SOMAIYA VIDYAVIHAR

K J Somaiya College of Science & Commerce

Autonomous (Affiliated to University of Mumbai)

Somaiya TRUST

Learning Outcomes based Curriculum Framework

(LOCF)

For

B.Sc. Mathematics

Undergraduate Programme

From

Academic year

2021-22

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 Post graduate

	Name	Designation	Institute/Industry
Head of the Department			
1	Subhash Krishnan	Chairperson	K.J. Somaiya College of Science and Commerce
Subject Expert nominated by Vice-Chancellor			
1	Dr. Ravi Rao	Professor (retired)	TIFR
Subject experts			
1	Dr. Chandrasekhar Khare	Professor	UCLA, Los Angeles
2	Dr. Jyotshana Prajapat	Professor	University of Mumbai
3	Mrs. Urmilla Pillai	Associate Professor	CHM College
4	Mr. JaiPrakash Sutar	Associate Professor (retired)	Vaze-Kelkar College
5	Mr. Nimesh G. Punjani	Assistant Professor	Lala Lajpatrai College
Representative from Industry/corporate sector/allied area			
1	Mrs. Rashmi R. Shilvant	Jr. College lecturer	K.J. Somaiya College of Science and Commerce
Meritorious Alumnus			
1	Mrs. Rashmi R. Shilvant	Jr. College lecturer	K.J. Somaiya College of Science and Commerce
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	Assistant Professor	K.J. Somaiya College of Science and Commerce
4	Mr. Prabhat Kumar Upadhyay	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 KJ 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 college carries 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.

1. Introduction

One of the significant reforms in the undergraduate education is to introduce the Learning Outcome-based Curriculum Framework (LOCF) which makes it learner-centric, interactive and outcome-oriented with well-defined aims, objectives and goals to achieve. Outcome based learning is the principal end of pedagogical transactions in higher education in today's world in the light of exponential changes brought about in science and technology, especially in mathematics, and the prevalent utilitarian world view of the society. The learning outcomes are attained by learners through skills acquired during a programme of study. Programme learning outcomes will include subject-specific skills and generic skills, including transferable global skills and competencies. It would also focus on knowledge and skills that prepare learners for further study, employment, and citizenship. They help ensure comparability of learning levels and academic standards across colleges/universities and provide a broad picture of the level of competence of graduates.

Key outcomes underpinning curriculum planning and development. The LOCF in Mathematics desires the courses of mathematics for B.Sc. with Mathematics as a subject, based on the expected learning outcomes and academic standards which are necessary for the graduates after completing these programmes. The following points were kept in mind while framing the syllabi.

1. Learners' attributes
2. Qualification descriptors
3. Programme learning outcomes

4. Course learning outcomes
5. Necessity of having elective courses
6. Applications of mathematics
7. Employability in IT, Finance and other sectors.

2. Learning Outcome based Curriculum Framework

The Bachelor's degree in B.Sc. with Mathematics as a subject, is awarded to the learners on the basis of knowledge, understanding, skills, attitudes, values and academic achievements sought to be acquired by learners at the end of these programmes. Hence, the learning outcomes of mathematics for these courses are aimed at facilitating the learners to acquire these attributes.

Syllabi of mathematics is framed in such a way that it may lead to all round development and delivery of complete curriculum planning. Hence, it provides specific guidelines to the learners to acquire sufficient knowledge during this programme. The objectives of LOCF (Mathematics) are to prepare the syllabi having standard level of study. It is also aimed at prescribing standard norms for teaching-learning process and examination pattern. Hence, the programme has been chalked out in such manner that there is scope of flexibility and innovation in:

1. Modifications of prescribed syllabi.
2. Teaching-learning methodology.
3. Assessment technique of learners and knowledge levels.
4. Learning outcomes of courses.
5. Inclusion of new elective courses subject to availability of experts

2.1 Nature and extent of B.Sc. Mathematics

Mathematics is the study of quantity, structure, space and change. It has 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 programme in Mathematics covers 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 Aim of Bachelor's degree Programme

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

1. Create 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: **Problem solving skills:** Proficient in analytical, quantitative and technical skills required for problem solving.

GA 2: **Enquiry based learning**: Trained to apply a rigorous, critical and logical approach to enquiry
GA 3: **Critical Thinking:** Adept in Critical evaluation of the knowledge gained in the advanced fields of Mathematics, IT, Data Science, Machine learning and Management.
GA 4: **Interdisciplinary Approach**: Implementing the knowledge of Mathematics in Environmental and Socio-economic domains of the society.
GA 5: **Communication Skills:** Communicate mathematics and interact effectively, clearly and precisely to an audience of peers and faculty.
GA 6: **Social Responsibility:** Socially a responsible citizen and help others to comprehend, assimilate and disseminate principles of mathematics and its applications.
GA7. **Cognitive Ability:** Help others in hypothetical reasoning, logical thinking, explanation, abstractions, and theories.

4. Qualification descriptors

Upon successful completion of the programme, students receive B.Sc. degree in the mathematics. B.Sc. Mathematics graduates of this department are expected to demonstrate the extensive knowledge of various concepts of Mathematics and its application thus contribute in research, development, teaching, government and public sectors. This programme will establish a foundation for student 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 Mathematics/Computer Science/ Information Technology
2. MBA
3. MCA
4. B. Ed.
5. Masters in Data Science

6. M. Phil.
7. Ph.D.
8. Postdoctoral

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 Learning Outcomes

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

PLO I Emphasize basic concepts of Mathematics in various situations.

PLO II Apply rigorous treatment to the concepts of Mathematics.

PLO III Create mathematical models/games through experiential learning.

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

PLO V Write programs proficiently in languages like C, Java, R, Python to implement various concepts of Mathematics.

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

5.1 Course Mapping

Semester	PLO / Course	I	II	III	IV	V	VI
I	CC I	√	√	√	√		
	CC II	√	√	√	√		
	AECC I FC*						
	SEC I STP I						
	SEC II BCE **						
II	CC I	√	√	√	√		√
	CC II	√	√	√	√		
	AECC I FC*						

	SEC I STP2						
	SEC II ICHI***						
III	CC I	√	√	√	√		√
	CC II	√	√	√	√		
	CC III	√	√	√	√		√
	AECC I FC*						
	SEC I STP3						
	SEC II ICH2***						
IV	CC I	√	√	√	√		
	CC II	√	√	√	√		
	CC III	√	√	√	√		
	AECC I FC*						
	SEC I STP4						
	SEC II ICH3***						
V	CC I	√	√	√	√		
	CC II	√	√	√	√		
	CC III	√	√	√	√		
	CC IV	√	√	√	√		
	DSE I	√				√	√
	DSE II	√				√	√
	DSE III	√				√	√
	DSE IV	√	√	√	√	√	√
	AECC I						

	EVS						
	SEC I	√			√		√
	SEC II	√			√		√
VI	CC I	√	√	√	√		
	CC II	√	√	√	√		
	CC III	√	√	√	√		
	CC IV	√	√	√	√		
	DSE I	√				√	√
	DSE II	√				√	√
	DSE III	√				√	√
	DSE IV	√				√	√
	AECC I EVS						
	SEC I	√			√		√
	SEC II	√			√		√
	SEC I	√			√		√
	SEC II	√			√		√

* FC = Foundation Course
** BCE = Basic communication in English
*** ICH = Indian Cultural Heritage (Value Education)

Structure of B.Sc. Mathematics programme

The curriculum frame work is designed around the choice-based credit system (CBCS). The programme consists of three years and six semesters (two semesters per year). To acquire a degree in B.Sc. Mathematics a learner must study:

1. Core Courses (CC):

a) A course which is required to be opted by a candidate as a core course.
b) There are eighteen Core courses (CC), two each, in semesters I and II; three each in semesters III and IV and four each in semesters V and VI (for 6 units).
c) Each Core Courses is compulsory.
d) Each CC is comprised of 2 credits for theory ie. 30 hours; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.
e) The purpose of fixing core papers is to ensure that the institution follows a minimum common curriculum so as to adhere to common minimum standard with other universities/institutions.
f) The course designed under this category aims to cover the basics that a student is expected to imbibe in that particular discipline.

