SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcomes based Curriculum Framework

(LOCF)

For

S.Y.B.Sc. Mathematics (Minor)

Undergraduate Programme

From

Academic year

2024-25

Vision & Mission

Mission:

- Equip the student with knowledge and skills of their chosen vocation
- Inculcate values.
- Provide them opportunities for all, round growth and prepare them for life.

Vision:

- To equip the students with advanced knowledge and skills in their chosen vocation.
- To provide value-based education and opportunities to students.
- To help them to face challenges in life.
- To nurture a scientific attitude, temperament and culture among the students.
- To continually review, develop and renew the approach to build India of the Founder's dream.

Goals and Objectives:

- To build a strong Academia-Industry bridge.
- To provide flexibility in the courses offered and proactively adapt to the changing needs of students and the society.
- To establish a centre for multidisciplinary activities.
- To mould individuals who would nurture the cultural heritage of our country and contribute to the betterment of the society.

Board of studies in Mathematics

Undergraduate and Postgraduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Subhash Krishnan	Chairman	K. J. Somaiya College of Science and Commerce
Subject Expert nominated by Vice-Chancellor			
1	Dr. Jyotshana Prajapat	Professor	University of Mumbai
Subject experts			
1	Prof. Ravi Rao	Professor	TIFR(retired)
2	Prof. Eknath Ghate	Professor	TIFR
3	Prof.Amitava Bhattacharya	Professor	TIFR
4	Prof. Amiya Bhowmick	Professor	ICT
5	Prof. Shripad Garge	Professor	IITB
6	Mr. Nimesh G. Punjani	Assistant Professor	Lala Lajpatrai College
7	Mrs. Maya Nair	Assistant Professor	SIES College
Representative from Industry/corporate sector/allied area			
1	Mr. Ananthkrishnan Subramanian	Director, Program Management	ZEOTAP
Meritorious Alumnus			
1	Mr. Sudhir Thakur	Jr. College lecturer	SIES Junior College of Commerce and Economics
Faculty of the specialisation			
1	Mrs. Sudha Agrawal	Associate Professor	K. J. Somaiya College of

			Science and Commerce
2	Dr. Mrs. Reema Khanna	Associate Professor	K. J. Somaiya College of Science and Commerce
3	Mr. Makarand Niphadkar	Associate Professor	K. J. Somaiya College of Science and Commerce
4	Mr. Prabhat Upadhayay	Assistant Professor	K. J. Somaiya College of Science and Commerce
5	Mr. Prashant Agre	Assistant Professor	K. J. Somaiya College of Science and Commerce
6	Mrs. Javeria Qureshi	Assistant Professor	K. J. Somaiya College of Science and Commerce

Foreword

Autonomy reflects efforts for excellence in academic performances, capability of self-governance and enhancement in the quality of education. In the year 2012, the UGC and University of Mumbai conferred the Autonomous Status to K. J. Somaiya College of Science and Commerce. Post this recognition and having several accolades to our credit, we made significant changes to our existing syllabi to reflect the changing business, industrial and social needs. A holistic education that provides opportunities to gain and share knowledge, experiment and develop beyond curriculum, is offered at our College.

Autonomous colleges carry a prestigious image for the students and the teachers and we have made a collaborative attempt to maintain a high level of quality in the standard of education that we impart.

Structured feedback obtained from the students, alumni and the experts from the industry and the changes suggested by them were duly incorporated in the syllabi. The Board of Studies constituted for each department meets to carry out in depth discussions about different aspects of the curriculum taking into cognizance the recent trends in the discipline.

The IQAC team has facilitated the conduct of a number of workshops and seminars to equip the faculty with the necessary skill set to frame the syllabi and competencies to deliver the same. Training was also provided to employ innovative evaluation methods pertaining to higher cognitive levels of revised Bloom's taxonomy. This ensured the attainment of the learning outcomes enlisted in the syllabus. Audits are conducted to critically review the practices undertaken in teaching, learning and evaluation. Innovative learning methodologies such as project-based learning, experiential learning and flip- class learning practiced by a committed fleet of faculty, supported by several hands have been our unique outstanding propositions. All efforts have been made to nurture the academic ambitions as well as the skills in co-curricular activities of the most important stakeholder i. e. student.

With sincere gratitude, I acknowledge the constant support and guidance extended by Shri Samir Somaiya, President- Somaiya Vidyavihar, and all the esteemed members of the Governing board and Academic council of the College. I also would like to acknowledge the Heads of the Departments and all the faculty members for their meticulous approach, commitment and significant contribution towards this endeavour for academic excellence.

Dr. Pradnya Prabhu
Principal

Acknowledgement

At the outset, I would like to thank our Principal Dr. Pradnya Prabhu for her guidance and support during the curriculum restructuring process. I am also grateful to all the esteemed members of the Board of Studies, for their constructive suggestions and contributions.

Above all, I am deeply indebted to all the young and vibrant colleagues in the Department of Mathematics for the long and arduous work they have put in during the compiling of the restructured syllabus.

Mr. Subhash Krishnan

Chairperson

Board of Studies in Mathematics

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Preamble

Mathematics is universally accepted as the queen of all sciences. This fact has been confirmed with the advances made in Science and Technology. Mathematics has become an imperative prerequisite for all the branches of science such as Physics, Statistics, Computer Science, Biology etc. This revised syllabus in Mathematics, B.Sc. Programme aims at catering to the needs of the learner in all these branches. Learners who have completed High School (Science) with Mathematics as one of the courses are eligible to take this programme. In High School the focus is on comprehending different tools to solve a problem whereas in the B.Sc. Mathematics programme emphasis will not only be to generate tools to solve but also to prove rigorously, when one can apply them, what condition will be required to be applied to obtain a desired output.

