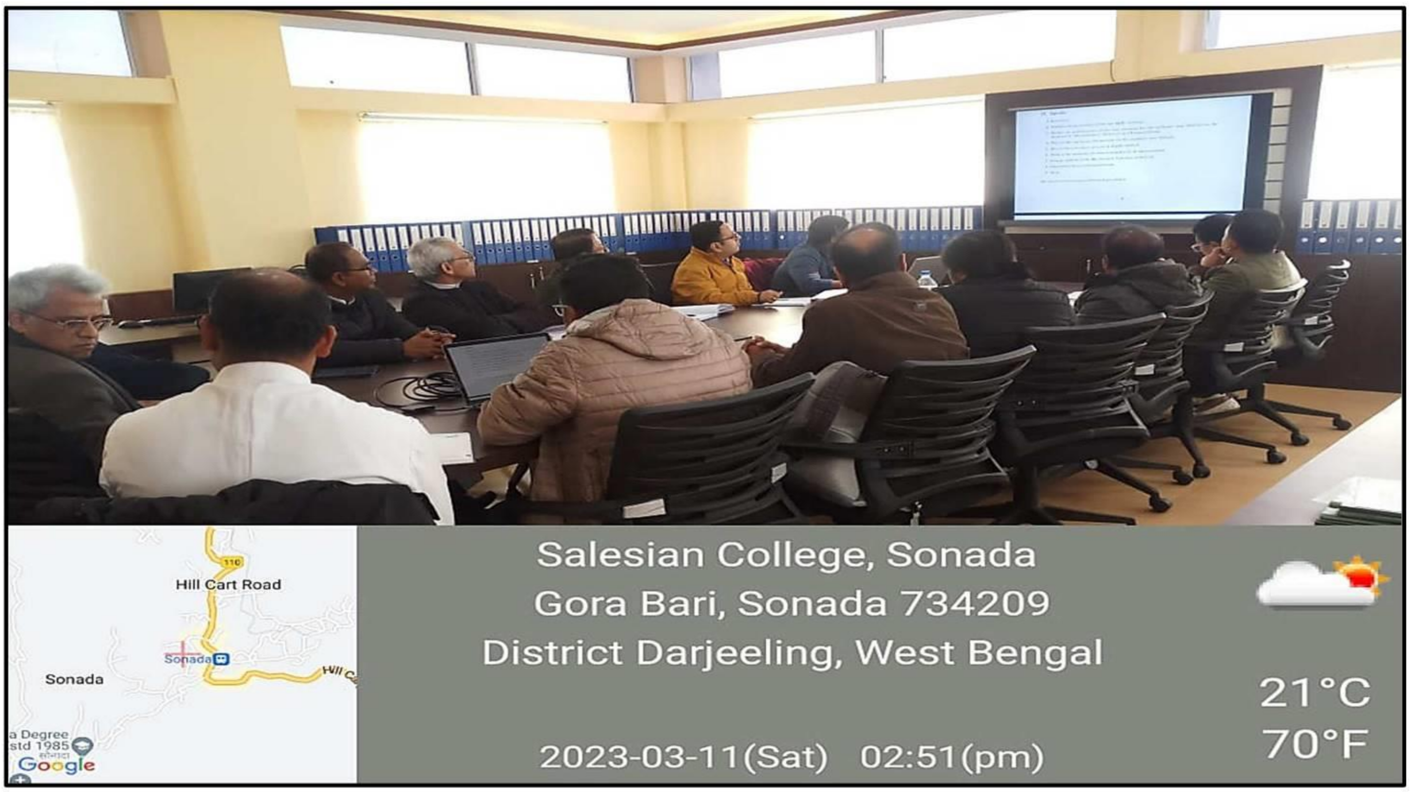
- Under the leadership of Dr. Fr. Babu Joseph, the office in Siliguri directed departments to record CIA, internal assessment, and university examination results. The department's faculty members were asked to provide a general assessment. It was decided that if a student has performed well in the internals but failed the university examination, his or her paper should be sent for reevaluation.
- Dr. Fr. George Thadathil suggested that faculty members sit with defaulters now, rather than later, and redo the answers to internal and university question papers as remedial classes in the department, keeping it signed by the student and teacher so that when the parent asks what action was taken, this can be shown. He stated that revision can be done prior to the start of the supplementary exam.
- Ms. Sradha Pradhan stated that a majority of students at the Sonada campus failed by only 1 or 2 marks, to which Dr. Fr. George Thadathil suggested that such students apply for reassessment.
- Mr. Subhajit Bose stated that after the results were released, Dr. Fr. Babu Joseph shared a template prepared by Mr. Rupam Majumder of his paper that had three columns of internal marks, university marks, and comments, and that it was thought that data entered here could be copied and analyzed when the University provides with the summarized sheet. It was later discovered that the university does not provide a summarized sheet for each individual subject for a student, so the faculty members had to manually go through every report card, put the marks on them, and then do the evaluation, and once the defaulters were identified, they were asked to prepare notes after classes on Saturdays and clarifications of doubts were done.

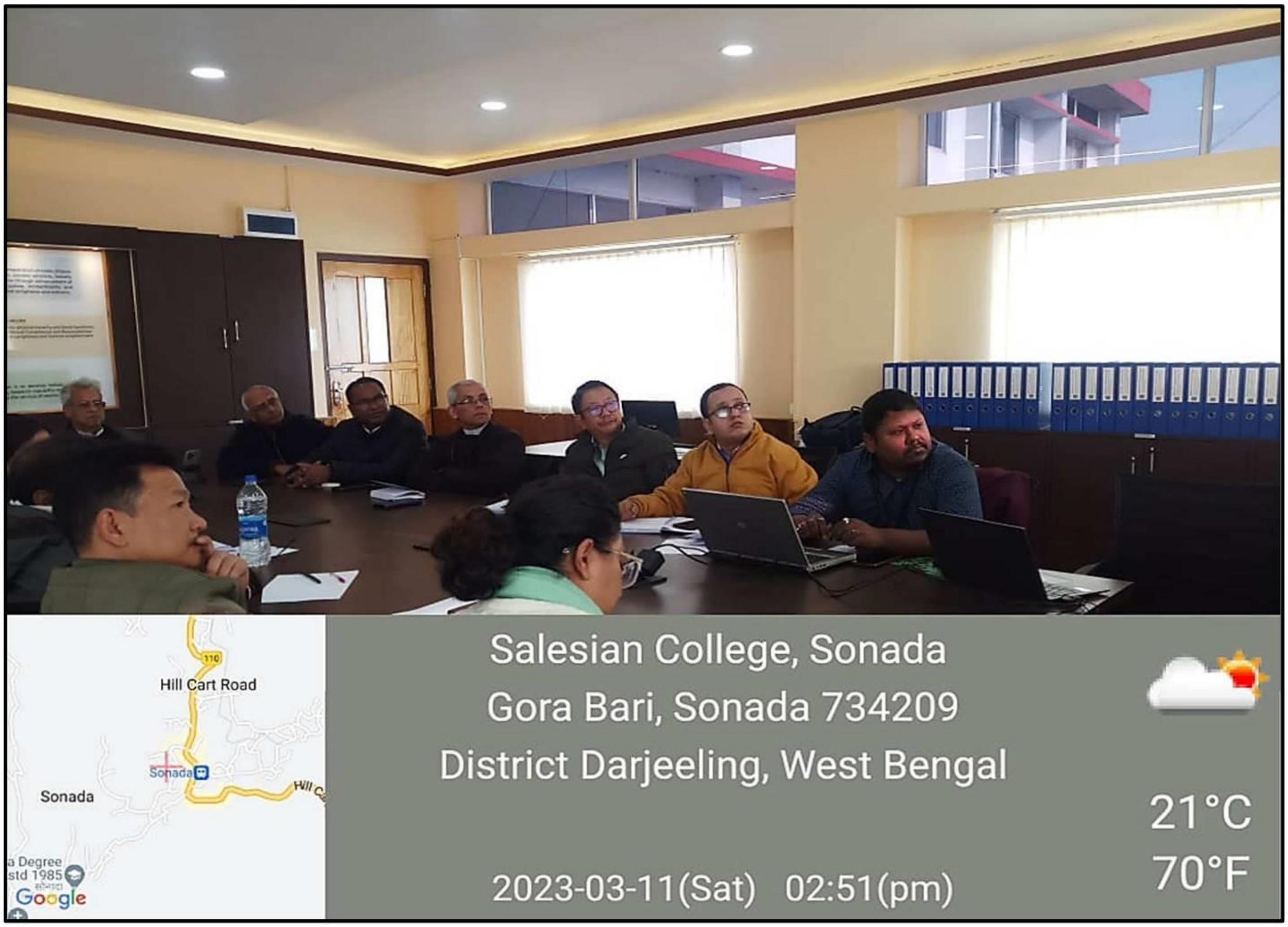
- Mr. Dhirodutta Subba proposed that CIA points be awarded generously. Though attendance is worth 5 points, the remaining 10 points for CIA should include the students' behavior as well as their academic performance.

- With the Revised Bloom's Taxonomy, cognitive factors can receive 40% of the weightage, while psychomotor and affective factors can receive 30% and 30%, respectively. As a result, the 10-mark breakdown would be 4+3+3, with the CIA calculated out of 4 and the 3+3 calculated considering the student's conduct, participation in class, relationship with peers, and so on.

**6. Review of Approval of HoDs manual at Siloam**

Mr. Subhajit Paul displayed a document manual that contained policies that were already on the website as well as policies that would be developed. The components of the policy manual were displayed. He stated that this manual will serve as a guidebook for the next few years.

