CENTRAL UNIVERSITY OF HARYANA

(*Established under the Central Universities Act, 2009*)

(NAAC Accredited 'A' Grade)

Curriculum and Syllabi

Integrated B.Sc.-M.Sc. (Mathematics)

(w.e.f. 2021-2022)

DEPARTMENT OF MATHEMATICS

SCHOOL OF BASIC SCIENCES

Approved by :	**BOS**	**School Board**	**Academic Council**
Approval Status :	√	√	√
Approval Date :	04/09/2021	20/09/2021	12.10.2021

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VISION AND MISSION

Vision and Mission of the University

Vision

To develop enlightened citizenship of a knowledge society for peace and prosperity of individuals, nation and the world, through promotion of innovation, creative endeavor's and scholarly inquiry.

Mission

To serve as a beacon of change, through multi-disciplinary learning, for creation of knowledge community, by building a strong character and nurturing a value-based transparent work ethics, promoting creative and critical thinking for holistic development and self-sustenance for the people of India. The University seeks to achieve this objective by cultivating an environment of excellence in teaching, research and innovation in pure and applied areas of learning.

Vision and Mission of the Department

Vision

To be an internationally recognized centre for research and teaching in mathematics. To encourage excellence, innovation, integrity and values for society in the department. To produce global leaders for academic and industry by imparting multidisciplinary and contemporary mathematical knowledge to the students.

Mission

- To contribute towards building calibre of the students by providing quality education and research in Mathematics through updated curriculum, effective teaching learning process.
- To impart innovative skills, team-work, ethical practices to the students so as to meet societal expectations.
- To build a strong base in Mathematics for various academic programs across the institute.

1. Background

i) Preamble

Mathematics is a fundamental part of human thoughts and logic, and Integral to attempts at understanding the world and ourselves. Mathematics, as we all know, provide an effective way of building mental discipline and encourages logical reasoning. In addition, mathematical knowledge plays a vital role in understanding the contents of others subjects such as Basic Sciences, Social sciences and in Music and Art. This has been argued and established that there can't be a nation without mathematics. Today, more than ever before, the challenges of globalization and digitalization obligate mathematicians and researchers to go beyond the local, national, and even continental frontiers of their knowledge.

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of Central University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in 32nd meeting of the Academic Council of the University held on April 23, 2021. The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms. At the outset, it may well be stated that NEP 2020 document owes it origin to meet the fundamental challenges of ever changing academics scales at Global level. Thus, a high priority task in the context of future education development agenda in India is fostering quality higher education. The idea is to involve young minds in knowledge production and of greater participation of knowledge itself. Participation in knowledge, by young minds, is an important departure from the existing structure at undergraduate level. Implementation of new structure is based on guiding principles of Learning Outcome based Curriculum Framework (LoCF). The fundamental premise underlying the learning outcome based approach to curriculum planning and development is that higher education qualifications such as Bachelor-Master integrated degree programme are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected of Graduate-Master of a programme of study. The LOCF approach is

envisioned to provide a focused, outcome-based syllabus at the Bachelor-Master integrated with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen student's experiences as they engage themselves in the programme of their choice. The Graduate-Master programme will prepare the students for academia and also prepare them to use this knowledge for employment. The given programme elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programme also state the attributes that it offers to inculcate at the graduation level. The Bachelor-Master integrated attributes encompass values related to wellbeing, emotional stability, critical thinking, and also skills for employability. The programme prepares students for sustainability and lifelong learning. This also tries to change the perception towards studying mathematics. This course is designed to break the stereotypes of mathematics learning and create interest amongst students to do Mathematics. This programme is organized to provide the greatest flexibility to its students. There are Core Disciplinary papers that provide the fundamental knowledge in the discipline of mathematics. The programme is otherwise envisaged to provide a large amount of choice so that students can adapt their education on the basis of their interests. These provide not just mathematical knowledge and skills but also a vital skill in other disciplines as well.

Flexible learning is important to choose one's academic pathway leading to the award of certificate, diploma, and degree. The multiple entry exit will be according to the UGC guidelines and University ordinances.

ii) Introduction:

The objective of this programme is to prepare the students with a new vision. One of the significant reforms in integrated B.Sc.-M.Sc. (Mathematics) programme is to introduce the Learning Outcomes-based Curriculum Framework (LOCF) which makes it student-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. The learning outcomes will be attained by students through skills acquired during this programme of study. Programme learning outcomes will include subject-specific skills and generic skills, including transferable global skills and competencies. This

programme would also focus on knowledge and skills that will prepare students for employment, and for further studies.

The quality education in mathematics is very challenging task for higher education system in India. In designing this course we have taken appropriate measures to define the minimum levels of learning for students in integrated B.Sc.-M.Sc. (Mathematics) programme. The given programme elaborates its nature and promises the outcomes that are to be accomplished by studying the courses. The programme also state the attributes that it offers to inculcate at the different levels. It is designed to bring out the best intellect of the student and also allow the student to keep pace with the contemporary development.

The Integrated B.Sc.-M.Sc. (Mathematics) programme offers student's access to Core Courses, Ability Enhancement Compulsory Courses, Skill Enhancement Courses, Discipline Specific Electives and Generic Electives. The Programme-learning outcomes and course learning outcomes have been clearly specified to help prospective students, parents and employers understand the nature and extent of the degree programme; to maintain national and international standards, and to help in student mobility.

iii) Learning Outcomes Based Approach to Curriculum Planning:

The learning outcomes-based curriculum framework for Integrated B.Sc.-M.Sc. (Mathematics) programme is based on the expected learning outcomes and graduate-master attributes that a graduate-master in mathematics is expected to attain. The curriculum for Integrated B.Sc.-M.Sc. (Mathematics) programme is prepared keeping in mind the needs and aspirations of students in mathematics as well as the evolving nature of mathematics as a subject. The course learning outcomes and the programme learning outcomes specify the knowledge, understanding, skills, attitudes and values that a student completing this degree is expected to know. The qualification of Integrated B.Sc.-M.Sc. (Mathematics) programme is awarded to a student who can demonstrate the attainment of these outcomes.

iv) Nature and Extent of the Integrated B.Sc.-M.Sc. (Mathematics) Programme:

The Integrated B.Sc.-M.Sc. (Mathematics) is of five years duration. Each year is divided into two semesters. The total numbers of semester are ten and it is presumed that each semester will be of eighteen weeks duration. The teaching and learning in the Integrated B.Sc.-M.Sc. (Mathematics) will involve theory classes (lectures), practical classes and tutorial classes.

Mathematics is usually described as the abstract science of number, quantity and space along with their operations. The scope of Mathematics is very broad and it has a wide range of applications in natural sciences, engineering, economics, social sciences and in data science. Integrated B.Sc.-M.Sc. (Mathematics) programme aims at developing the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life. Pursuing a degree in mathematics will introduce the students to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector and industry. The Integrated B.Sc.-M.Sc. (Mathematics) programme covers the full range of mathematics, from classical Calculus to Modern Cryptography, Information Theory, and Network Security. The course lays a structured foundation of Calculus, Real & Complex analysis, Abstract Algebra, Differential Equations (including Mathematical Modelling), Number Theory, Graph Theory, and C++ Programming exclusively for Mathematics. An exceptionally broad range of topics covering Pure & Applied Mathematics: Linear Algebra, Metric Spaces, Statistics, Linear Programming, Numerical Analysis, Mathematical Finance, Coding Theory, Mechanics and Biomathematics cater to varied interests and ambitions. Also hand on sessions in Computer Lab using various Computer Algebra Systems (CAS) softwares such as Maple, Mathematica, MATLAB, Maxima and R to have a deep conceptual understanding of the above tools are carried out to widen the horizon of students' self experience. The courses like Biomathematics, Mathematical Finance etc. emphasize on the relation of mathematics to other subjects like Biology, Economics and Finance. To broaden the interest for interconnectedness between formerly separate disciplines one can choose from the list of Generic electives for example one can opt for economics as one of the GE papers. Skill enhancement Courses enable the student acquire the skill relevant to the main subject. Choices from Discipline Specific Electives provides the student with liberty of exploring his interests within the main subject. The key importance is the theme of integrating mathematical and professional skills. The well structured programme empowers the student with the skills and knowledge leading to enhanced career opportunities in industry, commerce, education, finance and research.

