ROYAL GLOBAL UNIVERSITY
GUWAHATI

Royal School of Applied & Pure Sciences (RSAPS)

Department of Mathematics

COURSE STRUCTURE & SYLLABUS
(BASED ON NATIONAL EDUCATION POLICY 2020)

FOR

B.Sc. IN MATHEMATICS
(4 YEARS SINGLE MAJOR)

W.E.F

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1. Preamble

The National Education Policy (NEP) 2020 conceives a new vision for India's higher education system. It recognizes that higher education plays an extremely important role in promoting equity, human as well as societal well-being and in developing India as envisioned in its Constitution. It is desired that higher education will significantly contribute towards sustainable livelihoods and economic development of the nation as India moves towards becoming a knowledge economy and society.

If we focus on the 21st century requirements, the higher education framework of the nation must aim to develop good, thoughtful, well-rounded, and creative individuals and must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and twenty-first-century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education should be capable enough to enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. Overall, it should focus on preparing students for more meaningful and satisfying lives and work roles and enable economic independence.

Towards the attainment of holistic and multidisciplinary education, the flexible curricula of the University will include credit-based courses, projects in the areas of community engagement and service, environmental education, and value-based education. As part of holistic education, students will also be provided with opportunities for internships with local industries, businesses, artists, crafts persons, and so on, as well as research internships with faculty and researchers at the University, so that students may actively engage with the practical aspects of their learning and thereby improve their employability.

The undergraduate curriculums are diverse and have varied subjects to be covered to meet the needs of the programs. As per the recommendations from the UGC, introduction of courses related to Indian Knowledge System (IKS) is being incorporated in the curriculum structure which encompasses all of the systematized disciplines of Knowledge which were developed to a high degree of sophistication in India from ancient times and all of the traditions and practises that the various communities of India—including the tribal communities—have evolved, refined and preserved over generations, like for example Vedic Mathematics, Vedangas, Indian Astronomy, Fine Arts, Metallurgy, etc.

At RGU, we are committed that at the societal level, higher education will enable each student

to develop themselves to be an enlightened, socially conscious, knowledgeable, and skilled citizen who can find and implement robust solutions to its own problems. For the students at the University, Higher education is expected to form the basis for knowledge creation and innovation thereby contributing to a more vibrant, socially engaged, cooperative community leading towards a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation."

2. Introduction

The National Education Policy (NEP) 2020 clearly indicates that higher education plays an extremely important role in promoting human as well as societal well-being in India. As envisioned in the 21st-century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. According to the new education policy, assessments of educational approaches in undergraduate education will integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) that will lead to positive learning outcomes. This will lead to develop creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning, and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. and more in-depth learning.

The NEP highlights that the following fundamental principles that have a direct bearing on the curricula would guide the education system at large, viz.

i. Recognizing, identifying, and fostering the unique capabilities of each student topromote her/his holistic development.

ii. Flexibility, so that learners can select their learning trajectories and programmes, and thereby choose their own paths in life according to their talents and interests.

iii. Multidisciplinary and holistic education across the sciences, social sciences, arts, humanities, and sports for a multidisciplinary world.

iv. Emphasis on conceptual understanding rather than rote learning, critical thinking to encourage logical decision-making and innovation; ethics and human & constitutional values, and life skills such as communication, teamwork, leadership, and resilience.

v. Extensive use of technology in teaching and learning, removing language barriers, increasing access for Divyang students, and educational planning and management.

vi. Respect for diversity and respect for the local context in all curricula, pedagogy, and policy.

vii. Equity and inclusion as the cornerstone of all educational decisions to ensure that all students can thrive in the education system and the institutional environment are responsive to differences to ensure that high-quality education is available for all.

viii. Rootedness and pride in India, and its rich, diverse, ancient, and modern culture, languages, knowledge systems, and traditions.

2.1 Credits in Indian Context:

2.1.1 Choice Based Credit System (CBCS) By UGC

Under the CBCS system, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be earned by the students. This framework is being implemented in several universities across States in India. The main highlights of CBCS are as below :

- The CBCS provides flexibility in designing curriculum and assigning credits based on the course content and learning hours.
- The CBCS provides for a system wherein students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.
- CBCS also provides opportunity for vertical mobility to students from a bachelor's degree programme to masters and research degree programmes.

2.2 Definitions

2.2.1 Academic Credit:

An academic credit is a unit by which a course is weighted. It is fixed by the number of hours of instructions offered per week. As per the National Credit Framework;

1 Credit = 30 NOTIONAL CREDIT HOURS (NCH)

Yearly Learning Hours = 1200 Notional Hours (@40 Credits x 30 NCH)

30 Notional Credit Hours		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
1 Credit = 15 -22 Lecture Hours	10-15 Practicum Hours	0-8 Experiential Learning Hours

2.2.2 Course of Study:

Course of study indicate pursuance of study in a particular discipline/programme. Discipline/Programmes shall offer Major Courses (Core), Minor Courses, Skill Enhancement Courses (SEC), Value Added Courses (VAC), Ability Enhancement Compulsory Courses (AECCs) and Interdisciplinary courses.

2.2.3 Disciplinary Major:

The major would provide the opportunity for a student to pursue in-depth study of a particular subject or discipline. Students may be allowed to change major within the broad discipline at the end of the second semester by giving her/him sufficient time to explore interdisciplinary courses during the first year. Advanced-level disciplinary/interdisciplinary courses, a course in research methodology, and a project/dissertation will be conducted in the seventh semester. The final semester will be devoted to seminar presentation, preparation, and submission of project report/dissertation. The project work/dissertation will be on a topic in the disciplinary programme of study or an interdisciplinary topic.

2.2.4 Disciplinary/interdisciplinary minors:

Students will have the option to choose courses from disciplinary/interdisciplinary minors and skill-based courses. Students who take a sufficient number of courses in a discipline or an interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline or in the chosen interdisciplinary area of study. A student may declare the choice of the minor at the end of the second semester, after exploring various courses.

2.2.5 Courses from Other Disciplines (Interdisciplinary):

All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines given below. These courses are intended to broaden the intellectual experience and form part of liberal arts and science education. Students are

not allowed to choose or repeat courses already undergone at the higher secondary level (12^{th} class) in the proposed major and minor stream under this category.

i. Natural and Physical Sciences: Students can choose basic courses from disciplines such as Natural Science, for example, Biology, Botany, Zoology, Biotechnology, Biochemistry, Chemistry, Physics, Biophysics, Astronomy and Astrophysics, Earth and Environmental Sciences, etc.

ii. Mathematics, Statistics, and Computer Applications: Courses under this category will facilitate the students to use and apply tools and techniques in their major and minor disciplines. The course may include training in programming software like Python among others and applications software like STATA, SPSS, Tally, etc. Basic courses under this category will be helpful for science and social science in data analysis and the application of quantitative tools.

iii. Library, Information, and Media Sciences: Courses from this category will help the students to understand the recent developments in information and media science (journalism, mass media, and communication)

iv. Commerce and Management: Courses include business management, accountancy, finance, financial institutions, fintech, etc.,

v. Humanities and Social Sciences: The courses relating to Social Sciences, for example, Anthropology, Communication and Media, Economics, History, Linguistics, Political Science, Psychology, Social Work, Sociology, etc. will enable students to understand the individuals and their social behaviour, society, and nation. Students be introduced to survey methodology and available large-scale databases for India. The courses under humanities include, for example, Archaeology, History, Comparative Literature, Arts & Creative expressions, Creative Writing and Literature, language(s), Philosophy, etc., and interdisciplinary courses relating to humanities. The list of Courses can include interdisciplinary subjects such as Cognitive Science, Environmental Science, Gender Studies, Global Environment & Health, International Relations, Political Economy and Development, Sustainable Development, Women's, and Gender Studies, etc. will be useful to understand society.

2.2.6 Ability Enhancement Courses (AEC): Modern Indian Language (MIL) & English language focused on language and communication skills. Students are required to achieve competency in a Modern Indian Language (MIL) and in the

English language with special emphasis on language and communication skills. The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity. They would also enable students to acquaint themselves with the cultural and intellectual heritage of the chosen MIL and English language, as well as to provide a reflective understanding of the structure and complexity of the language/literature related to both the MIL and English language. The courses will also emphasize the development and enhancement of skills such as communication, and the ability to participate/conduct discussion and debate.

2.2.7 Skill Enhancement Course (SEC): These courses are aimed at imparting practical skills, hands-on training, soft skills, etc., to enhance the employability of students and should be related to Major Discipline. They will aim at providing hands- on training, competencies, proficiency, and skill to students. SEC course will be a basket course to provide skill-based instruction. For example, SEC of English Discipline may include Public Speaking, Translation & Editing and Content writing.

A student shall have the choice to choose from a list, a defined track of courses offered from 1st to 3rd semester.