2. Ability Enhancement Compulsory Courses (AECC)

a) There are six AECC courses. Student must take one Ability Enhancement Compulsory Courses (AECC) in semesters I-VI.
b) The AECC courses offered are:

AECC 1- Foundation Course (2 credits) (Semester I-IV),
AECC 2-Environmental Science (2 credits) (Semester V and VI).

3. Skill Enhancement Course (SEC):

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 twelve skill enhancement courses offered. Each student is supposed to take two in Sem I-IV (Sports Training Programme, Basic Communication in English and Indian Cultural Heritage) of 1 credit each. There are four discipline-related skill enhancement courses (SEC), two offered in each

semester V and semester VI each of 2 credit. The student is supposed to choose one SEC in Semester V and VI.

4. **Discipline Specific Elective Courses (DSE):**

a) Elective courses offered under the main discipline subject of study.

b) There are eight discipline specific elective courses (DSE), four in each semesters V and VI. The student is supposed to choose two out of four in each semester V and VI.

c) Each DSE theory course is of 2 credits i.e. 30 hours; 3 lectures of each 50 min per week and 1 credit for practical of two hour per week in every semester.

d) Research Project is offered as an option for the student to choose in lieu of a regular DSE course

5. **Generic Elective Course (GE)**

a) Students can opt for one interdisciplinary Generic Elective Course (GE) in each of the semester V and VI.

b) Generic elective courses are offered in cognate disciplines by different departments in the college.

c) Credits for these courses are granted as additional credits.

6.1 Content

Sr. No	Semester	Course number	Course Code	Course title
Core Course (CC)				
1	I	CC I	21USIMTCCIANL	Real Analysis – I
2		CC II	21USIMTCC2DIS	Discrete Mathematics
3		CC P	21USIMTCCP	Mathematics Practical
4	II	CC I	21US2MTCCICAL	Calculus – I
5		CC II	21US2MTCC2ALG	Algebra – I
6		CC P	21US2MTCCP	Mathematics Practical
7	III	CC I	22US3MTCCIANL	Real Analysis – II
8		CC II	22US3MTCC2LIN	Linear Algebra – I
9		CC III	22US3MTCC3COM 22US3MTCC4GRA	Elective course: (anyone) • Enumerative Combinatorics

				• Graph Theory
10		CC P	22US3MTCCP	Mathematics Practical
11	IV	CC I	22US4MTCCIODE	Ordinary Differential Equation
12		CC II	22US4MTCC2LIN	Linear Algebra – II
13		CC III	22US4MTCC3NUM 22US4MTCC4FIN	Elective course: (anyone) • Numerical Method • Financial Mathematics
14		CC P	22US4MTCCP	Mathematics Practical
15	V	CC I	23US5MTCCIDIF	Multivariate Differential Calculus
16		CC II	23US5MTCC2ALG	Algebra – II
17		CCP I	23US5MTCCPI	Mathematics Practical – Calculus and Algebra
18		CC III	23US5MTCC3ANL	Analysis – I
19		CC IV	23US5MTCC4NTC	Number Theory and Cryptography
20		CC P II	23US5MTCCP2	Mathematics Practical – Analysis and Number Theory
21	VI	CC I	23US6MTCCIINT	Multivariate Integral Calculus
22		CC II	23US6MTCC2ALG	Algebra – III
23		CC P I	23US6MTCCPI	Mathematics Practical – Calculus and Algebra
24		CC III	23US6MTCC3ANL	Analysis II
25		CC IV	23US6MTCC4CAN	Complex Analysis
26		CC P II	23US6MTCCP2	Mathematics Practical – Metric Topology and Complex Analysis
Discipline Specific Electives (DSE)				
1	V	DSE I	23US5MTDS1ACP	Algorithm and C programming
2		DSE II	23US5MTDS2AGT	Advance graph Theory
3		DSE III	23US5MTDS3OPRI	Operation Research – I
4		DSE IV	23US5MTDS4SNC	Swayam / NPTEL Course

5		DSE P	23US5MTDSP3	DSE Practical
6	VI	DSE I	23US6MTDS1AJP	Java programming
7		DSE II	23US6MTDS2OPR2	Operation Research – II
8		DSE III	23US6MTDS3GTC	Game Theory
9		DSE IV	23US6MTDS4SNC	Swayam / NPTEL Course
10		DSE P	23US6MTDSP3	DSE Practical
	Skill Enhancement Courses (SEC)			
1	I	SEC I	21US1SE1STP1	Sports Training Programme Level I
2		SEC II	21US1SE2BCE	Basic Communication in English
3	II	SEC I	21US2SE1STP2	Sports Training Programme Level II
4		SEC II	21US2SE2ICH1	Indian cultural Heritage Level I (value education)
5	III	SEC I	22US3SE1STP3	Sports Training Programme Level III
6		SEC II	22US3SE2ICH2	Indian cultural Heritage Level II (value education)
7	IV	SEC I	22US4SE1STP4	Sports Training Programme Level IV
8		SEC II	22US4SE2ICH3	Indian cultural Heritage Level III (value education)
9	V	SEC I	23US5MTSE1MAX1	Maxima - I
10		SEC II	23US5MTSE2SAG1	Sage - I
11		SEC III	23US5MTSE3MAP1	Maple - I
12		SEC IV	23US5MTSE4LAT1	LaTeX - I
13		SEC V	23US5MTSE5SQL	SQL
14	VI	SEC I	23US6MTSE1MAX2	Maxima-II
15		SEC II	23US6MTSE2SAG2	Sage - II
16		SEC III	23US6MTSE3MAP2	Maple - II
17		SEC IV	23US6MTSE4LAT2	LaTeX - II
18		SEC V	23US6MTSE5PLSQL	PL/SQL

Ability Enhancement Compulsory Course (AECC)				
1	I	AECC I	21US1AE1FOC	Foundation Course
2	II	AECC I	21US2AE1FOC	Foundation Course
3	III	AECC I	22US3AE1FOC	Foundation Course
4	IV	AECC I	22US4AE1FOC	Foundation Course
5	V	AECC I	23US5AE1EVS	Environmental Science
6	VI	AECC I	23US6AE1EVS	Environmental Science

6.2 Credit distribution for B.Sc. Mathematics

Semester	Course number	Course title	Credits		
			Theory	Practical	Total
I	CC I	Real Analysis – I	2	1	3
	CC II	Discrete Mathematics	2	1	3
	AECC I	Foundation Course	2	-	2
	SEC I	Sports Training Programme Level I	1	-	1
	SEC II	Basic Communication in English	1	-	1
II	CC I	Calculus – I	2	1	3
	CC II	Algebra – I	2	1	3
	AECC I	Foundation Course	2	-	2
	SEC I	Sports Training Programme Level II	1	-	1
	SEC II	Indian cultural Heritage Level I (value education)	1	-	1
III	CC I	Real Analysis – II	2	1	3
	CC II	Linear Algebra – I	2	1	3
	CC III	Elective course: (anyone) 1.Enumerative Combinatorics 2.Graph Theory	2	1	3
	AECC I	Foundation Course	2	-	2
	SEC I	Sports Training Programme Level III	1	-	1
	SEC II	Indian cultural Heritage Level II (value education)	1	-	1
IV	CC I	Ordinary Differential Equations	2	1	3
	CC II	Linear Algebra – II	2	1	3
	CC III	Elective course: (anyone) 1.Numerical Method 2.Financial Mathematics	2	1	3