Education is one of the most critical yardsticks in any country's development. The new National Education Policy (NEP) 2020 is an essential and comprehensive policy framework that aims to revamp the country's educational system from its foundation and to bring it at par with global standards. The larger aim of this policy is to transform the Indian education system by making it more inclusive, flexible and relevant to the changing needs of the society. Some of the key features of this policy are the introduction of vocational training, elective courses, emphasis on cultural studies, development of global skill sets and the promotion of multilingualism.

The policy seeks to bring about significant changes in the Higher Education structure, such as introducing a four-year undergraduate degree Programme, establishing multidisciplinary education and research universities, pooled credit bank and creating a National research Foundation to promote and support research activities in various fields. The new education policy enables every student to get quality education irrespective of their socio-economic background, gender or disability. NEP 2020 enables teachers to use a variety of learning techniques and experiments.

In the current fast paced world, simply cascading the knowledge in the classroom is not sufficient especially when the global requirements keep changing. Every learner should be encouraged to exchange ideas and thoughts in a collaborative approach. This leads to develop an environment which is cognitive in nature and not a one-way information flow. Keeping all this in mind, the curriculum under Learning Outcome-based Curriculum Framework (LOCF) is designed.

This Learning Outcome-based Curriculum Framework (LOCF) supports the fundamental principle of providing quality education in India. Our focus is to involve young minds to participate, contribute and add value at each stage in the field of their study. The introduction of Choice Based Credit System (CBCS) has maximized the benefits of the newly designed curriculum in multiple folds.

The LOCF will certainly help teachers to envisage the outcome expected from the learners at the end of the programme. For students, it will be a guide which shows how this curriculum will help them acquire all the skills and knowledge which are essential in their personal and academic growth. Higher education qualifications such as Bachelor's Degree Programme are awarded on the basis of demonstrated achievement of outcomes and academic standards; and this is the very essence of this curriculum.

1. Introduction

The B.Sc. Mathematics programme is developed by keeping in mind the interest of learners to explore the field of Mathematics. The framework helps to maintain the standard of degrees/programmes through periodic programme review within a broad framework of agreed/expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The BSc programme is planned in such a way that it allows flexibility and innovation in programme design, syllabi development, teaching-learning process and quality assessment of students' learning levels.

This curriculum framework is developed on the principles of student centric learning pedagogy. The platform intends to empower graduates with the skills required for pursuing Mathematics-related careers, higher education in Mathematics and allied subjects.

Various graduate attributes are emphasised in this framework such as critical thinking, basic psychology, scientific reasoning, moral ethical reasoning, etc. While designing this framework, an important aspect considered was the measurable teaching-learning outcome to ensure employability of the graduates. Implementation of modern pedagogical tools and concepts such as flip-class, hybrid learning, MOOCs and other e-learning platforms are suggested through this framework. The framework also focuses on issues relevant to India and also of the rest of the world.

Every course is designed in such a way that students get decent exposure to each topic by keeping an equilibrium between these topics and thus creating interest to pursue further education in the field of Mathematics. It covers the basic concepts of Mathematics to establish a strong foundation of the subject and helps students to explore the subject more. Topics varying from Algebra, Linear Algebra, Basic Calculus, Differential Calculus, Integral Calculus, Ordinary Differential Equations, Graph Theory, Numerical Methods, Metric topology, Number Theory and Complex Analysis are taught. Maxima and Latex are taught as skill enhancement courses in semesters V and VI respectively.

The practical sessions will help the students to gain sufficient skills in problem solving and appreciate the real world applications of the concepts taught. Students are also encouraged to improve their scientific writing skills through various assignments. The research-based project work in the curriculum ensures team building attitude within students and utilises every aspect of the team members in the success of any project. The project evaluation method is designed in such a way that it helps in creating a strong background for the research, skills to generate systematic reports and create effective presentation.

2. Learning Outcome based Curriculum Framework

LOCF focuses on curriculum framework, curriculum aims, learning targets and objectives. The curriculum framework also provides examples of effective learning, teaching and assessment practices. As the curriculum development is a collaborative and an on-going enhancement process, the LOCF instructs periodic reviews and revisions of the curriculum in accordance with the ever changing needs of students, teachers and society.

The framework describes how students are given exposure towards core knowledge of the subject, specialisation, choice based learning and other skill enhancement courses ensuring development of an integrated personality and employability. The template defines expected outcomes for the programme like core competency, communication skills, critical thinking, affective skills, problem-

solving, analytical, reasoning, research-skills, teamwork, digital literacy, moral and ethical awareness, leadership readiness along with specific learning course outcomes at the starting of each course. The Learning Outcomes based Curriculum Framework (LOCF) for B.Sc. Mathematics will certainly be a valuable document in the arena of outcome-based curriculum design.

2.1 Nature and extent of B.Sc. Mathematics

Mathematics is the study of quantity, structure, space and change. It has a very broad scope in science, engineering and social sciences. The key areas of study in mathematics are:

1. Calculus
2. Algebra
3. Geometry
4. Ordinary Differential Equations
5. Analysis
6. Combinatorics
7. Financial Mathematics

Degree programs in Mathematics cover topics from Calculus (one variable and multi variable), Algebra, Linear Algebra, Analysis (Real analysis, Complex analysis and Topology of Metric spaces), Number theory, Numerical methods, Ordinary differential equations, Combinatorics, Financial Mathematics, Fourier analysis, Operation research, programming languages such as C programming, Java programming, Python programming and use of Mathematical software such as Maple, Sage, LaTeX, etc. The depth and breadth of study of individual topics depend on the nature and devotion of learners in specific mathematics programmes. As a part of effort to enhance employability of mathematics graduates, the courses have been designed to include learning experiences, which offer them opportunities in various sectors of human activities. In this context, the experience of the project work in the areas of applications of Mathematics has a key role.

