NewEducationPolicy(NEP-2020)
Syllabus

DRAFT

Four-year
UndergraduateProgramme

Department of Mathematics

Cotton University

Panbazar, Guwahati
Assam

PART I

1.1 Introduction

Higher education plays a critical role in securing gainful work and/or offering further access to higher education. As a result, improving the quality of higher education should be given top priority in order to enable the next generation of students to acquire the skills, training, and knowledge they need to improve their thinking, comprehension, and application abilities and prepare them to compete, succeed, and excel globally.

The Cotton University envisions all of its programme in the best interests of its students, and in this effort, it has given all of its Undergraduate courses a new perspective. For all of its Undergraduate programme, it uses a Learning Outcome-based Curriculum Framework (LOCF).

At the undergraduate level, the LOCF approach is intended to provide a focused, outcome-based curriculum with an agenda to shape teaching-learning experiences in a more student centric manner. The LOCF strategy has been implemented to enhance students' experiences as they participate in their chosen programme. Students will be prepared for both academics and employment through the Undergraduate Programs.

The syllabus developed for B. Sc. (Honours) in Mathematics has the provision of ensuring the integrated personality of the students in terms of providing opportunity for exposure to the students towards Core Courses, Discipline Specific Courses, Generic Elective Courses, Ability Enhancement Courses and Skill Enhancement Courses with special focus on technical, communication and subject specific skills through practical and other innovative transitional modes to develop their employ-ability skills.

1.2 Learning Outcomes-based Approach to Curriculum Planning and Development

The basic objective of the learning outcome based approach to curriculum planning and development is to focus on demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected of graduates of a programme of study. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study.
The expected learning outcomes are used to set the benchmark to formulate the course outcomes, programme specific outcomes, programme outcomes and graduate attributes. These outcomes are essential for curriculum planning and development, and in the design, delivery and review of academic programmes. They provide general direction and guidance to the teaching-learning process and assessment of student learning levels under a specific programme.

The overall objectives of the learning outcomes-based curriculum framework are to:

- help formulate graduate attributes, qualification descriptors, programme learning outcomes and course learning outcomes that are expected to be demonstrated by the holder of a qualification;
- enable prospective students, parents, employers and others to understand the nature and level of learning outcomes (knowledge, skills, attitudes and values) or attributes a graduate of a programme should be capable of demonstrating on successful completion of the programme of study;
- maintain national standards and international comparability of learning outcomes and academic standards to ensure global competitiveness, and to facilitate student/graduate mobility; and
- provide higher education institutions an important point of reference for designing teaching-learning strategies, assessing student learning levels, and periodic review of programmes and academic standards.

1.3 Key outcomes underpinning curriculum planning and development

The learning outcomes-based curriculum framework is a framework based on the expected learning outcomes and academic standards that are expected to be attained by graduates of a programme of study. The key outcomes that underpin curriculum planning and development include Graduate Attributes, Programme Outcomes, Programme Specific Outcomes, and Course Outcomes.

1.3.1 Graduate Attributes

The disciplinary expertise or technical knowledge that has formed the core of the university courses. They are qualities that also prepare graduates as agents for social good in future. Some of the characteristic attributes that a graduate should demonstrate are as follows:

1. **Disciplinary knowledge**: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines
2. **Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions and articulating
3. **Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others
4. **Critical thinking**: Capability to apply analytic thought to a body of knowledge
5. **Problem solving**: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems
6. **Communication Skills**: Ability to express thoughts and ideas effectively in writing and orally
7. **Information/digital literacy**: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.
8. **Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion.
9. **Cooperation/Team work**: Ability to work effectively and respectfully with diverse teams
10. **Scientific reasoning**: Ability to analyze, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective

11. **Reflective thinking**: Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society.
12. **Multicultural competence**: Possess knowledge of the values and beliefs of multiple cultures and a global perspective
13. **Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work
14. **Leadership readiness/qualities**: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
15. **Lifelong learning**: Ability to acquire knowledge and skills, including 'learning how to learn', that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

1.3.2 Programme Outcomes (POs) for Undergraduate programme (Honours)

POs are statements that describe what the students graduating from any of the educational programmes should able to do. They are the indicators of what knowledge, skills and attitudes a graduate should have at the time of graduation.

PO1. In-depth knowledge: Understand the concepts and processes related to an academic field of study and demonstrate the applicability of their domain knowledge and its links to related disciplinary areas/subjects of study.
PO2. Specialized knowledge and skills: Demonstrate procedural knowledge and skills in areas related to one's specialization and current developments, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialization.
PO3. Analytical and critical thinking: Demonstrate independent learning, analytical and critical thinking of a wide range of ideas and complex problems and issues.
PO4. Research and Innovation: Demonstrate comprehensive knowledge about current research in the subject of specialization, critical observation to identify research problems and to collect relevant data from a wide range of sources, analysis and interpretation of data using methodologies as appropriate to the area of specialization for formulating evidence-based research output.
PO5. Interdisciplinary Perspective: Commitment to intellectual openness and developing understanding beyond subject domains.
PO6. Communication Competence: Demonstrate effective oral and written communicative skills to covey disciplinary knowledge and to communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study
PO7. Career development: Show proficiency in academic, professional, soft skills and employability required for higher education and placements.
PO8. Teamwork: Work in teams with enhanced interpersonal skills leadership qualities.

PO9. Commitment to the society and the Nation: Recognize the importance of social, environmental, human and other critical issues faced by humanity at the local, national and international level; appreciate the pluralistic national culture and the importance of national integration.

1.3.3 Programme Specific Outcomes (PSOs) in Mathematics

Programme specific outcomes include subject-specific skills and generic skills, including transferable global skills and competencies, the achievement of which the students of a specific programme of study should be able to demonstrate for the award of the degree. The programme specific outcomes would also focus on knowledge and skills that prepare students for further study, employment, and citizenship. They help ensure comparability of learning levels and academic standards across universities and provide a broad picture of the level of competence of graduates of a given programme of study. The attainment of PSOs for a programme is computed by accumulating PSO attainment in all the courses comprising the programme.

PSO1. Basic Concept: Ability to interpret and analyze various concepts and theories
PSO2. Understanding real life application: An understanding application of various methods and apply in real life problem.
PSO3. Research and Innovation: Use of knowledge to identify a wide range of contemporary problems and issues and acquire research skills to produce a well-researched written work using geographical research tools.
PSO4. Critical thinking: Able to identify critical problems.

Programme Outcomes (POs) matrix(Core)

Programme Outcome (PO)	MTH23C101	MTH23C201	MTH23C301	MTH23C302	MTH23C401	MTH23C402	MTH23C403	MTH23C501	MTH23C502	MTH23C503	MTH23C504
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Programme Outcome (PO)	MTH23C601	MTH23C602	MTH23C603	MTH23C604	MTH23C701	MTH23C702	MTH23C703	MTH23C704	MTH23C801	MTH23C802	MTH23C803
PO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Programme Outcome (PO)	MTH23C804
PO1	✔
PO2	✔
PO3	✔
PO4	✔
PO5	✔
PO6	✔

PO7	✔
PO8	✔
PO9	✔

Programme Specific Outcomes (PSOs) matrix(Core)

Programme Specific Outcome (PSO)	MTH23C101	MTH23C201	MTH23C301	MTH23C302	MTH23C401	MTH23C402	MTH23C403	MTH23C501	MTH23C502	MTH23C503	MTH23C504
PSO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PSO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PSO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PSO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Programme Specific Outcome (PSO)	MTH23C601	MTH23C602	MTH23C603	MTH23C604	MTH23C701	MTH23C702	MTH23C703	MTH23C704	MTH23C801	MTH23C802	MTH23C803
PSO1	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PSO2	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PSO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
PSO4	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

Programme Specific Outcome (PO)	MTH23C804
PSO1	✔
PSO2	✔
PSO3	✔
PSO4	✔

Programme Outcomes (POs) matrix(Minor)