	AECC I	Foundation Course	2	-	2
	SEC I	Sports Training Programme Level IV	1	-	1
	SEC II	Indian cultural Heritage Level III (value education)	1	-	1
V	CC I	Multivariate Differential Calculus	2	1	3
	CC II	Algebra – II	2	1	3
	CC III	Analysis – I	2	1	3
	CC IV	Number Theory and Cryptography	2	1	3
	DSE I/II	A. Algorithm and C programming B. Swayam / NPTEL Course	2	1	3
	DSE III/IV	C. Operation Research – I D. Advance graph Theory	2	1	3
	AECC I	Environmental science	1	-	1
	SEC I/II	A. Maxima -I B. Sage -I C. Maple -I D. LaTeX -I E. SQL		2	2
VI	CC I	Multivariate Integral Calculus	2	1	3
	CC II	Algebra – III	2	1	3
	CC III	Analysis II	2	1	3
	CC IV	Complex Analysis	2	1	3
	DSE I/II	A. Java programming B. Swayam / NPTEL Course	2	1	3

	DSE III/IV	C. Operation Research – II D. Game Theory	2	1	3
	AECC I	Environmental science	1	-	1
	AECC I	Environmental science	1		1
	SEC I/II	A. Maxima -2 B. Sage -2 C. Maple -2 D. LaTeX -2 E. PL/SQL		2	2

6.3 Semester Schedule

Semester	Core Course number	Core Course (CC) title	Discipline Specific Electives (DSE)	Generic Elective Course (GE)	Skill Enhancement Course (SEC)	Ability Enhancement Compulsory Course (AECC)
I	CC I	Real Analysis – I	-	-	I]Sports Training Programme Level I 2]Basic Communication in English	Foundation Course
	CC II	Discrete Mathematics	-	-		
II	CC I	Calculus – I	-	-	I] Sports Training Programme Level II 2] Indian cultural Heritage Level I	Foundation Course
	CC II	Algebra – I	-	-		

					(Value Education)	
III	CC I	Real Analysis – II	-	-	I] Sports Training Programme Level III 2] Indian cultural Heritage Level II (Value Education)	Foundation Course
	CC II	Linear Algebra – I	-	-		
	CC III	Elective course: (anyone) 1.Enumerative Combinatorics 2.Graph Theory	-	-		
IV	CC I	Ordinary Differential Equation	-	-	I] Sports Training Programme Level IV 2] Indian cultural Heritage Level III (Value Education)	Foundation Course
	CC II	Linear Algebra – II	-	-		
	CC III	Elective course: (anyone) 1.Numerical Method 2.Financial Mathematics	-	-		
V	CC I	Multivariate Differential Calculus	DSE I/II and DSE III/IV	GE	SEC I/II	Environmental Science
	CC II	Algebra – II				
	CC III	Analysis – I				
	CC IV	Number Theory and Cryptography				

VI	CC I	Multivariate Integral Calculus	DSE I/II and DSE III/IV	GE	SEC I/ II	Environmental Science
	CC II	Algebra – III				
	CC III	Analysis II				
	CC IV	Complex Analysis				

6.4 Course Learning Objectives

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

F. Y. B.Sc. Syllabus with effect from the Academic year 2021–2022

Syllabus - F. Y. B.Sc. Mathematics

Course No.	Course Title	Course Code	Credits	Hr.	Periods (50 min)	Module	Lectures per module (50 minutes)	Examination		
								Internal Marks	External Marks	Total Marks
SEMESTER I										
Core courses THEORY										
I	Real Analysis – I	21USIMT1	2	30	36	4	12	40	60	100
II	Discrete Mathematics	21USIMT2	2	30	36	4	12	40	60	100
Core courses PRACTICAL										
	Mathematics Practical	21USIMTCCP	2	75	90			40	60	100
SEMESTER II										
Core courses THEORY										
I	Calculus – I	21US2MT1	2	30	36	4	12	40	60	100
II	Algebra – I	21US2MT2	2	30	36	4	12	40	60	100
Core courses PRACTICAL										
	Mathematics Practical	21US2MTCCP	2	75	90			40	60	100

F.Y. B. Sc. (Mathematics) SEMESTER I
Core Course- I
COURSE TITLE: Real Analysis - I
COURSE CODE: 21USIMTCC1ANL CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: CLO 1: Prove analytical properties of real numbers. CLO 2: Prove results on convergence of sequence CLO 3: Prove results on sub sequences and Cauchy sequences in R. CLO 4: Prove or disprove convergence of series using different tests. CLO 5: Apply results proved in various situations in mathematics and real-world.		
Module 1	Real Numbers and their basic properties.	[1IL]
Learning Objectives The module is intended to: 1. Learn the basic properties of real numbers 2. Develop tools for future use		
Learning Outcomes After the successful completion of the module, the learner will be able to: 1. Distinguish between bounded / unbounded sets and intervals 2. Apply concept of neighbourhood 3. Use the tools developed effectively in understanding the arguments, and solving problems		
1.1	Axioms on R, the set of real numbers with respect to addition and multiplication. Commutative, associative and distributive properties of the operations of addition and multiplication. Existence and uniqueness of the additive identity, and the multiplicative identity.	[1L]

	Existence and uniqueness of additive inverse of every real number and multiplicative inverse of every non zero real number. Existence of R^+, the set of positive real numbers as a maximal subset of real numbers which contains 1 and is closed for addition as well as multiplication. Order axioms and law of trichotomy. The order relation $\leq$ and its properties w.r.t. addition and multiplication. **(To be introduced in class, questions to be asked only for Internal)** **This is a self-study submodule**	
1.2	Absolute value function and its properties. Triangle inequality. Its consequence: $\big\|\|x\| - \|y\|\big\| \leq \|x - y\|$.	[1.5L]
1.3	Basic inequalities arising out of non-negativity of square of a real number such as Cauchy Schwartz Inequality for real numbers using Euclidean norm. Arithmetic and Geometric means of a finite set of real numbers and A.M. $\geq$ G.M. inequality.	[2L]
1.4	Intervals in $\mathbb{R}$. Concept of infinity (∞). Open and closed intervals, bounded and unbounded intervals. ε-neighborhood of a point in $\mathbb{R}$. Deleted ε-neighborhood of a point. Hausdorff property of $\mathbb{R}$.	[0.5L]
1.5	Upper bound and lower bound of a subset of $\mathbb{R}$. Least upper bound property of $\mathbb{R}$. Supremum (lub) and infimum (glb) of a non-empty subset of $\mathbb{R}$. Characterization of lub and glb in terms of ε. Effect of translation and multiplication of every element by a non-zero scalar in case of a bounded subset of $\mathbb{R}$. Lub and Glb of sum of two non-empty bounded subset of $\mathbb{R}$	[3L]
1.6	Archimedean property of real numbers.	[3L]

	Its equivalence with the Density theorem for rational numbers. Density theorem for irrational numbers.	

Reference books

- R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd
- R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.
- Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
- Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real Analysis; Springer.