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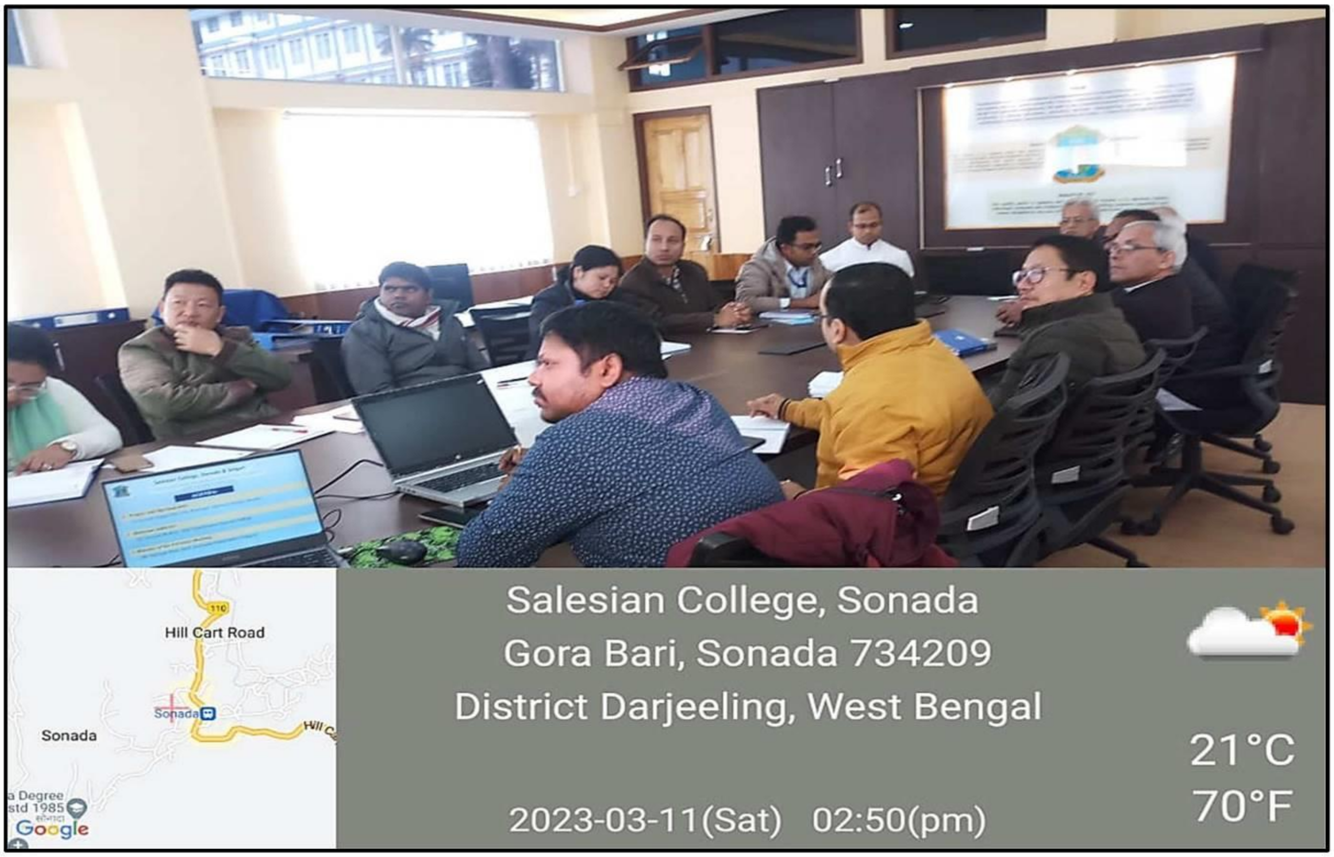
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## V: Observations by the External Members

Dr. Tapu Biswas appreciated the IQAC progress and praised the teamwork of the members. He thanked all the members and Fr. Principal as he was impressed with the progress and performance of both the campuses and the administration. He suggested incorporating and revising the data with the suggestions given in the meeting.

## VI: Observations by the Chairperson

In his final remarks, Fr (Prof) George Thadathil stated the following:

- The AQAR upload should not have any blank areas because there must be existing data between the two campuses.
- Regarding website management, thanks to Mr. Alfred's efforts, the ERP-related upload on the website will run more smoothly p.
- All faculty members should create a course plan that takes into account the number of days and lecture hours needed for each paper.
- Dr. Fr. Tomy Augustine and Fr. Saju PT will be asked to attend a meeting to make a decision on the mentoring manual.
- Mentoring training should be provided to faculty members.
- Based on the results of the psychometric test, it is decided to evaluate the students' performance throughout the semester based on their aptitude.
- MBA programme options will be explored.
- Integration with NEP will be implemented.

He thanked everyone for participating and especially Dr. Tapu Biswas for his time and presence.

## VII: Closing Remarks

Dr. Fr. Tomy congratulated the members on their progress and thanked Dr. Tapu Biswas for his insightful comments. He expressed his delight that the institution provides students with holistic development. He emphasized the incorporation of philosophy into the revised curriculum.

Fr. Nirmal Toppo concluded the meeting with a prayer at 5:20 p.m.

*Minutes by,*

Mr. Dhirendra Newar,

IQAC Secretary, SCS
Salesian College, Sonada Campus
Dated: March 11, 2023

*Assisted by,*

Ms. Edna Chettri,

Special Invitee Member,
Salesian College, Sonada Campus
Dated: March 11, 2023

Sd/-

Fr (Prof) George Thadathil,

Chairperson, IQAC, and Principal,
Salesian College, Sonada and Siliguri
Dated: March 11, 2023

# OBJECTIVES, LEARNING OUTCOMES, & GRADUATE ATTRIBUTES

Salesian College
Sonada | Siliguri

## Department of Mathematics

November 11, 2021

# Contents

This document lists the course and programme objectives, learning outcomes, and graduate attributes of the undergraduate programme with honours in Mathematics, in the department of Mathematics, Salesian College, Siliguri, under the affiliation of University of North Bengal. This document is in line with the layout suggested by the UGC as cited in [1].

# 1 Learning Objectives

## 1.1 Institutional objectives

The learning objectives of Salesian College, Siliguri for the students of department of Mathematics are

(a) to provide relevant pedagogies and motivations;

(b) to provide in-depth analysis and the sense of appreciation of Mathematical concepts;

(c) to foster scientific temper and encourage rational thinking;

(d) to provide right-based education specially to disadvantaged groups;

(e) to equip the students with skills for employability in the fields of both Industry and Academia.

## 1.2 Departmental objectives

The learning objectives of the Department of Mathematics for its students are

(a) to create deep interest in learning mathematics;

(b) to develop broad and balanced knowledge, and understanding of definitions, concepts, principles and theorems;

(c) to familiarise the students with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences;

(d) to enhance the ability of learners to apply the knowledge and skills acquired by them during the programme to solve specific theoretical and applied problems in mathematics;

(e) to provide students sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics;

(f) to encourage the students to develop a range of generic skills helpful in employment, internships and social activities.

# 2 Learning Outcomes

## 2.1 Institutional outcomes

A student with honours in Mathematics, graduating from Salesian College, Siliguri, will be able to

(a) pursue higher studies in different branches of Mathematics, along with related areas like Computer Science and Statistics;

(b) develop a strong sense of logical reasoning;

(c) model and solve real life problems using the subject knowledge;

(d) present Mathematics clearly and precisely by making vague ideas precise by formulating them in the language of Mathematics.

(e) join teaching profession in primary and secondary schools.

(f) be employable for Government jobs, jobs in banking, insurance and investment sectors, data analyst jobs and jobs in various other public and private enterprises.

## 2.2 Departmental outcomes

After completion of the programme, a student of Department of Mathematics, will be able to

(a) demonstrate fundamental systematic knowledge of mathematics and its applications in engineering, science, technology and mathematical sciences;

(b) demonstrate educational skills in areas of analysis, geometry, algebra, mechanics, differential equations, etc;

(c) apply knowledge, understanding, and skills to identify the difficult/unsolved problems in mathematics and to collect the required information in possible range of sources and try to analyse and evaluate these problems using appropriate methodologies;

(d) fulfil learning requirements in mathematics, drawing from a range of contemporary research works and their applications in diverse areas of mathematical sciences;

(e) apply disciplinary knowledge and skills in mathematics in newer domains and uncharted areas;

(f) identify challenging problems in mathematics and obtain well-defined solutions;

(g) exhibit subject-specific transferable knowledge in mathematics relevant to job trends and employment opportunities.

# 3 Course Specific Objectives & Outcomes – Core Courses

Each Core Course (CC) is of 6 credits.

## 3.1 Core Course 1: Calculus, Geometry and Differential Equations

### 3.1.1 Syllabus – CC 1

**Unit 1:** Hyperbolic functions, higher order derivatives, Leibnitz's rule and its applications to the problems of the type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points, envelopes, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hôspital's rule, applications in business, economics and life sciences.

**Unit 2:** Reduction formulæ, derivations and illustrations of reduction formulæ of the type $\int \sin nx\,dx$, $\int \cos nx\,dx$, $\int \tan nx\,dx$, $\int \sec nx\,dx$, $\int (\log x)^n\,dx$, $\int \sin^n x \sin^m x\,dx$, parametric equations, parametrising a curve arc length of a curve, arc length of parametric curves, area under a curve, area and volume of revolution, techniques of sketching conics.

**Unit 3:** Reflection properties of conics, rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, classification of quadrics, illustrations of graphing standard quadric surfaces like cone, ellipsoid.

**Unit 4:** Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

### 3.1.2 Learning objectives – CC 1

The course is introduced for the students to

(a) introduce the higher order derivatives and apply them in proper situations;

(b) illustrate the concept of asymptotes and envelopes;

(c) calculate limits in indeterminate forms by a repeated use of L'Hôspital's rule;

(d) classify concavity and convexity of a function from its graph and from its second derivative;
(e) categorize the properties of two and three dimensional shapes;
(f) trace a curve;
(g) solve first order ordinary differential equations utilizing the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.

### 3.1.3 Learning outcomes – CC 1

On completion of the course, a student will be able to
(a) calculate the higher order derivatives and apply them in proper situations;
(b) acquire the concept of asymptotes and envelopes;
(c) calculate limits in indeterminate forms by a repeated use of L'Hospital's rule;
(d) determine concavity and convexity of a function from its graph and from its second derivative;
(e) explain the properties of two and three dimensional shapes;
(f) trace a curve;
(g) solve first order ordinary differential equations utilizing the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.

## 3.2 Core Course 2: Algebra

### 3.2.1 Syllabus – CC 2

**Unit 1:** Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Theory of equations: relation between roots and coefficients, transformation of equation, Descartes rule of signs, cubic and biquadratic equation. Graphical representation of a polynomial and maximum, minimum of polynomial.

Inequality: The inequality involving AM $\geq$ GM $\geq$ HM, Cauchy-Schwartz inequality.

**Unit 2:** Equivalence relations. Functions, composition of functions, Invertible functions, one to one correspondence and cardinality of a set. Well-ordering property of positive integers, division algorithm, divisibility and Euclidean algorithm. Congruence relation between integers. Principles of mathematical induction, statement of Fundamental Theorem of Arithmetic.

**Unit 3:** Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation $A\mathbf{x} = b$, solution sets of linear systems, applications of linear systems, linear independence.

**Unit 4:** Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of $\mathbb{R}^n$, dimension of subspaces of $\mathbb{R}^n$, rank of matrix, eigen values, eigen vectors and characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

### 3.2.2 Learning objectives – CC 2

The course is introduced for the students to
(a) solve for the roots of real or complex polynomials using various methods;
(b) discuss and recognize relations, equivalence relations, partitions, and functions;
(c) employ De Moivre's theorem in a number of applications to solve numerical problems;
(d) identify consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank;
(e) introduce eigenvalues and corresponding eigenvectors for a square matrix.