Programme Outcome (PO)	MTH23M101	MTH23M201	MTH23M301	MTH23M401	MTH23M501	MTH23M601	MTH23M701	MTH23M801
PO1	✔	✔	✔	✔	✔	✔	✔	✔
PO2	✔	✔	✔	✔	✔	✔	✔	✔
PO3	✔	✔	✔	✔	✔	✔	✔	✔
PO4	✔	✔	✔	✔	✔	✔	✔	✔
PO5	✔	✔	✔	✔	✔	✔	✔	✔
PO6	✔	✔	✔	✔	✔	✔	✔	✔
PO7	✔	✔	✔	✔	✔	✔	✔	✔
PO8	✔	✔	✔	✔	✔	✔	✔	✔
PO9	✔	✔	✔	✔	✔	✔	✔	✔

Programme Specific Outcomes (PSOs) matrix(Minor)

Programme Specific Outcome (PO)	MTH23M101	MTH23M201	MTH23M301	MTH23M401	MTH23M501	MTH23M601	MTH23M701	MTH23M801
PSO1	✔	✔	✔	✔	✔	✔	✔	✔
PSO2	✔	✔	✔	✔	✔	✔	✔	✔
PSO3	✔	✔	✔	✔	✔	✔	✔	✔
PSO4	✔	✔	✔	✔	✔	✔	✔	✔

Programme Outcomes (POs) matrix(MDE)

Programme Outcome (PO)	MTH23MDE101	MTH23MDE201	MTH23MDE301
PO1	✔	✔	✔
PO2	✔	✔	✔
PO3	✔	✔	✔
PO4	✔	✔	✔
PO5	✔	✔	✔
PO6	✔	✔	✔
PO7	✔	✔	✔

PO8	✔	✔	✔
PO9	✔	✔	✔

Programme Specific Outcomes (PSOs) matrix(MDE)

Programme Specific Outcome (PSO)	MTH23MDE101	MTH23MDE201	MTH23MDE301
PSO1	✔	✔	✔
PSO2	✔	✔	✔
PSO3	✔	✔	✔
PSO4	✔	✔	✔

Programme Outcomes (POs) matrix(VAC)

Programme Outcome (PO)	MTH23 VAC C06	MTH23 VAC
PO1	✔	✔
PO2	✔	✔
PO3	✔	✔
PO4	✔	✔
PO5	✔	✔
PO6	✔	✔
PO7	✔	✔

PO8	✔	✔
PO9	✔	✔

Programme Specific Outcomes (PSOs) matrix(VAC)

Programme Specific Outcome (PSO)	MTH23 VAC C06	MTH23 VAC
PSO1	✔	✔
PSO2	✔	✔
PSO3	✔	✔
PSO4	✔	✔

Programme Outcomes (POs) matrix(SEC)

Programme Outcome (PO)	MTH23SEC101	MTH23SEC201	MTH23SEC301
PO1	✔	✔	✔
PO2	✔	✔	✔
PO3	✔	✔	✔
PO4	✔	✔	✔
PO5	✔	✔	✔
PO6	✔	✔	✔
PO7	✔	✔	✔
PO8	✔	✔	✔
PO9	✔	✔	✔

Programme Specific Outcomes (PSOs) matrix(SEC)

Programme Specific	MTH23SEC101	MTH23SEC201	MTH23SEC301

Outcome (PSO)			
PSO1	✔	✔	✔
PSO2	✔	✔	✔
PSO3	✔	✔	✔
PSO4	✔	✔	✔

1.4 Teaching-learning process

The department of Mathematics, Cotton University has student-centric teaching-learning pedagogies to enhance the learning experiences of the students. All classroom lectures are interactive in nature, allowing the students to have meaningful discussions and question and answer sessions. Apart from the physical classes, lectures are also held in online mode where students can have doubt clearing and discussions with the teachers. Most of the teachers use ICT facilities with power-point presentations, e-learning platforms and other innovative e-content platforms for student-centric learning methods.

The department has adopted participative teaching-learning practices, which includes seminars, presentations and group discussions. These participative teaching-learning practices are included in the curricula of almost all the courses. Apart from these, exposure visits, special lectures by invited experts, workshops, and National/International seminars are held to augment knowledge, encourage innovative ideas and expose the students to global academic and research advancement.

The short-term projects, research projects, assignments and field works, which are the integral components of all the courses, enable the students to solve practical problems. Students are also being engaged in sample surveys, data collection and analysis works of the in-house and external research projects for acquiring experiential learning. The laboratories of the department offer hands-on learning experiences to the students.

1.5 Assessment methods

A variety of assessment methods that are appropriate to the discipline are used to assess progress towards the course/programme learning outcomes. Priority is accorded to formative assessment. Progress towards achievement of learning outcomes is assessed using the following: closed-book examinations; problem based assignments; practical assignment; laboratory reports; individual project reports (case-study reports); team project reports; oral presentations, including seminar presentation; viva voce interviews; computerised testing and any other pedagogic approaches as per the context.

PART II

Structure of Under-Graduate programme in Mathematics

Choice Based Credit System

B.Sc. Mathematics, Cotton University

Semester	Paper Code	Paper name	Credit
SEM-1	MTH23C101	ALGEBRA-I	**3+1+0=4**
	MTH23MDE101	BASIC MATHEMATICS-I	**2+1+0=3**
	MTH23M101	ALGEBRA	**3+1+0=4**
	MTH23 VAC C06	VEDIC MATHEMATICS	**2+0+0=2**
	MTH23SEC101	C LANGUAGE	**2+1+0=3**
SEM-2	MTH23C201	ANALYSIS-I	**3+1+0=4**
	MTH23MDE201	BASIC MATHEMATICS-II	**2+1+0=3**
	MTH23M201	REAL ANALYSIS	**3+1+0=4**
	MTH23 VAC	HISTORY OF MATHEMATICS	**2+0+0=2**
	MTH23SEC201	PROGRAMMING WITH PYTHON	**1+0+2=3**
SEM-3	MTH23C301	VECTOR AND ANALYTIC GEOMETRY	**3+1+0=4**
	MTH23C302	ANALYSIS-II	**3+1+0=4**
	MTH23MDE301	MATHEMATICS-III	**2+1+0=3**
	MTH23M301	CALCULUS	**3+1+0=4**
	MTH23SEC301	LATEX	**1+0+2=3**
SEM-4	MTH23C401	DIFFERENTIAL EQUATIONS-I	**3+0+1=4**
	MTH23C402	LINEAR ALGEBRA-I	**3+1+0=4**
	MTH23C403	ALGEBRA-II	**3+1+0=4**
	MTH23M401	VECTOR AND ANALYTIC GEOMETRY	**3+1+0=4**
SEM-5	MTH23C501	ANALYSIS-III	**3+1+0=4**
	MTH23C502	MULTIVARIATE CALCULUS	**3+1+0=4**
	MTH23C503	NUMBER THEORY	**3+1+0=4**
	MTH23C504	ALGEBRA-III	**3+1+0=4**
	MTH23M501	DIFFERENTIAL EQUATIONS	**3+1+0=4**
SEM-6	MTH23C601	METRIC SPACE	**3+1+0=4**
	MTH23C602	COMPLEX ANALYSIS	**3+1+0=4**

	MTH23C603	DIFFERENTIAL EQUATIONS-II	**3+1+0=4**
	MTH23C604	NUMERICAL ANALYSIS	**3+1+0=4**
	MTH23M601	LINEAR ALGEBRA	**3+1+0=4**
SEM-7	MTH23C701	ANALYSIS-IV	**3+1+0=4**
	MTH23C702	DIFFERENTIAL EQUATIONS-III	**3+1+0=4**
	MTH23C703	ALGEBRA-IV	**3+1+0=4**
	MTH23C704	MECHANICS	**3+1+0=4**
	MTH23M701	MULTIVARIATE CALCULUS	**3+1+0=4**
SEM-8	MTH23C801	TOPOLOGY	**3+1+0=4**
	MTH23C802	LINEAR ALGEBRA-II	**3+1+0=4**
	MTH23C803	INTEGRAL TRANSFORMS	**3+1+0=4**
	MTH23C804	RIGID DYNAMICS AND HYDROSTATICS	**3+1+0=4**
	MTH23M801	ABSTRACT ALGEBRA AND NUMERICAL ANALYSIS	**3+1+0=4**

C-Core, M-Minor, MDE-Multi disciplinary elective, SEC-Skill Enhancement Course, VAC-Value added course

UG 1st SEMESTER

PAPER TITLE-ALGEBRA-I
PAPER CODE: MTH23C101
CREDIT-(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, number theory, group theory, symmetry group of a plane figure, basic concepts of cyclic groups, classification of subgroups of cyclic groups.