2.2.8 Value-Added Courses (VAC):

i. Understanding India: The course aims at enabling the students to acquire and demonstrate the knowledge and understanding of contemporary India with its historical perspective, the basic framework of the goals and policies of national development, and the constitutional obligations with special emphasis on constitutional values and fundamental rights and duties. The course would also focus on developing an understanding among student-teachers of the Indian knowledge systems, the Indian education system, and the roles and obligations of teachers to the nation in general and to the school/community/society. The course will attempt to deepen knowledge about and understanding of India's freedom struggle and of the values and ideals that it represented to develop an appreciation of the contributions made by people of all sections and regions of the

country, and help learners understand and cherish the values enshrined in the Indian Constitution and to prepare them for their roles and responsibilities as effective citizens of a democratic society.

ii. Environmental science/education: The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes, and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, and sustainable development and living. The course willalso deepen the knowledge and understanding of India's environment in its totality, its interactive processes, and its effects on the future quality of people's lives.

iii. Digital and technological solutions: Courses in cutting-edge areas that are fast gaining prominences, such as Artificial Intelligence (AI), 3-D machining, big data analysis, machine learning, drone technologies, and Deep learning with important applications to health, environment, and sustainable living that will be woven into undergraduate education for enhancing the employability of the youth.

iv. Health & Wellness, Yoga education, sports, and fitness: Course components relating to health and wellness seek to promote an optimal state of physical, emotional, intellectual, social, spiritual, and environmental well-being of a person. Sports and fitness activities will be organized outside the regular institutional working hours. Yoga education would focus on preparing the students physically and mentally for the integration of their physical, mental, and spiritual faculties, and equipping them with basic knowledge about one's personality, maintaining self-discipline and self-control, to learn to handle oneself well in all life situations. The focus of sports and fitness components of the courses will be on the improvement of physical fitness including the improvement of various components of physical and skills-related fitness like strength, speed, coordination, endurance, and flexibility; acquisition of sports skills including motor skills as well as basic movement skills relevant to a particular sport; improvement of tactical abilities; and improvement of mental abilities.

These are a common pool of courses offered by different disciplines and aimed towards embedding ethical, cultural and constitutional values; promote critical thinking. Indian knowledge systems; scientific temperament of students.

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2.2.9 Summer Internship /Apprenticeship:

The intention is induction into actual work situations**.** All students must undergo internships / Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the***summer term***. Students should take up opportunities for internships with local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations,artists, crafts persons, and a wide variety of organizations so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability. Students who wish to exit after the first two semesters will undergoa 4-credit work-based learning/internship during the summer term to get a UG Certificate.

2.2.9.1 Community engagement and service: The curricular component of 'community engagement and service' seeks to expose students to the socio- economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems. This can be part of summer term activity or part of a major or minor course depending upon the major discipline.

2.2.9.2 Field-based learning/minor project: The field-based learning/minor project will attempt to provide opportunities for students to understand the different socio-economic contexts. It will aim at giving students exposure to development-related issues in rural and urban settings. It will provide opportunities for students to observe situations in rural and urban contexts, andto observe and study actual field situations regarding issues related to socioeconomic development. Students will be given opportunities to gain a first- hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process. They would havethe opportunity to gain an understanding of the complex socio-economic problems in the community, and innovative practices required to generate

solutions to the identified problems. This may be a summer term project or part ofa major or minor course depending on the subject of study.

2.2.10 Indian Knowledge System:

In view of the importance accorded in the NEP 2020 to rooting our curricula and pedagogy in the Indian context all the students who are enrolled in the four-year UG programmes should be encouraged to take an adequate number of courses in IKS so that the ***total credits of the courses taken in IKS amount to at least five per cent of the total mandated credits*** *(i.e. min. 8 credits for a 4 yr. UGP & 6 credits for a 3 yr. UGP)***.** The students may be encouraged to take these courses, preferably *during the first four semesters of the UG programme*. At least half of these mandated credits should be in courses in disciplines which are part of IKS and are related to the major field of specialization that the student is pursuing in the UG programme. They will be included as a part of the total mandated credits that the student is expected to take in the major field of specialization. The rest of the mandated credits in IKS can be included as a partof the mandated Multidisciplinary courses that are to be taken by every student. All the students should take a Foundational Course in Indian Knowledge System, which is designed to present an overall introduction to all the streams of IKS relevant to the UG programme. The foundational IKS course is broad-based and cover introductorymaterial on all aspects.

2.2.11 Experiential Learning:

One of the most unique, practical & beneficial features of the National Credit Framework is assignment of credits/credit points/ weightage to the experiential learning including relevant experience and professional levels acquired/ proficiency/ professional levels of a learner/student. Experiential learning is of two types:

a. Experiential learning as part of the curricular structure of academic or vocational program. E.g., projects/OJT/internship/industrial attachments etc. This could be either within the Program- internship/ summer project undertaken relevant to the program being studied or as a part time employment (not relevant to the program being studied- up to certain NSQF level only). In case where

experiential learning is a part of the curricular structure the credits would be calculated and assigned as per basic principles of NCrF i.e., 40 credits for 1200 hours of notional learning.

b. Experiential learning as active employment (both wage and self) post completion of an academic or vocational program. This means that the experience attained by a person after undergoing a particular educational program shall be considered for assignment of credits. This could be either Full or Part time employment after undertaking an academic/ Vocation program.

In case where experiential learning is as a part of employment the learner would earn credits as weightage. The maximum credit points earned in this case shall be double of the credit points earned with respect to the qualification/ course completed. The credit earned and assigned by virtue of relevant experience would enable learners to progress in their career through the work hours put in during a job/employment.

3. Approach to Curriculum Planning

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications such as a Bachelor's Degree (Hons) programmes are earned and awarded on the basis of (a) demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and (b) academic standards expected of graduates of a programme of study.

The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes which in turn will help in curriculum planning and development, and in the design, delivery, and review of academic programmes.

Learning outcomes-based frameworks in any subject must specify what graduates completing a particular programme of study are (a) expected to know, (b) understand and (c) be able to do at the end of their programme of study. To this extent, LOCF in Mathematics is committed to allowing for flexibility and innovation in (i) programme design and syllabi development by higher education institutions (HEIs), (ii) teaching-learning process, (iii) assessment of student learning levels, and (iv) periodic programme review within institutional parameters as well as LOCF guidelines, (v) generating framework(s) of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes.

The key outcomes that underpin curriculum planning and development at the undergraduate level include Graduate Attributes, Qualification Descriptors, Programme Learning Outcomes, and Course Learning Outcomes.

3.1 Nature and extent of the B.Sc. (Hons.) Mathematics

Mathematics is the study of quantity (number theory), structure (algebra), space (geometry) and change (mathematical analysis). It has wide range of applications in natural sciences, engineering, economics, social sciences and even bio and medical sciences. The key areas of study in mathematics are:

i. Real & Complex analysis

ii. Calculus

iii. Abstract Algebra

iv. Number Theory

v. Graph Theory

vi. Differential Equations (including Mathematical Modelling)

vii. Linear Algebra

viii. Metric Spaces and Topology

ix. Numerical Analysis

x. Mechanics

As a part of effort to enhance employability of mathematics graduates, the well- structured programme empowers the students with the skills and knowledge leading to enhance career opportunities in various sectors of human activities.

3.2 Aims of B.Sc. Programme in Mathematics

The overall aims of B.Sc. in Mathematics Programme are:

- To create strong interest in learning mathematics.
- To develop broad and balanced knowledge and understanding of definitions, concepts, principles and theorems.

- To enable the learners to familiarize with suitable tools and skill of mathematics to solve specific problems of both theory and applications.
- To provide sufficient knowledge and skills that enable the learners to undertake further studies in mathematics and the areas on multiple disciplines concerned with mathematics.
- To encourage the students to develop a range of generic skills helpful in employment, internships and social activities.
- To impart research-based knowledge to create interest for further study.

4. Award of Degree in B.Sc. in Mathematics

The structure and duration of undergraduate programmes of study offered by the University as per NEP 2020 include:

Undergraduate programmes of either 3 or 4-year duration with Single Major, with multiple entry and exit options, with appropriate certifications:

4.1 UG Certificate: Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

4.2 UG Diploma: Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

4.3 3-year UG Degree: Students who will undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 120 credits and satisfying the minimum credit requirement.

4.4 4-year UG Degree (Honours): A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with 160 credits and have satisfied the credit requirements as given in Table 6 in Section 5.

4.5 4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a Faculty Member of the University. The research project/dissertation will be in the major discipline. The students who secure 160 credits,

including 12 credits from a research project/dissertation, will be awarded UG Degree (Honours with Research).

(Note: ***UG Degree Programmes with Single Major:*** A student must secure a minimum of 50% credits from the major discipline for the 3-year/4-year UG degree to be awarded a single major. For example, in a 3-year UG programme, if the total number of credits to be earned is 120, a student of Mathematics with a minimum of 60 credits will be awarded a B.Sc. in Mathematics with a single major. Similarly, in a 4-year UG programme, if the total number of credits to be earned is 160, a student of Chemistry with a minimum of 80 credits will be awarded a B.Sc. (Hons./Hon. With Research) in Chemistry in a 4-year UG programme with single major. Also the **4-year Bachelor's degree programme with Single Major** is considered as the preferred option since it would allow the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.).