2.2 Programme Education Objectives (PEOs)

The overall aims of B.Sc. with Mathematics as a subject are to:

1. Create a deep interest in learning mathematics.
2. Develop broad and balanced knowledge and understanding of definitions, concepts, principles and theorems.
3. Familiarize the learners with suitable tools of mathematical analysis to handle issues and problems in mathematics and related sciences.
4. 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.
5. Provide learners sufficient knowledge and skills enabling them to undertake further studies in mathematics and its allied areas on multiple disciplines concerned with mathematics.
6. Encourage the learners to develop a range of generic skills helpful in employment, internships and social activities

3. Graduate Attributes in Mathematics

Attributes expected from the graduates of B.Sc. Mathematics Programme are:

GA 1: Proficient in analytical, quantitative and technical skills required for problem solving.

GA 2: Trained to apply a rigorous, critical and logical approach to enquiry

GA 3: Adept in Critical evaluation of the knowledge gained in the advanced fields of Mathematics, IT, Data Science, Machine learning and Management.

GA 4: Implementing the knowledge of Mathematics in Environmental and Socio-economic domains of the society.

GA 5: communicate mathematics and interact effectively, clearly and precisely to an audience of peers and faculty.

GA 6: socially a responsible citizen and help others to comprehend, assimilate and disseminate principles of mathematics and its applications. Help in hypothetical reasoning, logical thinking, explanation, abstractions, theories.

4. Qualification descriptors

Undergraduate degree programmes of either 3 or 4-year duration, with multiple entry and exit points and re-entry options, with appropriate certifications such as:

- A UG certificate is awarded to students who opt to exit after completing 1 year (2 semesters) of study in the chosen fields of study with having secured 44 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.
- a UG diploma is awarded to students who opt to exit after 2 years (4 semesters) of study with having secured 88 credits and in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.
- A bachelor's degree is awarded after a 3-year (6 semesters) programme of study in major discipline with having secured 132 credits and minimum credit requirements as follows

Sr. No.	**Category of Courses**	**Minimum credit requirements**
1	Major Core Course	48

2	Minor Stream Course	20
3	Discipline Specific Elective Course	06
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	20
10	Open Elective Course	10
Total		132

- After completing the requirements of three year Bachelor's degree, candidate who meet the minimum CGPA of 7.5 shall be allowed to continue studies in the fourth year of undergraduate program to pursue and complete Bachelor's degree with honours/research (subject to change)
- A 4-year bachelor's degree (honours) is awarded after eight semesters programme of study with having secured 176 credits and minimum credit requirements as follows:

Sr. No.	Category of Courses	Minimum credit requirements
1	Major Core Course	76
2	Minor Stream Course	24
3	Discipline Specific Elective Course	14
4	Ability Enhancement Course	08
5	Skill Enhancement Course	06
6	Value Education Course	04
7	Vocational Skill Course	08
8	Indian Knowledge System	02
9	Co-curricular Course	24
10	Open Elective Course	10
Total		176

- They should do a research project or dissertation under the guidance of a faculty member of the University/College. The research project/dissertation will be in the

major discipline. The students who secure 176 credits, including 12 credits from a research project/dissertation, are awarded UG Degree with Research.

The 4-year bachelor's degree programme is considered a preferred option since it would provide the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.

Upon successful completion of the programme, students receive B.Sc. degree in Mathematics. B.Sc. Mathematics graduates of this department are expected to demonstrate the extensive knowledge of various concepts of Mathematics and its application thus contributing in research, development, teaching, government and public sectors. This programme will establish a foundation for students to further pursue higher studies in Mathematics. The list below provides a synoptic overview of possible employment areas provided by an undergraduate training in Mathematics.

The list below provides a synoptic overview of possible career paths provided by an undergraduate training in Mathematics:

1. Software engineer
2. Data Scientist
3. Data Analyst
4. Meteorologist
5. Teaching
6. Financial Manager/ trader
7. Actuary
8. Investment Analyst
9. Research Scientist
10. Game Designer

Job Roles for B.Sc. Mathematics graduate:

After graduation one can seek a professional career as:

1. Developer - Use mathematical formulas and models to develop platforms for other areas.
2. Manager - Apply mathematical theories and techniques to solve practical problems in business, engineering, the sciences, or other fields
3. Analyst - Develop mathematical or statistical models to analyse data
4. Information officer - Interpret data and report conclusions from their analyses
5. Use data analysis to support and improve business decisions
6. Researcher -
    - Applied Mathematician - Applied mathematicians use theories and techniques, such as mathematical modelling, to solve practical problems. These mathematicians typically work with individuals in other occupations to solve these problems. For example, they may work with chemists and materials scientists and chemical engineers to analyse the effectiveness of new drugs. Other applied mathematicians may work with industrial designers to study the aerodynamic characteristics of new automobiles.
    - Theoretical mathematicians - Theoretical mathematicians do research to identify unexplained issues in mathematics and resolve them. They are primarily concerned with exploring new areas and relationships of mathematical theories to increase knowledge and understanding about the field. Although some may not consider the practical use of their findings, the knowledge they develop can be an important part of many scientific and engineering achievements.

Higher Education options for B.Sc. Mathematics graduate:

1. M.Sc. in Math/Computer Science/ IT
2. MBA
3. MCA
4. B. Ed.
5. Masters in Data Science

The learners who complete three years of full-time study of an undergraduate programme of study will be awarded a Bachelor's degree in Mathematics.

5. Programme Specific outcomes (PSOs)

After the successful completion of modules in different courses of B.Sc. Mathematics, the learner will be able to:

PSO I Emphasize basic concepts of Mathematics in various situations.

PSO II Apply rigorous treatment to the concepts of Mathematics and appreciate the role of mathematical proofs in formal deductive reasoning and distinguish a coherent argument from a fallacious one.

PSO III Articulate mathematical principles and create mathematical models/games through experiential learning.