Additional Reference books:

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- G.B. Thomas and R.L. Finney; Calculus; Pearson Education.
- T. M. Apostol; Calculus (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education.
- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Module 2	Sequence of Real numbers	[9L]

Learning Objectives

The aim of the module is to:

1. Understand the meaning of a sequence
2. Understand the concept of limit of a sequence
3. Enable the learner to solve problems using definitions and develop the theory to reduce the complexity of definition
4. Apply the LUB property to monotonic bounded sequences
5. Obtain e, through a sequence

Learning Outcomes

The learner will be able to:

1. Use of sequential approach for solving problems
2. Apply tools developed in module 1 for proving results and solving problems

2.1	Sequence of real numbers, ε – n_0 definition, limit of a sequence, Uniqueness of Limit. Bounded Sequence, Convergent sequence is bounded. Algebra of convergent sequences **(Self-Study)** Standard examples such as a^n, $a^{1/n}$, $n^{1/n}$, $(n!)^{1/n}$. The number e as a limit of a sequence.	[4L]
2.2	monotonic sequences, every monotone bounded sequence is convergent. Examples of sequence of rational numbers converging to $\sqrt{a}, a \in R$, Standard examples such as a^n, $a^{1/n}$, $n^{1/n}$, $(n!)^{1/n}$. The definition of number e as a limit of a sequence. Every real number can be expressed as a limit of a sequence of rational numbers and also as limit of sequence of irrational numbers.	[5L]

Reference books

- R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd.
- R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.
- Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
- Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real Analysis; Springer.

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- T. M. Apostol; Calculus (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education.
- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Module 3	Subsequences and Cauchy Sequences over R	[9L]
Learning Objectives The aim of the module is to: 1. Understand the fact that for a convergent sequence, all subsequences give the same limit 2. Study of limit superior and limit inferior which allows to analyze the behavior of a sequence 3. Explore Cauchy sequence as an alternative definition to convergent sequence		
Learning Outcomes The learner will be able to: 1. Judge whether the sequence is Cauchy 2. Compute limit superior and limit inferior 3. Solve problems based on subsequences.		
3.1	Subsequence of a sequence. Convergence of a sequence implies convergence of its subsequence but not conversely. Convergence of $(x_{2n}), (x_{2n-1})$ to the same limit p implies convergence of (x_n) to p. Every bounded sequence has a convergent subsequence.	[4L]
3.2	Definition of a Cauchy sequence. Every convergent sequence is Cauchy (Self-Study). Every Cauchy sequence is bounded. If a subsequence of a Cauchy sequence is convergent then the sequence itself is convergent. Every Cauchy sequence of real numbers is convergent. Completeness of R.	[5L]
Reference books • R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd. • R. R. Goldberg; Methods of Real Analysis; Oxford and IBH. • Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.		

- Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real Analysis; Springer.

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- G.B. Thomas and R.L. Finney; Calculus; Pearson Education.
- T. M. Apostol; Calculus (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education.Maron;
- Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Module 4	Series of real numbers	[7L]

Learning Objectives

The aim of the module is to:

1. Understand that a sequence can be written as a series and vice versa
2. Prove the summability of series in terms of sequences of partial sums for simple examples
3. Expose the learner to use various tests of convergence and recognize the appropriate tests which can be applied for particular problems
4. Appreciate the importance of Geometric series and p-series in solving problems on comparison test
5. Understand that these tests are not exhaustive

Learning Outcomes

The learner will be able to:

1. Analyse the given problem with appropriate choice of test

4.1	Series of real numbers. Terms of a series and partial sums. Summability / Convergence of a real series in terms of convergence of its partial sums. Convergence of series implies convergence of n^{th} term to zero, and converse is false. Simple examples of convergent series and	[3L]

	divergent series without involving tests. Sum of two convergent series is convergent. If every term of a convergent series is multiplied by a constant, then the resultant series is convergent. Term wise product of two convergent series does not result into a convergent series.	
4.2	Geometric series. It converges if and only if the common ratio lies in $(-1,1)$. Series of nonnegative terms. Cauchy's condensation test. P-series converges if and only if $p > 1$. Comparison test in simple form.	[2L]
4.3	Alternating series and Leibnitz' test. Absolute convergence and conditional convergence. Absolute convergence implies conditional convergence and converse is false. Ratio test and root test (Statement only) and problems based on these tests.	[2L]

Reference books

- R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd.
- R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.
- Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
- Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real Analysis; Springer.

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- T. M. Apostol; Calculus (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education.

- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Question Paper Template

F.Y. B. Sc. (Mathematics) SEMESTER I
Core Course- I
COURSE TITLE: Real Analysis - I
COURSE CODE: 21USIMTCCIANL CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	2	8	5	5	-	-	20
II	2	8	5	-	-	5	20
III	2	8	5	-	5	-	20
IV	2	8	5	5	-	-	20
Total marks per objective	8	32	20	10	5	5	80
% Weightage	10%	40%	25%	12.5%	6.25%	6.25%	100

F.Y. B. Sc. (MATHEMATICS) SEMESTER I
Core Course- II
COURSE TITLE: Discrete Mathematics
COURSE CODE: 21USIMTCC2DIS CREDITS - 02]

Course Learning Outcomes
After the successful completion of the Course, the learner will be able to: CLO 1: Classify various types of relations CLO 2: Classify various types of functions. CLO 3: Prove results of induction, binomial theorem, divisibility, GCD and LCM. CLO 4: Prove properties of prime numbers. CLO 5: Apply results proved and concepts learnt to solve problems and to construct the set of integers and set of rational numbers, finding maximal, minimal element using Zorn's lemma.

Module 1	Sets and relations	[9L]
Learning Objectives The learner should be able to: 1. Identify reflexive, symmetric, anti-symmetric, transitive, equivalence relations and also give examples and counter examples for the same 2. Construct equivalence classes and analyze the construction of integers from natural numbers and the set of rational numbers from the set of integers through equivalence classes 3. Apply Zorn's Lemma to simple partially ordered sets		
Learning Outcomes At the end of the module the learner will be able to 1. Distinguish between various types of relations and illustrate them as well 2. Construct integers from natural numbers and the set of rational numbers from the set of integers 3. Apply their knowledge of partially ordered sets, totally ordered sets and obtain the maximal and minimal element		
1.1	Review of:	[1L]

	Union and intersection of sets. Complement of a subset. Power set of a finite set. Distributive properties of sets. De-Morgan's law. Difference and symmetric difference of sets. Cartesian product of sets. (Questions to be asked only in internal for maximum 5 marks) **(Self-Study Submodule)**	
1.2	Definition and examples of relations. Reflexive, symmetric, anti-symmetric, transitive equivalence relations. Examples. Equivalence class and partitions of sets. Equivalence relations induce partitions and any partition of a set induces an equivalence relation on the set.	[3L]
1.3	Construction of integers from the set of natural numbers through equivalence classes. Construction of the set of rational numbers from the set of integers through equivalence classes.	[2L]
1.4	Partially ordered set, totally ordered set, maximal and minimal element of a set with a given property. Zorn's Lemma (only Statement) and its simple applications.	[3L]

References:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.

Additional References:

- Introduction to theory of numbers by Niven and S. Zuckerman, Wiley Eastern.

<table>
<tr><td colspan="3">

- A survey of Modern Algebra by G. Birkoff and S. Maclane Mac Milan

</td></tr>
<tr><td>Module 2</td><td>Functions</td><td>[9L]</td></tr>
<tr><td colspan="3">

Learning Objectives

The learners should be able to

(1) Analyse functions and identify injective, surjective and bijective functions

(2) Apply this knowledge to composite of functions

(3) Comprehend binary operations and identify finite, countable and infinite sets.