5. Graduate Attributes:

The Learning Outcomes Descriptors and Graduate Attributes

Sl.no.	Graduate Attribute	**The Learning Outcomes Descriptors** ***(The graduates should be able to demonstrate the capability to:)***
GA1	Disciplinary Knowledge	acquire knowledge and coherent understanding of the chosen disciplinary/interdisciplinary areas of study.
GA 2	Complex problem solving	solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations.
GA 3	Analytical & Criticalthinking	apply analytical thought including the analysis and evaluation of policies, and practices. Able to identify relevant assumptions or implications. Identify logical flaws and holes in the arguments of others. Analyse and synthesize data from a variety of sources and draw valid conclusions and support them with evidence and examples.
GA 4	Creativity	create, perform, or think in different and diverse ways about the same objects or scenarios and deal with problems and situations that do not have simple solutions. Think ‘out of the box’ and generate solutions to complex problems in unfamiliar contexts by adopting innovative, imaginative, lateral thinking, interpersonal skills, and emotional intelligence.
GA 5	Communication Skills	listen carefully, read texts and research papers analytically, and present complex information in a clear and concise manner to different groups/audiences. Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media.

GA 6	Research-related skills	develop a keen sense of observation, inquiry, and capability for asking relevant/ appropriate questions. Should acquire the ability to problematize, synthesize and articulate issues and design research proposals, define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships. Should develop the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work.
GA 7	Collaboration	work effectively and respectfully with diverse teams in the interests of a common cause and work efficiently as a member of a team.
GA 8	Leadership readiness/qualities	plan the tasks of a team or an organization and setting direction by formulating an inspiring vision and building a team that can help achieve the vision.
GA 9	Digital and technological skills	use ICT in a variety of learning and work situations. Access, evaluate, and use a variety of relevant information sources and use appropriate software for analysis of data.
GA 10	Environmental awareness andaction	mitigate the effects of environmental degradation, climate change, and pollution. Should develop the technique of effective waste management, conservation of biological diversity,management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.

Programme Learning Outcomes in B.Sc. in Mathematics

PO1: Knowledge of Mathematics:

Acquire knowledge and coherent understanding of different topic of Mathematics and its applications to different fields.

PO2: Ability to solve complex problems solving:

Capacity to use the earned knowledge to solve different non-familiar problems and apply the learning to real world situations; capability to solve problems in computer graphics using concepts of linear algebra; Capability to apply the acquired knowledge in differential equations to solve specific problems in other disciplines.

PO3: Develop analytical & critical thinking:

Able to apply analytical methods to solve various problems appearing in different branches of mathematics and analyze the results and think critically to understand the involved rules or principles of mathematics.

PO4: Develop the ability to creativity

Able to think 'out of the box' and find solutions to complex problems of mathematics by adopting innovative and imaginative ideas.

PO5: Develop effective communications skills:

Capability to express various concepts of mathematics in effective and coherent manner using examples and visualizing their geometrical meaning both in writing and speaking; ability to present the complex mathematical ideas in clear, precise and confident way; ability to explain the development and importance of mathematics in various scientific developments; capability to communicate thoughts and views in mathematically or logically correct statements.

PO6: Develop research-related skills:

i) Potentiality to think and inquire about relevant/appropriate questions, ability to define problems, formulate and test hypotheses, formulate mathematical arguments and proofs, draw conclusions; ability to write the obtained results clearly.

ii) To know about the developments in various branches of mathematics.

PO7: Develop ability for collaboration/team work:

Able to work effectively and respectfully with diverse teams in the interests of a common cause and work efficiently as a member of a team in group project work.

PO8: Develop leadership qualities

Able to develop leadership qualities by enhancing problem-solving skills, decision-making abilities, critical thinking, communication skills, strategic thinking, resilience, perseverance, collaboration, and teamwork.

PO9: Develop digital and technological skills:

- Ability to use ICT and other online tools in solving problems or earning knowledge.
- Capacity to use appropriate software and programming skills to solve problems in mathematics.

PO10: Create environmental awareness and develop ability to address the problems:

Provides the tools and techniques necessary for analyzing data, modeling complex systems, optimizing resource allocation, assessing risks, and making informed decisions in the field of environmental awareness and action.

7. Programme Specific Outcomes in B.Sc. in Mathematics

PSO-1: Enable a student to be better and effective communicator of mathematics by written, computational and graphical means.

PSO-2: Ability to illustrate mathematical ideas from basic theorems and axioms.

PSO-3: Ability to apply mathematics to solve, analyze theoretical problems of mathematics.

PSO-4: Enable a student to identify applications of mathematics in other disciplines and in the real-world, leading to enhancement of career prospects in a relevant fields and

8. Teaching Learning Process

Teaching and learning in this programme involve classroom lectures, computer lab and tutorials.

It allows-

- The tutorials allow a closer interaction between the students and the teacher as each student gets individual attention.
- Written assignments and projects submitted by students
- Project-based learning
- Group discussion
- Home assignments
- Class tests
- Quizzes
- PPT presentations, Seminars, interactive sessions
- Co-curricular activity etc.
- Industrial Tour or Field visit

9. Assessment Methods

9.1 The Programme structures and examinations is based on Semester System.

9.2 In addition to end term examinations, student shall be evaluated for his/her academic performance in a Programme through, presentations, analysis, homework assignments, term papers, projects, field work, seminars, quizzes, class tests or any other mode as may be prescribed in the syllabi. The basic structure of each Programme shall be prescribed by the Board of Studies and approved by the Academic Council.

9.3 Credits assigned to it depending upon the academic load of the Programme which shall be assessed on the basis of weekly contact hours of lecture, tutorial and laboratory classes, self-study. The credits for the project and the dissertation shall be based on the quantum of work expected.

9.4 The components of internal assessment may vary. However, the following suggestive table indicates the distribution of marks for various components in a semester: -

	Component of Evaluation	**Marks**	**F Frequency**	**Code**	**Weightage (%)**
A	**Continuous Evaluation**				
I	Analysis/Class test	Combination of any three from (i) to (v) with 5 marks each	1-3	C	25%
ii	Home Assignment		1-3	H	
iii	Project		1	P	
iv	Seminar		1-2	S	
v	Viva-Voce/Presentation		1-2	V	
vi	MSE	MSE shall be of 10 marks	1-3	Q/CT	
vii	Attendance	Attendance shall be of 5 marks	100%	A	5%
B	Semester End Examination		1	SEE	70%
					100%

10. Programme Structure of B.Sc. in Mathematics

Year	Semester	Component	Couse code	Number of Courses	Course Level	Credit per Course	Total creditin the component
First Year	I	Major (Core)					
		Calculus	MAT012M101	2	100	3	6
		Classical Algebra and Trigonometry	MAT012M102			3	
		Minor					
		Fundamental Mathematics-I	MAT012N101	1	100	3	3
		Interdisciplinary					
		Introduction to Indian Knowledge System – I	IKS-1	1	100	3	3
		Communicative English-I	CEN982A101	1		1	1
		Behavioural Science-I	BHS982A102	1		1	1
		Mathematical programming tools-I	MAT012S111	1		3	3
		VAC- (Basket Course)	VAC-1	1		3	3
				7			**20**
	II	Major (Core)					
		Vector analysis and Linear Algebra	MAT012M201	2	100	3	6
		Analytical Geometry (2D & 3D)	MAT012M202			3	
		Minor					
		Fundamental Mathematics-II	MAT012N201	1	100	3	3
		Interdisciplinary					
		Introduction to Indian Knowledge System – II	IKS-II	1	100	3	3
		Communicative English-I	CEN982A201				
		Behavioural Science-I	BHS982A202				
		Mathematical programming tools-II	MAT012S211	1		3	3

		VAC- (Basket Course)	VAC-2	1	100	3	3
				7			**20**
Second Year	III	Major (Core)					
		Ordinary Differential Equations	MAT012M301	2	200	4	8
		Real Analysis	MAT012M302			4	
		Minor					
		Matrix algebra and Vector calculus	MAT012N301	1	200	4	4
		Interdisciplinary					
		Basket Course	IDC-3	1	200	3	3
		Communicative English-I	CEN982A301	1		1	1
		Behavioural Science-I	BHS982A302	1		1	1
		Introduction to data science	MAT012S311	1		3	3
				6			**20**
	IV	Major (Core)					
		Complex Analysis	MAT012M401	3	200	4	12
		Abstract Algebra	MAT012M402			4	
		Partial Differential Equations	MAT012M403			4	
		Minor					
		Coordinate Geometry	MAT012N401	2	200	3	6
		Differential Equations	MAT012N402			3	
		Communicative English-I	CEN982A401	1		1	1
		Behavioural Science-I	BHS982A402	1		1	1
				6			**20**

Year	Semester	Component	Couse code	Numbe rof Courses	Course Level	Credit per Course	Total credit in the component
Third Year	V	Major (Core)					
		Mechanics-I	MAT012M501	3	300	4	12
		Number Theory and Graph Theory	MAT012M502			4	
		Metric Space and Topology	MAT012M503			4	
		Minor					
		Real Analysis	MAT012N501	1	300	4	4
		Internship	MAT012M521	1		4	4
				5			**20**
	VI	Major (Core)					
		Numerical Methods	MAT012M601	4	300	4	16
		Transform Calculus (Laplace & Fourier)	MAT012M602			4	
		Linear Programming	MAT012M603			4	
		Mechanics-II	MAT012M604			4	
		Minor					
		Modern Algebra	MAT012N601	1	300	4	4
../				**5**			**20**
	VI I	Major (Core)					
		Advanced calculus	MAT012M701	4	400	4	16
		Spherical Trigonometry and Tensor Calculus	MAT012M702			4	
		Mathematical Logic & Combinatorics	MAT012M703			4	

		Python Programming	MAT012M704			4	
		Minor					
		Numerical Methods	MAT012N701	1	400	4	4
				5			**20**
	VIII	Major (Core)					
		Guide specific paper	MAT012M801	1	400	4	8
		Research Methodology	MAT012M802	1		4	
		Dissertation/Research Project	MAT012M823	1		12	12
		Or 400 level advanced course Core (in lieu of Dissertation/Research Project)					
		Advanced Real Analysis	MAT012M803	3	400	4	
		Fuzzy set theory	MAT012M804			4	
		Mathematical Modelling	MAT012M805			4	
				3/5			**20**

SYLLABUS (1ST SEMESTER)

Subject Name: Calculus	**Level: 100**	**Subject Code: MAT012M101**
L-T-P-C: 3-1-0-3	**Credit: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Calculus (MAT02M101)** is to impart the fundamental concepts of calculus and to explain various real-life problems which can be solved by using calculus.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different methods of finding higher order differential and integral calculus of various functions.	BT1
CO2	**Illustrate** various methods to find higher order differentiation and integration of various functions.	BT2
CO3	**Apply** differentiation to find extreme values of functions, Jacobian, physical properties of various transformations.	BT3
CO4	**Analyze** concepts of differential calculus and integral calculus theories and their applications to scientific problems.	BT4

Prerequisite:

- Basic concepts of function, limit, continuity, differentiability of single variable functions
- Basic differentiation of important functions (from 10+2 level).
- Basic integration of important functions (from 10+2 level).