PSO IV Formulate mathematical models to obtain feasible solutions to real-world problems amenable to mathematical analysis.

PSO V Proficiently write programs in languages like C, Java, R, Python to implement various concepts of Mathematics.

PSO VI Explore different Mathematical software tools for self-learning.

5.1 Course Mapping

Semester	PSO / Course	I	II	III	IV	V	VI
III	MJ I						
	MJ II						

	MN	√	√	√	√		√
	SEC	√	√	√	√		√
	VSC						
	AEC						
	IKS						
	CC						
IV	MJ I						
	MJ II						
	MN	√	√	√	√		√
	SEC	√	√	√	√		√
	VSC						
	CC						
	OE						

6. Structure of B.Sc. Mathematics programme

The curriculum framework is designed around the choice-based credit system (CBCS). The programme consists of three years UG having six semesters (two semesters per year) or four years UG (Honours) having eight semesters (two semesters per year). Credit Distribution for Eight Semester is as follows:

Semester	MJ	DSE	SEC	VSC	MN	AEC	VEC	IKS	CC	FP	INT/ APT	OE	Total
I	6	-	-	-	6	4	2	-	2	-	-	2	22
II	6	-	-	-	6	3	2	1	2	-	-	2	22
III	6	-	3	2	4	1	-	1	2	-	-	3	22
IV	6	-	3	2	4	-	-	-	2	2	-	3	22
V	12	-	-	-	-	-	-	-	-	2	8	-	22
VI	12	6	-	4	-	-	-	-	-	-	-	-	22

BSc with Honours – 22 credits in Sem VII and VIII

BSc with Research – 22 credits in Sem VII and VIII

To acquire a degree in B.Sc. Mathematics a learner must study

1. **Major Core Courses (MJ):**

   a) A course which is required to be opted by a candidate as a major core course. The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular subject or discipline.

   b) Students may be allowed to change majors within the broad discipline at the end of the second semester by giving her/him sufficient time to explore interdisciplinary courses during the first year.

c) There are twenty four Major Core courses (MJ), two each, in semesters I to IV; and four each in semesters V and VIII.

d) Each Major Core Courses is compulsory.

e) Each Major Core Course from semester I to VI is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1 credit for practical of two hours per week in every semester.

f) Each Major Core Course from semester VII and VIII is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1.5 credit for practical of three hours per week in every semester.

g) The purpose of fixing major core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standards with other universities/institutions.

2. **Minor Stream Course (MN):**

a) A course is chosen by a candidate from the interdisciplinary stream as a minor course. Minor Stream courses help a student to gain a broader understanding beyond the major discipline.

b) Students who take a sufficient number of courses in an interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline.

c) Students may declare the choice of the minor stream course at the end of the second semester after exploring various courses.

d) There are two each Minor stream course (MN), in semesters I and II. This Minor stream is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 1 credit for practical of two hours per week in every semester.

e) There is one each Minor stream course (MN) in semester III and IV. This Minor stream is comprised of 2 credits for theory ie. 30 hours; 2 lectures of each 1 hr per week and 2 credits for practical of four hours per week in every semester.

f) Each Minor stream Courses is compulsory.

3. Ability Enhancement Courses (AEC)

a) The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity.

b) Students are required to achieve competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills.

c) There are five AE courses spread over three semesters (I to III).

d) Each student is supposed to take two AE in semester I - English language and Modern Indian language of 2 credits each.

e) There are two AE in semester 2 - English language of two credits and Modern Indian language of 1 credit.

f) There is one AE in semester 3 - Modern Indian language of 1 credit.

4. Value Education Courses (VEC)

a) The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity,

management of biological resources, forest and wildlife conservation, and sustainable development and living.

b) The VEC courses offered are:

VEC 1- Environmental Science I (2 credits) (Semester 1),

VEC 1I- Environmental Science II (2 credits) (Semester 1I).

5. Co-Curricular courses (CC):

a) They are designed to provide skill-based knowledge and contain both lab/hands on training/field work.

b) The main purpose of these courses is to provide life skills in hands-on mode to increase employability.

c) There are two CC each in semester I to III – NCC (compulsory 1 credit course) and Other one from Music/Sports training program/Yoga/ Study Circle

d) There are three CC each in semester IV – NCC (compulsory 1 credit course), second one from Music/Sports training program/Yoga/ Study Circle of 1 credit and third one is Field project of 2 credits.

e) There are two CC semester V – Internship/ Apprenticeship (8 credit) and Field project (2 credit)

6. Open Elective (OE)

a) They are designed to provide multidisciplinary education.

b) Students can opt for one interdisciplinary Open Elective Course (OE) in each of semester I and II of two credits each.

c) Students can opt for one interdisciplinary Open Elective Course (OE) in each of the semester III and IV of three credits each.

d) Open courses are offered in cognate disciplines by different departments in the college.

7. Indian Knowledge System (IKS)

a) They are designed to recognize the rich heritage of ancient and eternal Indian knowledge and thought as a guiding principle.

b) Students can opt for one General IKS in semester 1I – Indian cultural Heritage of one credit.

c) There is one IKS based on a major subject in semester III of 1 credit.

8. Skill Enhancement Course (SEC):

a) They are designed to provide skill-based knowledge pertaining to the Major course to the learner.

b) The main purpose of these courses is to provide life skills in hands-on mode to increase employability.

c) There are Two skill enhancement courses offered. Each student is supposed to take one SEC in each semester III and IV of 3 credits each (2 credit theory and 1 credit practical).

9. Discipline Specific Elective Courses (DSE):

a) Elective courses offered under the major course subject of study.

b) There are two discipline specific elective courses (DSE), offered in semesters VI of 2 credits theory and 1 credit practical.

c) There is one discipline specific elective course (DSE), offered in semesters VII and VIII each of 2 credits theory and 2 credit practical.

d) There is one advanced level disciplinary course – Research Methodology of 4 credits offered in semester VII.