</td></tr>
<tr><td colspan="3">

Learning Outcomes

At the end of the module the learner will be able to

1. Classify relations as functions and non-functions
2. Differentiate various types of functions
3. Illustrate binary operations, finite, countable and infinite sets

</td></tr>
<tr><td>2.1</td><td>Definition of a function.
Domain, co-domain and the range of a function with examples of special functions such as constant, identity, inclusion, projection, floor and ceiling functions.
Injective, surjective and bijective functions.</td><td>[3L]</td></tr>
<tr><td>2.2</td><td>Composition of functions. Composite of bijective function is bijective but converse is not true. If gof is bijective then f is injective and g is surjective.
Invertible functions and the inverse of a function. If f is bijective then its inverse is also a bijective function. Direct and inverse image.</td><td>[3L]</td></tr>
<tr><td>2.3</td><td>Binary operations, simple examples.
Finite and infinite sets, Countable sets, cardinality of set, power set.</td><td>[3L]</td></tr>
<tr><td colspan="3">

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</td></tr>
<tr><th>Module 3</th><th>Natural numbers and Integers</th><th>[9L]</th></tr>
<tr><td colspan="3">Learning Objectives
The learner will be able to
1. Apply the well ordering principle to prove the principles of induction
2. Prove the Binomial Theorem using Pascal's identity and apply it to construct the Pascal's triangle
3. Study the divisibility properties of integers and prove the Division Algorithm and its applications
4. Calculate the GCD of 2 integers using the Euclidean Algorithm</td></tr>
<tr><td colspan="3">Learning Outcomes
At the end of the module, the learner will be able to
1. Prove various identities using the First and Second Principles of Induction
2. Demonstrate the Euclidean Algorithm by finding the GCD</td></tr>
<tr><td>3.1</td><td>Well ordering principle. 1 is the smallest natural number.
There is no natural number between 1 and 2.
First and second principle of mathematical induction.
Pascal's identity
Binomial theorem and simple consequences. Pascal's triangle.</td><td>[4L]</td></tr>
<tr><td>3.2</td><td>Definition and elementary properties of divisibility in Z .
Division Algorithm and applications.
G.C.D. and L.C.M of two integers and its basic properties including G.C.D. of two integers 'a' and 'b' (not both zero) can be expressed as ma + nb.
Proof of the lemma 'If a = bq + r then GCD (a, b) = (b, r)'
Euclidean Algorithm,
Euclid's Lemma.</td><td>[5L]</td></tr>
<tr><td colspan="3">References:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.

</td></tr>
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Additional References:

- Introduction to theory of numbers by Niven and S. Zuckerman, Wiley Eastern.
- A survey of Modern Algebra by G. Birkoff and S. Maclane Mac Milan

Module 4	Prime numbers and linear Diophantine equation	[9L]

Learning Objectives

The learner should be able to

1. Appreciate the proofs of Unique Factorization Theorem
2. Apply the properties of prime numbers to prove the infiniteness of the set of primes and special type of primes
3. Identify linear Diophantine equations
4. Solve linear Diophantine equations

Learning Outcomes

At the end of the module the learner will be able to

1. Prove the unique factorization theorem and the results that the set of primes is infinite and the set of primes of the type 4n – 1, 6n-1 etc. is infinite
2. Solve linear Diophantine equations

4.1	Prime numbers and its basic properties. Unique Factorization Theorem. The set of primes is infinite. The set of primes of the type 4n – 1 is infinite and other such examples.	[5L]
4.2	Linear Diophantine equation $ax + by = c$ The linear Diophantine equation $ax + by = c$ has solution if and only if $d \mid c$, where $d = GCD(a, b)$. If x_0, y_0 is any particular solution then any solution of the given Diophantine equation is given by $x = x_0 + (\frac{b}{d})t$ and $y = y_0 - (\frac{a}{d})t$, for varying t. Solving simple examples.	[4L]

References:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.

- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.

Additional References:

- Introduction to theory of numbers by Niven and S. Zuckerman, Wiley Eastern.
- A survey of Modern Algebra by G. Birkoff and S. Maclane Mac Milan

Question paper Template

F.Y. B. Sc. (Mathematics) SEMESTER I
Core Course- II
COURSE TITLE: Discrete Mathematics
COURSE CODE: 21USIMTCC2DIS [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	2	8	10	-	-	-	20
II	2	8	10	-	-	-	20
III	2	10	3	5	-	-	20
IV	2	5	8	5	-	-	20
Total marks per objective	8	31	31	10	-	-	80
% Weightage	10%	38.75%	38.75%	12.5%	-	-	100

F. Y. B. Sc. (Mathematics)
SEMESTER I - Practical
COURSE CODE: 21USIMTCCP Credit- 02

Learning Objectives and Outcomes	
Learning Objectives The Practical is intended to: 1. Solve problems based on the concepts learnt 2. Apply the concepts in various situation	
Learning Outcomes After the successful completion of the practical, the learner will be able to: 1. Solve problems 2. Apply the results proved 3. Generate examples and counter examples	
Core Course I	Real Analysis-I
1. Real Numbers and their basic properties. 2. Sequence of Real numbers 3. Sub sequences and Cauchy Sequences over R 4. Series of real numbers	
Core Course II	Discrete Mathematics
5. Sets and relations 6. Functions 7. Natural numbers and Integers 8. Prime numbers and linear Diophantine equation	
References Course I: • R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd. • R. R. Goldberg; Methods of Real Analysis; Oxford and IBH. • Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.	

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- T. M. Apostol; Calculus (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education.
- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

References Course II:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.

Additional References:

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- A survey of Modern Algebra by G. Birkoff and S. Maclane Mac Milan

Question Paper Template

F.Y. B. Sc. (Mathematics) SEMESTER I
Core Course- II
COURSE TITLE Mathematics Practical
COURSE CODE: 21USIMTCCP [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5 (journal)	12	13 (includes viva)	8	8	4	50

II	5 (journal)	12	13 (includes viva)	8	8	4	50
Total marks per objective	10	24	26	16	16	8	100
% Weightage	10%	24%	26%	16%	16%	8%	100

F.Y. B. Sc. (Mathematics) SEMESTER II

Core Course- I

COURSE TITLE: Calculus -1

COURSE CODE: 21US2MTCCICAL[CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: CLO 1: Understand properties of functions by observing their behaviour through graphs of the function. CLO 2: Prove various results of limits and continuity using the $\varepsilon - \delta$ definition, sequences and their properties. CLO 3: Prove Chain rule, inverse function theorem, Leibnitz theorem and Mean value theorem. CLO 4: Apply Taylor's theorem to generate series of standard functions, to calculate approximations and to optimise. CLO 5: Apply results proved, concepts defined to solve problems. CLO 6: Classify functions as to the number of times it is differentiable.		
Module 1	Graphs of real valued functions of one variable	[6L]
Learning Objectives The aim of the module is to: 1. Plot graph of a real valued function 2. Observe the increasing and decreasing nature of graph of a function 3. Observe the concavity of graph of a function 4. Find the asymptotes of a function 5. Observe effect of multiplicity of roots of functions on its graph		