Detailed Syllabus:

Modules	Topics / Course Contents	Periods
I	**Differentiation:** Successive differentiation, nth derivative of some standard functions and Leibnitz's theorem, function of several variables, limit and continuity of function of several variables, partial differentiation, partial derivatives of first and higher orders for functions of two and three variables, Euler's theorem on homogeneous functions, total derivatives.	15
II	**Application of differentiation:** Jacobian, maxima and minima of function of several variables (two and three variables only), Leibnitz's rule (differentiation under integral sign). Tangents and normal-angle of intersection of two curves, length of tangent, normal, derivative of arc-length, pedal equations, angle between radius vector and tangent, Asymptotes-definition and working rules for finding asymptotes (in case of Cartesian equations).	15

III	**Curvature and curve tracing:** Curvature-definition of curvature and radius of curvature (Cartesian and polar), formulae for radius of curvature, circle of curvature. Singular points, double points, cusp, node, conjugate point, multiple point, determination of multiple points of the curve $f(x,y)=0$. Curve tracing—tracing of catenary, cissoid, asteroid, cycloid, folium of Descartes, cardioide, lemniscate.	15
IV	**Integration and its applications:** Integrals of the form $\int \frac{px+q}{\sqrt{ax^2+bx+c}}dx$, $\int (px+q)\sqrt{ax^2+bx+c}\,dx$, $\int \frac{dx}{(px+q)\sqrt{ax^2+bx+c}}$ Integration of rational functions of sin x and cos x.(review only) Reduction formulae for integration of some functions, Multiple integral (double, triple integral and application), Change of variables, change of order of integration.	15
TOTAL		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	–	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Differential and Integral calculus;* Piskunov N.; Paperback edition; 2018; Aargon Press.

Reference Books:

1. Apostol Tom M.; *Calculus* Volume-1; Second edition; 1975; John Wiley and Sons.
2. Apostol Tom M.; *Calculus*, Volume-2; Second edition; 1975; John Wiley and Sons.
3. Ayres Frank , Jr., Mendalson Elliott; *Calculus*; 2013; (Schaum's Outlines), McGraw - Hill.

SYLLABUS (1ST SEMESTER)

Subject Name: Classical Algebra and Trigonometry Level: 100 Subject Code: MAT012M102

L-T-P-C: 3-1-0-3 Credit: 4 Scheme of Evaluation: T

Objective: The objective of **Classical Algebra and Trigonometry** (**MAT012M102)** is to impart the fundamental concepts of classical algebra and trigonometry and to apply the results of classical algebra and trigonometry to any other field of mathematics for higher study.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** concept of classical and trigonometry.	BT1
CO2	**Understand** inequalities and different inequality theorems.	BT2
CO3	**Solve** different types of algebraic equations.	BT3
CO4	**Analyze** various aspects of trigonometric and logarithm functions.	BT4

Prerequisites:

- Concept of Classical Set theory.

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	**Relations:** Review (Relations, Functions, Composition of functions, Invertible functions), Binary relation, Well ordering principle, Equivalence relation, congruence relation in integers, Equivalence class, Relation induced by a partition of a set, Fundamental theorem on Equivalence relation, Partial order relation, Chain, Hasse diagram of partially ordered set, Maximal, Minimal element, infimum, supremum.	15
II	**Inequalities:** Inequalities $AM \geq GM \geq HM$ and their generalizations, the theorem of weighted means, Cauchy Schwarz Inequality, Weirstrass' Inequalities, Extreme values of sum & product.	15
III	**Theory of equations:** Relation between the roots and coefficients of a general polynomial equation in one variable, Transformation of equations, Descarte's rule of signs, Strum's theorem (statement only), Symmetric functions of roots, Solution of cubic equation by Cardon's method, Solution of biquadratic equation by Ferrari's method.	15

IV	**De'Moivre's theorem and its applications:** De'Moivre's theorem, Expansion of cosx and sinx in positive integral powers of x, Logarithm of a complex number, Exponential and Trigonometric functions of a complex variable, Euler's expansion for cosine and sine, Inverse functions, Gregory's series and its variants.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	–	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Higher Algebra (classical);* Mapa S.K.; 2014; Sarat Book House; Calcutta.
2. *Part II- Plane Trigonometry*; Loney S. L.; Paperba edition; 2016; G.K. Publication Private limited.

Reference Books:

1. *Higher Algebra*; Hall H.S. and Knight S. R.; Paperback edition; 2016; Arihant Publications.
2. Das and Mukherjee; *Higher Trigonometry*; 33rd edition; 1933, Dhur and Sons; Kolkata.
3. Das B. & Maiti S. R.; *Higher Algebra*; 16th edition; 2010; Asoke Prakasan; Calcutta.
4. Bernard, S. & Child, J.M.; *Higher Algebra*; 2000; Macmillan India Ltd; Delhi.

SYLLABUS (1ST SEMESTER)

Subject Name: Fundamental Mathematics-I Level: 100 Subject Code: MAT012N101
L-T-P-C: 2-1-0-3 Credit: 3 Scheme of Evaluation: T

Objective: The objective of **Fundamental Mathematics-I (MAT02N101)** is to impart the fundamental concepts of calculus and to explain various real-life problems which can be solved by using calculus.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different methods of finding derivative and integration of various functions.	BT1
CO2	**Illustrate** different methods to find differentiation and integration of various functions.	BT2
CO3	**Apply** differentiation to find extreme values of functions, Jacobian and tangent and normal.	BT3
CO4	**Analyze** concepts of differential calculus and integral calculus theories and their applications to scientific problems.	BT4

Prerequisite:

- Basic concepts of function, limit, continuity, differentiability of single variable functions
- Basic differentiation and integration of important functions (from 10+2 level).

Detailed Syllabus:

Modules	Topics / Course Contents	Periods
I	**Differentiation:** Limit and continuity of a function, Derivative of a function, Geometrical meaning of derivative, Product rule, Quotient rule and chain rule of differentiation, Successive Differentiation, Leibnitz's theorem, Partial derivative and total derivative.	15
II	**Application of differentiation:** Rolle's theorem, Mean value theorem, Jacobian, Maxima or minima of a function of two variables, Tangent and normal. Leibnitz's rule for differentiation under integral sign.	15

III	**Integration:** Definition, Standard formulae, Rules of integration, Method of substitution, Integration by parts, Method of Partial fractions, Standard integrals, Definite integrals, Properties of definite integrals.	15
IV	**Application of integration:** Reduction formulae for some standard functions, Multiple integral (double and triple integral), Area, volume and surface area by integration.	15
TOTAL		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	–	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Differential and Integral calculus;* Piskunov N.; Paperback edition; 2018; Aargon Press.

Reference Books:

1. Apostol Tom M.; *Calculus* Volume-1; Second edition; 1975; John Wiley and Sons.
2. Apostol Tom M.; *Calculus*, Volume-2; Second edition; 1975; John Wiley and Sons.
3. Ayres Frank , Jr., Mendalson Elliott; *Calculus*; 2013; (Schaum's Outlines), McGraw - Hill.

SYLLABUS (1st SEMESTER)

Subject Name: Mathematical programming tools-I, Level: 100

Subject Code: MAT012S11
L-T-P-C: 0-0-6-3 Credit Units: 3 Scheme of Evaluation: P

Course Objectives:

The objective of Mathematical programming tools-I is to familiarize students with the usage of mathematical software (Mathematica/MATLAB/Maxima/Maple).

After successful completion of the course, student will be able to

Sl No	Course outcome	Bloom's Taxonomy Level
CO1	Define basic terms relating to Mathematica	BT1
CO2	Demonstrate different functions using codes of Mathematica	BT2
CO3	Apply different codes of Mathematica to find outputs.	BT3
CO4	Compare and conclude the output obtained by using Mathematica	BT4

Prerequisites:

- Knowledge of fundamentals of algebra, calculus and linear algebra.