#### 3.2.3 Learning outcomes – CC 2

On completion of the course, a student will be able to

(a) find roots of real or complex polynomials using various methods;
(b) define and recognize relations, equivalence relations, partitions, and functions;
(c) employ De Moivre's theorem in a number of applications to solve numerical problems;
(d) recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank;
(e) find eigenvalues and corresponding eigenvectors for a square matrix.

### 3.3 Core Course 3: Real Analysis

#### 3.3.1 Syllabus – CC 3

**Unit 1:** Review of Algebric and order properties of $\mathbb{R}$, $\epsilon$-neighborhood of a point in $\mathbb{R}$. Idea of countable sets, uncountable sets and uncountability of $\mathbb{R}$. Bounded above sets, bounded below sets, bounded sets, unbounded sets. Suprema and infima. Completeness property of $\mathbb{R}$ and its equivalent properties. The Archimedean property, density of rational (and irrational) numbers in $\mathbb{R}$, intervals. Limit points of a set, isolated points, open set, closed set, derived set, illustrations of Bolzano-Weierstrass theorem for sets, compact sets in $\mathbb{R}$, Heine-Boreal Theorem.

**Unit 2:** Sequences, bounded sequence, convergent sequence, limit of a sequence, limit inferior and limit superior. Limit theorems. Monotone sequences, monotone convergence theorem. Subsequences, divergence criteria. Monotone subsequence theorem (statement only), Bolzano Weierstrass theorem for sequences. Cauchy sequence, Cauchy's convergence criterion.

**Unit 3:** Infinite series, convergence and divergence of infinite series, Cauchy criterion, tests for convergence: comparison test, limit comparison test, ratio test, Cauchy's $n^{\text{th}}$ root test, integral test. Alternating series, Leibniz test. Absolute and conditional convergence.

#### 3.3.2 Learning objectives – CC 3

The course is introduced for the students to

(a) discover different properties of the real line $\mathbb{R}$;
(b) introduce and explain bounded, convergent, divergent, Cauchy, and monotonic sequences, and calculate limit superior, limit inferior of bounded sequences;
(c) analyse the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

#### 3.3.3 Learning outcomes – CC 3

On completion of the course, a student will be able to

(a) describe different properties of the real line $\mathbb{R}$;
(b) define and recognize bounded, convergent, divergent, Cauchy, and monotonic sequences, and calculate limit superior, limit inferior of bounded sequences;
(c) apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

### 3.4 Core Course 4: Differential Equations and Vector Calculus

#### 3.4.1 Syllabus – CC 4

**Unit 1:** Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation.

Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

**Unit 2:** Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

**Unit 3:** Equilibrium points, Interpretation of the phase plane. Power series solution of a differential equation about an ordinary point, solution about a regular singular point.

**Unit 4:** Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions.

### 3.4.2 Learning objectives – CC 4

The course is introduced for the students to

(a) discuss exact solutions of solvable first order differential equations and linear differential equations of higher order using various methods;

(b) introduce Picard's method of obtaining successive approximations of solutions of first order differential equations, and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations;

(c) describe the concept of a general solution of a linear differential equation of an arbitrary order, and also to obtain them using prescribed methods;

(d) formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines;

(e) introduce the phase plane analysis;

(f) explore the vector triple product and product of four vectors and use it to find the equation of straight lines, planes in vector form.

### 3.4.3 Learning outcomes – CC 4

On completion of the course, a student will be able to

(a) compute exact solutions of solvable first order differential equations and linear differential equations of higher order using various methods;

(b) apply Picard's method of obtaining successive approximations of solutions of first order differential equations, and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations;

(c) describe the concept of a general solution of a linear differential equation of an arbitrary order, and also to obtain them using prescribed methods;

(d) formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines;

(e) execute the phase plane analysis;

(f) find the vector triple product and product of four vectors and use it to find the equation of straight lines, planes in vector form.

## 3.5 Core Course 5: Theory of Real Functions and Introduction to Metric Spaces

### 3.5.1 Syllabus – CC 5

**Unit 1:** Limits of functions ($\epsilon$-$\delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity. Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

**Unit 2:** Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra of differentiable functions . Relative extrema, interior extremum theorem. Rolle's theorem. Mean value theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities and approximation of polynomials.

**Unit 3:** Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of reminder, application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, $\log(1+x)$, $\frac{1}{ax+b}$ and $(x+1)^n$. Application of Taylor's theorem to inequalities.

**Unit 4:** Metric spaces: Definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, subspaces, dense sets, separable spaces. Sequences in metric spaces, Cauchy sequences. Complete metric spaces, Cantor's theorem.

### 3.5.2 Learning objectives – CC 5

The course is introduced for the students to

(a) examine and calculate the limit, and investigate the continuity of a function at a point;
(b) describe with different properties of a continuous and uniformly continuous functions;
(c) develop the consequences of various mean value theorems for differentiable functions;
(d) introduce the basic definition and topology of metric spaces;
(e) identify complete and incomplete metric spaces.

### 3.5.3 Learning outcomes – CC 5

On completion of the course, a student will be able to

(a) examine and calculate the limit, and investigate the continuity of a function at a point;
(b) describe with different properties of a continuous and uniformly continuous functions;
(c) describe the consequences of various mean value theorems for differentiable functions;
(d) describe the basic definition and topology of metric spaces;
(e) identify complete and incomplete metric spaces.

## 3.6 Core Course 6: Group Theory – I

### 3.6.1 Syllabus – CC 6

**Unit 1:** Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

**Unit 2:** Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

**Unit 3:** Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

**Unit 4:** External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

**Unit 5:** Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems.

### 3.6.2 Learning objectives – CC 6

The course is introduced for the students to

(a) recognize the mathematical objects called groups;
(b) specify the fundamental concepts of groups and symmetries of geometrical objects;
(c) explain the significance of the notions of cosets, normal subgroups, and factor groups;
(d) analyse consequences of Lagrange's theorem;
(e) describe about structure preserving maps between groups and their consequences.

### 3.6.3 Learning outcomes – CC 6

On completion of the course, a student will be able to

(a) recognize the mathematical objects called groups;
(b) link the fundamental concepts of groups and symmetries of geometrical objects;
(c) explain the significance of the notions of cosets, normal subgroups, and factor groups;
(d) analyse consequences of Lagrange's theorem;
(e) describe about structure preserving maps between groups and their consequences.

## 3.7 Core Course 7: Riemann Integration and Series of Functions

### 3.7.1 Syllabus – CC 7

**Unit 1:** Riemann integration: inequalities of upper and lower sums, Darboux integration, Darboux theorem, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions. Riemann integrability of monotone and continuous functions, properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for integrals; Fundamental theorem of Integral Calculus.

**Unit 2:** Improper integrals. Convergence of Beta and Gamma functions.

**Unit 3:** Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions.

Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass $M$-Test.

**Unit 4:** Fourier series: Definitions of Fourier coefficients and series, Riemann Lebesgue lemma, Bessel's inequality, Parseval's identity, Dirichlet's condition. Examples of Fourier expansions and summation results for series.

**Unit 5:** Power series, radius of convergence, Cauchy Hadamard theorem. Differentiation and integration of power series, Abel's theorem, Weierstrass approximation theorem.

### 3.7.2 Learning objectives – CC 7

The course is introduced for the students to

(a) summarize some of the properties of Riemann integrable functions, and apply the fundamental theorems of integration;

(b) identify and test the convergence of an improper integral;

(c) calculate Fourier transforms of functions belonging to $\mathcal{L}^1(\mathbb{R})$ class of functions;

(d) explain Parseval's identity, Plancherel's theorem, and applications of Fourier transforms to boundary value problems;

(e) explore Fourier series, Bessel's inequality, and solve term by term differentiation and integration of Fourier series.

### 3.7.3 Learning outcomes – CC 7

On completion of the course, a student will be able to

(a) list some of the properties of Riemann integrable functions, and apply the fundamental theorems of integration;

(b) identify and test the convergence of an improper integral;

(c) calculate Fourier transforms of functions belonging to $\mathcal{L}^1(\mathbb{R})$ class of functions;

(d) explain Parseval's identity, Plancherel's theorem, and applications of Fourier transforms to boundary value problems;

(e) find Fourier series, prove Bessel's inequality, and find term by term differentiation and integration of Fourier series.

## 3.8 Core Course 8: Multivariate Calculus

### 3.8.1 Syllabus – CC 8

**Unit 1:** Functions of several variables, limit and continuity of functions of two or more variables.

Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

**Unit 2:** Double integration over rectangular region, double integration over non-rectangular region, double integrals in polar co-ordinates, triple integrals, triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

**Unit 3:** Definition of vector field, divergence and curl.

Line integrals, applications of line integrals: mass and work. Fundamental theorem for line integrals, conservative vector fields, independence of path.

**Unit 4:** Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem. The Divergence theorem.

### 3.8.2 Learning objectives – CC 8

The course is introduced for the students to

(a) distinguish the conceptual variations while advancing from one variable to several variables in calculus;

(b) analyse multivariable calculus in optimization problems;

(c) demonstrate the line integral, surface integral, and volume integrals;

(d) apply the multivariable calculus tools in physics, economics, optimization, and in understanding the architecture of curves and surfaces in plane and space etc.;
(e) identify the importances of Green, Gauss, and Stoke's theorems in other branches of mathematics.

#### 3.8.3 Learning outcomes – CC 8

On completion of the course, a student will be able to
(a) distinguish the conceptual variations while advancing from one variable to several variables in calculus;
(b) apply multivariable calculus in optimization problems;
(c) calculate the line integral, surface integral, and volume integrals;
(d) apply the multivariable calculus tools in physics, economics, optimization, and in understanding the architecture of curves and surfaces in plane and space etc.;
(e) identify the importances of Green, Gauss, and Stokes' theorems in other branches of mathematics.

### 3.9 Core Course 9: Ring Theory and Linear Algebra – I

#### 3.9.1 Syllabus – CC 9

**Unit 1:** Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristics of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

**Unit 2:** Ring homomorphisms, properties of ring homomorphisms. Isomorphism theorems I, II and III, field of quotients.

**Unit 3:** Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

**Unit 4:** Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms. Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

#### 3.9.2 Learning objectives – CC 9

The course is introduced for the students to
(a) describe the fundamental concepts in ring theory such as of the ideals, quotient rings, integral domains, and fields;
(b) demonstrate the concepts of vector spaces, subspaces, bases, dimension and their properties with examples;
(c) identify matrices with linear transformations;
(d) compute eigenvalues and eigenvectors of linear transformations.

#### 3.9.3 Learning outcomes – CC 9

On completion of the course, a student will be able to
(a) describe the fundamental concepts in ring theory such as of the ideals, quotient rings, integral domains, and fields;
(b) demonstrate the concepts of vector spaces, subspaces, bases, dimension and their properties with examples;
(c) identify matrices with linear transformations;
(d) compute eigenvalues and eigenvectors of linear transformations.