10. Vocational Skill Course (VSC)

a) Vocational courses are designed to provide practical, hands-on training, competencies, and proficiency to students, ultimately enhancing their skills and employability.

b) These courses are tailored to prepare individuals for specific careers and industries.

c) There are two VSC offered, one each in semester III to IV, each one is of two credits.

d) There is one VSC offered in semester VI of 4 credits.

11. On Job Training (OJT)

a) On Job training of 4 credits is offered in semester VIII to enhance the specific skills and competencies required for a particular job

b) OJT bridges the gap between theory and practical application, promoting a deeper understanding of concepts.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
1	III	MJ I		Course from Statistics/ Physics/ Chemistry
2		MJ II		Course from Statistics/ Physics/ Chemistry
3		MJ P		Based on MJ I and MJ II
4		MN	24US3MTMNICAL1	Integral Calculus - I
5		MN P	24US3MTMNP	Mathematics Practical
6		SEC		Course from Statistics/ Physics/ Chemistry
7		SECP		Course from Statistics/ Physics/ Chemistry
8		VSC		Course from Statistics/ Physics/ Chemistry
9		AEC-I		Modern Indian Language level I (Hindi/Marathi)
10		CC	24US3CCEMI	Emotional Intelligence
11		IKS		Course from Statistics/ Physics/ Chemistry
12		OE	24US3OEFHR / 24US3OEIFM / 24US3OESCW	Fundamentals of Human Rights / Introduction to Financial Market /Scientific Writing
13	IV	MJ I		Course from Statistics/ Physics/

				Chemistry
14		MJ II		Course from Statistics/ Physics/ Chemistry
15		MJ P		Based on MJ I and MJ II
16		MN	24US4MTMNODE	Ordinary Differential Equations
17		MN P	24US4MTMNP	Mathematics Practical
18		SEC		Course from Statistics/ Physics/ Chemistry
19		SECP		Course from Statistics/ Physics/ Chemistry
20		VSC		Course from Statistics/ Physics/ Chemistry
21		FP		Course from Statistics/ Physics/ Chemistry
22		CC I	24US4CCSOL	Science of Life
23		CC II	24US4CCSTP	Sports training program
24		OE	24US4OEIWC / 24US4OEEGI / 24US4OEISS	Basic Of Investment And Wealth Creation / Emerging Gender Issues in India / Introduction to Soft Skills

6.2 Credit distribution for B.Sc. Mathematics

Semester	Course number	Course title	Credits		
			Theory	Practical	Total

III	MJ I	Course from Statistics/ Physics/ Chemistry	2	1	3
	MJ II	Course from Statistics/ Physics/ Chemistry	2	1	3
	MN	Integral Calculus - I	2	2	4
	SEC	Course from Statistics/ Physics/ Chemistry	2	1	3
	VSC	Course from Statistics/ Physics/ Chemistry	-	2	2
	AEC II	Modern Indian Language Level I	1	-	1
	IKS	Course from Statistics/ Physics/ Chemistry	1	-	1
	CC I	Emotional intelligence	2	-	2
	OE	Fundamentals of Human Rights / Introduction to Financial Market /Scientific Writing	3	-	3
	Total				**22**
IV	MJ I	Course from Statistics/ Physics/ Chemistry	2	1	3
	MJ II	Course from Statistics/ Physics/ Chemistry	2	1	3
	MN	Ordinary Differential Equations	2	2	4

	SEC	Course from Statistics/ Physics/ Chemistry	2	1	3
	VSC	Course from Statistics/ Physics/ Chemistry	-	2	2
	FP	Course from Statistics/ Physics/ Chemistry	2	-	2
	CC I	Science of Life	-	1	1
	CC II	Sports training program	-	1	1
	OE	Basic Of Investment And Wealth Creation / Emerging Gender Issues in India / Introduction to Soft Skills	3	-	3
	Total				**22**

6.3 Semester Schedule

Semester	Major Core Courses (MJ)	Minor Stream Courses (MN)	Ability Enhancement Compulsory Course (AEC)	Field Project	Indian Knowledge e System (IKS)	Co-Curricular Course (CC)	Open Elective (OE)
III	1] MJ1 Course from	1] MN Integral Calculus	1] AEC I Modern Indian	Course from Statisti	Course from Statistics/	1] Emotional Intelligence	Fundamentals of Human Rights / Introducti

	Statistics/ Physics/ Chemistry 2] MJ2 Course from Statistics/ Physics/ Chemistry 3] SEC Course from Statistics/ Physics/ Chemistry 4]VSC Course from Statistics/ Physics/ Chemistry	– I	Language Level I	cs/ Physics/ Chemistry	Physics/ Chemistry		on to Financial Market /Scientific Writing

IV	1] MJ1 Course from Statistics/ Physics/ Chemistry 2] MJ2 Course from Statistics/ Physics/ Chemistry 3] SEC Course from Statistics/ Physics/ Chemistry 4] VSC Course from Statistic	1] MN Ordinary Differential Equations Mathematics		Course from Statistics/ Physics/ Chemistry		1] Science of life II] Sports training program	Basic Of Investment And Wealth Creation / Emerging Gender Issues in India / Introduction to Soft Skills t

	s/ Physics/ Chemistry						

6.4 Course Learning Objective

The three-year undergraduate Mathematics programme is designed to familiarize and strengthen students with core Mathematics concepts and rigorously prove results in Mathematics. The objective of structured syllabus in Mathematics is to make the concepts and basics of Mathematics clear and interesting to students and also to ensure the development of vertical growth in the subject. The idea behind this is to enable students to develop analytical skills and critical thinking.