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	**Functions of single variable and their Graphs:** Use of Mathematica as a calculator, Defining Function of single variable, Computing and plotting functions in 2D, Plot Options.	15
II	**Functions of two variables and their Graphs:** Plotting functions of two variables using Plot3D function, Contour Plot using "**ContourPlot"**, Plotting para metric curves surfaces using 'ParametricPlot3D' function, Customizing plots.	15
III	**Algebra:** Factoring, Expanding and plot polynomials, Finding Roots of Polynomials with 'Solve' and 'NSolve', Partial fractions using 'Apart', Simplification, Solving Systems of Equations.	15

IV	**Calculus:** Computing Limits, Derivative of a given function, Partial Derivative of a function, Finding higher Order Derivatives.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
-	60	30 (Problem solving, Project, Internship, Seminar, Workshop)

Text Books:

1. Bruce F. Torrence, Eve A. Torrence, *The Student's Introduction to Mathematica ® A Handbook for Precalculus, Calculus, and Linear Algebra*, CUP

Referencet Book:

1. Bindner, Donald & Erickson, Martin. (2011): *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.

SYLLABUS (2nd SEMESTER)

Subject Name: Vector Analysis and Linear Algebra **Level: 100**
Subject Code: MAT012M201
L-T-P-C: 3-1-0-3 **Credit: 3** **Scheme of Evaluation: T**

Objectives: The objective of **Vector Analysis and Linear Algebra (MAT012C201)** is to provide the fundamentals & concept of vector algebra, vector calculus and matrix algebra.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Remember** the definitions and formulae of vector calculus and linear algebra.,	BT1
CO2	**Understand** the theories of vector analysis and linear algebra.	BT2
CO3	**Apply** the theories of vector analysis and linear algebra to solve related problems.	BT3
CO4	**Analyze** the theories of vector analysis and linear algebra with examples.	BT4

Prerequisites:

- Position vector, collinear vectors, parallel vectors, coplanar vectors, unit vectors, modulus of a vector, rectangular resolution of a vector, vector addition, scalar product and vector product of two and three vectors
- Matrix addition and multiplication.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Vector Algebra: Scalar and vector product of four vectors, Conditions for collinearity and coplanarity, Vector equations of line and Plane, Distance of a point from a line, length of perpendicular from a point to a plane, distance of a point from a plane, Equation of the line of intersection of two planes. Shortest distance between two skew lines.	15
II	Vector Calculus: Ordinary differentiation of vector functions, Partial derivatives, Vector differential operator, Properties & significance of gradient, divergence & curl, Laplacian, Level surface, Directional derivative. Line, Surface and volume integrals. Green's theorem (with proof) and applications. Stokes theorem, Gauss divergence theorem (without proof) and their applications.	15

III	Matrix Algebra and Determinants: Algebra of matrices/Identity, scalar, diagonal matrix and Trace/Transpose of a Matrix, Power Matrices, Invertible Matrices/ Special Matrices: Symmetric, Skew-symmetric Matrices, Idempotent, nilpotent and orthogonal Matrices / Complex Matrices, Hermitian and Skew-Hermitian Matrices, Unitary Matrices / Normal Matrices and Properties / square block matrices. Basic properties of determinants, Cofactors, minors, principal minors / Singular and non-singular matrices/Evaluation of determinants: Laplace expansion / Adjoint and its properties / Volume as a determinant.	15
IV	System of linear equations: System of linear equations / Elementary row operations; pivots / Inverse of a matrix (Gauss-Jordan reduction), Cramer's rule, Rank of a matrix, Echelon matrices, Normal form/ consistency and inconsistency of the system (homogeneous and non-homogeneous) / solution using Gauss elimination and Gauss-Jordan elimination / LU Decomposition method.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Vector Analysis*; Spiegal Murrary, 2nd Edition, 2017; Tata McGraw Hill Education.
2. *Linear Algebra*, Hoffman Kenneth and Kunze Ray, 2015, PHI learning private limited.

Reference Books:

1. Narayana Shanti; *A Text Book of Vector Calculus;* 2003; S. Chand & Co., New Delhi.
2. Lipschutz Seymour, *Linear Algebra*, 2017, Tata McGraw-Hill publishing Co Ltd.
3. Friedberg, Insel, Spence, "*Linear Algebra",* 4th edition 2015, Pearson Education India.
4. Raisinghania M. D.; *Vector Analysis*; 2nd Edition; 2015; S. Chand And Co.

SYLLABUS (2nd SEMESTER)

Subject Name: Analytical Geometry	**Level: 100**	**Subject Code: MAT012M202**
L-T-P-C: 3-1-0-3	**Credit: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Analytical Geometry (MAT012M202)** is to impart fundamental laws and formulas of coordinate geometry and to demonstrate the algebraic methods to study geometry and to make graphical representations of algebraic equations.

Prerequisites:

- Basic concepts (absolute value, graphing, distance formula), inclination and slope of a line, division of a line segment, analytic proofs of geometric theorems, relations, and functions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of two- and three-dimensional geometry.	BT1
CO2	**Understand** the equation and geometry of two- and three-dimensional coordinate system.	BT2
CO3	**Apply** the theories of two- and three-dimensional coordinate geometry to solve related problems.	BT3
CO4	**Analyze** two- and three-dimensional coordinate geometry to sketch different geometrical shapes.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	Transformation and Pair of Straight Lines: Transformation of Rectangular axes, Invariants, Removal of the xy-term, Pair of straight lines: Condition that the general equation of second degree in two variables may represent two straight lines, Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$, and Angle bisector between pair of lines.	15
II	General Equation of Second Degree: General Equation of Second degree of two variables for conic section, Parabola, Standard form of the equation of a Parabola, Different forms of Parabola, Parametric Equation of a Parabola, Ellipse, Standard form of the equation of a Ellipse, Different forms of Ellipse, Parametric Equation of a Ellipse, Hyperbola, Standard form of the equation of Hyperbola, Conjugate Hyperbola, Parametric Equation of a Hyperbola, Pole, and Pair of tangents.	15

III	**Three-dimensional Geometry-I:** Rectangular Cartesian Co-ordinates in space, Direction cosines and angle between two lines, Equation of Plane in General form, Intercept and Normal form, Plane passing through three points, and Angle between two Planes. Straight line in symmetrical form, Angle between two lines, Coplanar lines, and Skew lines.	15
IV	**Three-dimensional Geometry-II:** Sphere: Plane section of a sphere, Sphere through a given circle. Intersection of two spheres, Condition for orthogonality of two spheres, Cone, Equation of the Cone with the origin as vertex and a given curve as a base, Equation of the Right Circular Cone and Cylinder, Equation of a Cylinder, Equation of a Right Circular Cylinder.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Seminar, Internship, Workshop, Field Trip)

Text Books:

1. *The Elements of Coordinate Geometry*; Loney S. L.; 6th Edition, 2016, Arihant Publication.

Reference Books

1. Bell R. J. T., *An Elementary Treatise on Co-ordinate Geometry*; 2018; Franklin Classics.
2. Askwith E. H.; *A Course of Pure Geometry*, 2018; Franklin Classics.
3. Vittal P. R.; *Analytical Geometry 2D and 3D*; 2013; Pearson Education.

SYLLABUS (2ND SEMESTER)

Subject Name: Fundamental Mathematics-II Level: 100 Subject Code: MAT012N201
L-T-P-C: 2-1-0-3 Credit: 3 Scheme of Evaluation: T

Objective: The objective of **Fundamental Mathematics-II (MAT02N201)** is to impart the fundamental concepts of classical algebra and trigonometry and to apply the results of classical algebra and trigonometry to any other field of mathematics for higher study.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** concept of classical and trigonometry.	BT1
CO2	**Understand** inequalities and different inequality theorems.	BT2
CO3	**Solve** different types of algebraic equations.	BT3
CO4	**Analyze** various aspects of trigonometric and logarithm functions.	BT4

Prerequisites:

- Concept of Classical Set theory.

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	**Relations:** Set, Relations, Functions, Composition of functions, Invertible function, Binary relation, Equivalence relation, Equivalence class, Relation induced by a partition of a set.	15
II	**Inequalities:** Inequalities $AM \geq GM \geq HM$ and their generalizations, Cauchy Schwarz Inequality, Weirstrass' Inequalities, Extreme values of sum & product.	15
III	**Theory of equations:** Relation between the roots and coefficients of a general polynomial equation in one variable, Symmetric functions of roots, Transformation of equations, Descarte's rule of signs, Solution of cubic equation by Cardon's method.	15

IV	**De'Moivre's theorem and its applications:** De'Moivre's theorem, Expansion of cosx and sinx in positive integral powers of x, Logarithm of a complex number, Exponential and Trigonometric functions of a complex variable, Euler's expansion for cosine and sine, Inverse functions, Gregory's series.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Higher Algebra (classical);* Mapa S.K.; 2014; Sarat Book House; Calcutta.
2. *Part II- Plane Trigonometry*; Loney S. L.; Paperba edition; 2016; G.K. Publication Private limited.

Reference Books:

1. *Higher Algebra*; Hall H.S. and Knight S. R.; Paperback edition; 2016; Arihant Publications.
2. Das and Mukherjee; *Higher Trigonometry*; 33rd edition; 1933, Dhur and Sons; Kolkata.
3. Das B. & Maiti S. R.; *Higher Algebra*; 16th edition; 2010; Asoke Prakasan; Calcutta.
4. Bernard, S. & Child, J.M.; *Higher Algebra*; 2000; Macmillan India Ltd; Delhi.