2. Aims of Integrated B.Sc.-M.Sc. (Mathematics) programme:

The overall aims of Integrated B.Sc.-M.Sc. (Mathematics) programme are follows:

i) Inculcate strong interest in learning mathematics and have balanced knowledge for understanding of definitions, key concepts, principles and theorems in mathematics.

ii) Enable students to apply the knowledge and skills acquired by them during the programme to solve problems in mathematics.

iii) Train students to communicate mathematical ideas in a lucid and effective manner, which will be helpful in wage employment, self-employment and entrepreneurship.

iv) Provide students with sufficient knowledge and skills that enable them to undertake research in different fields of mathematics and related disciplines.

v) To encourage the use of relevant software such as MATLAB, Maple, R and MATHEMATICA.

3. Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)

Program Outcomes:

Students enrolled in the integrated B.Sc.-M.Sc. Programmes offered by the Departments under the School of Basic Sciences will have the opportunity to learn and master the following components in addition to attain important essential skills and abilities:

PO-No.	Component	Outcomes
PO-1	Basic Knowledge	Capable of delivering basic disciplinary knowledge gained during the programme.
PO-2	In-depth Knowledge	Capable of describing advanced knowledge gained during the programme.
PO-3	Critical thinking and Problem Solving abilities	Capable of analyzing the results critically and applying acquired knowledge to solve the problems.
PO-4	Creativity and innovation	Capable to identify, formulate, investigate and analyze the scientific problems and innovatively to design and create products and solutions to real life problems.
PO-5	Research aptitude and global competency	Ability to develop a research aptitude and apply knowledge to find the solution of burning research problems in the concerned and associated fields at global level.
PO-6	Holistic and multidisciplinary education	Ability to gain knowledge with the holistic and multidisciplinary approach across the fields.
PO-7	Skills enhancement	Learn specific sets of disciplinary or multidisciplinary

		skills and advanced techniques and apply them for betterment of mankind.
PO-8	Leadership and Teamwork abilities	Ability to learn and work in a groups and capable of leading a team even.
PO-9	Environmental and human health awareness	Learn important aspects associated with environmental and human health. Ability to develop eco-friendly technologies.
PO-10	Ethical thinking and Social awareness	Inculcate the professional and ethical attitude and ability to relate with social problems.
PO-11	lifelong learning skills and Entrepreneurship	Ability to learn lifelong learning skills which are important to provide better opportunities and improve quality of life. Capable to establish independent startup/innovation center etc.

Programme Specific Outcomes (PSOs):

On completion of Integrated B.Sc.-M.Sc. (Mathematics) Programme a student**:**

Number	**Programme Specific Outcomes**
PSO-1	Will have a strong foundation in both pure and applied mathematics.
PSO-2	Will be able to apply mathematical skills for solving problems and for preparing various competitive exams.
PSO-3	Will be able to communicate mathematical knowledge effectively, in writing as well as orally.
PSO-4	Will identify applications of mathematics in other disciplines, leading to enhancement of career prospects in different fields and research areas.
PSO-5	Will have basic knowledge of programming and computational techniques as required for employment.
PSO-6	Should have the knowledge of the fundamental axioms in mathematics and capability of developing ideas based on them and inculcate mathematical

	reasoning.
PSO-7	Will be able to locate and analyse the different mathematical texts with appropriate theoretical framework.
PSO-8	Have the knowledge of a wide range of mathematical techniques and application of mathematical methods/tools in science, social science, engineering and technology.
PSO-9	Should be able to develop analytical skills, critical thinking, creativity, communication and presentation skills through assignments, seminar and project work.
PSO-10	Should be able to apply their skills and knowledge that translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.

4. Integrated B.Sc.-M.Sc. (Mathematics) Attributes:

On completion of the course students are expected to have acquired the skills of multi dimensional thinking, analytical reasoning, rational enquiry, problems solving, effective communication, and exploring the different areas of pure and Applied mathematics. The attributes expected from the students of Integrated B.Sc.-M.Sc. (Mathematics) Programme are as:

a. **Disciplinary Knowledge**: Capability of demonstrating comprehensive knowledge of basic concepts and ideas in mathematics and its subfields, and its applications to other disciplines.

b. **Communications skills:** Ability to communicate various concepts of mathematics in effective and coherent manner both in writing and orally, ability to present the complex mathematical ideas in clear, precise and confident way.

c. **Multidimensional thinking and analytical reasoning:** Ability to apply multidimensional thinking in understanding the concepts in mathematics and allied areas; identify relevant assumptions, hypothesis, implications or

conclusions; formulate mathematically correct arguments; ability to analyse and generalise specific arguments or empirical data to get broader concepts.

d. **Problem solving**: Be able to apply mathematical skills and logical reasoning for solving different kinds of non-familiar problems. Capability to solve problems in computer graphics using concepts of linear algebra; linear programming, C, C++, Matlab, Maple and Mathematica. Capability to apply the knowledge gained from different areas of mathematics to solve specific problems or models in operations research, physics, chemistry, electronics, medicine, economics, finance etc.

e. **Research-related skills**: Capability to ask and inquire about relevant/appropriate questions, ability to define problems, formulate hypotheses, test hypotheses, formulate mathematical arguments and proofs, draw conclusions; ability to write clearly the results obtained.

f. **Self-directed learning**: Ability to work independently, ability to search relevant resources, capability to use ICT tools and e-content for self-learning and enhancing knowledge in mathematics.

g. **Moral and ethical awareness**: Ability to identify unethical behavior such as fabrication or misrepresentation of data, committing plagiarism, infringement of intellectual property rights.

h. **Employment**: Have sound knowledge of mathematical modelling, programming and computational techniques as required for employment in industry.

5. Qualification Descriptors for Integrated B.Sc.-M.Sc. (Mathematics) (Possible Career Pathways):

Students who choose Integrated B.Sc.-M.Sc. (Mathematics) programme, develop the ability to think critically, logically and analytically and hence use mathematical reasoning in everyday life. Pursuing a degree in mathematics will introduce the students to a number of interesting and useful ideas in preparations for a number of mathematics careers in education, research, government sector, business sector, entrepreneurship and industry. The key importance is the theme of integrating mathematical and professional skills. The well-structured programme empowers the student with the skills and knowledge leading to enhanced career opportunities in industry, commerce, education,

finance and research. The qualification descriptors for Integrated B.Sc.-M.Sc. (Mathematics) programme may include the following:

i. Demonstrate fundamental/systematic and coherent knowledge of the academic field of mathematics and its applications and links to engineering, science, technology, economics and finance; demonstrate procedural knowledge that create different professionals like teachers and researchers in mathematics, quantitative analysts, actuaries, risk managers, professionals in industry and public services.

ii. Demonstrate educational skills in areas of analysis, geometry, algebra, mechanics, differential equations etc.

iii. Demonstrate comprehensive knowledge about materials, including scholarly, and/or professional literature, relating to essential learning areas pertaining to the field of mathematics, and techniques and skills required for identifying mathematical problems.

iv. Apply the acquired knowledge in mathematics and transferable skills to new/unfamiliar contexts and real-life problems.

v. Demonstrate mathematics-related and transferable skills that are relevant to some of the job trades in education sector, entrepreneurship and employment opportunities.

6. Structure of integrated B.Sc.-M.Sc. (Mathematics) Programme:

The Integrated B.Sc.-M.Sc. (Mathematics) programme is a five year course divided into 10 semesters. A student is required to have complete the credit as per University ordinance and UGC guidelines. The scheme and syllabus of the course are subject to change according to the UGC guidelines, NEP 2020 and University ordinance.