It is our attempt that students achieve this objective through systematic reading and class lectures and through feedback on their written work-assignments, project/research papers, presentations, discussions, debates, etc. our intention is to enable students to formulate cogent arguments, presenting the necessary evidence to establish these, based on a training in Mathematics.

7. Detailed B.Sc. Mathematics Syllabus

S. Y. B.Sc. Syllabus with effect from the Academic year 2023–2024

Syllabus - S. Y. B.Sc. Mathematics (MINOR)

Course No.	Course Title	Course Code	Credits	Periods (1 Hr)	Module	Lectures per module (1 hr)	Examination		
							Internal Marks	External Marks	Total Marks
SEMESTER III									
Minor Stream courses THEORY									

I	Integral Calculus –I	24US3MTMNICAL1	2	30	2	15	20	30	50
Minor Stream courses PRACTICAL									
1	Mathematics Practical	24US3MTMNP	2	60			CIE		50
SEMESTER IV									
Minor Stream courses THEORY									
I	Ordinary Differential Equations	24US4MTMNODE	2	30	2	15	20	30	50
Minor Stream courses PRACTICAL									
1	Mathematics Practical	24US4MTMNP	2	60			CIE		50

S.Y. B. Sc. (Mathematics) SEMESTER III

Minor Stream Course- I

COURSE TITLE: Integral Calculus I

COURSE CODE: 24US3MTMN1CALI [CREDITS - 02]

Course Learning Outcomes

After the successful completion of the Course, the learner will be able to:

CLO 1: Apply properties of Riemann Integrable functions

CLO 2: Apply Fundamental Theorem of Calculus in various situations.

Module 1	**Riemann Integration**	**[15 L]**

Learning Objective

The learner should be able to:

1. Understand theory of Riemann integration.
2. Understand Uniform continuity of functions and its consequences with respect to Riemann integrability of functions.

Learning Outcome:

After the successful completion of the module, the learner will be able to:

1. Evaluate upper and lower Riemann sum, upper and lower integral of a function.
2. Decide whether a function is riemann integrable or not.
3. Apply basic properties of Riemann integrable functions.

1.1	Partition of a set, partition of an interval in a finite number of subintervals. Upper Riemann sum and lower Riemann sum of a function with respect to a partition.	[3L]
1.2	Upper integral, lower integral of a function. Definition of Riemann integrability and integral of a function over an interval. Simple examples.	[3L]
1.3	Riemann criterion for integrability with examples. Basic properties of Riemann integrable (R-integrable) functions. Monotonic functions over a closed and bounded interval are R-integrable. Definition of Uniformly continuous function and simple examples. An	[8L]

	important result: A continuous function defined on a closed and bounded interval is uniformly continuous. (proof not expected) Continuous functions defined over a closed and bounded interval are R-integrable. R- integrability of piecewise continuous functions over bounded intervals.	
1.4	Integration as a limit of sum.	[1L]

Reference Books:

1. R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd..
2. R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.

Additional Reference books:

3. Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
4. Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real
5. Analysis; Springer.

Module 2	Fundamental theorem of Calculus and Applications	[15L]

Learning Objectives

The learner should be able to:

1. Understand various forms of Fundamental theorem of Calculus.
2. Apply Fundamental theorem of Calculus

Learning outcomes

The learner will be able to:

1. Prove various forms of Fundamental theorem of calculus
2. Evaluate integrals using various techniques based on the Fundamental theorem of Calculus.

3. Evaluate area of regions in a plane, volume of solids obtained by rotating a curve.		
2.1	Fundamental theorems of calculus in various forms. First form, Cauchy's theorem, Second form.	[5L]
2.2	Integration by parts, Change of variable formula, Mean Value theorem for integrals. Differentiation of a function which is defined using integration.	[5L]
2.3	Computation of area under a curve, area of bounded regions.	[3L]
2.4	Volume of regions obtained by rotating a curve about an axis.	[2L]

Reference Books:

1. R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd..
2. R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.

Additional Reference books:

1. Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
2. Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real Analysis; Springer.

Question Paper Template

S.Y. B. Sc. (Mathematics) SEMESTER III

Minor Core Course- I

COURSE TITLE: Integral Calculus I

COURSE CODE: 24US3MTMNICAL1 [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5	5	5	5	5		25
II	5	5	5	5	5		25
Total marks per objective	10	10	10	10	10		50
% Weightage	20%	20%	20%	20%	20%	-	100

S. Y. B. Sc. (Mathematics)

SEMESTER III - Practical

COURSE CODE: 24US3MTMNP Credits- 02

Course Learning Outcomes

CLO 1: To apply concepts of integral calculus in solving problems

CLO2**:** To apply concepts of Linear transformations and diagonalisation to real life problems

Learning Objectives:

The Practical is intended to

1. Solve problems based on the concepts learnt
2. Apply the concepts in various situation

Learning Outcome:

After the successful completion of the practical, the learner will be able to:

1. Apply the results proved to the other sciences
2. Create examples and counterexamples
3. Solve modern and classical problems

Group A	Integral Calculus 1

1. Problems on partitions, Computation of upper sum and lower sum of a function with respect to a given partition.
2. Computation of Upper integral and Lower integral. Testing Riemann Integrability using Definition.
3. Problems on use of Riemann's Criterion and properties of R-integrable functions.
4. Problems on Uniform continuity
5. Problems on piecewise continuous functions.
6. Examples of R-integrable functions having infinitely many discontinuities.