Course Learning Outcomes : This course will enable the students to:
CO1: Determine number of positive/negative real roots of a real polynomial.
CO2: Solve cubic and quadratic polynomial equations with special condition on roots and in general.
CO3: Employ De-Moivre's theorem in a number of applications to solve numerical problems.
CO4: Use modular arithmetic and basic properties of congruences. Recognize the algebraic structure, namely groups, and classify subgroups of cyclic
groups.

Unit – I (12 Hours)

General properties of polynomials and equations, fundamental theorem of algebra, relations between the roots and the coefficients, upper bounds for the real roots; theorems on imaginary, integral and rational roots; newton's method for integral roots, Descartes' rule of signs;

Unit – II (10 Hours)

De-Moivre's theorem for integer and rational indices and their applications, the nth roots of unity, Euler's expansion of sine and cosine, hyperbolic function, inverse function, Gregory's series, Cardan's solution of the cubic, Descartes' solution of the quadratic equation.

Unit – II (8 Hours)

Division algorithm in $\mathbb{Z}$, divisibility and the euclidean algorithm, fundamental theorem of arithmetic, modular arithmetic and basic properties of congruence.

Unit – III (18 Hours)

Groups, basic properties, symmetries of a square, dihedral group, order of a group, order of an element, subgroups, center of a group, centralizer of an element, cyclic groups and properties, generators of a cyclic group, classification of subgroups of cyclic groups.

Text Books :

1. Andreescu, Titu & Andrica, D. (2014). Complex numbers from A to...Z. (2nd ed.).

Birkhäuser.
2. Dickson, Leonard Eugene (2009). First Course in the Theory of Equations. John Wiley & Sons, Inc. The Project Gutenberg eBook: http://www.gutenberg.org/ebooks/29785
3. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint 2021.
4. Goodaire, Edgar G., & Parmenter, Michael M. (2006). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2018.

Reference Books :

1. Burnside, W.S., & Panton, A.W. (1979), The Theory of Equations, Vol. 1. Eleventh Edition, (Fourth Indian Reprint. S. Chand & Co. New Delhi), Dover Publications, Inc.
2. Burton, David M. (2011). Elementary Number Theory (7th ed.). McGraw-Hill Education Pvt. Ltd. Indian Reprint.
3. Rotman, Joseph J. (1995). An Introduction to The Theory of Groups (4th ed.). Springer-Verlag, New York.

PAPER TITLE: BASIC MATHEMATICS-I

PAPER CODE:MTH23MDE101

(CREDIT 2+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the concept of set, operations with set, mapping, relations, algebraic system, matrix, determinants, truth table etc.

Course Learning Outcome: This course will enable the students:

CO1: Understand and apply different operations on set.
CO2: Understand apply concepts of relations and mappings.
CO3: Solve system of linear equations by applying concept of matrix.
CO4: Apply the concept of divisors, primes, gcd, congruence.
CO4: Understand the statements involving the connecting words- difference among contradiction, converse and contrapositive.

Unit-I (06 Hours)

Sets, equal sets, subsets, universal set, union and intersection of sets, venn diagrams, operations with sets, the product sets, mapping, one-to-one mapping, onto mapping

Unit-II (06 Hours)

Relations, properties of binary relations, equivalence relations, equivalence class, ordering in sets, operations, types of binary operations, well defined operations, algebraic systems.

Unit-III (10 Hours)

Matrix, different types of matrices, operations, properties, invertible matrices, determinants, adjoint of matrix, solution of system of linear equations,

Unit-IV (04 Hours)

Divisors, primes, gcd, congruence, an application to the calendar.

Unit-V (06 Hours)

Statements, Connecting words/ phrases "if and only if, "implies", "and/or", "implied by", "and", "or", "there exists" and their use through variety of examples related to real life and mathematics. Validating the statements involving the connecting words- difference among contradiction, converse and contrapositive. truth table.

Text Books:

1. Frank Ayres, L. R. Jaising, Theory and problems of abstract algebra, Mcgraw Hill
2. M. K. Sen and B. C. Chakraborty, Introduction to discrete mathematics, Books and allied ltd
3. Burton, David M. (2011). Elementary Number Theory (7th ed.). McGraw-Hill Education Pvt. Ltd. Indian Reprint.

PAPER TITLE-ALGEBRA
PAPER CODE:MTH23M101
CREDIT-(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, number theory, group theory, symmetry group of a plane figure, basic concepts of cyclic groups, classification of subgroups of cyclic groups.

Course Learning Outcomes : This course will enable the students to:
CO1: Determine number of positive/negative real roots of a real polynomial.
CO2: Solve cubic and quardatic polynomial equations with special condition on roots and in general.
CO3: Employ De-Moivre's theorem in a number of applications to solve numerical problems.
CO4: Use modular arithmetic and basic properties of congruences.

Unit – I (12 Hours)

General properties of polynomials and equations, fundamental theorem of algebra, relations between the roots and the coefficients, upper bounds for the real roots; theorems on imaginary, integral and rational roots; newton's method for integral roots, Descartes' rule of signs;

Unit – II (10 Hours)

De-Moivre's theorem for integer and rational indices and their applications, the nth roots of unity, Euler's expansion of sine and cosine, hyperbolic function, inverse function, Gregory's series, Cardan's solution of the cubic, Descartes' solution of the quadratic equation.

Unit – II (8 Hours)

Division algorithm in $\mathbb{Z}$, divisibility and the euclidean algorithm, fundamental theorem of arithmetic, modular arithmetic and basic properties of congruences.

Unit – III (18 Hours)

Groups, basic properties, symmetries of a square, dihedral group, order of a group, order of an element, subgroups, center of a group, centralizer of an element, cyclic groups and properties, generators of a cyclic group, classification of subgroups of cyclic groups.

Text Books :

1. Andreescu, Titu & Andrica, D. (2014). Complex numbers from A to...Z. (2nd ed.). Birkhäuser.
2. Dickson, Leonard Eugene (2009). First Course in the Theory of Equations. John Wiley & Sons, Inc. The Project Gutenberg eBook: http://www.gutenberg.org/ebooks/29785
3. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint 2021.
4. Goodaire, Edgar G., & Parmenter, Michael M. (2006). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2018.

Reference Books :

1. Burnside, W.S., & Panton, A.W. (1979), The Theory of Equations, Vol. 1. Eleventh Edition, (Fourth Indian Reprint. S. Chand & Co. New Delhi), Dover Publications, Inc.
2. Burton, David M. (2011). Elementary Number Theory (7th ed.). McGraw-Hill Education Pvt. Ltd. Indian Reprint.
3. Rotman, Joseph J. (1995). An Introduction to The Theory of Groups (4th ed.). Springer-Verlag, New York.