Duration: Integrated B.Sc.-M.Sc. (Mathematics) program is a full-time integrated program offered by the Department of Mathematics. This is a 5-years program, consisting of ten semesters with two semesters per year.

Eligibility: 10+2 in Science Streams or equivalent of any recognized board in India with Mathematics as one of the optional subjects having minimum 50% marks or equivalent grade in aggregate for UR category and 45% or equivalent grade for SC/ST/OBC/PWD/EWS candidates.

7. Course Type

Core Courses (CC)

Generic Elective Courses (GEC)

Discipline Specific Elective Courses (DSEC)

Skill Enhancement Courses (SEC)

Ability Enhancement Compulsory Courses (AECC)

Total Credit: Semester-wise distribution of credits: 22+ 22+ 28 + 28+24+24

CORE COURSES (CC)

S.No.	Course code	Course title	L	T	P	Credit
1.	SBSMAT 03 01 01 C 4046	Calculus (P)	4	0	4	6
2.	SBSMAT 03 01 02 C 5106	Algebra	5	1	0	6
3.	SBSMAT 03 02 01 C 5106	Real Analysis	5	1	0	6
4.	SBSMAT 03 02 02 C 4046	Differential Equations (P)	4	0	4	6
5.	SBSMAT 03 03 01 C 5106	Theory of Real Functions	5	1	0	6
6.	SBSMAT 03 03 02 C 5106	Group Theory I	5	1	0	6
7.	SBSMAT 03 03 03 C 4046	Partial Differential Equations and System of ODE (P)	4	0	4	6
8.	SBSMAT 03 04 01 C 4046	Numerical Methods (P)	4	0	4	6
9.	SBSMAT 03 04 02 C 5106	Riemann Integration and Series of Functions	5	1	0	6
10.	SBSMAT 03 04 03 C 5106	Ring Theory and Linear Algebra I	5	1	0	6
11.	SBSMAT 03 05 01 C 5106	Multivariate Calculus	5	1	0	6
12.	SBSMAT 03 05 02 C 5106	Group Theory II	5	1	0	6
13.	SBSMAT 03 06 01 C 5106	Metric Spaces and Complex Analysis	5	1	0	6
14.	SBSMAT 03 06 02 C 5106	Ring Theory and Linear Algebra II	5	1	0	6

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)

(Offered to the Students of Integrated B.Sc.-M.Sc. (Mathematics) by the Department)

S.No.	Course code	Course title	L	T	P	Credit
1.	SBSMAT 03 05 01 DSE 5106	Portfolio Optimization	5	1	0	6
2.	SBSMAT 03 05 02 DSE 5106	Theory of Equations	5	1	0	6
3.	SBSMAT 03 05 03 DSE 5106	Analytical Geometry	5	1	0	6
4.	SBSMAT 03 05 04 DSE 5106	Industrial Mathematics	5	1	0	6
5.	SBSMAT 03 05 05 DSE 5106	Boolean Algebra and Automata Theory	5	1	0	6
6.	SBSMAT 03 05 06 DSE 5106	Probability and Statistics	5	1	0	6
7.	SBSMAT 03 06 01 DSE 5106	Linear Programming	5	1	0	6
8.	SBSMAT 03 06 02 DSE 5106	Discrete Mathematics	5	1	0	6
9.	SBSMAT 03 06 03 DSE 5106	Bio-Mathematics	5	1	0	6
10.	SBSMAT 03 06 04 DSE 4046	Mathematical Modeling	5	1	0	6
11.	SBSMAT 03 06 05 DSE 5106	Mechanics	5	1	0	6
12.	SBSMAT 03 06 06 DSE 5106	Differential Geometry	5	1	0	6

GENERIC ELECTIVE COURSE (GEC)

(Offered to Integrated B.Sc.-M.Sc. Programme of others Departments only)

S. No.	Course code	Course title	L	T	P	Credit
1.	SBSMAT 03 01 01 GE 4046	Object Oriented Programming in C++(P)	4	0	4	6
2.	SBSMAT 03 01 02 GE 5106	Finite Element Methods	5	1	0	6
3.	SBSMAT 03 01 03 GE5106	Algebra	5	1	0	6
4.	SBSMAT 03 02 01 GE 5106	Econometrics	5	1	0	6
5.	SBSMAT 03 02 02 GE 5106	Mathematical Finance	5	1	0	6
6.	SBSMAT 03 02 03 GE 5106	Real Analysis	5	1	0	6
7.	SBSMAT 03 03 01 GE 5106	Cryptography and Network Security	5	1	0	6
8.	SBSMAT 03 03 02 GE 5106	Information Security	5	1	0	6
9.	SBSMAT 03 03 03 GE 5106	Theory of Real Function	5	1	0	6
10.	SBSMAT 03 04 01 GE 5106	Applications of Algebra	5	1	0	6
11.	SBSMAT 03 04 02 GE 5106	Combinatorial Mathematics	5	1	0	6
12.	SBSMAT 03 04 03 GE 4046	Numerical Method	4	0	4	6

Note: Any MOOCs course for PG students on SWAYAM can also be taken as DCEC or GEC course on the recommendations of the department.

Ability Enhancement Compulsory Courses (AECC)*:

S. No	Course Code	Course Title	L	T	P	Credit
1.	SBSMAT 03 01 01 AECC 3104	Environmental Sciences	3	1	0	4
2.	SBSMAT 03 01 02 AECC 3104	प्राचीनभारतीयसंस्कृतिः, दर्शनं भाषाविज्ञानं च (1)	3	1	0	4
3.	SBSMAT 03 02 01 AECC 3104	: हिंदी भाषा : रचना एवं व्यवहार	3	1	0	4
4.	SBSMAT 03 02 02 AECC 3104	English	3	1	0	4

SKILL ENHANCEMENT ELECTIVE COURSES (SEEC)*:

The department may offer more than one courses depending on specialization and strength of faculty members, and the student has to opt one among the following.

S. No	Course Code	Course Title	L	T	P	Credit
1.	SBSMAT 03 03 01 SEC 3104	Logic, Sets and Graph Theory	3	1	0	4
2.	SBSMAT 03 03 02 SEC 3024	Computer fundamental and Programming in C	3	0	2	4
3.	SBSMAT 03 04 01 SEC 3024	Object Oriented Programming in C++(P)	3	0	2	4
4.	SBSMAT 03 04 02 SEC 3104	Operating System: Linux and Computer Graphic	3	1	0	4

*** 1. University/Department may add more choices for Ability Enhancement Compulsory and Skill Enhancement Elective Courses.**

2. Two AEEC courses (Environmental Sciences and English/MIL) will be taught in first two semesters according to the availability of the faculty members in respective departments.

SEMESTER-WISE COURSES AND CREDIT DISTRIBUTION

Scheme and Syllabus of Integrated B.Sc.-M.Sc. in Mathematics

(CHOICE BASED CREDIT SYSTEM)

Semester I

Total credits: 22

S. No.	Course Title	Course Code	L	T	P	Credits
1	Calculus (P)	SBSMAT 03 01 01 C 4046	4	0	4	6
2	Algebra	SBSMAT 03 01 02 C 5106	5	1	0	6
3	AECC1		3	1	0	4
4	GE -1		5	1	0	6

Semester II

Total credits: 22

S. No.	Course Title	Course Code	L	T	P	Credits
1	Real Analysis	SBSMAT 03 02 01 C 5106	5	1	0	6
2	Differential Equations (P)	SBSMAT 03 02 02 C 4046	4	0	4	6
3	AECC2		3	1	0	4
4	GE -2		5	1	0	6

Semester III

Total credits: 28

S. No.	Course Title	Course Code	L	T	P	Credits
1	Theory of Real Functions	SBSMAT 03 03 01 C 5106	5	1	0	6
2	Group Theory I	SBSMAT 03 03 02 C 5106	5	1	0	6
3	Partial Differential Equations and System of ODE (P)	SBSMAT 03 03 03 C 4046	4	0	4	6
4	SEC1		3	1	0	4
5	GE 3		5	1	0	6