## 3.10 Core Course 10: Metric Spaces and Complex Analysis

### 3.10.1 Syllabus – CC 10

**Unit 1:** Continuous mapping, sequential criterion and other characterizations of continuity. Uniform continuity. Connectedness, connected subsets of $\mathbb{R}$.

Compactness: Sequential compactness, Heine-Borel property, totally bounded spaces, finite intersection property and continuous functions on compact sets.

Homeomorphism. Contraction mappings. Banach fixed point theorem and its application to ordinary differential equation.

**Unit 2:** Limits, limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings.

Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

**Unit 3:** Analytic functions, examples of analytic functions, exponential function, logarithmic function, trigonometric function, derivatives of functions, and definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.

**Unit 4:** Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.

**Unit 5:** Laurent series and its examples, absolute and uniform convergence of power series.

### 3.10.2 Learning objectives – CC 10

The course is introduced for the students to

(a) describe several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano-Weierstrass property, compactness, and connectedness;
(b) identify complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complex plane on the Riemann sphere;
(c) describe the differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations;
(d) apply the Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals;
(e) apply Liouville's theorem in fundamental theorem of algebra;
(f) evaluate Taylor and Laurent series expansions of analytic functions;
(g) classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

### 3.10.3 Learning outcomes – CC 10

On completion of the course, a student will be able to

(a) describe several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano-Weierstrass property, compactness, and connectedness;
(b) identify complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complex plane on the Riemann sphere;
(c) describe the differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations;
(d) apply the Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour integrals;

(e) apply Liouville's theorem in fundamental theorem of algebra;
(f) evaluate Taylor and Laurent series expansions of analytic functions;
(g) classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

## 3.11 Core Course 11: Group Theory – II

### 3.11.1 Syllabus – CC 11

**Unit 1:** Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.

**Unit 2:** Properties of external direct products, the group of units modulo $n$ as an external direct product, internal direct products, Fundamental theorem of finite abelian groups.

**Unit 3:** Group actions, stabilizers and kernels, permutation representation associated with a given group action. Applications of group actions. Generalized Cayley's theorem. Index theorem.

**Unit 4:** Groups acting on themselves by conjugation, class equation and consequences, conjugacy in $S_n$, $p$-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of $A_n$ for $n \geq 5$, non-simplicity tests.

### 3.11.2 Learning objectives – CC 11

The course is introduced for the students to
(a) describe inner automorphisms and their properties;
(b) examine group structure to finite permutation groups (Cayley's theorem);
(c) develop and apply Sylow's Theorems;
(d) construct groups with given specific conditions;
(e) investigate symmetry using group theory.

### 3.11.3 Learning outcomes – CC 11

On completion of the course, a student will be able to
(a) describe inner automorphisms and their properties;
(b) extend group structure to finite permutation groups (Cayley's Theorem);
(c) prove and apply Sylow's Theorems;
(d) generate groups with given specific conditions;
(e) investigate symmetry using group theory.

## 3.12 Core Course 12: Numerical Methods

### 3.12.1 Syllabus – CC 12

**Theory (4 credits)**

**Unit 1:** Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.

**Unit 2:** Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-Falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

**Unit 3:** System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. LU decomposition.

**Unit 4:** Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Numerical differentiation: Methods based on interpolations, methods based on finite differences.

**Unit 5:** Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's $1/3^{\text{rd}}$ rule, Simpsons $3/8^{\text{th}}$ rule, Weddle's rule, Boole's Rule. midpoint rule, Composite trapezoidal rule, composite Simpson's $1/3^{\text{rd}}$ rule, Gauss quadrature formula. The algebraic eigen value problem: Power method. Approximation: Least square polynomial approximation.

**Unit 6:** Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of orders two and four.

**Practical (2 credits)**

Using any software/programming language, execute the following tasks:

1. Calculate the sum $1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{N}$.
2. Enter 100 integers into an array and sort them in an ascending order.
3. Solution of transcendental and algebraic equations by
   (a) bisection method,
   (b) Newton-Raphson method,
   (c) secant method,
   (d) Regula-Falsi method;
4. Solution of system of linear equations by
   (a) LU decomposition method,
   (b) Gaussian elimination method,
   (c) Gauss-Jacobi method,
   (d) Gauss-Seidel method;
5. Interpolation
   (a) Lagrange interpolation,
   (b) Newton interpolation;
6. Numerical integrations by
   (a) trapezoidal rule,
   (b) Simpson's $1/3^{\text{rd}}$ rule,
   (c) Weddle's rule,
   (d) Gauss quadrature;
7. Solution of ordinary differential equations by
   (a) Euler method,
   (b) Modified Euler method,
   (c) Runge Kutta method.

### 3.12.2 Learning objectives – CC 12

The course is introduced for the students to

(a) categorize numerical solutions of algebraic and transcendental equations;
(b) introduce numerical solutions of system of linear equations and check the accuracy of the solutions;
(c) describe various interpolating and extrapolating methods;
(d) solve initial and boundary value problems in differential equations using numerical methods;
(e) analyse various numerical methods in real life problems.

#### 3.12.3 Learning outcomes – CC 12

On completion of the course, a student will be able to

(a) obtain numerical solutions of algebraic and transcendental equations;

(b) find numerical solutions of system of linear equations and check the accuracy of the solutions;

(c) describe various interpolating and extrapolating methods;

(d) solve initial and boundary value problems in differential equations using numerical methods;

(e) apply various numerical methods in real life problems.

### 3.13 Core Course 13: Ring Theory and Linear Algebra – II

#### 3.13.1 Syllabus – CC 13

**Unit 1:** Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, and unique factorization in $\mathbb{Z}[x]$. Divisibility in integral domains, irreducible, primes, unique factorization domains, Euclidean domains.

**Unit 2:** Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators. Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, canonical forms.

**Unit 3:** Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator. Least squares approximation, minimal solutions to systems of linear equations. Normal and self-adjoint operators. Orthogonal projections and Spectral theorem.

#### 3.13.2 Learning objectives – CC 13

The course is introduced for the students to

(a) describe polynomial rings, principal ideal domain, Euclidean domain and unique factorisation domain, and their relationships;

(b) check reducibility of a polynomial;

(c) describe dual basis and find the connections between dual basis and linear transformations;

(d) describe the concept of minimal polynomial;

(e) develop an idea about inner product space and proceed to normed linear spaces;

(f) use Gram-Schmidt process to find orthogonal set of non-null vectors from any arbitrary set of vectors.

#### 3.13.3 Learning outcomes – CC 13

On completion of the course, a student will be able to

(a) describe polynomial rings, principal ideal domain, Euclidean domain and unique factorisation domain, and their relationships;

(b) check reducibility of a polynomial;

(c) describe dual basis and find the connections between dual basis and linear transformations;

(d) describe the concept of minimal polynomial;

(e) develop an idea about inner product space and proceed to normed linear spaces;

(f) use Gram-Schmidt process to find orthogonal set of non-null vectors from any arbitrary set of vectors.

## 3.14 Core Course 14: Partial Differential Equations and Applications

### 3.14.1 Syllabus – CC 14

**Unit 1:** Partial differential equations: basic concepts and definitions. Mathematical problems. First order equations: classification, construction and geometrical interpretation. Method of characteristics for obtaining general solution of quasi linear equations. Canonical forms of first order linear equations. Method of separation of variables for solving first order partial differential equations.

**Unit 2:** Derivation of heat equation, wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order linear equations to canonical forms.

**Unit 3:** The Cauchy problem, Cauchy-Kowalewskaya theorem, Cauchy problem of an infinite string. Initial boundary value problems. Semi-infinite string with a fixed end, semi-infinite string with a free end. Equations with non-homogeneous boundary conditions. Non-homogeneous wave equation. Method of separation of variables, solving the vibrating string problem. Solving the heat conduction problem.

**Unit 4:** Central force. Constrained motion, varying mass, tangent and normal components of acceleration, modelling ballistics and planetary motion, Kepler's second law.

### 3.14.2 Learning objectives – CC 14

The course is introduced for the students to

(a) describe the origin of PDEs and distinguish the integrals of first order linear partial differential equation into complete, general and singular integrals;
(b) recognize the major classification of PDEs and the qualitative differences between the classes of equations;
(c) implement a range of techniques to solve first & second order partial differential equations;
(d) teach a range of techniques to solve first & second order partial differential equations;
(e) explore physical phenomena using partial differential equations such as the heat and wave equations.

### 3.14.3 Learning outcomes – CC 14

On completion of the course, a student will be able to

(a) describe the origin of PDEs and distinguish the integrals of first order linear partial differential equation into complete, general and singular integrals;
(b) recognize the major classification of PDEs and the qualitative differences between the classes of equations;
(c) apply a range of techniques to solve first & second order partial differential equations;
(d) model physical phenomena using partial differential equations such as the heat and wave equations.

# 4 Course Specific Objectives & Outcomes – Discipline Specific Electives

Each Discipline Specific Elective course (DSE) carries 6 credits.

## 4.1 Discipline Specific Elective 1A: Probability and Statistics

### 4.1.1 Syllabus – DSE 1A

**Unit 1:** Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

**Unit 2:** Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function and calculation of covariance from joint moment generating function, linear regression for two variables.

**Unit 3:** Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. Central limit theorem for independent and identically distributed random variables with finite variance, Markov chains, Chapman-Kolmogorov equations, classification of states.

**Unit 4:** Random Samples, Sampling Distributions, Estimation of parameters, Testing of hypothesis.

### 4.1.2 Learning objectives – DSE 1A

The course is introduced for the students to

(a) identify distributions in the study of the joint behaviour of two random variables;

(b) establish a formulation helping to predict one variable in terms of the other,i.e., correlation and linear regression;

(c) introduce central limit theorem.

### 4.1.3 Learning outcomes – DSE 1A

On completion of the course, a student will be able to

(a) identify distributions in the study of the joint behaviour of two random variables;

(b) establish a formulation helping to predict one variable in terms of the other,i.e., correlation and linear regression;

(c) prove and apply central limit theorem.

## 4.2 Discipline Specific Elective 1B: Linear Programming

### 4.2.1 Syllabus – DSE 1B

**Unit 1:** Introduction to linear programming problem. Theory of simplex method, graphical solution, convex sets, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method. Big-$M$ method and their comparison.

**Unit 2:** Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual. Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

**Unit 3:** Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure,linear programming solution of games.

### 4.2.2 Learning objectives – DSE 1B

The course is introduced for the students to

(a) analyse and solve linear programming models of real life situations;

(b) introduce graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points;

(c) discover the simplex method to solve LPP's;

(d) describe the relationships between the primal and dual problems;

(e) implement the applications of transportation, assignment and two-person zero-sum game problems.