PAPER TITLE : VEDIC MATHEMATICS

PAPER CODE:MTH23VAC C06
CREDIT(2+0+0)

Workload: 2 Lectures, 0 Tutorial (per week) **Credits:** 2 (2+0+0) **Total number of lectures:** 30

Course Objectives: Foster the love for mathematics by creating a positive attitude through vedic and ancient Indian mathematics, help students appreciate ancient Indian mathematics and its contribution to the world, enhance computational proficiency by involving procedures in linear and matrix algebra, improve geometrical thinking by understanding the basic tenets

of geometry such as construction of line segments, angles, triangles and circles as used in ancient India develop conceptual knowledge of mathematical concepts, appreciate the need of conceptual knowledge over
procedural processes

Course Learning Outcomes: After completion of the course,students shall be able to

CO1: Think critically

CO2: Find mathematical solution of algebraic expressions

CO3: Solve system of linear equations and matrices faster and with ease.

CO4: Appreciate the Mathematical advancements of Ancient India.

Unit - I (04 Hours)

Vedic maths - high speed addition and subtraction, vedic maths - history of vedic maths and its features, vedic maths formulae-*sutras* and *upsutras,* addition in vedic maths-without carrying, dot method, subtraction in vedic maths-*nikhilam, navatash caramam dashatah* (all from 9 last from 10), fraction-addition and subtraction

Unit - II(04 Hours)

Vedic maths- miracle multiplication and excellent division, multiplication in vedic maths, base methods (any two number up to three digits), multiplication by urdhva tiryak sutra, miracle multiplication- any three-digit number by series of 1's and 9's, division byurdhva tiryak sutra (Vinculum method)

Unit -III(04 Hours)

Vedic maths - lightening squares and rapid cubes, square of any two-digit numbers: base method, square of numbers ending in 5: ekadhikena purvena sutra, easy square roots: dwandwa yoga (dulpex) sutra, square root of 2: *baudhayana shulbasutra*, cubing yavadunam sutra

Unit - IV(04 Hours)

Vedic maths- enlighten algebra and geometry: factoring quadratic equations: *anurupyena, adyamadyenantyamantya sutra*, concept of baudhayana (Pythogoras) theorem, crcling a square: *baudhayana shulbasutra*, concept of pi: *baudhayana shulbasutra*, concept of angle ( ), 0^0, 30^0, 45^0, $60^0$and 90^0: *baudhayana* number

Unit - V (04 Hours)

Contribution of Indian Mathematicians- Varahmihir, Brahmagupta, Aryabhatta etc.

Unit - VI (04 Hours)

Easy Solution of linear equations- Introduction of simple equation, Solutions of simple equations, Solutions of linear equations in two variables, Practical application of linear equations in two variables

Unit - VII (04 Hours)

High Speed Matrix Algebra- Introduction and history of Matrices and Determinants,

Matrices and Determinants of third order, Inverse of Matrices

Unit - VIII (04 Hours)

Vedic Geometry- Different forms of straight lines, The Triangle, The Cyclic Quadrilateral, Squares, and the Circle, Geometrical constructions (such as *Altars*), Transformation of simple shapes,
Kalpa Sutras-*Srautha Sutras* and *Sulbha Sutras*

Text Books :

1. Vedic Mathematics, Swami Bharati Krishna Trithaji,*Motilal Banarsidas, New Delhi.*

2. The Essential of Vedic Mathematics, Rajesh Kumar Thakur, *Rupa Publications,New Delhi*
3. Vedic Mathematics For All Ages, Vandana Singhal, *Motilal Banarsidas Publishers.*
4. Elements of Vedic Mathematics, Udayan S. Patankar, Sunil M. Patankar, TTU Press.
5. Vedic Mathematics: The Problem Solver, Ronak Bajaj, *Black Rose Publications.*
6.Vedic Geometry Course, S.K. Kapoor, *Lotus Press*
7. Gardner, Robert and J.F.Staal. *Altar of Fire*.Documentary.The Film Study Center at Harvard University, 1976
8. Vedic Mathematics Made Easy,Dahaval Bathia, Jai co Publishing, New Delhi2019.
9. Vedic Mathematics: Sixteen Simple Mathematical Formulae from the Vedas, Jagadguru Swami Sri Bharati Krishna Tirthaji, Motilal Banarsidas, New Delhi 2015
10.Learn Vedic Speed Mathematics systematically, Chaitanya A.Patil, 2018

Reference Books :

1. A Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, *Wiley Eastern Limited, New Delhi*
2. Magical World of Mathematics, VG Unkalkar, *Vandana publishers, Bangalore*
3. Vedic Mathematics-Modern Research Methods, Tiwari P., *Cumpus Books International*
4. Learning Vedic Mathematics, S.K. Kapoor, *Lotus Press Publications*
5. Vedic Mathematics Made Easy, Dahaval Bathia, *Jaico Publishing, New Delhi*
6. Vedic Mathematics New Horizons Advance Lessons, S.K. Kapoor, *Lotus Press*
7. Enjoy Vedic Mathematics, SM Chauthaiwale, R Kollaru, The Art of Living, Banglore

C LANGUAGE
PAPER CODE:MTH23SEC101
CREDITS (2+0+0)

Course Objectives:The objective of the course is to introduce a brief introduction of compiler, syntax, variable, operators etc. Also basic concept of conditional statement, loops, arrays, function etc.

Course Course Learning Outcomes : This course will enable the students to:
CO1: Understand the basic idea of compiler, interpreter, assembler.
CO2: Understand algorithm and flowchart.
CO3: Understand and apply elementary data types, syntax, operators etc.

CO4: Understand and apply, conditional Statement, array and functions etc.

Unit-I (12 Hours)

Brief introduction of compiler, interpreter, assembler; algorithm and flowchart.

Unit-II (10 Hours)

Elementary data types; variables, constants and identifiers; integer, character, floating point and string constants, variable declaration, initialization of variables, constant data types; local and global variables; syntax and semantics, reserved words, expression in C, operator precedence and associativity, unary, binary and ternary operators, C arithmetic operators, assignment operators, relational operators, logical and bitwise operators, expression statement; header files and library functions.

Unit-III (10 Hours)

Conditional statement: if, if-else, switch; go to statements; loops: for, while and do-while loops; continue statement, nested control statement, array: one dimensional array, two dimensional arrays, function: user defined functions; recursive function.

Lab work:

To evaluate an arithmetic expression, to find gcd, factorial, Fibonacci number, prime number generation, reversing digits of an integer number, finding square root of a number, roots of a quadratic equation, sum of different algebraic and trigonometric series and logarithmic series, base conversion, test for palindrome, addition subtraction and multiplication of matrices, to find the greatest and smallest of a finite number of numbers.

Text Books:

1. E. Balagurusamy, Programming in ANSI C, Tata McGraw Hill, 2010.
2. T. Jeyapoovan, A first course in programming with C, Vikas Publishing House, 2004.

Reference Books :

1. B. W. Kernighan & Dennis M. Ritchie, C programming language, Prentice Hall, 1983.
2.Y. Kanetkar, Let us C, B.P. Publication, 2016.

UG 2nd SEMESTER

PAPER TITLE- ANALYSIS-I
PAPER CODE:MTH23C201
CREDIT-(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives : The course will develop a deep and rigorous understanding of real line $\mathbb{R}$ with algebraic,order and completeness properties to prove the results about convergence and divergence of sequences and series of real numbers.

Course Learning Outcomes : This course will enable the students to:
CO1: Understand the fundamental properties of the real numbers, including completeness and Archimedean, and density property of rational numbers in $\mathbb{R}$.
CO2: Learn to define sequences in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$ and find the limit.
CO3: Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate the limit superior and limit inferior of a bounded sequence.
CO4: Apply limit comparison, ratio, root, and alternating series tests for convergence and absolute convergence of infinite series of real numbers.

Unit – I (12 Hours)

Algebraic and order properties of $\mathbb{R}$, absolute value of a real number, bounded above and bounded below sets, supremum and infimum of a non-empty subset of $\mathbb{R}$, the completeness property of $\mathbb{R}$, archimedean property, density of rational numbers in $\mathbb{R}$.