SYLLABUS (2nd SEMESTER)

Subject Name: Mathematical programming tools-II **Level: 100**

Subject Code: MAT012S211
L-T-P-C: 0-0-6-3 **Credit Units: 3** **Scheme of Evaluation: P**

Course Objectives:

The objective of Mathematical programming tools-II is to familiarize students with the usage of mathematical software (Mathematica/MATLAB/Maxima/Maple).

After successful completion of the course, student will be able to

Sl No	Course outcome	Bloom's Taxonomy Level
CO1	Define basic terms relating to Mathematica	BT1
CO2	Demonstrate different functions using codes of Mathematica	BT2
CO3	Apply different codes of Mathematica	BT3
CO4	Compare and conclude the output obtained by using Mathematica	BT4

Prerequisites:

- Knowledge of fundamentals of algebra, calculus and linear algebra.

Detailed Syllabus:

Modules	Topic /Course content	Periods
I	**Working with Matrices I:** Write Matrices and use of 'MatrixForm', Check dimensions of a given matrix, Matrix addition and multiplication, Transpose, Determinant, Inverse of a matrix.	15
II	**Working with Matrices II:** Minors and cofactors, Working with large matrices**,** Performing Gauss elimination, Solving system of linear equations, Eigenvalue and Eigenvectors of a matrix, Rank and nullity of a matrix**.**	15
III	**Lines and Line Segments**: Parallel and Perpendicular Lines, Angle between Lines, Two–Point Form, Point–Slope Form, Slope–Intercept Form, Intercept Form, Normal Form.	15

IV	**Circles and Conic:** Plotting of circle, Circle Through Three Points, Plotting of parabola, Parabola from Focus and Directrix, Plotting of ellipse, Ellipse from Vertices and Eccentricity, Ellipse from Foci and Eccentricity	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
-	60	30 (Problem solving, Project, Internship, Seminar, Workshop)

Text Books:

1. Bruce F. Torrence, Eve A. Torrence, *The Student's Introduction to Mathematica ® A Handbook for Precalculus, Calculus, and Linear Algebra*, CUP
2. Exploring Analytic Geometry with Mathematica, Donald L. Vossler, Anaheim, California USA, 1999.

Referencet Book:

1. Bindner, Donald & Erickson, Martin. (2011): *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics*. CRC Press, Taylor & Francis Group, LLC.

SYLLABUS (3rd SEMESTER)

Subject Name: Ordinary Differential Equations		**Subject Code: MAT012M301**
L-T-P-C: 3-1-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objectives: The objective of **Ordinary Differential Equations** (**MAT012M301)** is to understand different forms of first ordinary differential equations, their solution methods and application to physical problems.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different terms and definitions related to ordinary differential equations and identify different solution methods for ODE.	BT1
CO2	**Understand** the different methos of first and higher order differential equations.	BT2
CO3	**Apply** different methods to solve related problems of ordinary differential equations.	BT3
CO4	**Analyze** the solution of differential equations relating to physical or real-life problems.	BT4

Prerequisites:

- Concept of Differential Calculus and Integral Calculus from HS (10+2) level.
- Concept of Ordinary Differential Equation from HS (10+2) level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Equations of first order** Introduction to differential equations, Separation of variables, Homogeneous Equation and equation reducible to homogeneous form, Exact differential equation and equation reducible to exact differential equation, Linear differential equations and equations reducible to linear form, Bernoulli's equation, Equation solvable for x, y and p, Clairaut's equation.	18
II	**Higher order homogeneous and non-homogeneous linear differential equations** Linear equations with constant coefficients, Homogeneous (Cauchy-Euler) Equation, Equations reducible to homogeneous form, Method of variation of parameters, Method of undetermined coefficients, Method of operators, Wronskian and its properties.	18

III	**Simultaneous and total differential equations** Ordinary simultaneous differential equations, working rules for solving simultaneous equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$, total differential equations, condition for integrability, condition for exactness and methods of solution.	18
IV	**Application of ODE** Trajectory, orthogonal trajectories in cartesian and polar coordinates, population dynamics, chemical reaction, equation of motion.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Differential Equations*, Ross S. L., 3rd Edition, 2007, Wiley India.

Reference Books:

1. Raisinghania M.D., *Ordinary and Partial Differential Equations*, 19th edition, 2017, S. Chand and Co., New Delhi.
2. Coddington E. A. and Levinson N., *Theory of Ordinary Differential Equations*, Indian Edition., 2017 , Tata McGraw-Hill, New Delhi.
3. Ayers Jr Frank, *Schaum's Outline Series of Theory and problems of differential equations* , Reprint, 1989, Tata McGraw-Hill, New Delhi.
4. F. Brauer F. and Nohel J. A., *The Qualitative Theory of Ordinary Differential Equations: An Introduction*, New edition, 1999, Dover Publications Inc.

SYLLABUS (3rd SEMESTER)

Subject Name: Real Analysis		**Subject Code: MAT012M302**
L-T-P-C: 3-1-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Real Analysis (MAT012M302)** is to develop independent thinking and problem-solving skills in various analytical properties of the real number system.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of Real analysis.	BT1
CO2	**Understand** the theories of Real analysis.	BT2
CO3	**Apply** the theories of Real analysis to solve related problems.	BT3
CO4	**Analyze** the theories of Real analysis with examples.	BT4

Prerequisite:

- Concept of Set theory and Calculus from HS level.

Modules	Topics / Course Contents	Periods
I	**Real Number System** Algebraic properties of $\mathbb{R}$, Absolute value and the real line, bounded and unbounded sets, Supremum and infimum of subsets of $\mathbb{R}$, Completeness property of $\mathbb{R}$, Archimedean property, Dense property of rational numbers, Neighborhood of a point in $\mathbb{R}$, Open and closed sets in $\mathbb{R}$.	18
II	**Sequences and Series** Sequences and their limits, convergent sequence, limit theorem, monotone sequence, subsequences, Limit superior and limit inferior for bounded sequence, series, convergence of series, Cauchy criterion for series, comparison tests, d'Alembert's Ratio Test, Cauchy's Root Test, Leibnitz's test for alternating series.	18

III	**Limits and continuity of functions** Cluster/Limit point, Limit of functions ($\epsilon - \delta$ approach), sequential criterion for limits, Divergence criterion, limit theorems, infinite limits, limits at infinity, Continuity, Algebra of continuous functions, the maximum-minimum theorem.	18
IV	**Uniform continuity of functions and Differentiation** Uniform continuity, Lipschitz function, Differentiability of functions, Algebra of differentiable functions, Rolle's theorem, Mean value theorem, intermediate value property of derivatives, L'Hospital's rules.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Introduction to Real Analysis*; Bartle, Robert G., Sherbert Donald R.; Fourth Edition; 2018;Wiley India Pvt. Ltd.
2. *A Basic Course in Real Analysis*; Kumar, A. and Kumaresan, S.; Reprint 2016; CRC Press.

Reference Book:

1. *Mathematical Analysis*; Malik, S.C. and Arora Savita; Fifth edition; 2017; New Age ScienceLtd.
2. *Introduction to Analysis*, Mattuck, Arthur. ;1999; Prentice Hall.
3. *A Course in Calculus and Real Analysis*; Ghorpade, Sudhir R. & Limaye, B. V.; 2006; Undergraduate Texts in Mathematics, Springer (SIE).
4. *Principles of Mathematical Analysis*; Rudin Walter; Third Edition; 2017; McGraw HillEducation.
5. *Basic Real Analysis*; Sohrab, Houshang H.; Second Edition; 2014; Birkhauser.
6. *Elementary Analysis: The Theory of Calculus*; Ross, Kenneth A.; Second Edition; 2013; Springer.

SYLLABUS (3rd SEMESTER)

Subject Name: Matrix algebra and Vector calculus		**Subject Code: MAT012N301**
L-T-P-C: 3-1-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objectives: The objective of **Matrix algebra and Vector calculus (MAT012N301)** is to provide the fundamentals & concept of matrix algebra, vector algebra and vector calculus.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Remember** the definitions and formulae of vector calculus and matrix algebra.,	BT1
CO2	**Understand** the theories of vector analysis and matrix algebra.	BT2
CO3	**Apply** the theories of vector analysis and matrix algebra to solve related problems.	BT3
CO4	**Analyze** the theories of vector analysis and matrix algebra with examples.	BT4

Prerequisites:

- Position vector, collinear vectors, parallel vectors, coplanar vectors, unit vectors, modulus of a vector, rectangular resolution of a vector, vector addition, scalar product and vector product of two and three vectors.
- Matrix addition and multiplication.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Matrix Algebra and Determinants:** Algebra of matrices/Identity, scalar, diagonal matrix and Trace/Transpose of a Matrix, Power Matrices, Invertible Matrices/ Special Matrices: Symmetric, Skew-symmetric Matrices, Idempotent, nilpotent and orthogonal Matrices / Complex Matrices, Hermitian and Skew-Hermitian Matrices, Unitary Matrices / Normal Matrices and Properties / square block matrices. Basic properties of determinants, Cofactors, minors, principal minors / Singular and non-singular matrices/Evaluation of determinants: Laplace expansion / Adjoint and its properties.	15

II	**System of linear equations:** System of linear equations / Elementary row operations; pivots / Inverse of a matrix (Gauss-Jordan reduction), Cramer's rule, Rank of a matrix, Echelon matrices, Normal form/ consistency and inconsistency of the system (homogeneous and non-homogeneous) / solution using Gauss elimination and Gauss-Jordan elimination / LU Decomposition method.	15
III	**Vector Algebra:** Conditions for collinearity and coplanarity, Vector equations of line and Plane, Distance of a point from a line, length of perpendicular from a point to a plane, distance of a point from a plane, Equation of the line of intersection of two planes. Shortest distance between two skew lines.	15
IV	**Vector Calculus:** Ordinary differentiation of vector functions, Partial derivatives, Vector differential operator, Properties & significance of gradient, divergence & curl, Laplacian, Level surface, Directional derivative. Line and Surface integral, Statement of Green's and Stoke's Theorem and their simple applications.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Vector Analysis*; Spiegal Murrary, 2nd Edition, 2017; Tata McGraw Hill Education.
2. *Linear Algebra*, Hoffman Kenneth and Kunze Ray, 2015, PHI learning private limited.