### 4.2.3 Learning outcomes – DSE 1B

On completion of the course, a student will be able to

(a) analyse and solve linear programming models of real life situations;

(b) provide graphical solutions of linear programming problems with two variables, and illustrate the concept of convex set and extreme points;

(c) apply the simplex method to solve LPP's;

(d) describe the relationships between the primal and dual problems;

(e) describe the applications of transportation, assignment and two-person zero-sum game problems.

## 4.3 Discipline Specific Elective 2A: Number Theory

### 4.3.1 Syllabus – DSE 2A

**Unit 1:** Diophantine equation, Gaussian integers, Euclidean Algorithm for gcd, linear representation of gcd, primes and factorizations, consequences of unique prime factorization, linear Diophantine equation.

**Unit 2:** Congruence arithmetic, inverse mod $p$, Fermat's little Theorem, congruence theorem of Wilson and Lagrange, inverse mod $k$, quadratic, Diophantine equations. Gaussian integers, Divisibility and primes in $\mathbb{Z}[i]$ and $\mathbb{Z}$. Conjugates, division in $\mathbb{Z}[i]$, Fermat's two square theorem, Pythagorean triples.

**Unit 3:** Linear congruence, Chinese remainder theorem, Euler's criterion, Legendre symbol, quadratic reciprocity.

### 4.3.2 Learning objectives – DSE 2A

The course is introduced for the students to

(a) implement some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences;

(b) describe number theoretic functions, modular arithmetic and their applications;

(c) develop modular arithmetic and determine primitive roots of prime and composite numbers;

(d) research in some open problems in number theory, viz., the Goldbach conjecture and twin-prime conjecture.

(e) describe public crypto systems, in particular, RSA.

#### 4.3.3 Learning outcomes – DSE 2A

On completion of the course, a student will be able to

(a) describe some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences;
(b) describe number theoretic functions, modular arithmetic and their applications;
(c) familiarise with modular arithmetic and find primitive roots of prime and composite numbers;
(d) know about open problems in number theory, namely, the Goldbach conjecture and twin-prime conjecture.
(e) apply public crypto systems, in particular, RSA.

### 4.4 Discipline Specific Elective 2B: Mechanics

#### 4.4.1 Syllabus – DSE 2B

**Unit 1:** Co-planar forces. Astatic equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work. Forces in three dimensions. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium.

**Unit 2:** Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Stability of nearly circular orbits. Motion under the inverse square law. Slightly disturbed orbits. Motion of artificial satellites. Motion of a particle in three dimensions. Motion on a smooth sphere, cone and on any surface of revolution.

**Unit 3:** Degrees of freedom. Moments and products of inertia. Momental Ellipsoid. Principal axes. D'Alembert's principle. Motion about a fixed axis. Compound pendulum. Motion of a rigid body in two dimensions under finite and impulsive forces. Conservation of momentum and energy.

#### 4.4.2 Learning objectives – DSE 2B

The course is introduced for the students to

(a) describe necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body;
(b) determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight;
(c) solve problems about the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles;
(d) introduce the Kepler's laws of the planetary motions.

#### 4.4.3 Learning outcomes – DSE 2B

On completion of the course, a student will be able to

(a) describe necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body;
(b) determine the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight;
(c) solve problems about the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles;
(d) learn that a particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions.

## 4.5 Discipline Specific Elective 3A: Point Set Topology

### 4.5.1 Syllabus – DSE 3A

**Unit 1:** Countable and Uncountable Sets, Schroeder-Bernstein Theorem, Cantor's Theorem. Cardinal numbers and cardinal arithmetic. Continuum Hypothesis, Zorn's Lemma, Axiom of Choice. Well- ordered sets, Hausdorff's maximal principle. Ordinal numbers.

**Unit 2:** Topological spaces, basis and Sub basis for a topology, subspace topology, interior points, limit points, derived set, boundary of a set, closed sets, closure and interior of a set. Continuous functions, open maps, closed maps and homeomorphisms. Product topology, quotient topology, metric topology, Baire category theorem.

**Unit 3:** Connectedness. Distinguishing topological spaces via connectedness, intermediate value theorem, path connectedness, compact spaces, compact subspaces of the real line, limit point compactness.

### 4.5.2 Learning objectives – DSE 3A

The course is introduced for the students to

(a) demonstrate knowledge and understanding of concepts such as open and closed sets, interior, closure and boundary;

(b) develop new topological spaces by using subspace, product and quotient topologies;

(c) utilise continuous functions and homeomorphisms to describe the structure of a topological space;

(d) develop idea about and different definitions of compactness.

(e) develop idea about connectedness, path-connectedness.

### 4.5.3 Learning outcomes – DSE 3A

On completion of the course, a student will be able to

(a) demonstrate knowledge and understanding of concepts such as open and closed sets, interior, closure and boundary;

(b) create new topological spaces by using subspace, product and quotient topologies;

(c) use continuous functions and homeomorphisms to describe the structure of a topological space;

(d) develop idea about and different definitions of compactness.

(e) develop idea about connectedness, path-connectedness.

## 4.6 Discipline Specific Elective 3B: Boolean Algebra and Automata Theory

### 4.6.1 Syllabus – DSE 3B

**Unit 1:** Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

**Unit 2:** Definition, examples and properties of modular and distributive lattices, Boolean algebra, Boolean polynomials, minimal and maximal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, Logic gates, switching circuits and applications of switching circuits.

**Unit 3:** Introduction: Alphabets, strings and languages. Finite automata and regular languages: deterministic and non deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

**Unit 4:** Context free grammars and pushdown automata: context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non deterministic PDA, properties of context free languages, normal forms, pumping lemma, closure properties, decision properties.

**Unit 5:** Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence.

### 4.6.2 Learning objectives – DSE 3B

The course is introduced for the students to

(a) transfer numbers into different systems and perform arithmetic operations there;
(b) identify various methods for representing characters in a computer;
(c) design circuits for simple Boolean expressions, and implement basic logic gates using universal gates;
(d) define Automata;
(e) discuss the acceptability of a string by finite automation;
(f) construct non-deterministic finite state machine.

### 4.6.3 Learning outcomes – DSE 3B

On completion of the course, a student will be able to

(a) convert numbers into different systems and perform arithmetic operations there;
(b) identify various methods for representing characters in a computer;
(c) design circuits for simple Boolean expressions, and implement basic logic gates using universal gates;
(d) define Automata;
(e) discuss the acceptability of a string by finite automation;
(f) construct non-deterministic finite state machine.

## 4.7 Discipline Specific Elective 4A: Differential Geometry

### 4.7.1 Syllabus – DSE 4A

**Unit 1:** Theory of space curves: Space curves. Planer curves, curvature, torsion and Serret-Frenet formula. Osculating circles, osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

**Unit 2:** Theory of surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula. Conjugate and asymptotic lines.

**Unit 3:** Developables: Developable associated with space curves and curves on surfaces. Minimal surfaces. Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem.

#### 4.7.2 Learning objectives – DSE 4A

The course is introduced for the students to

(a) describe various properties of curves including Serret-Frenet formulae and their applications;

(b) utilize the interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulæ;

(c) describe the role of *Gauss's Theorema Egregium* and its consequences;

(d) implement problem-solving techniques with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.

#### 4.7.3 Learning outcomes – DSE 4A

On completion of the course, a student will be able to

(a) describe various properties of curves including Serret-Frenet formulae and their applications;

(b) describe the interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulæ;

(c) describe the role of *Gauss's Theorema Egregium* and its consequences;

(d) apply problem-solving techniques with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.

### 4.8 Discipline Specific Elective 4B: Theory of Equations

#### 4.8.1 Syllabus – DSE 4B

**Unit 1:** General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.

**Unit 2:** Symmetric functions. Applications of symmetric function of the roots. Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic. Properties of the derived functions.

**Unit 3:** Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations.

**Unit 4:** Separation of the roots of equations, Strums theorem. Applications of Sturm's theorem, conditions for reality of the roots of an equation. Solution of numerical equations.

#### 4.8.2 Learning objectives – DSE 4B

The course is introduced for the students to

(a) describe the graphical representation of a polynomial, maximum and minimum values of a polynomial,

(b) acquire the concept of symmetric functions,

(c) use Newton's theorem to find the sums of power of roots, homogeneous products, limits of the roots of equation,

(d) define Sturm's theorem and its application.

#### 4.8.3 Learning outcomes – DSE 4B

On completion of the course, a student will be able to

(a) describe the graphical representation of a polynomial, maximum and minimum values of a polynomial,

(b) acquire the concept of symmetric functions,

(c) use Newton's theorem to find the sums of power of roots, homogeneous products, limits of the roots of equation,

(d) derive Sturm's theorem and its application.

# 5 Course Specific Objectives & Outcomes – Generic Electives

Each Generic Elective course (GE) carries 6 credits.

## 5.1 Generic Elective 1: Calculus, Geometry and Differential Equations

### 5.1.1 Syllabus – GE 1

**Unit 1:** Hyperbolic functions, higher order derivatives, Leibnitz's rule and its applications to the problems of the type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n \sin x$, $(ax+b)^n \cos x$, concavity and inflection points, envelopes, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hôspital's rule.

**Unit 2:** Reduction formulæ, derivations and illustrations of reduction formulæ of the type $\int \sin nx\,dx$, $\int \cos nx\,dx$, $\int \tan nx\,dx$, $\int \sec nx\,dx$, $\int (\log x)^n\,dx$, $\int \sin^n x \sin^m x\,dx$, parametric equations, parametrising a curve arc length of a curve, arc length of parametric curves, area under a curve, area and volume of revolution.

**Unit 3:** Reflection properties of conics, rotation of axes and second degree equations, classification of conics using the discriminant, polar equations of conics.

Spheres. Cylindrical surfaces. Central conicoids, paraboloids, plane sections of conicoids, generating lines, classification of quadrics.

**Unit 4:** Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

### 5.1.2 Learning objectives – GE 1

The course is introduced for the students to

(a) introduce the higher order derivatives and apply them in proper situations;

(b) illustrate the concept of asymptotes and envelopes;

(c) calculate limits in indeterminate forms by a repeated use of L'Hôspital's rule;

(d) classify concavity and convexity of a function from its graph and from its second derivative;

(e) categorize the properties of two and three dimensional shapes;

(f) trace a curve;

(g) solve first order ordinary differential equations utilizing the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.

#### 5.1.3 Learning outcomes – GE 1

(a) calculate the higher order derivatives and apply them in proper situations;
(b) acquire the concept of asymptotes and envelopes;
(c) calculate limits in indeterminate forms by a repeated use of L'Hospital's rule;
(d) determine concavity and convexity of a function from its graph and from its second derivative;
(e) explain the properties of two and three dimensional shapes;
(f) trace a curve;
(g) solve first order ordinary differential equations utilizing the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.