Unit – II (20 Hours)

Sequences and their limits, convergent sequence, limit theorems, monotone sequences,monotone convergence theorem, subsequences, Bolzano-Weierstrass theorem for sequences,limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's convergence criterion.

Unit – III (16 Hours)

Convergence and divergence of infinite series of real numbers, necessary condition for convergence, Cauchy criterion for convergence, tests for convergence of positive term series, integral test, basic comparison test, limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test, alternating series, Leibniz test, absolute and conditional convergence.

Text Books :

1. Bartle, Robert G., & Sherbert, Donald R. (2011). Introduction to Real Analysis (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
2. Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

3. Denlinger, Charles G. (2011). Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

Reference Books :

1. Aliprantis C. D., & Burkinshaw, O. (1998). Principles of Real Analysis (3rd ed.). Academic Press.
2. Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.
3. Thomson, B. S., Bruckner, A. M., & Bruckner, J. B. (2001). Elementary Real Analysis. Prentice Hall.

PAPER TITLE: BASIC MATHEMATICS-II
PAPER CODE:MTH23MDE201
CREDIT:3(2+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is introduce basic idea of derivative, its geometric interpretation, its application on different types of functions, idea of continuity and some related important theorems. also introduce basic concepts of integration, definite integrals as a limit of a sum, fundamental theorem of calculus and its applications. Introduce related terminology of linear programming (L.P.) problems, mathematical formulation of L.P. problems and solution for problems in two variables.

Course Learning Outcome: This course will enable the students:

CO1: Apply concept of derivative on many real life problems.
CO2: Apply the concept of integration to find area and on other real life problems.
CO3: Solve linear programming problems with two variables using graphical method.
CO4: Study problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions.

Unit-I (10 Hours)

Derivative introduced as rate of change both as that of distance function and geometrically, intuitive idea of limit, definitions of derivative, relate it to slope of tangent of the curve, derivative of sum, difference, product and quotient of functions. Derivatives of polynomial and trigonometric functions. Continuity and differentiability, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit function. Concept of exponential and logarithmic functions and their derivatives. Logarithmic differentiation. derivative of functions expressed in parametric forms. Second order derivatives. Rolle's and Lagrange's Mean Value Theorems (without proof) and their geometric interpretations.

Unit-II (06 Hours)

Applications of derivatives : Rate of change, increasing/ decreasing functions, tangents and normals, approximation, maxima and minima. Simple problems (that illustrate basic principles and understanding of the subject as well as real-life situations).

Unit-III (10 Hours)

Integration as inverse process of differentiation. Integration of a variety of functions by substitution, by partial fractions and by parts, only simple integrals. Definite integrals as a limit of a sum. Fundamental Theorem of Calculus (without proof). Basic properties of definite integrals and evaluation of definite integrals. Applications in finding the area under simple curves.

Unit-IV (06 Hours)

Introduction, related terminology such as constraints, objective function, optimization, different types of linear programming (L.P.) problems, mathematical formulation of L.P. problems, graphical method of solution for problems in two variables, feasible and infeasible regions, feasible and infeasible solutions, optimal feasible solutions.

Reference Books:

1. Shanti Narayan and P K Mittal (2018). Differential Calculus. 15th Ed (Revised)., S Chand Publication, New Delhi
2. Shanti Narayan and P K Mittal (2016). Integral Calculus. 11th Ed (Revised), S Chand Publication, New Delhi
K. Swarup, P.K. Gupta and M.Mohan, Operations Research(Ninth Edition) , Sultan Chand Sons, New Delhi, 2002

PAPER TITLE- REAL ANALYSIS
PAPER CODE: MTH23M201
CREDIT: 4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives : The course will develop a deep and rigorous understanding of real line $\mathbb{R}$ with algebraic,order and completeness properties to prove the results about convergence and divergence of sequences and series of real numbers.

Course Course Learning Outcomes : This course will enable the students to:

CO1: Understand the fundamental properties of the real numbers, including completeness and Archimedean, and density property of rational numbers in $\mathbb{R}$.
CO2: Learn to define sequences in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$ and find the limit.
CO3: Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate the limit superior and limit inferior of a bounded sequence.
CO4: Apply limit comparison, ratio, root, and alternating series tests for convergence

and absolute convergence of infinite series of real numbers.

Unit – I (12 Hours)

Algebraic and order properties of $\mathbb{R}$, absolute value of a real number, bounded above and bounded below sets, supremum and infimum of a non-empty subset of $\mathbb{R}$, the completeness property of $\mathbb{R}$, Archimedean property, density of rational numbers in $\mathbb{R}$.

Unit – II (20 Hours)

Sequences and their limits, convergent sequence, limit theorems, monotone sequences,monotone convergence theorem, subsequences, Bolzano-Weierstrass theorem for sequences,limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's convergence criterion.

Unit – III (16 Hours)

Convergence and divergence of infinite series of real numbers, necessary condition for convergence, Cauchy criterion for convergence, tests for convergence of positive term series, integral test, basic comparison test, limit comparison test, D'alembert's ratio test, Cauchy's nth root test, Raabe's test, alternating series, lionize test, absolute and conditional convergence.

Text Books :

1. Bartle, Robert G., & Sherbert, Donald R. (2011). Introduction to Real Analysis (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
2. Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
3. Denlinger, Charles G. (2011). Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

Reference Books :

1. Aliprantis C. D., & Burkinshaw, O. (1998). Principles of Real Analysis (3rd ed.). Academic Press.
2. Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.
3. Thomson, B. S., Bruckner, A. M., & Bruckner, J. B. (2001). Elementary Real Analysis. Prentice Hall.

PAPER TITLE : HISTORY OF MATHEMATICS
PAPER CODE:MTH23 VAC
CREDIT: 2(2+0+0)

Workload: 2 Lectures, 0 Tutorial (per week) **Credits:** 2 (2+0+0) **Total number of lectures: 30**

Course Objectives : The primary objective of this course is to familiarize the learners with history of woks of Pythagoras, Greek geometry, mathematics in ancient china and India, history of development of solutions of polynomial equations and calculus.

Course Learning Outcome: This course will enable the students to:
CO1: Learn about the works of Pythagoras and Greek Geometry
CO2: Learn about Mathematics in ancient China and India
CO3: Learn about the history of development of solutions of polynomial equations and Calculus.
CO4: Study of areas and volumes, maxima, minima and tangents, the Arithmetica Infinitorum of Wallis, Newton's calculus of infinite series, calculus of Leibniz.

Unit-I (The theorem of Pythagoras) (5 Hours)
Pythagorean triples, rational points on a circle, right-angled triangles, irrational numbers, definition of distance.

Unit-II (Greek Geometry) (05 Hours)
Deductive method, regular polyhedra, ruler and compass constructions, conic sections.

Unit-III (Number Theory in Asia) (06 Hours)
The Euclidean algorithm, the Chinese remainder theorem, linear Diophantine equations, Pell's equation in Brahmagupta, Pell's equation in Bhaskara II, rational triangles, Ramanujan.

Unit -IV(Polynomial Equations) (06 Hours)
Algebra, linear equations and eliminations, quadratic equations, quadratic irrationals, the solution of cubic, angle division, higher degree equations.

Unit-V(Calculus) (06 Hours)
Early results on areas and volumes, maxima, minima and tangents, the Arithmetica Infinitorum of Wallis, newton's calculus of infinite series, calculus of Leibniz.

Text Books :
1.John Stillwell (2010), Mathematics and Its History, Springer

Reference Books :
1. Victor J. Katz(1998): A History of Mathematics: An Introduction, Addison-Wesley

PROGRAMMING WITH PYTHON
PAPER CODE:MTH23SEC201
CREDITS: 2(1+1+0)

Workload: 1 Lectures, 1 Tutorial (per week) **Credits:** 2 (1+1+0) **Total number of lectures:** 30

Course Objective: This course is designed to introduce the student to the basics of programming using Python. The course covers the topics essential for developing well

documented modular programs using different instructions and built-in data structures available in Python. The course aims to provide exposure to basic problem-solving techniques with computers.