Learning Outcomes Learner will be able to: 1. Plot graphs of real valued functions 2. Identify various properties of function through graph such as increasing, decreasing nature, concavity 3. Find horizontal and vertical asymptotes of a function if it has any 4. Construct a function having a particular horizontal and vertical asymptote 5. Deduce whether multiplicity of a root of a polynomial is even or odd from its graph		
1.1	Real valued functions of one variable. Representation of such a function by its graph. Observing the increasing, decreasing nature, local extrema and global extrema, concavity of the graph and asymptotes.	[2L]
1.2	Examples including linear functions, Absolute value function, polynomial function of degree 2 and higher degrees. Observation that number of roots is less or equal to the degree of the polynomial, observations w.r.t. degree of polynomial and number of extrema, number of points of inflection. Graphs of trigonometric functions, inverse trigonometric functions, exponential function and logarithmic function. Floor function and ceiling function.	[2L]

1.3	Characteristic function of a set, Dirichlet's function. Effect of shifting the origin, composing with reflection, expansion or contraction along X-axis or Y-axis, observing graph of inverse function as reflection of graph of given function along the line y=x. Observing graph of function $f\left(\frac{1}{x}\right)$ from the graph of $f(x)$. Graphs of $y = sin\ sin\ \frac{1}{x}$, $x\ sin\ sin\ \frac{1}{x}$, $x^2\ sin\ sin\ \frac{1}{x}$ etc	[2L]

Reference books

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- Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
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- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Module 2	Limits and continuity of real valued functions of one variable	[9L]

Learning Objectives The aim of the module is to: 1. Understand the $\varepsilon - \delta$ definition of limit and continuity 2. Comprehend the equivalence of $\varepsilon - \delta$ definition of continuity with the sequential continuity 3. Study algebra of limits and continuity 4. Obtain limit of a function at a point		
Learning Outcomes Learner will be able to: 1. Use $\varepsilon - \delta$ definition as well definition in terms of sequences to find limit of a function 2. Use $\varepsilon - \delta$ definition of continuity as well as sequential continuity to prove the continuity or discontinuity of a function at a given point 3. Find left-hand and right-hand limit of a function 4. Construct functions having discontinuity at desired points		
2.1	Definition of limit of a function at a point in terms of ε - δ and sequence. Equivalence of both the definition. Uniqueness of limit. **(Self-Study)** Boundedness of a function having limit in a neighbourhood. Concept of two sided and one-sided limits. Infinite limit and limit at infinity.	**[2L]**
2.2	Sum rule, scalar multiplication, product rule and division rule. Sandwich theorem. Computations of limits using rules. Nonexistence of limit of functions such as $sin\ sin\ \frac{1}{x}$ Discussion on the three limits: $\frac{sinsin\,x}{x}$, $\frac{e^x-1}{x}$, $\frac{loglog\,(1+x)}{x}$ **(Self-Study submodule)**	**[3L]**
2.3	sequential continuity, Continuity of a function at a point in terms of limits. Continuity of a function over an interval, over a set.	**[4L]**

	Definition of continuity of a function at a point in terms of ε and δ. Algebra of continuous functions. Discontinuity of function such as $sin\frac{1}{x}$ at the origin, step function etc Polynomial functions are continuous. Function such as $\|x\|$, $x\|x\|$, $xsin\frac{1}{x}$, $x^2sin\frac{1}{x}$ etc are continuous Removable and irremovable discontinuities. Functions having finite number of discontinuities in an interval. Functions having infinite number of discontinuities in an interval. A function which is discontinuous everywhere. A function which is continuous only at a point. Composition of continuous functions and taking a limit inside a continuous function. Composite of continuous functions is continuous but converse is not true. Two important properties of Continuous functions: Intermediate value property and Continuous function on a closed and bounded interval attains it maximum value and minimum value. (Without proof)	

Reference books

- R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd.
- R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.
- Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.

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- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education.
- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Module 3	Differentiability of real valued functions of one variable	[9L]

Learning Objectives

The aim of the module is to:

1. Define differentiability of a function at a point
2. Study geometrical interpretation of derivative
3. Study algebra of differentiation
4. Prove chain rule and inverse function theorem
5. Find Higher derivatives of a function
6. Use Leibnitz rule of differentiation to find higher order derivatives
7. Study mean value theorems (Rolle's and Lagrange's)

Learning Outcomes

Learner will be able to:

1. Find derivative of a function
2. Apply Leibnitz rule to find higher derivatives of a function
3. Solve problems on implicit differentiation
4. Construct examples which are not differentiable at desired points
5. Calculate derivative of inverse of a function at a given point
6. Construct functions which are differentiable n times but not n+1 times at a point
7. Solve problems based on Rolle's and Lagrange's mean value theorem

3.1	Definition of differentiability of a real valued function of one variable at a point in terms of a limit.	[3L]

	Differentiability of a function over an interval or a set. Geometrical interpretation and derivative as a linear approximation in a neighbourhood of the point. Derivative as rate of change and Leibnitz notation.	
3.2	Differentiability implies continuity but not converse. Differentiability does not imply continuity over an interval. Algebra of derivatives. Chain rule of differentiation. Computation of derivative of inverse function. Implicit differentiation (problems only)	[3L]
3.3	Rolle's Mean Value Theorem Lagrange's Mean Value Theorem. Higher order derivatives and Leibnitz' rule. Function that are n times differentiable but not differentiable beyond n^{th} order.	[3L]

Reference books

- R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd.
- R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.
- Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
- Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real Analysis; Springer.

Additional Reference books:

- H. Anton, I. Bivens and S. Davis; Calculus; John Wiley and Sons, Inc
- G.B. Thomas and R.L. Finney; Calculus; Pearson Education.
- T. M. Apostol; Calculus (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education
- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Module 4	Applications of derivatives	[12L]

Learning Objectives

The aim of the module is to:

1. Obtain Taylor's polynomial and Taylor's series of a function about a point
2. Compute radius of convergence of a power series
3. Determine increasing and decreasing nature of a function using derivative
4. Determine concavity of a function using second derivative
5. Find extrema of a function using second and higher derivative test
6. Calculate limits using L'Hospital rule
7. Discuss real life problems based on application of derivative

Learning Outcomes

Learner will be able to:

1. Find Taylor's polynomial and Taylor's series of a function about a given point
2. Find radius of convergence of a function
3. Decide about increasing and decreasing nature of a function
4. Find point of inflection of a function
5. Find points of extrema of a function
6. Solve problems based on L'Hospital rule
7. Formulate word problems and solve them

4.1	Taylor's theorem in Lagrange's remainder form (without proof). Taylor polynomial of n^{th} order and Taylor's series about a point. Approximation of a n times differentiable function using Taylor's theorem.	**[6L]**
4.2	Increasing and decreasing functions. Concavity in terms of second derivative. Point of inflexion. Local extreme values. Second derivative test and its extension to test using higher order derivatives (without proof). L'Hospital's Rule (without proof) Curve sketching (only for practical)	**[6L]**

Reference books

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

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

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- G.B. Thomas and R.L. Finney; Calculus; Pearson Education.
- T. M. Apostol; Calculus (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Edu cation.
- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

Question Paper Template

F.Y. B. Sc. (Mathematics) SEMESTER II
Core Course- I
COURSE TITLE: Calculus -I
COURSE CODE: 21US2MTCC1CAL [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	2	8	3	3	-	-	16
II	2	8	5	-	-	5	20
III	2	8	5	-	5	-	20
IV	2	8	7	7	-	-	24
Total marks per objective	8	32	20	10	5	5	80
% Weightage	10%	40%	25%	12.5%	6.25%	6.25%	100

F.Y. B. Sc. (MATHEMATICS) SEMESTER II
Core Course- II
COURSE TITLE: Algebra - 1
COURSE CODE: 21US2MTCC2ALG [CREDITS - 02]