Semester IV

Total credits: 28

S. No.	Course Title	Course Code	L	T	P	Credits
1	Numerical Methods (P)	SBSMAT 03 04 01 C 4046	4	0	4	6
2	Riemann Integration and Series of Functions	SBSMAT 03 04 02 C 5106	5	1	0	6
3	Ring Theory and Linear Algebra I	SBSMAT 03 04 03 C 5106	5	1	0	6
4	SEC2		3	1	0	4
5	GE 4		5	1	0	6

Semester V

Total credits: 24

S. No.	Course Title	Course Code	L	T	P	Credits
1	Multivariate Calculus	SBSMAT 03 05 01 C 5106	5	1	0	6
2	Group Theory II	SBSMAT 03 05 02 C 5106	5	1	0	6
3	DSE 1		5	1	0	6
4	DSE 1		5	1	0	6

Semester VI

Total credits: 24

S. No.	Course Title	Course Code	L	T	P	Credits
1	Metric Spaces and Complex Analysis	SBSMAT 03 06 01 C 5106	5	1	0	6
2	Ring Theory and Linear Algebra II	SBSMAT 03 06 02 C 5106	5	1	0	6
3	DSE 3		5	1	0	6
4	DSE 4		5	1	0	6

8. COURSE-LEVEL LEARNING OUTCOMES

Course Structure

SEMESTER – I

<table>
<tr><td>Course No: 1</td><td colspan="3">Course Name: Calculus (P)</td><td colspan="3">Course Code:
SBSMAT 03 01 01 C 4046</td></tr>
<tr><td rowspan="2">Batch:

2021-2026</td><td rowspan="2">Programme:

Integrated B.Sc.-M.Sc. (Mathematics)</td><td>Semester:</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td>Contact Hrs per Week: 6</td></tr>
<tr><td>I</td><td>4</td><td>0</td><td>4</td><td>6</td><td>Total Hours: 90</td></tr>
<tr><td colspan="2">Total Evaluation Marks:
100

CIE:
TEE:</td><td colspan="6">Examination Duration: 3 hours

Pre-requisite of course: Nil</td></tr>
<tr><td>Course Objective</td><td colspan="7">The course objective is to understand the axiomatic foundation of the real number system, in particular the notion of completeness and some of its consequences; understand the concepts of limits, continuity, compactness, differentiability, and integrability, rigorously defined;. Students should also have attained a basic level of competency in developing their own mathematical skill.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After going through this course the students will be able to
• Understand the method of successive differentiation and Taylor series expansions.
• Be familiar with concepts of asymptotes, curvature and singular points.</td></tr>
</table>

	• Apply the concepts of calculus for tracing and rectification of the curves in Cartesian, parametric and polar coordinates. • Understand reduction formulae and be familiar with the method of finding volumes and surfaces of solids of revolution.

Unit No.	Content of Each Unit	Hours of Each Unit
I	Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$ concavity and inflection points, asymptotes L'Hospitals rule, applications of maxima and minima.	22
II	Curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nx\, dx$, $\int \cos nx\, dx$, $\int \tan nx\, dx$, $\int \sec nx\, dx$, $\int (\log x)^n dx$, $\int \sin^n x \cos^m x\, dx$ volume by slicing, disks and washer methods, volumes by cylindrical shells.	23
III	Parameterizing a curve, arc length, arc length of parametric curves and area of surface of revolution. Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.	23
IV	Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, connectedness.	22

Books Recommended:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005
2. B. C. Das & B. N. Mukherjee, Differential Calculus, U. N. Dhur and Sons. Pvt. Ltd.
3. S. Narayan & P. K. Mittal, Integral Calculus, S. Chand Publishing.
4. S. Narayan & P. K. Narayan, A Text Book on Vector Calculus, S. Chand Publishing.
5. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi,2007.
6. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
7. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

List of Practical (using any software)

Plotting of graphs of function $e^{ax + b}$, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b| and to illustrate the effect of a and b on the graph.

(i) Plotting the graphs of polynomials of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.

(ii) Sketching parametric curves (E.g., Trochoid, cycloid, epicycloids and hypocycloid).

(iii) Obtaining surface of revolution of curves.

(iv) Tracing of conics in Cartesian coordinates/ polar coordinates.

(v) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid and hyperbolic paraboloid using Cartesian coordinates.

(vi) Matrix operations (addition, multiplication, inverse, transpose).

<table>
<tr><td>Course No: 2</td><td colspan="3">Course Name: Algebra</td><td colspan="4">Course Code:
SBSMAT 03 01 02 C 5106</td></tr>
<tr><td rowspan="2">Batch:

2021-2026</td><td rowspan="2">Programme:

Integrated B.Sc.-M.Sc. (Mathematics)</td><td rowspan="2">Semester:

I</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td>Contact Hrs per Week: 06</td></tr>
<tr><td>5</td><td>1</td><td>0</td><td>6</td><td>Total Hours: 90</td></tr>
<tr><td colspan="2">Total Evaluation Marks:
100

CIE:
TEE:</td><td colspan="6">Examination Duration: 3 hours

Pre-requisite of course: N.A.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of the course is to introduce basic structures of algebra like matrices, system of linear equation and linear transformation which are the main pillars of modern mathematics. The course gives the student a good mathematical maturity and enables to build mathematical thinking and skill.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After going through this course the students will be able to
• Work with the trigonometric form of complex numbers including De-Moivre's formula.
• Be familiar with the Euler form $re^{i\theta}$ of complex numbers
• Apply the elementary operations on the matrices. Compute the eigenvalues, eigen function, characteristic equation and minimal polynomial of a given matrix.
• Obtain the solution of the systems of linear equations using the concept of rank of matrices</td></tr>
<tr><td>Unit No.</td><td colspan="5">Content of Each Unit</td><td colspan="2">Hours of Each Unit</td></tr>
<tr><td>I</td><td colspan="5">Polar representation of complex numbers, n^{th} roots of unity, De</td><td colspan="2">23</td></tr>
</table>

	Moivre's theorem for rational indices and its applications. Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set.	
II	Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.	22
III	Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence.	23
IV	Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, Characterizations of invertible matrices. Subspaces of $\mathbf{R^n}$, dimension of subspaces $\mathbf{R^n}$ and rank of a matrix, Eigenvalues, Eigen Vectors and Characteristic Equation of a matrix.	22

Books Recommended:

1. Hall & Night, Higher Algebra, Arihant Publishers, 2013.
2. K. Hoffman, R.A. Kunze, Linerar Algebra 2nd Ed., Prentice-Hall of India Pvt. Ltd.,1971.
3. S. L. Loney, Plane Trigonometry, Arihant Publishers, 2016.
4. D. C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. R.G. Bartle and D. R. Sherbert, Introduction to Real Ananlysis. Willy Std Edition, 2014.
6. B. Das & B N Mukherjee, Higher Trigonometry, U N Dhur & Sons, 2007.
7. T. Andreescu and D. Andrica, Complex Numbers from A to Z, Birkhauser,2006
8. E. G. Goodaire and M. M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.