Course Learning Outcomes: On successful completion of the course, students will be able to:
CO1: Develop, document, and debug modular python programs to solve computational problems. Select a suitable programming construct and data structure for a situation.
CO2: Use built-in strings, lists, sets, tuples and dictionary in applications.
CO3: Define classes and use them in applications.
CO4: Use files for I/O operations.

THEORY

Unit I(08 Hours)
Introduction to the python language and interpreter. basic syntax, variables and basic data types in python.

UNIT II (08 Hours)
Operators in python. input and output, control statements.

Unit III(08 Hours)
Arrays in python, strings and characters, functions, lists.

Unit IV (08 Hours)
Tuples, dictionaries, exceptions, files in python.

PRACTIAL

SAMPLE LABS

- Write a very simple Python program to display your name.
- Write a program in Python to check if a number is positive, print an appropriate message
- Write a Python program to multiply all the items in a list
- Write a Python program to get the largest number from a list
- Write a Python program to get the smallest number from a list
- Write a program to demonstrate sort(), reverse() methods
- Write a Python program to remove duplicates from a list
- Write a program to prompt for a file name, and then read through the file line-by-line
- Write a Python program to read first n lines of a file
- Write a Python program to read last n lines of a file
- Write a Python program to count the number of lines in a text file
- Write a Python program to count the frequency of words in a file
- Write a Python program to write a list to a file

- Write a Python program to copy the contents of a file to another file
- Write a Python program to append text to a file and display the text
- Write a Python program to create a tuple
- Write a Python program to create a tuple with different data types
- Write a Python program to create a tuple with numbers and print one item
- Write a Python program to unpack a tuple in several variables
- Write a Python program to add an item in a tuple
- Write a program to create a function that takes two arguments, name and age, and print their value.
- Write a program to create function func1() to accept a variable length of arguments and print their values.

Text Books:

16. Python for Everybody, Dr. Charles R. Severance.
17. Core Python Programming, Dr. R Nageswara Rao.

Reference Books:

Fundamentals of Python, Kenneth and Lambert, Cengage Learning
Beginning Programming with Python, John Paul Mueller
Python All-in-One for Dummies, John Shovic
Python for Beginners, Timothy C. Needham
Python Programming, Ramsey Hamilton
Learning with Python, Allen Downey

UG 3rd SEMESTER

PAPER TITLE: VECTOR AND ANALYTIC GEOMETRY
PAPER CODE:MTH23C301

CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The course aims at, studying product of three and four vectors and their geometrical properties, vector differentiation, transformation of coordinates, pair of straight lines, general equation of second degree, polar equation of conics, equation of a sphere, cone, cylinder etc.

Course Learning Outcomes: This course will enable the students to:
CO1: Learn and apply product of three and four vectors with their geometrical properties and learn to differentiate vector valued functions.
CO2: Learn concepts of transformation of coordinate and apply it.
CO3: Learn concepts of pair of straight lines: Homogeneous equation of second degree etc.
CO4: Learn about classification of general equation of second degree, parabola, ellipse and hyperbola, tangent, normal, pole and polar, conjugate diameters, asymptotes etc. Learn about three-dimensional objects such as spheres, cones and cylinders and apply it.

Unit – I (10 Hours)

Product of three and four vectors and their geometrical properties; solutions of vector equations. vector valued functions, differentiation of vector valued functions.

Unit – II (08 Hours)

Transformation of coordinates: Transformation of axes, rotation of axes, invariants, removal of xy-term, pair of straight lines: homogeneous equation of second degree, angle between the pair of lines given by the homogeneous equation, bisectors of the angles between the pair of lines, condition that the general equation of second degree may represent a pair of straight lines, point of intersection, equation of the pair of lines joining the origin to the points of intersection of a line and a curve.

Unit - III (14 Hours)

Classification of general equation of second degree**,** representing lines, parabola, ellipse and hyperbola, tangent, normal, pole and polar, conjugate diameters, asymptotes, reduction to standard form. Polar equation of conics: polar equation of a conic with respect to focus as pole, equation of a chord, tangent, normal.

Unit - IV (16 Hours)

Equation of a sphere, plane section of sphere, tangents and tangent plane to a sphere; equation of a cone, enveloping cone of a sphere, right circular cone; equation of a cylinder, enveloping cylinder and right circular cylinder.

Text Books :

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Indian reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Narayan, Shanti & Mittal, P. K. (2007). Analytical Solid Geometry. S. Chand & Company Pvt Ltd. India.

Reference Books :

1. Bell, Robert J.T. (1972). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan & Co. Ltd. London.
2. George B. Thomas, Jr., & Ross L. Finney (2012). Calculus and Analytic Geometry (9th ed.). Pearson Indian Education Services Pvt Ltd. India.
3. Das, B (2021). Analytical Geometry of two and three dimensions with vector analysis.Orient Book Company.

PAPER TITLE- ANALYSIS-II
PAPER CODE:MTH23C302
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives : The primary objective to introduce the basic tools of calculus, also known as 'science of variation', to provide a way of viewing and analyzing the real-world.

Course Learning Outcomes : This course will enable the students to:
CO1: The notion of limits, continuity and uniform continuity of functions.
CO2: Geometrical properties of continuous functions on closed and bounded intervals.
CO3: Applications of derivative, relative extrema and mean value theorems.
CO4: Higher order derivatives, Taylor's theorem, indeterminate forms and tracing of curves.

Unit – I (16 Hours)

Limits of functions (ε - δ and sequential approach), algebra of limits, squeeze theorem, one-sided limits, infinite limits and limits at infinity; continuous functions and its properties on closed and bounded intervals; uniform continuity.

Unit – II (16 Hours)

Differentiability of a real-valued function, algebra of differentiable functions, chain rule, relative extrema, interior extremum theorem, Rolle's theorem, mean-value theorem and its applications, intermediate value theorem for derivatives.

Unit – III (16 Hours)

Higher order derivatives and calculation of the nth derivative, Leibnitz's theorem; Taylor's theorem, Taylor's series expansions of e^x, sin x, cos x. indeterminate forms, L'Hôspital's rule; concavity and inflection points; singular points, asymptotes, tracing graphs of rational functions and polar equations.

Text Books :

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pvt. Ltd. Reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Bartle, Robert G., & Sherbert, Donald R. (2011). Introduction to Real Analysis (4th ed.). John Wiley & Sons. Wiley India edition reprint.
3. Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.
4. Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Reference Books :

1. Apostol, T. M. (2007). Calculus: One-Variable Calculus with An Introduction to Linear Algebra (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
2. Ghorpade, Sudhir R. & Limaye, B. V. (2006). A Course in Calculus and Real Analysis. Undergraduate Texts in Mathematics, Springer (SIE). Indian reprint.

PAPER TITLE : MATHEMATICS-III
PAPER CODE:MTH23MDE301
CREDIT:3(2+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is introduce basic idea of fundamental principal of counting, factorial and its simple application. Also Pascal's triangle,binomial theorem, random experiments, probability of an event, conditional probability, sequence , series, measure of dispersion, range, mean deviation, variance and standard deviation etc.

Course Learning Outcome: This course will enable the students:

CO1: Understand basic idea of fundamental principal of counting, factorial and its simple

application.

CO2: Understand basic idea of Pascal's triangle,binomial theorem and its simple application.

CO3: Understand basic idea of probability and its application.

CO4: Understand measure of dispersion , sequence , series and its application.

Unit-I (08 Hours)

Fundamental principle of counting, Factorial n. Permutations and combinations, derivation of formulae and their connections, simple applications.

Unit-II (05 Hours)

History, statement and proof of the binomial theorem for positive integral indices, pascal's triangle, general and middle term in binomial expansion, simple applications.