Course Learning Outcomes		
After the successful completion of the Course, the learner will be able to: CLO 1: Prove properties of congruences and Construct Z_n, U(n). CLO 2: Apply division algorithm and Rational root theorem to discuss irreducibility and roots of a polynomial. CLO 3: Apply algebraic properties of the set of Complex numbers to find the nth roots of a complex number and other related problems. CLO 4: Verify group axioms and associated properties on subgroups. CLO 5: Apply principles, results and definitions to solve problems.		
Module 1	**Congruences**	**[9L]**
Learning Objectives The learner should be able to 1. Apply the properties of congruence equations to solve examples 2. Apply various theorems related to congruence to solve problems		
Learning Outcomes At the end of the module, the learner will be able to 1. Use Euler's theorem and other results as tools to prove the divisibility tests and other results 2. Relate the knowledge of equivalence relations to introduce of Z_n		
1.1	Congruence: Definition and elementary properties, simple examples using algebraic properties.	[3L]
1.2	Euler phi-function (Totient) and examples. Fermat's little Theorem. Solving simple problems using these theorems. Euler's theorem (statement only)	[3L]

	Wilson's theorem. Simple problems. Decimal representation of an integer, Divisibility test for 3, 9 and 11, finding last digit.	
1.3	Introduction to $Z_n, U(n)$ addition and multiplication in Z_n, multiplicative inverse in Z_n (Whenever it exists). Set of units in Zn (U(n)) Solving equation in $Z_n, U(n)$	[3L]

References:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.
- complex numbers from A to Z by Dorin Andrica
- University Algebra by N. S. Gopalkrishnan, New Age International Ltd.

Additional References:

- Introduction to theory of numbers by Niven and S. Zuckerman, Wiley Eastern.
- A first course in Abstract Algebra by J. B. Fraleigh
- Contemporary Abstract Algebra by J. Gallian
- A survey of Modern Algebra by G. Birkoff and S. Maclane Mac Milan
- Complex variables and Application by Brown and Churchill McGraw Hill.

Module 2	Polynomials	[9L]

Learning Objectives

The learners should be able to:

1. Use various tools to find roots of a polynomial
2. Check if a polynomial is irreducible.

Learning Outcomes

At the end of the module the learner will be able to:

1. Determine whether a polynomial has a rational root
2. Differentiate reducibility of a polynomial over one set to another

2.1	Polynomials in one variable with real coefficients. Degree, leading coefficient and monic polynomial. Division Algorithm (without proof). G.C.D of two polynomials (Euclidean method)	[3L]
2.2	Root and factor of a polynomial, multiplicity of a root, Remainder Theorem, Factor Theorem. Rational root theorem. Factorization over Q	[3L]
2.3	Irreducible polynomial, Eisenstein's criteria (without proof). Number of real roots of nth degree polynomial is at most n. Reciprocal polynomial, Repeated root of a polynomial is also a root of its derivative. Relation between the roots and the coefficients of a polynomial. Examples.	[3L]

References:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.
- complex numbers from A to Z by Dorin Andrica
- University Algebra by N. S. Gopalkrishnan, New Age International Ltd.

Additional References:

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- Contemporary Abstract Algebra by J. Gallian
- A survey of Modern Algebra by G. Birkoff and S. Maclane Mac Milan
- Complex variables and Application by Brown and Churchill McGraw Hill.

Module 3	Complex numbers	[9L]

Learning Objectives The learner should be able to 1. Determine polar representation of a complex number 2. Appreciate the fact that an only linear polynomials are irreducible over complex number field C 3. Apply the concepts learnt to establish various properties		
Learning Outcomes At the end of the module, the learner is well equipped to 1. Prove properties of complex number field 2. Find n^{th} roots of any complex number 3. Apply Fundamental theorem of Algebra		
3.1	Review of a complex number, Polar representation. Argand diagram. Conjugate and its properties.	[2L]
3.2	Fundamental theorem of algebra (only statement). Complex roots of a Real Polynomial occur in conjugate pairs. Factorization of a real polynomial as a product of linear and quadratic polynomials over R. Odd degree polynomial has a real root. De-Moivre's Theorem. Roots of unity, primitive n^{th} roots of unity and associated properties. Roots of a complex number.	[7L]

References:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.
- complex numbers from A to Z by Dorin Andrica
- University Algebra by N. S. Gopalkrishnan, New Age International Ltd.

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- Complex variables and Application by Brown and Churchill McGraw Hill.

Module 4	Groups	[9L]

Learning Objectives

The learner should be able to

1. Use the knowledge acquired so far to test various group axioms
2. Apply the various properties of a group and its elements to solve problems

Learning Outcomes

At the end of the module, the learner will be able to

1. Determine whether the given set forms a group under the indicated operation
2. Verify other properties in the given group

4.1	Group; definition and simple examples like $\mathbb{Q}$, $\mathbb{R}$ under addition, the group of nth roots of unity. The group Z_n under addition. Verification of Z_n^* being a group under multiplication. Abelian and non-abelian groups. Order of a group, order of elements of a group.	[2L]
4.2	Subgroup, Necessary and sufficient condition for a subset to be a subgroup. Testing whether $xHx^{-1} = H$ for a given x in the group G and $H < G$.	[2L]
4.3	Permutation group: Permutations on n symbols. The group S_n under composition and $o(S_n) = n!$ Cycles and transpositions, representations of a permutation as a product of disjoint cycles, and as product of transposition (only through examples). Listing permutations in the group S_3, S_4 etc. Sign of a permutation, odd and even permutations (Statement only). A_n, the alternating subgroup of S_n.	[2L]

	The group D_n of symmetry of a regular polygon for n=3 & 4.	
4.4	Partition of a positive integer, its relation to decomposition of a permutation as product of disjoint cycles, Conjugate of an element in a group.	[2L]
4.5	Solving equations in a group.	[1L]

References:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.
- complex numbers from A to Z by Dorin Andrica
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- A survey of Modern Algebra by G. Birkoff and S. Maclane Mac Milan
- Complex variables and Application by Brown and Churchill McGraw Hill.

Question Paper Template
F.Y. B. Sc. (Mathematics) SEMESTER II
Core Course- II
COURSE TITLE: Algebra - I
COURSE CODE: 2IUS2MTCC2ALG[CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	2	8	10	-	-	-	20
II	2	8	10	-	-	-	20
III	2	10	3	5	-	-	20

IV	2	5	8	5	-	-	20
Total marks per objective	8	31	31	10	-	-	80
% Weightage	10%	38.75%	38.75%	12.5%	-	-	100

F. Y. B. Sc. (Mathematics)
SEMESTER II - Practical
COURSE CODE: 21US2MTCCP Credit- 02

Learning Objectives and Outcomes	
Learning Objectives The practical is intended to 1. Learn Problem solving skills 2. Apply results proved 3. Create examples and counter examples	
Learning Outcomes After the successful completion of the practical, the learner will be able to: 1. Solve problems based on the concepts learnt 2. Apply results proved 3. Generate examples and counter examples	
Core Course I	**Calculus - I**
1. Graphs of real valued functions of one variable 2. Limits and continuity of real valued functions of one variable 3. Differentiability of real valued functions of one variable 4. Applications of derivatives. Curve sketching.	
Core Course II	**Organic preparation**
5. Congruences 6. Polynomials 7. Complex Numbers 8. Group theory	

References course I:

- R.G. Bartle and D. R Sherbert; Introduction to Real Analysis; John Wiley and Sons (Asia) P.Ltd.
- R. R. Goldberg; Methods of Real Analysis; Oxford and IBH.
- Ajit Kumar, S. Kumaresan; A Basic Course in Real Analysis; CRC Press.
- Ghorpade, Sudhir R., Limaye, Balmohan V.; A Course in Calculus and Real Analysis; Springer.