Course No: 03	Course Name: Environmental Sciences				Course Code: SBSMAT 03 01 01 AECC 3104		
Batch: 2021-2026	**Programme: Integrated B.Sc.-M.Sc. (Mathematics)**	**Semester: I**	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 2**
			3	1	0	4	**Total Hours: 30**
Total Evaluation Marks: 100 **CIE:** **TEE:**		**Examination Duration:** 3 hours **Pre-requisite of course:**					
Course Objective	To aware the students the need for sustainable development, problems of pollution, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer, loss of biodiversity and need of worldwide efforts in its conservation.						
	After going through this course the students will be able to • Get the knowledge about trends of biological diversity and conservation strategies and thereafter be able to create awareness for its conservation and development. • Understanding of issues concerning different natural resources will be helpful to find scientific solution based on participatory approach. • Know about the local environmental issues, movements and an important role to minimize the impact of these aspects. • Knowledge about the types of pollution and pollution control						
Unit No.	**Content of Each Unit**						**Hours of**

		Each Unit
I	Definition, scope and importance of the environmental science, Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems.	8
II	Introduction, kinds of ecosystem, structure and functions, abiotic and biotic component, Ecological energetics, Energy flow models, Food chain and Food web, Ecological Pyramids-types, Ecological succession, Introduction, types, structure and function of the following ecosystem :- a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems.	7
III	Introduction – Definition, value and types: genetic, species and ecosystem diversity. Bio- geographical classification and Hot-spots of India. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation.	7
IV	Definition, cause, effects and control measures of Air, Water, Soil, Marine and Noise pollution. Solid Waste Management: Causes, effects and control measures of wastes. Seventeen Sustainable Developmental Goals, Environment Protection Act, Air Act, Water Act, Wildlife Protection Act, Forest Conservation Act, Public awareness.	8

Books Recommended:

1. Bharucha E, (2002) The Biodiversity of India, Mapin Publishing
2. Cao G, Orru R (2014) Current Environmental Issues and Challenges. 2014th edition; Springer
3. Cunningham W P, Cunningham M A (2008) Principles of Environment Science. Enquiry and Applications. 5th Edition. Tata McGraw Hill, New Delhi
4. Dash M C, Dash S P (2009) Fundamentals of Ecology. 3rd McGraw Hill Education
5. Gibbs J, Malcolm L, Sterling J (2008) Problem-Solving in Conservation Biology and Wildlife Management. 2nd ed. Wiley-Blackwell
6. Ginley D, Cahen, D (2011) Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press
7. Gilbert M (2007) An Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi
8. Khan I (2019) Forest Governance and Sustainable Resource Management. SAGE Publications. India.
9. Odum E P, Barrett W, (2005) Fundamentals of Ecology. 5th ed. Cengage Learning.
10. Sharma P D (2017) Ecology and Environment. 13th ed. Rastogi Publications
11. Thangadurai D, Ching G, Jeyabalan S, Islam S (2019) Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management. United States: Apple Academic Press

<table>
<tr><td>Course No: 04</td><td colspan="3">Course Name:
प्राचीनभारतीयसंस्कृतिः, दर्शनं भाषाविज्ञानं च (1)</td><td colspan="4">Course Code:
SBSMAT 03 01 02 AECC 3104</td></tr>
<tr><td>Batch:

2021-2026</td><td>Programme:

Integrated B.Sc.-M.Sc. (Mathematics)</td><td>Semester :
I</td><td>L

3</td><td>T

1</td><td>P

0</td><td>Credits

4</td><td>Contact Hrs per Week: 2

Total Hours: 30</td></tr>
<tr><td colspan="3">Total Evaluation Marks:
100

CIE:

TEE:</td><td colspan="5">Examination Duration: 3 hours

Pre-requisite of course:</td></tr>
<tr><td>Course Objective /उद्देश्यः</td><td colspan="7">1. संस्कृतेतर-विषयाणामध्येतृभ्यः संस्कृताध्ययनाय सौकर्योत्पादनम्; 2. भारतीयज्ञानसंपदाधारभूतानां वेदादि-शास्त्राणामुपनिषदां च रुचिरुत्पादनम्; 3. संस्कृतेनोपनिबद्धानां नीतिवाक्यानां गीतायां वर्णितस्य कर्मयोगस्य च तत्त्व-संधारणाय यत्नः; 4. सामान्य-भाषाविज्ञानस्य परिचयः।</td></tr>
</table>

	पाठ्यक्रमाध्ययनस्य फलम् / Course Level Learning Outcome: • अध्येतारः वेदादि-शास्त्राणामुपनिषदां च तत्त्वान् ज्ञात्वा स्वाध्याय प्रयत्नशीलाः भवेयुः। • व्यावहारिकदृष्ट्या संस्कृतज्ञानेन अन्यविषयाणामध्येतारः तत्तद् स्वविषयानुगुणं संस्कृतभाषायामुप- लभ्यमानानां ग्रन्थानां प्रति यत्नशीलाः स्युः। • वेदोपनिषत्–गीता–नीतिशास्त्र–भाषाशास्त्रादीनां विषयाणां सम्यगध्ययनेनास्माकं पूर्वजानां वैदुष्येण परिचयः संजायेत। • भारतीय-चिन्तनपरम्परायाः समृद्धिं ज्ञातुमयं पाठ्यक्रमः प्रकृष्टमाध्यमः संजायेत।	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	**घटकम्-1:** (क) यजुर्वेदः (34. 1-6)-शिवसंकल्पमन्त्राः; (ख) तैत्तिरीयोपनिषद् - शिक्षावल्ली (अनुशासनोपनिषद्)	8
II	**घटकम्-2:** भर्तृहरिः- नीतिशतकम् : 1-50 श्लोकाः	7
III	**घटकम्-3:** भगवद्गीता – तृतीयाध्यायः (कर्मयोगः)	7

IV	**घटकम्-4:** सामान्यभाषाविज्ञानम्- (क) वर्णमाला, वर्णानाम् उच्चारणस्थानानि प्रयत्नाश्च; (ख) भाषाविज्ञानस्य सामान्यः परिचयः, भाषापरिवर्तनस्य कारणानि, अर्थपरिवर्तनस्य कारणानि च	8

अनुशंसितग्रन्थाः -

1. उवव्ट-महीधर, शुक्लयजुर्वेदभाष्य, मोतीलाल बनारसीदास, दिल्ली, 2007

2. स्वामी दयानन्द सरस्वती, यजुर्वेदभाष्य, सम्पा० ब्रह्ममदत्त जिज्ञासु, रामलाल कपूर ट्रस्ट, सोनीपत (हरियाणा)

3. तैत्तिरीयोपनिषद्, हिन्दी व्याख्याकार - स्वामी प्रखर प्रज्ञानन्द सरस्वती, काशी, 2013

4. भर्तृहरि, नीतिशतक, सम्पादक एवं हिन्दी व्याख्याकार - जनार्दन शास्त्री पाण्डेय, मोतीलाल बनारसीदास, दिल्ली, 2014

5. नीतिशतकम्, 'नीतिपथ' हिन्दी व्याख्याकार - राजेश्वर शास्त्री मुसलगाँवकर, चौखम्भा, वाराणसी

6. श्रीमद्भगवद्गीता (हिन्दी अनुवाद सहित), गीता प्रैस, गोरखपुर, 2015

7. श्रीकृष्ण त्रिपाठी, श्रीमद्भगवद्गीता (द्वितीय, तृतीय एवं चतुर्थ अध्याय), 2005

8. देवीदत्त शर्मा, भाषिकी और संस्कृत भाषा, हरियाणा साहित्य अकादमी, चण्डीगढ़, 1990

9. कपिलदेव द्विवेदी, भाषा-विज्ञान एवं भाषा-शास्त्र, विश्वविद्यालय प्रकाशन, चौक, वाराणसी, 2012

10. कर्णसिंह, भाषाविज्ञान, साहित्य भण्डार, मेरठ

11. Burrow, T., The Sanskrit Language, 2016

12. Gune, P.D., An Introduction to Comparative Philology, Oriental Book House, Poona, 1958

13. The Taittirīya Upaniṣad, Eng. Tr. and Commentary by Swami Muni Narayana Prasad, D.k. Print world (P), Ltd., New Delhi-2009