Reference Books:

1. Narayana Shanti; *A Text Book of Vector Calculus;* 2003; S. Chand & Co., New Delhi.
2. Lipschutz Seymour, *Linear Algebra*, 2017, Tata McGraw-Hill publishing Co Ltd.
3. Friedberg, Insel, Spence, "*Linear Algebra",* 4th edition 2015, Pearson Education India.
4. Raisinghania M. D.; *Vector Analysis*; 2nd Edition; 2015; S. Chand And Co.
5. Tallack J.C; *Introduction to Vector Analysis*; 1st Edition; 2009; Cambridge University Press.

SYLLABUS (3rd SEMESTER)

Paper III/Subject Name: Introduction to Data Science Subject Code: MAT012S311

L-T-P-C: 2-0-2-3Credit Units: 3 Scheme of Evaluation: TP (T-40%, P-30%, CE-30%)

Objective: The objectives of the course **Introduction to Data Science (MAT01S311)** are to impart the knowledge of data handling with R.

Course Outcome:

After successful completion of the course, students will be able to		
Sl. No.	Course outcome	Bloom's Taxonomy Level
CO1	**State** various methods of assembling, storing and cleaning of data	BT1
CO2	**Discuss** univariate and bivariate data	BT2
CO3	**Apply** various techniques of data handling	BT3
CO4	**Examine** the nature and shape of the data	BT4

Prerequisite:

- Basic concepts of averages.
- Basic knowledge of MS-Excel.

Detailed Syllabus:

Modules	Topics / Course Content	Periods
I	**Data Collection:** Concept of a statistical population and sample from a population; qualitative and quantitative data. Primary data, secondary data, questionnaire and schedule. Construction of tables with one or more factors of classification. Diagrammatic and Graphical representation of non-frequency data. Frequency distribution, cumulative frequency distribution and their graphical representation - histogram, frequency polygon and Ogive, Syntax of R.	**15**
II.	**Data Handling-1:** Univariate data: Concepts of Central tendency or location, Mean, Median and Mode. Concept of Dispersion, range, Mean Deviation and Standard Deviation and their relative measures, Skewness, Kurtosis, Syntax of R.	**15**
III.	**Data Handling-2:** Bivariate Data: Introduction to Correlation, Diagrammatic method and Mathematical methods of simple correlation, probable error, rank correlation for untied and tied ranks. Introduction to simple regression and prediction, Syntax of R.	**15**

IV	**Hands-on Programme with R:** Construction of Frequency distribution and drawing of charts, Mean Deviation and Standard Deviation, Data Cleaning, Summary statistics, Correlation and Regression.	**15**
TOTAL		**60**

Credit distribution		
Theory	Practicum	Experiential Learning
30	30	30 (Problem solving, Presentation, Project, Internship. Seminar, Workshop, Field Trip)

Text Books:

1. *Fundamentals of Mathematical Statistics*; Gupta S. C., Kapoor V. K.; 10th revised edition, 2014, Sultan Chand and Sons, New Delhi
   Sultan Chand & Sons Publishers.
2. *Basics of R and Data Analysis in Research"*; Kalita. B; 2023; Himalaya Publishing House, Mumbai.

Reference Books:

1. *Statistical Methods: An Introductory Text*; Medhi. J; 2006; New Age International Publishers.
2. Choudhury L; "*Introduction to Statistics*"; Vol 1 & 2, 2002, Kitap Ghar, Guwahati.
3. Saxena H C; "*Calculus of Finite Difference & Numerical Analysis*"; 2010; S. Chand.
4. Spiegel Murray R, Schiller John J, Srinivasan R. Alu; "*Schaum's outline: Probability and Statistics*"; 4th Edition; 2012; Mc Graw –Hill Education.
5. Hooda R P; "*Statistics for Business and Economics*"; 3rd Edition, Macmillan India Ltd.
6. Goon A.M., Gupta M.K. and Dasgupta B.; "*Fundamentals of Statistics* (Vol.2)"; 2001; World Press.

SYLLABUS (4th SEMESTER)		
Subject Name: Complex Analysis		**Subject Code: MAT012M401**
L-T-P-C: 3-1-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Complex Analysis** (**MAT012M401)** is **t**o provide the fundamental concepts of complex analysis.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the different terms of complex number system.	BT1
CO2	**Understand** the theories of complex analysis.	BT2
CO3	**Apply** the theories of complex analysis to solve related problems.	BT3
CO4	**Analyze** different theories of complex analysis.	BT4

Prerequisites:

- Concept of real number system and calculus in the set of real numbers.

Detailed Syllabus:

Modules	Topics /Course content	Periods
I	**Complex Numbers:** Introduction to Complex number system (Fundamental operations with complex numbers, Vector representation of complex coordinates, Absolute value and conjugate coordinates with properties), Graphical representation of complex numbers (e.g. straight line, triangle, circle) and related problems, Polar form of complex numbers, De Moivre's Theorem, Roots of Complex numbers, Stereographic Projection, Dot and Cross product, Point sets and regions in complex plane, Extended complex plane.	18
II	**Functions, Limits and Continuity:** Variables and functions, Single and multiple valued functions, Inverse functions, Transformations, Curvilinear coordinates, Branch points and branch lines, Riemann surfaces, limits, Theorems on limits, Infinity, Continuity, Theorems on continuity, Uniform continuity, Sequences, Limit of a sequence, Infinite series.	18

III	**Complex Differentiation:** Differentiability, Analytic function, Cauchy Riemann Equations, Polar form of Cauchy Riemann Equations, Harmonic Functions, Harmonic conjugates, Geometric representation of derivative, Higher order derivatives, L'Hospital's Rule, Singularities, Construction of Analytic function, Orthogonal system	18
IV	**Elementary functions and definite integrals:** Elementary functions, Periodic functions, Zero of a function, Exponential Function, Trigonometric functions, Hyperbolic functions, Logarithimic function, Complex exponents, inverse trigonometric functions, Inverse hyperbolic functions, Definite integrals of functions, Contours, Contour integrals and its examples, Moduli of contour integrals.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship. Seminar, Workshop, Field Trip)

Text Books:

1. *Complex Variables and Applications;* Churchill R.V. and Brown J.W.; 8th edition; 2017; McGraw Hill Education.
2. *Schaum's Outline of Complex Variables*; Spiegel M.R.; 2edition; 2017; McGraw-Hill.

Reference Books:

1. Ahlfors L. V.; *Complex Analysis*; 3nd Edition; 2000; McGraw-Hill.
2. D. Sarason; *Complex Function Theory*; 2008; Hindustan Book Agency, Delhi.
3. Rudin, W.; *Real and Complex Analysis*; 3rd edition; 2017; McGraw-Hill.
4. Conway J. B.; *Functions of one complex variable;* Springer International Student edition; 2012; Narosa Publishing House, New Delhi.
5. ITL ESL Research and Development wing; *Complex analysis; 2012;* Pearson Education, New Delhi

SYLLABUS (4th SEMESTER)

Subject Name: Abstract Algebra **Subject Code: MAT012M402**
L-T-P-C: 3-1-0-4 **Credit Units: 4** **Scheme of Evaluation: T**

Objective: The objective of **Abstract Algebra** (**MAT012M402)** is to provide the concept of algebraic structures and their applications.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of Abstract Algebra.	BT1
CO2	**Understand** the theories of Abstract Algebra.	BT2
CO3	**Apply** the theories of Abstract Algebra.to solve related problems.	BT3
CO4	**Examine** the theories of Abstract Algebra with examples.	BT4

Prerequisites:

- Knowledge of set theory

Detailed Syllabus:

Modules	Topics/Course content	Periods
I	Binary relation, Equivalence relation, Equivalence class, Mappings, Composition of mappings, Binary operations, Concept of algebraic structure, Semigroup, Group.	18
II	Abelian Group, Order of a group, Subgroups, Cosets, Lagrange's theorem, Index of a subgroup, Order of an element of a group, Cyclic groups, Permutation, Cycle, Transposition, Product of disjoint cycles, Even and odd permutations, Permutation Group, Symmetric group, Alternating Group.	18
III	Normal sub-groups of a Group, Quotient Group, Homomorphism, Fundamental theorem of Homomorphism, Isomorphism of Groups. First, Second and Third isomorphism theorems, Cayley's theorem, Centralizer, Normalizer, Center of a group.	18

IV	Rings, Unitary and commutative rings. Sub-ring Divisors of zero, Integral domain, Field, sub-field, Characteristic of a ring, Ideals, Ideal generated by a subset of a ring, Operations on ideals, Prime and Maximal ideals.	18
Total		72

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Contemporary Abstract Algebra*; Gallian J. A.; 8th edition; 2013; Cengage Publication.
2. I. N. *Herstein*; *Topics in Algebra*; 2nd edition; 2006; John *Wiley* & Sons; New York.