7. Problems on using integration to find limit of sum
8. Problems on Integration by parts and change of variable formula.
9. Problems on Mean value theorem for integrals.
10. Problems on differentiation of functions defined using integration.
11. Problems on computation of area under graph of a nonnegative function and computation of area of a region in the plane bounded by known curves.
12. Problems on evaluating volume of regions in the space obtained by rotating a curve or a region in a plane.
Group B **Linear Algebra**
1. Testing if a given map is a Linear transformation using definition and properties
2. Finding a linear transformation from its images on basis vectors; with a given kernel or image set.
3. Finding kernel and image of a linear transformation, verification of Rank nullity theorem.
4. Problems on Non-singular linear transformation
5. Problems on Vector space isomorphism.
6. Finding Matrix of a linear transformation w.r.t. given bases and vice versa, verifying algebra of matrices associated with a linear transformation.
7. Finding characteristic polynomial, eigen values and eigen vectors of a matrix
8. Eigen space, geometric multiplicity, properties of eigen values.
9. Caley Hamilton theorem- verification, and its applications

10. Diagonalisation of a matrix, Finding power of diagonalizable matrix
11. Similar matrices have same eigen values but matrices with same eigen values may not be similar.. 12. Application of Eigen values in image processing

S.Y. B. Sc. (Mathematics) SEMESTER IV

Minor Core Course- I

COURSE TITLE: Ordinary Differential Equations

COURSE CODE: 24US4MTMNODE

[CREDITS - 02]

Course Learning Outcome		
After the successful completion of the Course, the learner will be able to: CLO 1: Solve Differential equations of order 1 using various methods and apply techniques of solving first order differential equations to real life situations in physics, chemistry, life sciences. CLO 2: Solve Differential equations of order 2 using various methods and apply techniques of solving second order differential equations to real life situations in physics.		
Module 1	Differential equations of order 1	[15L]
Learning Objectives:		

Learner should be able to 1. Classify differential equations w.r.t. degree and order 2. Solve a differential equation by method of exact differential equations. 3. Solve linear and Bernoulli's differential equations. 4. Apply differential equations to some real-life problems.		
Learning Outcome: After the successful completion of the module, the learner will be able to: 1. Solve problems on ordinary differential equations of first order. 2. Apply differential equations to problems related to microbiology, chemistry, physics		
1.1	Introduction to differential equations. Ordinary and partial differential equations. Examples of differential equations arising out of several situations. Forming a differential equation. Classification of differential equations on the basis of order, degree. Linear and nonlinear differential equations of a specified order. General solution and particular solution of a differential equation. First order differential equations in variables separable form. Homogeneous differential equations of order 1. Simple substitutions to convert a given first order differential equation to one of these forms Questions on 1.1 to be asked only in practical/internal exams and not in the end semester exam.	[2L]
1.2	Exact differential equations. Necessary and sufficient condition for a differential equation $M(x,y)dx + N(x,y)dy = 0$ to be exact. Integrating factors. Rules for finding Integrating factors. Simple problems on computation of integrating factors to convert non exact differential equations to exact differential equations. (No theory questions expected)	[5L]
1.3	Linear differential equation of order 1. Establishing the formula to obtain its solution. Bernoulli's differential equation. Its solution by	[3L]

	converting it to a linear differential equation.	
1.4	Applications of differential equations: Obtaining a family of curves orthogonal to a given family of curves. Exponential growth and decay. L-C circuits and R-L circuits. Spread of an infection.	[5L]

Reference books

1. Differential equations with Applications and Historical Notes -G. F. Simmons

Additional Reference books:

1. M.D. Raisinghania; Advanced Differential Equations; S. Chand Publications
2. H. K. Dass; Higher Engineering Mathematics; S. Chand Publications

Module 2	Second order equations	[15L]

Learning Objectives

Learner should be able to

1. Solve problems on second order homogeneous differential equations.
2. Use of Wronskian to generate a basis of the space of solutions of a homogeneous.
3. Apply method of undetermined coefficients (UDC) and method of variation of parameters to solve nonhomogeneous differential equations.
4. Apply second order differential equations to solve real-life problems.

Learning outcomes

The learner will be able to:

1. Apply Wronskian to check linear independence of solutions of a differential equation.
2. Solve second order homogeneous differential equations.
3. Apply the method of undetermined coefficients to find a particular integral of a differential equation.

4. Apply the method of variation of parameters to find a particular integral of a differential equation. 5. Apply the operator method to find a particular integral of a differential equation. 6. Apply ordinary differential equations of second order to problems related to astronomy and physics.		
2.1	The general second order linear differential equation. The linear differential equations with constant coefficients. Existence and Uniqueness Theorem for the solutions of a second order initial value problem (statement only. Proof to be done as an activity by students and not to be asked in Exam).	[1L]
2.2	Homogeneous and non-homogeneous second order linear differential equations: The set of solutions of a homogeneous equation as a vector space. Linear dependence and linear independence of the solutions. Wronskian of a linear differential equation. Wronskian is either identically zero or it does not vanish anywhere in the domain. Use of Wronskian in deciding linear independence of solutions. The general solution of a homogeneous differential equation. The use of a known solution to find the general solution of a homogeneous equation. The general solution of a non-homogeneous second order equation, Complementary functions and particular integrals.	[3L]
2.3	The homogeneous equation with constant coefficients, auxiliary equation, the general solution corresponding to real and distinct roots, real and equal roots and complex roots of the auxiliary equation. Non-homogeneous equations: The method of undetermined coefficients. The method of variation of parameters. The Operator	[6L]

	Method to solve second order and higher order differential equations. Euler's equation and its solution by converting it to a linear differential equation with constant coefficients.	
2.4	Motion of a freely falling body under constant acceleration due to gravity neglecting the air resistance. Motion under constant gravitational force along with an air resistance proportional to the instantaneous velocity or to the square of instantaneous velocity. S.H.M. and Hook's Law. Simple problems on elastic strings and springs.	[5L]

Reference books

1. Differential equations with Applications and Historical Notes -G. F. Simmons

Additional Reference books:

1. M.D. Raisinghania; Advanced Differential Equations; S. Chand Publications
2. H. K. Dass; Higher Engineering Mathematics; S. Chand Publications