14. The Nīti and Vairāgya śatakas of Bhartrihari, M.R. Kale, Motilal Banarsidass, Delhi, 2017

Course No: 05	**Course Name:** Object Oriented Programming in C++				**Course Code:** SBSMAT 03 01 01 GE 4046		
Batch: 2021-2026	**Programme: Integrated B.Sc.-M.Sc. (Mathematics)**	**Semester: I**	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
			4	0	4	6	**Total Hours: 90**
Total Evaluation Marks: 100 **CIE:** **TEE:**		**Examination Duration:** 3 hours **Pre-requisite of course:**					
Course Objective	The main objective of this course is to define and highlight the importance of object oriented programming. The students will see how to use concepts of object oriented programming in real-life using C++ programming language. The students will learn potential C++ features like overloading, type conversions, inheritance.						
	After going through this course the students will be able to • Write C-programmes to solve Mathematical problems. • Design algorithms to solve problems. • Understand the OOPS likes Encapsulation, Data Abstraction, Inheritance and Polymorphism. • Emphasize on the importance of use of Friend Functions for efficient C++						

	programming.	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	OOP Paradigm: Comparison of Programming paradigms, Characteristics of Object-Oriented Programming Languages, Object-based programming languages C++: Brief History of C++,Structure of a C++ program, Difference between C and C++ - cin, cout, new, delete operators, ANSI/ISO Standard C++, Comments, Working with Variables and const Qualifiers. Enumeration, Arrays and Pointer.	23
II	Implementing oops concepts in C++ Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Default Parameter Value, Using Reference variables withFunctions.	22
III	Abstract data types, Class Component, Object & Class, Constructors Default and Copy Constructor, Assignment operator deep and shallow coping, Access modifiers – private, publicand protected. Implementing Class Functions within Class declaration or outside the Class declaration. instantiation of objects, Scope resolution operator, Working with Friend Functions, Using Static Class members.	22
IV	Understanding Compile Time Polymorphism function overloading Rules of Operator Overloading (Unary and Binary) as member function/friend function, Implementation of operator overloading of Arithmetic Operators, Overloading Output/Input,Prefix/ Postfix Increment and decrement Operators, Overloading comparison operators, Assignment, subscript and function call Operator, concepts of namespaces.	23

Practical to be performed in lab Marks: 20, Contact hrs:30
Books Recommended: 1. R. Venugopal, Rajkumar, and T. Ravishanker, Mastering C++, TMH,1997. 2. B. Lippman and J. Lajoie, C++ Primer, 3rd Ed., Addison Wesley,2000. 3. Eckel, Thinking in C++, 2nd Ed., President, Mindview Inc., Prentice Hall.Parasons, Object Oriented Programming with C++, BPB Publication. 4. B. Stroustrup, The C++ Programming Language, 3rd Ed., Addison Welsley.

Course No: 6	**Course Name:** Finite Element Methods				**Course Code:** SBSMAT 03 01 02 GE 5106		
Batch: 2021-2026	**Programme: Integrated B.Sc.-M.Sc. (Mathematics)**	**Semester :** II	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
			5	1	0	6	**Total Hours: 90**
Total Evaluation Marks: 100 **CIE:** **TEE:**		**Examination Duration:** 3 hours					

Course Objective	The objective of the course includes an introduction about different finite element methods in one- two and three-dimensions. The course focuses on analyzing variety of finite elements as per the requirements of solutions of differential equations.	
Course Outcomes :	After going through this course the students will be able to • Describe finite element methods • Differential equations using finite element methods • Emphasize on the importance of use of Simplex elements in two and three dimensions. • Understand the Interpolation functions, numerical integration and modeling considerations.	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	Introduction to finite element methods, comparison with finite difference methods, Methods of weighted residuals, collocations, least squares and Galerkin's method. Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.	23
II	Applications to solving simple problems of ordinary differential equations. Linear, quadratic and higher order elements in one dimensional and assembly, solution of assembled system.	22
III	Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries.	23
IV	Interpolation functions, numerical integration, and modeling considerations**.** Solution of two dimensional partial differential equations under different Geometric conditions.	22

Books Recommended:

1. J.N. Reddy, Introduction to the Finite Element Methods, Tata McGraw-Hill,2003.
2. K.J. Bathe, Finite Element Procedures, Prentice-Hall,2001.
3. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite Element Analysis, John Wiley and Sons,2002.
4. T. J.R. Hughes, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Dover Publication,2000.
5. G. R. Buchanan, Finite Element Analysis, McGraw Hill,1994.

Course No: 7	**Course Name:** Algebra			**Course Code:** SBSMAT 03 01 03 GE 5106			
Batch: 2021-2026	**Programme: Integrated B.Sc.-M.Sc. (Mathematics)**	**Semester:** I	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
			5	1	0	6	**Total Hours: 90**
Total Evaluation Marks: 100		**Examination Duration:** 3 hours					
		Pre-requisite of course: N.A.					

CIE: **TEE:**		
Course Objective	The objective of the course is to introduce basic structures of algebra like matrices, system of linear equation and linear transformation which are the main pillars of modern mathematics. The course gives the student a good mathematical maturity and enables to build mathematical thinking and skill.	
Course Outcomes:	After going through this course the students will be able to • Work with the trigonometric form of complex numbers including De-Moivre's formula. • Be familiar with the Euler form $re^{i\Theta}$ of complex numbers • Apply the elementary operations on the matrices. Compute the eigen values, eigen function, characteristic equation and minimal polynomial of a given matrix. • Obtain the solution of the systems of linear equations using the concept of rank of matrices	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	Polar representation of complex numbers, n^{th} roots of unity, De Moivre's theorem for rational indices and its applications. Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set.	23
II	Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.	23
III	Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence	22

IV	Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, Characterizations of invertible matrices. Subspaces of $\mathbf{R^n}$, dimension of subspaces $\mathbf{R^n}$ and rank of a matrix, Eigenvalues, Eigen Vectors and Characteristic Equation of a matrix.	22

Books Recommended:

1. Hall & Night, Higher Algebra, Arihant Publishers, 2013.
2. K. Hoffman, R.A. Kunze, Linerar Algebra 2nd Ed., Prentice-Hall of India Pvt. Ltd.,1971.
3. S. L. Loney, Plane Trigonometry, Arihant Publishers, 2016.
4. D. C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint,2007.
5. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis. Willy Std Edition, 2014.
6. B Das & B N Mukherjee, Higher Trigonometry, U N Dhur & Sons, 2007.
7. T. Andreescu and D. Andrica, Complex Numbers from A to Z, Birkhauser,2006.
8. E. G. Goodaire and M. M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.

Course No: 08	Course Name: Real Analysis				Course Code: SBSMAT 03 02 01 C 5106		
Batch: 2021-2026	**Programme: Integrated B.Sc.-M.Sc. (Mathematics)**	**Semester:** II	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
			5	1	0	6	**Total Hours: 90**
Total Evaluation Marks: 100 **CIE:** **TEE:**		**Examination Duration:** 3 hours **Pre-requisite of course:**					

Course Objective	This course presents a rigorous treatment of fundamental concepts in analysis. To introduce students to the fundamentals of mathematical analysis and reading and writing mathematical proofs. The course objective is to understand the axiomatic foundation of the real number system, in particular the notion of completeness and some of its consequences; understand the concepts neighborhood of a point, countable sets , sequence and series, rigorously defined;. Students should also have attained a basic level of competency in developing their own mathematical arguments and communicating them to others in writing
Course Outcomes:	After going through this course the students will be able to • Identify the properties of the number system and Describe various analytical properties of the real number system. • Explain the concept of sequences and their types and Identify the convergence of sequences and series of positive terms. • Apply various important convergence tests to the given series. • Understand the difference between conditional and absolute convergence of alternating series.

Unit No.	Content of Each Unit	Hours of

		Each Unit
I	Review of Algebraic and Order Properties of *R*, neighborhood of a point in *R*, Idea of countable sets, uncountable sets and uncountability of *R*. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of *R*, The Archimedean Property.	23
II	Density of Rational (and Irrational) numbers in *R*, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets. Sequences, Bounded sequence, Convergent sequence, Limit of a sequence.	23
III	Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.	22
IV	Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Test for Convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n^{th} root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.	22

Books Recommended:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Kumar and S. Kumarasen, A Basic Course in Real Analysis, CRC Press, 2014.
3. G. B. Thomas and R. L. Finney, Calculus, Pearson, 9th Ed, 2005.
4. G. G. Bilodeau , P. R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett,2010.
5. S. Thomson, A. M. Bruckner and J. B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
6. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.