Reference Books:

1. Malik D. S., Mordeson J.N., Sen M. K. ; *Fundamentals of Abstract Algebra* ; 1996; McGraw Hill Company.
2. *A course in Abstract Algebra*, V.K. Khanna, S.K. Bhamri, Vikash Publishing House Pvt Ltd.
3. *Modern Algebra*; Singh Surajeet and Zameeruddin Qazi; Eighth Edition; 2006; Vikash Publishing House Pvt Ltd.
4. Fraleigh John B.; *A First Course in Abstract Algebra*; 7th edition; 2013; Pearson Education India.
5. Dummit D. and Foote R.; *Abstract Algebra*; 3rd edition; 2011; *Wiley*; New York.
6. Jacobson, N.*; I & II Basic Algebra*; Second edition; 2009; Hindusthan Publishing Corporation, India.

SYLLABUS (4th SEMESTER)

Subject Name: Partial Differential Equations		**Subject Code: MAT012M403**
L-T-P-C: 3-1-0-4	**Credit Units: 4**	**Scheme of Evaluation: T**

Objective: The objective of **Partial Differential Equations** (**MAT012M403**) is to develop the concepts of different forms of partial differential equations, their solution methods and application to physical problems.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** different terms and definitions related to partial differential equations and identify different solution methods for PDE.	BT1
CO2	**Understand** the different methos of first and higher order partial differential equations.	BT2
CO3	**Apply** tdifferent methods to solve related problems of partial differential equations.	BT3
CO4	**Analyse** the solution of partial differential equations relating to physical or real-life problems.	BT4

Prerequisites:

- Concept of Differential Calculus and Integral Calculus.
- Concept of Ordinary differential equations.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Linear partial differential equations of first order** Introduction to first order PDE, solution by direct integration, Lagrange's method of solving First order linear PDE, Integral surfaces passing through a given curve, surfaces orthogonal to a given system of curves.	**18**
II	**Non-linear partial differential equations of first order** Charpit's methods of solving first order but of any degree PDE, Standard forms of solution, Complete integral, particular integral, singular integral and general integral for solution of non-linear PDE, Jocobi's method of solving PDE with three independent variables.	**18**

III	**Linear partial differential equations with constant coefficients** Homogeneous and non-homogeneous linear PDE with constant coefficients, equations reducible to linear equations with constant coefficients, solution under given geometrical conditions	**18**
IV	**Second order partial differential equations** Solution of PDE of order two with variable coefficients, Laplace's transformation (Canonical forms), Monge's method, Method of separation of variables for Laplace equations, Heat equations, Wave equations	**18**
Total		**72**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
72	-	48 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Book:

1. *Elements of partial differential equations*, Snedden Ian Naismith, Reprint, 2006, Dover Publications Inc.
2. *Ordinary and Partial Differential Equations,* Raisinghania M.D., 19th Edition, 2017, S. Chand & Company Ltd.

Reference Books:

1. Logan J. David, *Applied Partial Differential Equations*, 3rd Edition, 2014, Springer Nature.
2. Tveito Aslak, Winther Ragnar., *Introduction to partial differential equations: a computational approach*, Vol. 25, 2005, Springer-Verlag Berlin Heidelberg.

SYLLABUS (4th SEMESTER)

Subject Name: Coordinate Geometry	**Level: 100**	**Subject Code: MAT012N401**
L-T-P-C: 2-1-0-3	**Credit: 3**	**Scheme of Evaluation: T**

Objective: The objective of **Coordinate Geometry (MAT012N401)** is to impart fundamental laws and formulas of coordinate geometry and to demonstrate the algebraic methods to study geometry and to make graphical representations of algebraic equations.

Prerequisites:

- Basic concepts (absolute value, graphing, distance formula), inclination and slope of a line, division of a line segment, analytic proofs of geometric theorems, relations, and functions.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Recall** the definitions and formulae of two- and three-dimensional geometry.	BT1
CO2	**Understand** the equation and geometry of two- and three-dimensional coordinate system.	BT2
CO3	**Apply** the theories of two- and three-dimensional coordinate geometry to solve related problems.	BT3
CO4	**Analyze** two- and three-dimensional coordinate geometry to sketch different geometrical shapes.	BT4

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Transformation and Pair of Straight Lines:** Transformation of Rectangular axes, Invariants, Removal of the xy-term, Pair of straight lines: Condition that the general equation of second degree in two variables may represent two straight lines, Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$.	15
II	**General Equation of Second Degree:** General Equation of Second degree of two variables for conic section, Parabola, Standard forms of the equation of a Parabola Ellipse, Standard forms of the equation of an Ellipse, Hyperbola, Standard forms of the equation of Hyperbola.	15

III	**Three-dimensional Geometry-I:** Rectangular Cartesian Co-ordinates in space, Direction cosines and angle between two lines, Equation of Plane in General form, Intercept and Normal form, Plane passing through three points, and angle between two Planes. Straight line in symmetrical form, angle between two lines.	15
IV	**Three-dimensional Geometry-II:** Sphere: Plane section of a sphere, Sphere through a given circle. Intersection of two spheres, Condition for orthogonality of two spheres, Cone, Equation of the Cone with the origin as vertex and a given curve as a base, equation of right circular cone, Cylinder, Equation of a Cylinder, and equation of Right Circular Cylinder.	15
Total		60

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

2. *The Elements of Coordinate Geometry*; Loney S. L.; 6th Edition, 2016, Arihant Publication.

Reference Books

4. Bell R. J. T., *An Elementary Treatise on Co-ordinate Geometry*; 2018; Franklin Classics.
5. Askwith E. H.; *A Course of Pure Geometry*, 2018; Franklin Classics.
6. Vittal P. R.; *Analytical Geometry 2D and 3D*; 2013; Pearson Education.

SYLLABUS (4th SEMESTER)

Subject Name: Differential Equations **Subject Code: MAT012N402**
L-T-P-C: 2-1-0-3 **Credit Units: 3** **Scheme of Evaluation: T**

Objectives: The objective of **Differential Equations (MAT012N402)** is to introduce the fundamental concepts of ordinary and partial differential equations and to explain the methods to solve such equations.

Course Outcomes:

After successful completion of the course, student will be able to		
Sl No	**Course Outcome**	**Bloom's Taxonomy Level**
CO1	**Define** the first order differential equations and learn to solve first order differential equations by using different standard methods.	BT1
CO2	**Understand** the second order linear differential equations and able to apply the methods to solve such equations.	BT2
CO3	**Apply** different standard methods to solve first order linear and non-linear partial differential equations.	BT3
CO4	**Analyze** second order partial differential equations and find it's solution by standard methods.	BT4

Prerequisites:

- Concept of Differential Calculus and Integral Calculus from HS (10+2) level.
- Concept of Ordinary Differential Equation from HS (10+2) level.

Detailed Syllabus:

Modules	Topics / Course content	Periods
I	**Equations of first order** Introduction to differential equations (origin, order and degree, formation, types of solution), Separation of variables, Homogeneous Equation and equation reducible to homogeneous form, Exact differential equation, Linear differential equations, Bernoulli's equation, Application of first order differential equations.	**15**
II	**Higher order linear differential equations** Linear equations with constant coefficients, Homogeneous (Cauchy-Euler) Equation, Equations reducible to homogeneous form, Method of variation of parameters.	**15**
III	**Linear and Non-linear partial differential equations of first order** Definition, order, degree and formation of PDE, solve by direct integration, Lagrange's method of solving First order linear PDE, Classification of first	**15**

	order PDE, Non-linear PDE, Charpit's method of solution, Standard forms of solution.	
IV	**Linear partial differential equations with constant coefficients and Second order PDE** Homogeneous and non-homogeneous linear PDE with constant coefficients, Classification of second order PDE, Solution of second order PDE by Monge's method and Method of separation of variables.	**15**
Total		**60**

Credit Distribution		
Theory	**Practicum**	**Experiential Learning**
60	-	30 (Problem solving, Presentation, Project, Internship, Seminar, Workshop, Field Trip)

Text Books:

1. *Differential Equations*, Ross S. L., 3rd Edition, 2017, Reprint, Wiley India.
2. *Applied Partial Differential Equations*, Logan J. David, 3rd Edition, 2014, Springer Nature.

Reference Books:

1. Raisinghania M.D., *Ordinary and Partial Differential Equations*, 2017, S. Chand and Co., New Delhi.
2. Coddington E. A. and Levinson N., *Theory of Ordinary Differential Equations*, 1st Edn., 2017, Tata McGraw-Hill, New Delhi.
3. *Elements of partial differential equations*, Snedden Ian Naismith, Reprint, 2006, Dover Publications Inc.
4. **Tveito** Aslak**, Winther** Ragnar., *Introduction to partial differential equations: a computational approach*, Vol. 25, 2005, Springer-Verlag Berlin Heidelberg.