Question paper template

S.Y. B. Sc. (Mathematics) SEMESTER IV
Core Course- I
COURSE TITLE: Ordinary Differential Equations
COURSE CODE: 24US4MTMNODE

CREDITS - 02

Module	Rememberin g/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creatin g	Total marks
I	5	5	5	5	5		25
II	5	5	5	5	5	5	25
Total marks per objective	10	10	10	10	10		50
% Weightage	20%	20%	20%	20%	20%	-	100

S.Y. B. Sc. (Mathematics) SEMESTER IV

COURSE TITLE: Mathematics Practical

COURSE CODE: 24US4MTMNP

[CREDITS - 02]

Learning Objectives: The Practical is intended to: 1. Solve problems based on the concepts learnt 2. Apply the concepts in various situation
Learning Outcome: After the successful completion of the practical, the learner will be able to: 1. Apply the results proved to the other sciences 2. Create examples and counterexamples 3. Solve modern and classical problems

Group A	Ordinary differential equations

1	Identifying degree and order of a differential equation. Forming a simple differential equation from a given situation.	
2	Problems on Separation of variables, simple substitutions and solving a homogeneous differential equation of order 1.	
3	Identifying whether a differential equation is exact and solving an exact differential equation. Finding integrating factors using rules. Testing whether a given function is an integrating factor of a non-exact differential equation.	
4	Linear differential equations and Bernoulli differential equation	
5	Applications of first order differential equations	
6	Verifying whether the given function is a solution of a differential equation of order two. Checking linear dependence using Wronskian. Use of one solution to find second linearly independent solution. Finding a particular solution from the general solution using given conditions.	
7	Solving a second order linear homogeneous differential equation with constant coefficients.	
8	Problems on method of undetermined coefficients.	
9	Problems on method of variation of parameters.	

10	Problems on operator method.	
11	Problems on motion under gravitational force	
12	Problems on S.H.M. and Hook's Law.	

Group B	Algebra-II

1	problems on Groups including subsets of IR under addition and multiplication, groups of matrices, residue classes modulo n	
2	problems on Permutation groups, Finding inverse, signature, conjugates of a permutation, solving equations in permutation groups	
3	groups of rotations and reflection of an equilateral triangle, square and rectangle	
4	Finding order of elements in given groups	
5	Problems on cyclic groups	
6	Finding all the generators of a group, and of all the subgroups of a cyclic group	
7	Problems on group homomorphism	
8	Verifying if given subgroup is normal	
9	Application of fundamental theorem of group homomorphism	
10	Problems using correspondence theorem	
11	Problems on quotient groups	
12	Application of Cayley's theorem	

8. Teaching learning process

The pedagogic methods adopted, involve direct lectures, tutorial discussions, as well as technology- supported presentations. We believe that education is interactive and all sessions between students and teachers are based upon reciprocity and respect.

1) The lectures (of 1 hr duration) delivered to one whole class at a time systematically deal with the themes of the syllabus. This constitutes the core of the teaching- learning process. The students are provided with bibliographic references and encouraged to go through at least some readings so that they could be more interactive and ask more relevant questions in the class. This also helps obtain knowledge beyond the boundaries of the syllabi.

2) Wherever needed, teachers use audio-video based technology devices (e. g. power point, YouTube videos) to make their presentations more effective. Some courses require that students see a documentary or feature film and course themes are structured so that discussions of these will further nuance the critical engagement of students with ideas introduced in their textual materials.

3) Remedial coaching, bridge courses are adopted to enhance the scope of learning for the learners. Remedial sessions are conducted to offer assistance on certain advanced topics. Bridge courses facilitate to develop a concrete basis for the topics to be learnt in the coming academic year.

9. Assessment Methods

Evaluation Pattern: Theory

● Assessments are divided into two parts: Mid Semester Examination (MSE) and End Semester Examination (ESE).

● The Mid Semester Examination shall be conducted by the College at the Mid of each semester (20 M) – Duration: 30 Min.

● The End Semester Examination shall be conducted by the College at the end of each semester. (30M) Duration: 1 hour

End Semester Examination Paper Pattern

Question No	Module	Marks with Option	Marks without Option
1	I	5 M x 5 Q = 25	3 M x 5 Q = 15 M
2	2	5 M x 5 Q = 25	3 M x 5 Q = 15 M

Each question will have five sub questions a, b, c, d, e and out of which any three should be answered.

Evaluation pattern: Practical

- Continuous Assessment for 50 Marks throughout the entire semester.
- 50 Marks Evaluation as per the following rubrics

Core Course	CIE	Journal	Total
I	20M	5M	25M
II	20M	5M	25M

10. Program and Course Code Format

The course is coded according to following criteria:

1. First two numbers in each course code indicates year of implementation of syllabus (23- year of implementation is 2023-24)
2. Third letter 'U' designates undergraduate
3. Fourth letter 'S' designate Science discipline and the digit followed is for semester number (S1 – 1st Semester)
4. Letter 'MT' is for Mathematics discipline (MT =Mathematics). This forms the programme code 23USMT. For the further course codes programme code is amended as follows
5. To represent Major Core Course (MJ) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
6. To represent Minor Stream Course (MN) followed by course number digit (1/2/3/4) and three lettered code representing the title of the course.
7. For Ability enhancement course code, (AEC) alphabets followed by a digit (1/2) followed by 'EVS'-Environmental science are used.
8. For Value Added course code, (VEC) alphabets followed by a digit (1/2) followed by 'EVS'-Environmental science are used.
9. For Indian Knowledge System course code, (IKS) alphabets followed by a digit (1/2) followed by 'ICH'- Indian Cultural Heritage is used.
10. For Co-curricular course code, (CC) alphabets followed by a digit (1/2).
11. For Open Elective course code, (OE) alphabets followed by a digit (1/2).
12. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.