Additional Reference books:

- H. Anton, I. Bivens and S. Davis; *Calculus*; John Wiley and Sons, Inc.
- G.B. Thomas and R.L. Finney; *Calculus*; Pearson Education.
- T. M. Apostol; *Calculus* (Vol. I); John Wiley and Sons (Asia) P. Ltd.
- W. Rudin; Principles of mathematical Analysis; Tata McGraw- Hill Education.
- Maron; Calculus of one variable.
- Shanti Narayan and Raisinghania; Elements of Real Analysis; S. Chand

References course II:

- Discrete Mathematics by Norman L. Biggs, Clarendon Press.
- Elementary Number theory by David Burton Seventh Edition, McGraw Hill Education (India) Pvt Ltd.
- complex numbers from A to Z by Dorin Andrica
- University Algebra by N. S. Gopalkrishnan, New Age International Ltd.

Additional References:

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Question Paper Template

F.Y. B. Sc. (Mathematics) SEMESTER I
Core Course- II
COURSE TITLE Mathematics Practical
COURSE CODE: 21USIMTCCP [CREDITS - 02]

Module	Remembering/ Knowledge	Understanding	Applying	Analysing	Evaluating	Creating	Total marks
I	5 (journal)	12	13 (includes viva)	8	8	4	50
II	5 (journal)	12	13 (includes viva)	8	8	4	50
Total marks per objective	10	24	26	16	16	8	100
% Weightage	10%	24%	26%	16%	16%	8%	100

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.

I) The lectures (of fifty minutes duration) are 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.
4) There will be a blend of online and offline teaching and learning.

9. Assessment Methods

Evaluation Pattern: Theory

- Assessments are divided into two parts: Continuous Internal Assessment (CIA) & Semester End Examination.
- The Semester End Examination shall be conducted by the college at the end of each semester.
- Semester End Examination (external) (60 M)- Duration:
  2 hours Paper Pattern

Guidelines about conduct of Projects/Case Study.

Projects/ Case Study/ Book Review:
Conduct and Evaluation: A learner can submit a project/ Case Study/ do a Book review. The project should be 10-page typed pages in an A4 size paper with font size of 12. The topic of project should be selected in consultation of the teacher. **Maximum marks allotted for this is 20 and the remaining 20 marks are from tests and other activities.**

The topic can be of expository / historical survey / interdisciplinary nature and the material covered in the project / case study should go beyond the scope of the syllabus. The learner must clearly mention the sources (Book / on-line) used for the project/ case study. The use of Mathematical software is encouraged. The project should be done under the supervision of a faculty in a college/ university or an institution.

The following Marking scheme is suggested for evaluation of projects / case study:

30% marks for exposition
20% marks for literature
20% marks for Scope
10% marks for originality
20% marks for presentation.

Continuous evaluation:

Internal evaluation (40%):

1. There will be 40 marks continuous evaluation.
2. A learner can be assigned projects/book review, this will be evaluated out of 20 marks.
3. The project / book review will be under the guidance of the mentor allotted to the learners by the head of the department.
4. There will be regular tests which can be of the form quiz/ descriptive test/ objective test/ group discussion presentation etc.
5. Each test will be marked out of 20 marks.
6. The total score obtained in all of the above will finally be averaged to 40 marks.
7. A learner should secure at least 40% marks to be eligible to get a passing grade (The learner needs to secure minimum of 16 marks out of 40 to pass the internal for each theory course).
8. A learner who has failed to secure a passing grade /absent for any reason in the internal evaluation will have to give test out of 40 marks, consisting of Questions based on the entire syllabus.
9. All tests will be averaged to 25 marks, other activities averaged to 15 marks.

Semester end Examination (60%):

At the end of the semester there will be a semester end exam carrying a maximum of 60 marks.

1. There will be 4 Questions one from each Module. Each question will carry 15 marks unless otherwise stated in the syllabus (with option, maximum of 25 marks). The question paper will cover the whole syllabus in such a way that

a learner will need to have understood each topic well to have secured 80% and above and an average learner can at least secure a passing grade.

2. A learner should secure at least 40% marks to be eligible to get a passing grade (The learner needs to secure minimum of 24 marks out of 60 to pass the semester end examination for each theory course).

Practical examination

3. Practical Examination out of 100 marks will be conducted based on the theory courses.
4. 40% evaluation will be based on continuous evaluation and balance 60% will be Semester end examination.
5. Certified Journal will be part of internal evaluation.
6. Internal evaluation will be based on experiential learning such as preparing Mathematical model/ Games/quizzes, Applying Concepts learnt in other areas of mathematics or other Sciences, Presentations.
7. Contribution during Cooperative/Participative learning will be evaluated during regular practical. No prior intimation will be given.
8. Semester end examination of the Practical examination will be descriptive and will be based on the entire syllabus of both theory courses.

Distribution of marks for practical examination out of 100. (Corresponding modification for exam conducted out of 150 marks)

Mathematical Subject

	Course 1	Course 2	Total
	Internal Continuous Assessment		
Objective questions	6	6	12
Journal	5	5	10
Viva	5	5	10

Modelling	4	4	8
Total	20	20	40
	Semester end descriptive problem solving		
Comprehension type	6	6	12
Application type	8	8	16
Analysis type	8	8	16
Evaluation/Creating type	8	8	16
Total	30	30	60

For Computer programming courses		
	Internal Continuous Assessment	
	Project	20%
	Making modifications/writing the required statements as per constraints given/new. (Includes viva)	15%
	Journal	5%
	Total	40
	Semester end practical examination	
		Marks
Writing programs (3 programs)	Applying it to mathematical Concepts learnt (creating kind)	25%
	Understanding type	10%
	Applying type	10%

	Compiling and execution	5%
	Correcting errors and obtaining output	10%
	Total	60

Examination for unsuccessful learners (Termed as ATKT examination)

9. Internal examination will be a test conducted out of 40 marks based on the entire syllabus. It will be written test/ online test as per the situation. Details of the pattern etc will be uploaded in the noticeboard section of our website kjssc.somaiya.edu
10. Semester Exam will have the same paper pattern as the regular exam. (Subject to change.)
11. Internal Component of the Practical Examination (40%) will be objective based examination. This will include journal marks (only Certified Journal will be eligible for marks)
12. Notice regarding syllabus will be uploaded in the noticeboard section in our website.

10. Programme 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 (21- year of implementation is 2021-22)
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 21USIMT. For the further course codes programme code is amended as follows
5. To designate the semester, add the digit (1-6) after S in the programme code. (Eg: 21USIMT- for semester I)
   For the further course codes, addition to the programme code should be done as per the following instructions.
6. To represent core courses (CC) 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, (AE) alphabets followed by a digit (1/2) followed by 'FOC'- Foundation course, 'EVS'-Environmental science are used.
8. For Skill enhancement courses code (SE) followed by digits (1/2/3) followed by letters 'STP'-Sports training programme, BCE-Basic Communication in English 'ICH'-Indian cultural heritage, followed by digits (1/2/3) representing the levels

are used. In case of subject related SEC, (SE) followed by digits (1/2/3) followed by a three lettered code representing the title of the course are used.

9. For Discipline specific elective course (DS) of Semester V and VI, (DS) followed by digits (1/2/3/4) followed by a three lettered code representing the title of the course are used.
10. 'P' followed by digit indicates practical course number. (Practical course number will be added for semesters only where there is more than one course.