<table>
<tr><td>Course No: 9</td><td colspan="3">Course Name: Differential Equations</td><td colspan="4">Course Code:
SBSMAT 03 02 02 C 4046</td></tr>
<tr><td rowspan="2">Batch:

2021-2026</td><td rowspan="2">Programme: Integrated B.Sc.-M.Sc. (Mathematics)</td><td rowspan="2">Semester:

II</td><td>L</td><td>T</td><td>P</td><td>Credits</td><td>Contact Hrs per Week: 06</td></tr>
<tr><td>4</td><td>0</td><td>4</td><td>6</td><td>Total Hours: 90</td></tr>
<tr><td colspan="2" rowspan="2">Total Evaluation Marks:
100

CIE:

TEE:</td><td colspan="6">Examination Duration: 3 hours</td></tr>
<tr><td colspan="6">Pre-requisite of course: N.A.</td></tr>
<tr><td>Course Objective</td><td colspan="7">The objective of this course is to introduce ordinary differential equations, general, particular, explicit, implicit and singular solutions of a differential equation. This course further explains the analytic techniques in computing the solutions of various ordinary differential equations.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">After going through this course the students will be able to
• Use the techniques to solve differential equations and apply these techniques in various mathematical models used in real life problems.
• Be familiar with formation of differential equations and to solve exact differential equations by finding integrating factors.
• Find solution of Lagrange's equations, Clairauts equations and other standard equations of first order but not of first degree.
• Learn the concept of auxiliary equation, particular integral for linear differential equations with constant co-efficients and their solution</td></tr>
<tr><td>Unit No.</td><td colspan="5">Content of Each Unit</td><td>Hours of</td></tr>
</table>

		Each Unit
I	Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.	22
II	Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.	23
III	General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients.	23
IV	Euler's equation, method of undetermined coefficients, method of variation of parameters. Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.	22

List of Practical (using any software)

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only)
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic Volterra model, with density

dependence, effect of DDT, two prey one predator).

9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
10. Battle model (basic battle model, jungle warfare, long range weapons).
11. Plotting of recursive sequences.
12. Study the convergence of sequences through plotting.

Books Recommended:

1. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
2. E. A. Coddington, An Introduction to Ordinary Differential Equation, Dover Publications, 1961.
3. G. R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York,2009.
4. C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India,2005.
5. M. L. Abell, J. P. Braselton, Differential Equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press,2004.

Course No: 10	Course Name: **हिंदी भाषा : रचना एवं व्यवहार** .				Course Code: SBSMAT 03 02 01 AECC 3104		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
2021-2026	**Integrated B.Sc.-M.Sc. (Mathematics)**	**II**	3	1	0	4	**Total Hours: 30**
Total Evaluation Marks: 100 **CIE:** **TEE:**		**Examination Duration:** 3 hours **Pre-requisite of course:**					
Course Objective	• □□□□, □□□□□□□ □□□ □□□□□□□ □□ □□□□□□□ □□□□□□ □□ □□□□□□□ ।						
Course Outcomes:	◆ भाषा, बोली और व्याकरण के विविध घटकों का परिचय । ◆ संचार माध्यमों के स्वरूप और भाषा का ज्ञान । ◆ रचना पाठ से साहित्य बोध ।						

Unit No.	Content of Each Unit	Hours of Each Unit
I	भाषा की परिभाषा एवं विशेषताएं भाषा और व्याकरण हिंदी की ध्वनियों का वर्गीकरण (स्वर, व्यंजन और वर्तनी)	8

II	हिंदी भाषा व बोलियों का संक्षिप्त परिचय हिंदी की संवैधानिक स्थिति : राजभाषा, संपर्क भाषा और राष्ट्रभाषा कार्यालयी हिंदी : पल्लवन, संक्षेपण, टिप्पण पत्र लेखन : सरकारी, अर्द्ध-सरकारी	7
III	संचार माध्यमों का स्वरूप एवं भाषा संचार माध्यमों का सामाजिक प्रभाव कंप्यूटर में हिंदी का अनुप्रयोग	8
IV	**कहानी : चंद्रधर शर्मा 'गुलेरी' :** उसने कहा था; **प्रेमचंद :** नशा **निबंध : हजारी प्रसाद द्विवेदी :** नाखून क्यों बढ़ते हैं; **बालमुकुंद गुप्त :** बनाम लार्ड कर्जन **कविता : सूर्यकांत त्रिपाठी 'निराला' :** वर दे, वीणा वादिनी वर दे ! **जयशंकर प्रसाद :** हिमाद्रि तुंग शृंग से	7

अनुशंसित पुस्तकें :

1. हिंदी : उद्भव, विकास और रूप; डॉ हरदेव बाहरी; किताब महल इलाहाबाद; 1969.
2. हिंदी भाषा; डॉ भोलानाथ तिवारी; किताब महल, इलाहाबाद; 2004.
3. हिंदी व्याकरण; कामता प्रसाद गुप्त; नागरी प्रचारिणी सभा, काशी; 1927.
4. व्यावहारिक हिंदी व्याकरण तथा रचना; हरदेव बाहरी; लोकभारती प्रकाशन, इलाहाबाद; 1972.
5. कंप्यूटर और हिंदी; हरिमोहन; तक्षशिला प्रकाशन, दिल्ली; 2015.

6. रेडियो और दूरदर्शन पत्रकारिता; हरिमोहन; तक्षशिला प्रकाशन, दिल्ली; 2017.

Course No: 11	**Course Name:** English				**Course Code:** SBSMAT 03 02 02 AECC 3104		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
2021-2026	**Integrated B.Sc.-M.Sc. (Mathematics)**	**II**	3	1	0	4	**Total Hours: 30**
Total Evaluation Marks: 100 **CIE:** **TEE:**		**Examination Duration:** 3 hours **Pre-requisite of course:**					

Course Objective	The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.	
Course Outcomes:	The present course hopes to address some of these aspects through an interactive mode of teaching-learning process and by focusing on various dimensions of communication skills. Some of these are: Language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, notetaking etc. While, to an extent, the art of communication is natural to all living beings, in today's world of complexities, it has also acquired some elements of science. It is hoped that after studying this course, students will find a difference in their personal and professional interactions.	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	Introduction: Theory of Communication, Types and modes of Communication. Language of Communication: Verbal and Non-verbal (Spoken and Written) Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication	8
II	Speaking Skills: Monologue Dialogue, Group Discussion, Effective Communication/ Mis- Communication, Interview Public Speech	7
III	Reading and Understanding, Close Reading, Comprehension Summary, Paraphrasing, Analysis and Interpretation, Translation(from Indian language to English and vice-versa) ,Literary/Knowledge Texts	8
IV	Writing Skills, Documenting, Report Writing, Making notes, Letter	7

	writing	

Books Recommended :

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

Course No: 12	**Course Name:** Econometrics				**Course Code:** SBSMAT 03 02 01 GE 5106		
Batch: 2021-2026	**Programme: Integrated B.Sc.-M.Sc. (Mathematics)**	**Semester: II**	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
			5	1	0	6	**Total Hours: 90**
Total Evaluation Marks: 100 **CIE:**		**Examination Duration:** 3 hours					
		Pre-requisite of course:					

TEE:		
Course Objective	Econometrics is a set of research tools used to estimate and test economic relationships. The methods taught in this introductory course can also be employed in the business disciplines of accounting, finance, marketing and management and in many social science disciplines. The aim of this course is to provide you with the skills helpful in filling the gap between being "a student of economics" and being "a practicing economist."	
Course Outcomes	After going through this course the students should be able to • Design models and solve problems related to Economic issues. • Describe the Statistical Concepts • Understand the Detection, Remedies and Multicollinearity. • Be familiars with the Type I and Type II errors.	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	Statistical Concepts Normal distribution; chi-square, t and F-distributions; estimation of parameters; properties of estimators; testing of hypotheses: defining statistical hypotheses; distributions of test statistics; testing hypotheses related to population parameters; Type I and Type II errors; power of a test; tests for comparing parameters from two samples.	22
II	Simple Linear Regression Model: Two Variable Case Estimation of model by method of ordinary least squares; properties of estimators; goodness of fit; tests of hypotheses; scaling and units of measurement; confidence intervals; Gauss-Markov theorem; forecasting.	23