## 5.2 Generic Elective 2: Algebra

#### 5.2.1 Syllabus – GE 2

**Unit 1:** Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Theory of equations: relation between roots and coefficients, transformation of equation, Descartes rule of signs, cubic and biquadratic equation. Graphical representation of a polynomial and maximum, minimum of polynomial.

Inequality: The inequality involving AM $\geq$ GM $\geq$ HM, Cauchy-Schwartz inequality.

**Unit 2:** Equivalence relations. Functions, composition of functions, Invertible functions, one to one correspondence and cardinality of a set. Well-ordering property of positive integers, division algorithm, divisibility and Euclidean algorithm. Congruence relation between integers. Principles of mathematical induction, statement of Fundamental Theorem of Arithmetic.

**Unit 3:** Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation $A\mathbf{x} = b$, solution sets of linear systems, applications of linear systems, linear independence.

**Unit 4:** Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, characterizations of invertible matrices. Subspaces of $\mathbb{R}^n$, dimension of subspaces of $\mathbb{R}^n$, rank of matrix, eigen values, eigen vectors and characteristic equation of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix.

#### 5.2.2 Learning objectives – GE 2

The course is introduced for the students to

(a) solve for the roots of real or complex polynomials using various methods;
(b) discuss and recognize relations, equivalence relations, partitions, and functions;
(c) employ De Moivre's theorem in a number of applications to solve numerical problems;
(d) identify consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank;
(e) introduce eigenvalues and corresponding eigenvectors for a square matrix.

#### 5.2.3 Learning outcomes – GE 2

On completion of the course, a student will be able to

(a) find roots of real or complex polynomials using various methods;
(b) define and recognize relations, equivalence relations, partitions, and functions;
(c) employ De Moivre's theorem in a number of applications to solve numerical problems;

(d) recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank;
(e) find eigenvalues and corresponding eigenvectors for a square matrix.

## 5.3 Generic Elective 3: Differential Equations and Vector Calculus

### 5.3.1 Syllabus – GE 3

**Unit 1:** Lipschitz condition and Picard's Theorem (Statement only). General solution of homogeneous equation of second order, principle of super position for homogeneous equation.

Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.

**Unit 2:** Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients. Basic theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions.

**Unit 3:** Equilibrium points, Interpretation of the phase plane. Power series solution of a differential equation about an ordinary point, solution about a regular singular point.

**Unit 4:** Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions.

### 5.3.2 Learning objectives – GE 3

The course is introduced for the students to

(a) discuss exact solutions of solvable first order differential equations and linear differential equations of higher order using various methods;
(b) introduce Picard's method of obtaining successive approximations of solutions of first order differential equations, and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations;
(c) describe the concept of a general solution of a linear differential equation of an arbitrary order, and also to obtain them using prescribed methods;
(d) formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines;
(e) introduce the phase plane analysis;
(f) explore the vector triple product and product of four vectors and use it to find the equation of straight lines, planes in vector form.

### 5.3.3 Learning outcomes – GE 3

On completion of the course, a student will be able to

(a) compute exact solutions of solvable first order differential equations and linear differential equations of higher order using various methods;
(b) apply Picard's method of obtaining successive approximations of solutions of first order differential equations, and Power series method for higher order linear equations, especially in cases when there is no method available to solve such equations;
(c) describe the concept of a general solution of a linear differential equation of an arbitrary order, and also to obtain them using prescribed methods;

(d) formulate mathematical models in the form of ordinary differential equations to suggest possible solutions of the day to day problems arising in physical, chemical and biological disciplines;
(e) execute the phase plane analysis;
(f) find the vector triple product and product of four vectors and use it to find the equation of straight lines, planes in vector form.

## 5.4 Generic Elective 4: Group Theory

### 5.4.1 Syllabus – GE 4

**Unit 1:** Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (through matrices), elementary properties of groups.

**Unit 2:** Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

**Unit 3:** Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

**Unit 4:** External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

**Unit 5:** Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms. First, Second and Third isomorphism theorems (statements only).

### 5.4.2 Learning objectives – GE 4

The course is introduced for the students to
(a) recognize the mathematical objects called groups;
(b) specify the fundamental concepts of groups and symmetries of geometrical objects;
(c) explain the significance of the notions of cosets, normal subgroups, and factor groups;
(d) analyse consequences of Lagrange's theorem;
(e) describe about structure preserving maps between groups and their consequences.

### 5.4.3 Learning outcomes – GE 4

On completion of the course, a student will be able to
(a) recognize the mathematical objects called groups;
(b) link the fundamental concepts of groups and symmetries of geometrical objects;
(c) explain the significance of the notions of cosets, normal subgroups, and factor groups;
(d) analyse consequences of Lagrange's theorem;
(e) describe about structure preserving maps between groups and their consequences.

## 5.5 Generic Elective 5: Numerical Methods

### 5.5.1 Syllabus – GE 5

**Unit 1:** Algorithms. Convergence. Errors: relative, absolute. Round off. Truncation.

**Unit 2:** Transcendental and polynomial equations: Bisection method, Newton's method, secant method, Regula-Falsi method, fixed point iteration, Newton-Raphson method. Rate of convergence of these methods.

**Unit 3:** System of linear algebraic equations: Gaussian elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

**Unit 4:** Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation. Numerical differentiation: Methods based on interpolations, methods based on finite differences.

**Unit 5:** Numerical Integration: Newton Cotes formula, Trapezoidal rule, Simpson's $1/3^{\text{rd}}$ rule, Simpsons $3/8^{\text{th}}$ rule, Weddle's rule, Boole's Rule. midpoint rule, Composite trapezoidal rule, composite Simpson's $1/3^{\text{rd}}$ rule.

**Unit 6:** Ordinary differential equations: The method of successive approximations, Euler's method, the modified Euler method, Runge-Kutta methods of order two.

#### 5.5.2 Learning objectives – GE 5

The course is introduced for the students to

(a) categorize numerical solutions of algebraic and transcendental equations;
(b) introduce numerical solutions of system of linear equations and check the accuracy of the solutions;
(c) describe various interpolating and extrapolating methods;
(d) solve initial and boundary value problems in differential equations using numerical methods;
(e) analyse various numerical methods in real life problems.

#### 5.5.3 Learning outcomes – GE 5

On completion of the course, a student will be able to

(a) obtain numerical solutions of algebraic and transcendental equations;
(b) find numerical solutions of system of linear equations and check the accuracy of the solutions;
(c) describe various interpolating and extrapolating methods;
(d) solve initial and boundary value problems in differential equations using numerical methods;
(e) apply various numerical methods in real life problems.

# 6 Course Specific Objectives & Outcomes – Skill Enhancement Courses

Each Skill Enhancement Course (SEC) carries 2 credits.

## 6.1 Skill Enhancement Course 1A: Logic and Sets

### 6.1.1 Syllabus – SEC 1A

**Unit 1:** Introduction: propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contrapositive and inverse propositions and precedence of logical operators.

Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, quantifiers, binding variables and negations.

**Unit 2:** Sets, subsets, set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

**Unit 3:** Difference and Symmetric difference of two sets. Set identities, generalized union and intersections.

Relations: Product set. Composition of relations, types of relations, partitions, equivalence Relations with example of congruence modulo relation. Partial ordering relations, $n$-ary relations.

#### 6.1.2 Learning objectives – SEC 1A

The course is introduced for the students to

(a) introduce the concept of mathematical logic;
(b) illustrate the concept of sets, Venn diagrams and counting principles;
(c) understand the concepts of relations and functions.

#### 6.1.3 Learning outcomes – SEC 1A

On completion of the course, a student will be able to

(a) determine logical connectives, tautology and contradiction;
(b) represent sets by Venn diagrams;
(c) acquire the concept of algebra of sets and their relationships;
(d) classify different types of relations and functions.

### 6.2 Skill Enhancement Course 1B: C++

#### 6.2.1 Syllabus – SEC 1B

**Unit 1:** Programming paradigms, characteristics of object oriented programming languages, brief history of C++, structure of C++ program, differences between C and C++, basic C++ operators, Comments, working with variables, enumeration, arrays and pointer.

**Unit 2:** Objects, classes, constructor and destructors, friend function, inline function, encapsulation, data abstraction, inheritance, polymorphism, dynamic binding, operator overloading, method overloading, overloading arithmetic operator and comparison operators.

**Unit 3:** Template class in C++, copy constructor, subscript and function call operator, concept of namespace and exception handling.

#### 6.2.2 Learning objectives – SEC 1B

The course is introduced for the students to

(a) illustrate the concept of object oriented programming languages;
(b) illustrate the concepts of friend function, inline function and overloading;
(c) introduce the concepts of template class, constructor, subscript.

#### 6.2.3 Learning outcomes – SEC 1B

On completion of the course, a student will be able to

(a) describe the concept of object oriented programming languages;
(b) describe objects, constructor and destructors, inline and friend functions;
(c) acquire the concept of template class in C++.

## 6.3 Skill Enhancement Course 2A: Graph Theory

### 6.3.1 Syllabus – SEC 2A

**Unit 1:** Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bipartite graphs, isomorphism of graphs. Trees and forests, paths and cycles.

**Unit 2:** Eulerian circuits, Eulerian graph, semi-Eulerian graph, theorems, Hamiltonian cycles,theorems Representation of a graph by matrix, the adjacency matrix, incidence matrix, weighted graph.

**Unit 3:** Travelling salesman's problem, shortest path, Tree and their properties, spanning tree, Dijkstra's algorithm, Warshall algorithm. Connectivity, matching in bipartite graphs, matching in general graphs.

### 6.3.2 Learning objectives – SEC 2A

The course is introduced for the students to

(a) present the concepts of basic graph and its properties, multigraph and digraph etc.;
(b) illustrate the idea of bipartite graph and use it to Eulerian circuit and Hamiltonian cycles;
(c) introduce the concept of travelling salesman problem.

### 6.3.3 Learning outcomes – SEC 2A

On completion of the course, a student will be able to

(a) describe graphs with examples and types;
(b) describe bipartite graph and its relationship with regular graph and Eulerian circuit;
(c) acquire the concept of travelling salesman problem.

## 6.4 Skill Enhancement Course 2B: Operating System – Linux

### 6.4.1 Syllabus – SEC 2B

**Unit 1:** Linux – the operating system: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, overview of Linux architecture, installation, start up scripts, system processes (an overview), Linux security.

**Unit 2:** The Ext2 and Ext3 file systems: General characteristics of the Ext3 file system, file permissions.

User management: types of users, the powers of root, managing users (adding and deleting) using the command line and GUI tools.

**Unit 3:** Resource management in Linux: file and directory management, system calls for files process Management, signals.