Unit-III (08 Hours)

Random experiments: Outcomes, sample spaces, Events : Occurrence of events, 'not', 'and' & 'or' events, exhaustive events, mutually exclusive events, axiomatic probability, connections with the theories of earlier classes, probability of an event, probability of 'not', 'and' & 'or' events. Multiplication theorem on probability. Conditional probability, independent events, total probability, Baye's theorem. Random variable and its probability distribution, mean and variance of haphazard variable. Repeated independent (Bernoulli) trials and binomial distribution.

Unit-IV (05 Hours)

Sequence and Series. arithmetic progression (A.P.), arithmetic mean (A.M.), geometric progression (G.P.), general term of a GP., sum of n terms of a GP., geometric mean (G.M.), relation between A.M. and GM. Sum to n terms of the special series

Unit-V (06 Hours)

Measure of dispersion, range, mean deviation, variance and standard deviation of ungrouped/ grouped data, analysis of frequency distributions with equal means but different variances.

Reference Books:

1. S. K. Mapa, Higher Algebra, Asoke Prakasan

2. M. K. Sen and B. C. Chakraborty, Introduction to discrete mathematics, Books and allied ltd

3. Elements of probability and statistics, Tata McGraw-Hill Pvt. Com Ltd.

PAPER TITLE: CALCULUS
PAPER CODE:MTH23M301
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives:the course objectives of this course is to understand the quantitative change in the behaviour of the variables and apply them on the problems related to the environment.

Course Learning Outcomes: Upon completion of this course, students will be able to:

CO1. Understand continuity and differentiability in terms of limits. Describe asymptotic behavior in terms of limits involving infinity.
CO2. Understand the importance of mean value theorems and its applications.
CO3. Learn about Maclaurin's series expansion of elementary functions.
CO4. Use derivatives to explore the behavior of a given function, locating and classifying its extrema, and graphing the polynomial and rational functions.

Unit – I (17 Hours)

Limits and continuity, types of discontinuities; differentiability of functions; successive differentiation: calculation of the nth derivatives, Leibnitz theorem; partial differentiation, Euler's theorem on homogeneous functions.

Unit – II (17 Hours)

Rolle's theorem, mean value theorems and applications to monotonic functions and inequalities; expansion of functions: Taylor's theorem, Taylor's series, Maclaurin's series expansion of e^x, sin x , cos x , log(1 + x) and $(1 + x)^m$; indeterminate forms.

Unit – III (14 Hours)

Concavity and inflection points, asymptotes (parallel to axes and oblique), relative extrema, tracing graphs of polynomial functions, rational functions, and polar equations.

Text Books:

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). Wiley India Pvt. Ltd. New Delhi. International Student Version. Indian Reprint 2016.
2. Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.

Reference Books :

1. Thomas Jr., George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' Calculus (13^{th}ed.). Pearson Education, Delhi. Indian Reprint 2017.

PAPER TITLE:LATEX

PAPER CODE:MTH23SEC301

CREDITS: 2(2+0+0)

Workload: 2 Lectures, 0 Tutorial (per week) **Credits:** 2(2+0+0) **Total number of lectures: 30**

Course Objective: The purpose of this course is to help you begin using LaTeX, a mathematical typesetting system designed for the creation of beautiful books—and especially for books that contain a lot of mathematics, complicated symbols and formatting.

Course Learning Outcomes: This course will enable the students to:

CO1: Create and typeset a LaTeX document

CO2: Typeset a mathematical document
CO3: Draw pictures in LaTeX.
CO4: Create Tikz pictures in a document.

Unit-I (08 Hours)

Installing LATEX in windows and linux, basics of LATEX, LATEX input files, input file structure, layout of the document.

Unit-II (08 Hours)

typesetting text: structure of text, line breaking and page breaking, special characters and symbols, space between words, titles, chapters, and sections, cross references, footnotes, emphasized words, environments, including graphics and images, floating bodies.

Unit-III (08 Hours)

typesetting mathematical formulae: single equations, building blocks of a mathematical formula, single equations that are too long, multiple equations, arrays and matrices, spacing in math mode, math fonts, theorems, lemmas, mathematical symbols.

Unit-IV (08 Hours)

Specialities: bibliography, indexing, installing extra packages, latex and pdf, creating presentations.

Producing mathematical graphics: picture environment, pgf and tikz graphics packages.

Textbooks and References :

1. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl, The Not So Short Introduction to LATEX 2e, Version 6.3, Free Software Foundation, Inc., 675 Mass Ave, Cambridge, MA 02139, USA.
2. Leslia Lamport, LATEX a Document Preparation System, Addison-Wesley Publishing Company, Inc. 2nd Edition, USA.

UG 4th SEMESTER

PAPER TITLE: DIFFERENTIAL EQUATIONS-I
PAPER CODE:MTH23C401
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The main objective of this course is to introduce the students the exciting world of differential equations and their applications and mathematical modeling.

Course Learning Outcomes: The course will enable the students to:

CO1: Learn the basics of differential equations and compartmental models.
CO2: Formulate differential equations for various mathematical models.
CO3: Solve first order non-linear differential equations, linear differential equations of higher order and system of linear differential equations using various techniques.
CO4: Apply these techniques to solve and analyze various mathematical models.

Unit – I (08 Hours)
Review of first order and first degree differential equations. Concept of implicit, general and singular solutions.Linear equations, Bernoulli's equation, exact equations and integrating factors.

Unit –II (12 Hours)
First order higher degree equations solvable for p, x and y; Clairaut's form. Orthogonal trajectories. initial value problems. Total differential equations: Solution by inspection, solution of homogeneous equation and use of auxiliary equations. Applications of first order differential equations to newton's law of cooling, exponential growth and decay problems.

Unit – III (08 Hours)
General solution of homogenous equation of second order. Wronskian and its properties, linear homogeneous and non-homogeneous equations of higher order with constant coefficients. Cauchy- Euler's equations.

Unit – IV (12 Hours)
Linear second order differential equations with variable coefficients. Standard methods: Removal of the first derivative(reduction to Normal form), transformation of equations by changing the independent variable, and method of variation of parameters. System of simultaneous linear differential equations.

Unit–V (08 Hours)
Introduction to compartmental models, Lake pollution model; Density-dependent growth model, Interacting population models, Predator-prey model.

Practical (30 Hours)- Practical / Lab work to be performed in a Computer Lab:
Modeling of the following problems using SageMath/Mathematica/MATLAB/Maple/Maxima/Scilab etc.

1. Solutions of first and second order differential equations.
2. Plotting of family of solutions of differential equations of first and second order.
3. Growth and decay model (exponential case only).
4. Newton's law of cooling
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Density-dependent growth model.
7. Predatory-prey model (basic Volterra model, with density dependence, effect of DDT, two prey one predator).

Text Books:

1. Barnes, Belinda & Fulford, Glenn R. (2015). *Mathematical Modeling with Case Studies*, Using Maple and MATLAB (3rd ed.). CRC Press. Taylor & Francis Group.
2. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). *Differential Equations and Boundary Value Problems*: *Computing and Modeling* (5th ed.). Pearson Education.
3. Ross, Shepley L. (2014). *Differential Equations* (3rd ed.). Wiley India Pvt. Ltd.

Reference Books:

1. Simmons, George F. (2017). *Differential Equations with Applications and Historical Notes* (3rd ed.). CRC Press. Taylor & Francis Group.

PAPER TITLE:LINEAR ALGEBRA-I
PAPER CODE:MTH23C402
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the basic idea of vector space, subspaces, linear span and linear independence, basis, dimension, dimension of sum of subspaces, quotient spaces and its dimension, linear maps, null space, range, rank and nullity of a linear map, invariant subspaces, eigenvalues and eigenvectors, inner product, norms, Cauchy-Scwarz inequality, orthonormal basis, orthogonal projection, linear functional and adjoints.