III	Multiple Linear Regression Model Estimation of parameters; properties of OLS estimators; goodness of fit - R2 and adjusted R2 ; partial regression coefficients; testing hypotheses – individual and joint; functional forms of regression models; qualitative (dummy) independent variables.	23
IV	Violations of Classical Assumptions: Consequences, Detection and Remedies Multicollinearity; heteroscedasticity; serial correlation. Specification Analysis Omission of a relevant variable; inclusion of irrelevant variable; tests of specification errors.	22

Books Recommended:

1. J. L. Devore, Probability and Statistics for Engineers, Cengage Learning,2010.
2. J. E. Freund, Mathematical Statistics, Prentice Hall,1992.
3. R. J. Larsen and Morris L. Marx, An Introduction to Mathematical Statistics and its Applications, Prentice Hall,2011.
4. D. N. Gujarati and D.C. Porter, Essentials of Econometrics, McGraw Hill, 4th Ed., International Edition,2009.
5. C. Dougherty, Introduction to Econometrics, Oxford University Press, 3rd Ed., Indian edition,2007.

Course No: 13	**Course Name:** Mathematical Finance				**Course Code:** SBSMAT 03 02 02 GE 5106		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
2021-2026	**Integrated B.Sc.-M.Sc. (Mathematics)**	II	5	1	0	6	**Total Hours: 90**

Total Evaluation Marks: 100 **CIE:** **TEE:**	**Examination Duration:** 3 hours	
Course Objective	This course introduces the basic concepts of Financial Management such as Insurance and Measurement of returns under uncertainty situations. The philosophy of this course is that Time value of Money - Interest rate and discount rate play a fundamental role in Life Insurance Mathematics – Construction of Morality Tables.	
Course Outcomes:	After going through this course the students will be able to • Build quantitative models of financial mathematics/industries • Apply models to obtain information of practical value in the financial mathematics • Understand the terms random returns, portfolio mean return and variance. • Design models and solve problems related to financial issues	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR.	20
II	Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.	24
III	Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, One fund theorem,	23

	capital market line, Sharpe index.	
IV	Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.	23

Books Recommended:

1. D. G. Luenberger, Investment Science, Oxford University Press, Delhi,1998.
2. J. C. Hull, Options, Futures and Other Derivatives, 6th Ed., Prentice-Hall India, Indian reprint,2006.
3. S. Ross, An Elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA,2003.

Course No: 14	**Course Name:** Real Analysis				**Course Code:** SBSMAT 03 02 03 GE 5106		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs per Week: 06**
2021-2026	**Integrated B.Sc.-M.Sc. (Mathematics)**	II	5	1	0	6	**Total**

							Hours: 90

Total Evaluation Marks: 100 **CIE:** **TEE:**	**Examination Duration:** 3 hours **Pre-requisite of course:**

Course Objective	This course presents a rigorous treatment of fundamental concepts in analysis. To introduce students to the fundamentals of mathematical analysis and reading and writing mathematical proofs. The course objective is to understand the axiomatic foundation of the real number system, in particular the notion of completeness and some of its consequences; understand the concepts neighborhood of a point, countable sets , sequence and series, rigorously defined;. Students should also have attained a basic level of competency in developing their own mathematical arguments and communicating them to others in writing	
Course Outcomes:	After going through this course the students will be able to • Identify the properties of the number system and Describe various analytical properties of the real number system. • Explain the concept of sequences and their types and Identify the convergence of sequences and series of positive terms. • Apply various important convergence tests to the given series. • Understand the difference between conditional and absolute convergence of alternating series.	
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
I	Review of Algebraic and Order Properties of *R*, neighborhood of a point in *R*, Idea of countable sets, uncountable sets and uncountability of *R*. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of *R*, The Archimedean Property.	23
II	Density of Rational (and Irrational) numbers in *R*, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for	23

	sets. Sequences, Bounded sequence, Convergent sequence, Limit of a sequence.	
III	Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion.	22
IV	Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Test for Convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's n^{th} root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.	22

Books Recommended:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Kumar and S. Kumarasen, A Basic Course in Real Analysis, CRC Press, 2014.
3. G. B. Thomas and R. L. Finney, Calculus, Pearson, 9th Ed, 2005.
4. G. G. Bilodeau , P. R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett,2010.
5. S. Thomson, A. M. Bruckner and J. B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
6. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.

9. Teaching-Learning Process

- Lectures
- Discussions
- Simulations
- Role Playing
- Participative Learning
- Interactive Sessions
- Seminars
- Research-based Learning/Dissertation or Project Work

- Technology-embedded Learning

10. Implementation of Blended Learning

Blended Learning is a pedagogical approach that combines face to-face classroom methods with computer-mediated activities in the process of teaching and learning. It implies nice blend of face-to-face and online activities to make the learning processes more interesting and engaging. It focuses on integration of traditional classroom activities and innovative ICT-enabled strategies. It emphasises student-centric learning environment where the teacher is the facilitator for productive and measurable learning outcomes. It optimises and compliments the face to face learning, giving ample freedom and flexibility to the students and teachers to access and explore the wide range of open-access sources such as video lectures, podcasts, recordings and articles through digital platforms. It gives freedom and autonomy to the teachers in selection of appropriate digital platforms, resources and time-slots to complement and supplement face to face learning. The Blended Learning doesn't undermine the role of the teacher, rather it gives him/her an opportunity to explore the unexplored in accordance with the requirements of the curriculum.

Key features of Blended Learning

- **Student-Centric Pedagogical Approach** focusing on flexibility in timing, quality content, needs and interests of students and freedom to study through the mode of his/her choice;
- Freedom to Select variety of mediums and techniques;
- Increased student engagement in learning;
- Enhanced teacher and student interaction;
- Improved student learning outcomes;
- More flexible teaching and learning environment;
- More responsive for self and continuous learning;
- Better opportunities for experiential learning;
- Increased learning skills;
- Greater access to information, improved satisfaction and learning outcomes.

Note: Resolution no (c) as per minutes circulated by VC office**:** It was resolved that Blended Learning with 40% component of online teaching and 60% face to face classes for each programme, be adopted

11. Assessment and Evaluation

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills
- Open Book Examination for better understanding and application of the knowledge acquired
- Group Examinations on Problem solving exercises
- Seminar Presentations
- Review of Literature
- Collaborative Assignments

12. Keywords

- LOCF
- NEP-2020
- Blended Learning
- Face to face (F to F) Learning
- Programme Outcomes
- Programme Specific Outcomes
- Course-level Learning Outcomes
- Postgraduate Attributes
- Learning Outcome Index
- Formative Assessment and Evaluation
- Comprehensive and Continuous Evaluation
- Multiple Entry
- Multiple Exit

13. References

- Draft Blended Mode of Teaching and Learning: Concept Note available on UGC website, https://www.ugc.ac.in/pdfnews/6100340_Concept-Note-Blended-Mode-of-Teaching-and-Learning.pdf

- Guidelines for Multiple Entry and Exit in Academic Programmes offered in Higher Education Institutions, https://www.education.gov.in/sites/upload_files/mhrd/files/upload_document/abc_doc.pdf
- National Education Policy-2020, https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
- Quality Mandate for Higher Education in India, https://www.ugc.ac.in/e-book/Quality%20Mandate%20E-BOOK/mobile/index.html

- The draft subject specific LOCF templates available on UGC website, https://www.ugc.ac.in/ugc_notices.aspx?id=MjY5OQ==

13. Appendices

Nil