IPC: Pipes, FIFOs, System V IPC, message queues, system calls for processes, memory management.

### 6.4.2 Learning objectives – SEC 2B

The course is introduced for the students to

(a) present the concept of Linux and its history;
(b) illustrate the relationship between Linux to Unix;
(c) introduce the Ext2 and Ext3 file systems;
(d) introduce to the resource management in Linux.

### 6.4.3 Learning outcomes – SEC 2B

On completion of the course, a student will be able to

(a) describe the definition of Linux;
(b) describe the connectives of Linux with Unix;
(c) present the concepts of Ext2 and Ext3 functions;
(d) describe the resource management system in Linux.

# 7 Graduate Attributes

1. **Disciplinary knowledge:** Capability of demonstrating comprehensive knowledge of mathematics and understanding of one or more disciplines which form a part of an undergraduate programme of study.

2. **Communications skills:**
   - Ability to communicate various concepts of mathematics effectively using examples and their geometrical visualizations.
   - Ability to use mathematics as a precise language of communication in other branches of human knowledge.
   - Ability to communicate long standing unsolved problems in mathematics.
   - Ability to show the importance of mathematics as precursor to various scientific developments since the beginning of the civilization.
   - Ability to explain the development of mathematics in the civilizational context and its role as queen of all sciences.

3. **Critical thinking and analytical reasoning:**
   - Ability to employ critical thinking in understanding the concepts in every area of mathematics.
   - Ability to analyze the results and apply them in various problems appearing in different branches of mathematics.

4. **Problem solving:**
   - Capability to solve problems in computer graphics using concepts of linear algebra.
   - Capability to solve various models such as growth and decay models, radioactive decay model, drug assimilation, LCR circuits and population models using techniques of differential equations.
   - Ability to solve linear system of equations, linear programming problems and network flow problems.
   - Ability to provide new solutions using the domain knowledge of mathematics acquired during this programme.

5. **Research-related skills:**
   - Capability for inquiring about appropriate questions relating to the concepts in various fields of mathematics.
   - To know about the advances in various branches of mathematics.

6. **Information/digital literacy:**
   - Capability to use appropriate softwares to solve system of equations and differential equations.
   - Capability to understand and apply the programming concepts of C++ to mathematical investigations and problem solving.

7. **Self-directed learning:** Ability to work independently and do in-depth study of various notions of mathematics.

8. **Moral and ethical awareness/reasoning:** Ability to identify unethical behaviour such as fabrication, falsification or misrepresentation of data and adopting objective, unbiased and truthful actions in all aspects.

9. **Lifelong learning:** Ability to think, acquire knowledge and skills through logical reasoning and to inculcate the habit of self-learning.

## References

[1] "Learning Outcomes based Curriculum Framework (LOCF), B.A./B.Sc. (Hons) Mathematics & B.A./B.Sc. with Mathematics as a subject", University Grants Commission, New Delhi, 2019, URL: https://www.ugc.ac.in/pdfnews/4540979_LOCF-Final_Mathematics-report.pdf.

Subhajit Paul

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UR for **September 1, 2021 to September 30, 2021**

| Subject | Date & Time | Duration | Type | Mode of Teaching | Class Type | Attendance | Description | Class Link | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Total No. Of Classes :36 | | | | | | | | | |
| Riemann Integration and Series of Functions | Thu,September 2, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:8<br>Absent :4<br>% Present :66.67 | Mathematical formulation of the integration process | https://drive.google.com/file/d/1Schr60y5GDlzMVJzNIgHyJI2ENPqc1w5/view?usp=sharing | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Fri,September 3, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:7<br>Absent :5<br>% Present :58.33 | Infinite limits at infinity | https://drive.google.com/file/d/1kZlDBA07zxcIzuAfnrm_2yddE-F7ua1z/view?usp=sharing | via G Suite |
| Theory of Real Functions and Introduction to Metric Space | Fri,September 3, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:6<br>Absent :6<br>% Present :50.00 | sin x < x < tan x | https://drive.google.com/file/d/1kZlDBA07zxcIzuAfnrm_2yddE-F7ua1z/view?usp=sharing | via G-Suite |
| Riemann Integration and Series of Functions | Sat,September 4, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:3<br>Absent :9<br>% Present :25.00 | Testing of the standing belief on integration | https://drive.google.com/file/d/1wnj720tq78cHDEQ7ri2Sa5xi9PItYY_d/view?usp–sharing | via G-Suite |
| Group Theory II | Mon,September 6, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8<br>Present:8<br>Absent :0<br>% Present :100.00 | Equivalence of internal and external direct products | Forgot to record! | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Mon,September 6, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:5<br>Absent :7<br>% Present :41.67 | Evaluation of limit of (sin x / x) as x tends to 0 | https://drive.google.com/file/d/1kNYKxvkuuXDT0zvkHXnfI6k_CiWhIs_1/view?usp=sharing | via G-Suite |
| Group Theory II | Tue,September 7, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8<br>Present:8<br>Absent :0<br>% Present :100.00 | Internal and External direct products for n many groups | https://drive.google.com/file/d/1LkwNUkt2-rgQZUwSjlknXthUTInltGmc/view?usp=sharing | via G Suite |
| Theory of Real Functions and Introduction to Metric Space | Tue,September 7, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:6<br>Absent :6<br>% Present :50.00 | Evaluation of limit (e^x-1)/x | https://drive.google.com/file/d/1Rfg7PFfZt4s7SRzT-KpWycnQl1QYsQxA/view?usp=sharing | via G-Suite |
| Group Theory II | Wed,September 8, 2021<br>11:10 AM<br>12:10 PM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8<br>Present:6<br>Absent :2<br>% Present :75.00 | Worked out examples | https://drive.google.com/file/d/10GGrbZ-ndY2YNfsK5DUs5gJbVZUombea/view?usp=sharing | via G-Suite |
| Riemann Integration and Series of Functions | Thu,September 9, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:5<br>Absent :7<br>% Present :41.67 | Necessary condition for integrability | https://drive.google.com/file/d/1uamNdpvjY1nkrDJ3sN_uY3SaSzQ81Dzv/view?usp=sharing | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Fri,September 10, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:3<br>Absent :9<br>% Present :25.00 | Worked out examples | https://drive.google.com/file/d/1O1vnfAqoEo72eC3aDrAVjr59OoJKRT4C/view?usp=sharing | via G Suite |
| Theory of Real Functions and Introduction to Metric Space | Fri,September 10, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:4<br>Absent :8<br>% Present :33.33 | Doubt clarification | https://drive.google.com/file/d/1O1vnfAqoEo72eC3aDrAVjr59OoJKRT4C/view?usp–sharing | via G-Suite |
| Riemann Integration and Series of Functions | Sat,September 11, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:5<br>Absent :7<br>% Present :41.67 | Darboux's contribution; refinement of partitions | https://drive.google.com/file/d/1WUDtz4FrGOkLV27J6vrakypqZrj8yzc-/view?usp–sharing | via G-Suite |
| Group Theory II | Tue,September 14, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8<br>Present:7<br>Absent :1<br>% Present :87.50 | Worked out examples | https://drive.google.com/file/d/11oqjcDkcRCVcW6LES3KiiJqH8F3cV7am/view?usp=sharing | via G Suite |
| Theory of Real Functions and Introduction to Metric Space | Tue,September 14, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:4<br>Absent :8<br>% Present :33.33 | Discussion on class test | https://drive.google.com/file/d/1K7JrB6E7rcDlysaxIbkmg6goPDfjQCmt/view?usp=sharing | via G-Suite |
| Group Theory II | Wed,September 15, 2021<br>11:10 AM<br>12:10 PM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8<br>Present:6<br>Absent :2<br>% Present :75.00 | Worked out examples | https://drive.google.com/file/d/1Wl-RcymDPDNtKz4GK_NNS__98W_ltX2F/view?usp=sharing | via G-Suite |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Riemann Integration and Series of Functions | Thu,September 16, 2021 08:40 AM 09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:7 Absent :5 % Present :58.33 | Upper and lower integral and definition of integrability | https://drive.google.com/file/d/1yOQgJV_KtF0OMUFOv-dgHB-CQo_Vdbvj/view?usp=sharing | via G-Suite |
| Algebra | Thu,September 16, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:10 Present:8 Absent :1 % Present :80.00 | Interesting sums | https://drive.google.com/file/d/1-IEJdPVGOQvRzsJ8RXVRJDug1lPWTowv/view?usp=drive_web | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Fri,September 17, 2021 08:40 AM 10:40 AM | 2.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:8 Absent :4 % Present :66.67 | Introduction to continuity; Sequential criterion | https://drive.google.com/file/d/1BDTCKYPvTKEGKn1S_fEqTiAl-0DGLo3F/view?usp=sharing | via G-Suite |
| Riemann Integration and Series of Functions | Sat,September 18, 2021 08:40 AM 09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:6 Absent :6 % Present :50.00 | NASC for Darboux integrability | https://drive.google.com/file/d/1zD4Zipv_PocRnJgTq62O_qmF_JXMQ-hK/view?usp=sharing | via G-Suite |
| Algebra | Sat,September 18, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:10 Present:9 Absent :0 % Present :90.00 | The habit of thinking using sums (contd.) | https://drive.google.com/file/d/15paMuiVafk5fhYofFQoiAd75GhHwvpZD/view?usp=sharing | via G-Suite |
| Group Theory II | Mon,September 20, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8 Present:7 Absent :1 % Present :87.50 | Revision of exercise sums | https://drive.google.com/file/d/1bnG4v4ViU-A8ak5YpDlplXjelqmx8e5U/view?usp=sharing | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Mon,September 20, 2021 08:40 AM 09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:6 Absent :6 % Present :50.00 | Algebra and examples of continuous functions | https://drive.google.com/file/d/15FcHlTXxAx4AEtUtFIUWI7zZarDk1crg/view?usp=sharing | via G-Suite |
| Group Theory II | Tue,September 21, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8 Present:7 Absent :1 % Present :87.50 | Worked out examples on Direct products | https://drive.google.com/file/d/101vcvnj3CbWR0dp0Ix_jFcKpleoFkc1F/view?usp=sharing | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Tue,September 21, 2021 08:40 AM 09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:6 Absent :6 % Present :50.00 | Worked out examples on Continuity | https://drive.google.com/file/d/1bwTZKsf3IqD-pCYK9Naa7O1L0PScxnnV/view?usp=sharing | via G-Suite |
| Algebra | Wed,September 22, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:10 Present:6 Absent :3 % Present :60.00 | Sum on right angled triangle. | https://drive.google.com/file/d/1viWAFAbzWj239QQNq57UnhW_h1tZQrpw/view?usp=drive_web | via G-Suite |
| Group Theory II | Wed,September 22, 2021 11:10 AM 12:10 PM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8 Present:7 Absent :1 % Present :87.50 | Worked out example on Direct products | https://drive.google.com/file/d/1kbHofrq6hNc4p2jvCPPSlk9E3OJfaCXm/view?usp=sharing | via G-Suite |
| Riemann Integration and Series of Functions | Thu,September 23, 2021 08:40 AM 09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:6 Absent :6 % Present :50.00 | Darboux's theorem and its corollaries | https://drive.google.com/file/d/1FRkmCTR1E3xGqsVH_em-e48Zie15TiZe/view?usp=sharing | via G-Suite |
| Algebra | Thu,September 23, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:10 Present:7 Absent :3 % Present :70.00 | Mathematical reasoning | https://drive.google.com/file/d/1Zgr44St8W86p5YbB4XsGNtX8oPotg6St/view?usp=sharing | via G-Suite |
| Group Theory II | Mon,September 27, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8 Present:7 Absent :1 % Present :87.50 | Introduction to Group actions | https://drive.google.com/file/d/1nd9X0hsFXhdLaSujh7JPaxsdQrdXcMLJ/view?usp=sharing | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Mon,September 27, 2021 08:40 AM 09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:6 Absent :6 % Present :50.00 | Detour to Algebra | https://drive.google.com/file/d/131qghsIsU6O8bIQnjZDBPlZ0JGv9NqZR/view?usp=sharing | via G-Suite |
| Group Theory II | Tue,September 28, 2021 09:40 AM 10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:8 Present:8 Absent :0 % Present :100.00 | Group actions | https://drive.google.com/file/d/1nQ65AhXAIBF-TxzADB6Y9urJ1Bdgpk57/view?usp=sharing | via G-Suite |
| Theory of Real Functions and Introduction to Metric Space | Tue,September 28, 2021 08:40 AM 09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12 Present:6 Absent :6 % Present :50.00 | Remembrance of introductory concepts of continuity | https://drive.google.com/file/d/1HCO68PlkG3zJPI15KoGAjYvvSkAQTzuY/view?usp=sharing | via G-Suite |

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|---|---|---|---|---|---|---|---|---|---|
| Algebra | Wed,September 29, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:10<br>Present:8<br>Absent :2<br>% Present :80.00 | Introduction to sets | https://drive.google.com/file/d/1hoKiIB-pmIcsHH1BdE8-SwxWVrGgGxd3/view?usp=sharing | via G-Suite |
| Algebra | Thu,September 30, 2021<br>09:40 AM<br>10:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:10<br>Present:6<br>Absent :4<br>% Present :60.00 | Introduction to set theory | https://drive.google.com/file/d/1ec6a6uUYH2htSVO6EcgjodarFxHsF_Dy/view?usp=sharing | via G-Suite |
| Riemann Integration and Series of Functions | Thu,September 30, 2021<br>08:40 AM<br>09:40 AM | 1.00 | Core Course | ICT | Theory | Students Enrolled:12<br>Present:9<br>Absent :3<br>% Present :75.00 | Equivalence of Riemann and Darboux integration | https://drive.google.com/file/d/1lOCmee9NkTQcbIquZENS5zsLemVFwhMW/view?usp=sharing | via G-Suite |
| | Total No Of Hours : 37 | | | | | | | | |

## Research & Creative Activities

| Date | Description | |
|---|---|---|
| Count :3 | | |
| Fri<br>September 24, 2021 | | Sponsor/Event: FDP on blended learning Phase 2<br>Place:Salesian College, Siliguri |
| Sat<br>September 25, 2021 | | Sponsor/Event: FDP on Blended learning - Phase 2<br>Place:Salesian College, Siliguri |
| Sat<br>September 25, 2021 | | Sponsor/Event: FDP on Blended learning - Phase 2<br>Place:Salesian College, Siliguri |

## Professional & Administrative Activities

| Date | Description |
|---|---|

## College Activities

| Date | Description | |
|---|---|---|
| Count :11 | | |
| Thu<br>September 2, 2021 | Student related co-curricular, extension and field based activities | Details:<br>Orientation programme for new batch of students |
| Fri<br>September 3, 2021 | Student related co-curricular, extension and field based activities | Details:<br>Session held in the orientation programme: Introduction of Mathematics as an academic subject |
| Wed<br>September 1, 2021 | Student related co-curricular, extension and field based activities | Details:<br>Inaugural orientation programme |
| Wed<br>September 1, 2021 | Administrative Responsibilities | Details:<br>Organised and evaluated demo class for recruit of guest lecturer in Statistics |
| Thu<br>September 9, 2021 | Administrative Responsibilities | Details:<br>Interviewed new applicants |
| Sat<br>September 4, 2021 | Administrative Responsibilities | Details:<br>Interviewed new applicant |
| Mon<br>September 13, 2021 | Student related co-curricular, extension and field based activities | Details:<br>Organised on campus orientation programme |
| Thu<br>September 16, 2021 | Administrative Responsibilities | Details:<br>Interviewed new applicant |
| Fri<br>September 17, 2021 | Administrative Responsibilities | Details:<br>Interviewed new applicant |
| Wed<br>September 22, 2021 | Administrative Responsibilities | Details:<br>Interviewed new applicant |
| Sat<br>September 18, 2021 | Administrative Responsibilities | Details:<br>Interviewed new applicant |

## Co-Curricular Organised

| Date | Title | Report Uploaded |
|---|---|---|

Salesian College
Sonada & Siliguri

# Self-Appraisal Report

Subhajit Paul

September,2021

## 1 Personal Details

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|---|---|
| ID : | **SL15074** |
| Name : | **Subhajit Paul** |
| Designation : | **Assistant Professor** |
| Department : | **Mathematics** |
| Other Assosciations : | **Head of the department; Associate Se** |

## 2 Summary Of Activities During The Period

**2.1 Teaching And Evaluation :**
Took 37 hours of classes in last month according to the following distribution: CC 2 (Sem – I): 6 hours CC 5 (Sem – III): 13 hours CC 7 (Sem – III): 8 hours CC 11 (Sem – V): 10 hours Prepared question papers and evaluated answer-scripts for the weekly tests of the following courses • Core Course 5 • Core Course 7

**2.2 Research And Publication :**
Yet to be done.

**2.3 Mentoring :**
Hosted a session of academic counselling for the new students on September 03, 2021.

**2.4 Administrative Activities** :
• September 1: Organised and evaluated demo class for recruit of guest lecturer in Statistics. • September 2: Organised departmental orientation for new batch of students. • September 4: Interview of the new applicants. • September 9: Interview of the new applicants. • September 13: Organised on-campus orientation programme for the new batch of students. • September 16: Interview of the new applicants. • September 17: Interview of the new applicants. • September 18: Interview of the new applicants. • September 22: Interview of the new applicants.

**2.5 Co-curriculars And Assosciations** :
• September 1: In house Orientation programme for the new batch of students. • September 24: Delivered a talk in the FDP on Blended learning – Phase 2 at SCSC. • September 24: Attended the FDP on Blended learning – Phase 2 at SCSC. • September 25: Attended the FDP on Blended learning – Phase 2 at SCSC.

**2.6 Others :**
Not in this month.

## 3 Self Appraisal

**3.1 Orgnaization of Classes** : Above Expection
**Challenges :** New subject with more abstract mathematics.
**Outcomes :** With proper orientation and enough motivation, students are gradually showing interests in the subjects.

**3.2 Delivery of Content** : At Expection
Challenges : • Virtual classroom, • Not much effective interaction with the students.
Outcomes: Could gain attention of some first-year students after some academic counselling.

**3.3 Mentoring** : Below Expection
Challenges :
Outcomes: Could gain attention of some first-year students after some academic counselling.

**3.4 Quality Of Output From Assignments :** Below Expection
Challenges : Declining interest among students; tendency to copy everything.
Outcomes: Explanation of the assignments in the class makes a point for self-evaluation for the students.

**3.5 Quality Of Administrative Activities :** Outstanding
Challenges : No automated system of notifying the department for new applications.
Outcomes: Managed by checking the applicants' list everyday.

**3.6 Output From Association Activities :** Below Expection
Challenges :
Outcomes:

**3.7 Research Activities :** At Expection
Challenges :
Outcomes: Editing my book on Metric Spaces.

# Notice

## (For Faculty and Management)

Date: 19.10.2022

Dear Deans, HoDs, & Heads of Schools,

Greetings to all. Here are some important information regarding End Semester (Internal) Examinations. Please read them carefully.

**1.1. Dates of End Semester (Internal) Exams**

The End Semester Exam for 3rd and 5th semester will be beginning from 21st November 2022 and ending in 25th November 2022 while for 1st semester it will be starting from 5th December and ending on 8th December 2022.

**1.2. Submission of the Question Papers by the Faculty**

Two sets of questions should be prepared for each subjects and both needs to be submitted to the Exam office by 31st October 2022 for the 3rd and 5th Semesters and 10th November for the 1st semester exams through email (exams@salesiancollege.net). The HoDs needs to make sure that all the questions are set according to the University pattern, spelling and grammar mistakes are eliminated and the template which is provided by the Exam office is strictly followed.

**1.3. Moderation Committee**

A moderation committee set up by the exam committee will be doing the moderation of question papers. The work of moderation could start on 2nd November 2022 and end by 5th November 2022 for the 3rd and 5th semesters while it will begin on 11th November and ends by 15th November 2022 for the 1st semester. The printing and packing of the Questions papers will be done by the exam office.

**1.4. Use of Unfair Means**

Any use of unfair means needs to be strictly dealt with. The normal rule is that anyone caught using unfair means will have to pay a fine of ₹1000/- apart from being debarred from that particular exam.

**1.5. Absence in the End Semester Exam**

If anyone is absent for the End Semester Exam he/ she will not have the possibility of re-examination and the internal marks will be calculated out of 5 instead of 10 for the particular paper or for the entire examination.

**1.6. Common Faculty Meeting**

A meeting of all faculty will be held on 1st November at 12.00 pm in Marengo Hall to review the submission status of the question papers of the End Semester Exam for 3rd and 5th semesters.

**1.7. Correction of Answer Scripts**

Correction of Answer scripts should be over by 2nd December 2022 for the 3rd and 5th Semesters while it should be completed by 14th December for the 1st semester exams.

**1.8. Submission of Marks**

The marks of 3rd and 5th Semester Examinations to be submitted to the Exam office by 3rd December 2022 while for the 1st semester exams the last date for submission will be 15th December 2022.

Babu Joseph

Fr. Dr. Babu Joseph,

Convenor of Examinations

Salesian College Siliguri

Dr. (Fr.) Babu Joseph
Vice Principal & Convenor of Examination
Salesian College, Siliguri
Don Bosco Road, Siliguri-734001

Debdut Sengupta

EXAMINATION CO-ORDINATOR
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