Course Learning Outcomes: This course will enable the students to:
CO1: Understand vector space, subspaces, sums and direct sum of subspaces, complementary subspaces, quotient spaces.
CO2: Familiarize with linear span and linear independence, basis, dimensions.
CO3: Understand linear Maps, null space, range, rank and nullity of a linear map, linear Isomorphism, matrix of a linear map.
CO4: Apply concept of eigenvalues and eigenvectors, polynomials to operators, upper triangular matrices, diagonal matrices. Construct orthonormal basis of a vector space. 6. Familiarize with linear functional and adjoints

Unit– I(16Hours)
Vector space, subspaces, sums and direct sum of subspaces, linear span and linear independence, basis, dimensions, existence of complementary subspaces of a subspace of finite dimension, dimension of sum of subspaces, quotient spaces and its dimension.

Unit– II (14 Hours)
Linear maps, null space, range, rank and nullity of a linear map, linear isomorphism, matrix of a linear map, invertibility [12 classes]

Unit– III(10 Hours)
Invariant subspaces, eigenvalues and eigenvectors, polynomials applied to operators, upper triangular matrices, diagonal matrices, invariant subspaces on real vector spaces

Unit– IV (08 Hours)
Inner product, norms, Cauchy-Scwarz inequality, orthonormal basis, orthogonal projection and minimization problems, linear functional and adjoints.

Text Books:
1. S. Axler(2015), Linear Algebra Done Right, Springer

Reference Books:

- K. M. Hoffman & R. Kunze(1971), Linear Algebra, Prentice Hall of India,
- S. Kumaresan(2000), Linear Algebra A Geometric Approach, Prentice Hall of India
- P.K.Saikia(2009), Linear Algebra, Pearson

PAPER TITLE:ALGEBRA-II
PAPER CODE:MTH23C403
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives : The primary objective of this course is to introduce symmetric groups, normal subgroups, factor groups, and direct products of groups, the notions of group homomorphism to study the isomorphism theorems with applications and classification of groups with small order according to isomorphisms.

Course Learning Outcomes: This course will enable the students to:
CO1: Analyse the structure of 'small' finite groups, and examine examples arising as groups of
permutations of a set, symmetries of regular polygons.
CO2: Understand the significance of the notion of cosets, Lagrange's theorem and its consequences.
CO3: Know about group homomorphisms and isomorphisms and to relate groups using these mappings.
CO4: Express a finite abelian group as the direct product of cyclic groups of prime power orders. Learn about external direct products and its applications to data security and electric circuits.

Unit – I (20 Hours)
Permutation groups and group of symmetries, cycle notation for permutations and properties, even and odd permutations, alternating groups; cosets and its properties, Lagrange's theorem and consequences including Fermat's little theorem, number of elements in product of two finite subgroups; normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Unit – II (16 Hours)
Group homomorphisms, isomorphisms and properties, Cayley's theorem; first, second and third isomorphism theorems for groups; automorphism, inner automorphism, automorphism groups, automorphism groups of cyclic groups, applications of factor groups to automorphism groups.

Unit – III (12 Hours)
External direct products of groups and its properties, the group of units modulo as an external direct product, applications to data security and electric circuits; internal direct products; fundamental theorem of finite abelian groups and its isomorphism classes.

Text Books:

1. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint 2021.

Reference Books:

18. Artin, Michael. (1991). Algebra (2nd ed.). Pearson Education. Indian Reprint 2015.
19. Dummit, David S., & Foote, Richard M. (2016). Abstract Algebra (3rd ed.). Student Edition. Wiley India.
20. Herstein, I. N. (1975). Topics in Algebra (2nd ed.). Wiley India, Reprint 2022.
21. Rotman, Joseph J. (1995). An Introduction to The Theory of Groups (4th ed.). Springer-Verlag, New York.
22. Singh, S. and Qazi, Z. (2022), Modernj Algebra(6th Ed.), S. Chand and Company Ltd.

PAPER TITLE: VECTOR AND ANALYTIC GEOMETRY
PAPER CODE:MTH23M401
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:**4 (3+0+1)**Total number of lectures:**45

Course Objectives: The course aims at, studying product of three and four vectors and their geometrical properties, vector differentiation, transformation of coordinates, pair of straight lines, general equation of second degree, polar equation of conics, equation of a sphere, cone, cylinder etc.

Course Learning Outcomes: This course will enable the students to:
CO1: Learn and apply product of three and four vectors with their geometrical properties and learn to differentiate vector valued functions.
CO2: Learn concepts of transformation of coordinate and apply it.
CO3: Learn concepts of pair of straight lines: Homogeneous equation of second degree etc.

CO4: Learn about classification of general equation of second degree, parabola, ellipse and hyperbola, tangent, normal, pole and polar, conjugate diameters, asymptotes etc. Learn about three-dimensional objects such as spheres, cones and cylinders and apply it.

Unit – I (10 Hours)

Product of three and four vectors and their geometrical properties; solutions of vector equations. vector valued functions, differentiation of vector valued functions.

Unit – II (08 Hours)

Transformation of coordinates: transformation of axes, rotation of axes, invariants, removal of xy-term. pair of straight lines: homogeneous equation of second degree, angle between the pair of lines given by the homogeneous equation, bisectors of the angles between the pair of lines, condition that the general equation of second degree may represent a pair of straight lines, point of intersection, equation of the pair of lines joining the origin to the points of intersection of a line and a curve.

Unit - III (14 Hours)

Classification of general equation of second degree**,** representing lines, parabola, ellipse and hyperbola, tangent, normal, pole and polar, conjugate diameters, asymptotes, reduction to standard form, . Polar equation of conics: polar equation of a conic with respect to focus as pole, equation of a chord, tangent, normal.

Unit - IV (16 Hours)

Equation of a sphere, plane section of sphere, tangents and tangent plane to a sphere; equation of a cone, enveloping cone of a sphere, right circular cone; equation of a cylinder, enveloping cylinder and right circular cylinder.

Text Books :

1. Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). John Wiley & Sons Singapore Pte. Ltd. Indian reprint (2016) by Wiley India Pvt. Ltd. Delhi.
2. Narayan, Shanti & Mittal, P. K. (2007). Analytical Solid Geometry. S. Chand & Company Pvt Ltd. India.

Reference Books :

1. Bell, Robert J.T. (1972). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan & Co. Ltd. London.
2. George B. Thomas, Jr., & Ross L. Finney (2012). Calculus and Analytic Geometry (9th ed.). Pearson Indian Education Services Pvt Ltd. India.
3. Das, B (2021). Analytical Geometry of two and three dimensions with vector analysis.Orient Book Company.

UG 5th SEMESTER

PAPER TITLE:ANALYSIS-III
PAPER CODE: MTH23C501
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to understand the integration of bounded functions on a closed and bounded interval and its extension to the cases where either the interval of integration is infinite, or the integrand has infinite limits at a finite number of points on the interval of integration, learn some of the properties of Riemann integrable functions, its generalization and the applications of the fundamental theorems of integration and get an exposure to the utility of integration for practical purposes.

Course Learning Outcomes: This course will enable the students to:

CO1: Understand some of the classes and properties of Riemann integrable functions.
CO2: Apply the Riemann sums to the volume and surface of a solid of revolution.
CO3: Get insight of integration by substitution and integration by parts.
CO4: Learn about convergence of improper integrals including, beta and gamma functions.

Unit – I (19 Hours)

Definition of upper and lower Darboux sums, Darboux integral, inequalities for upper and lower darboux sums, necessary and sufficient conditions for the Darboux integrability; mannerism's definition of integrability by Riemann sum and the equivalence of Riemann's and Darboux's definitions of integrability; definition and examples of the Riemann-stieltjes integral.

Unit – II (16 Hours)

Riemann integrability of monotone functions and continuous functions, properties of Riemann integrable functions; definitions of piecewise continuous and piecewise monotone functions and their Riemann integrability; intermediate value theorem for integrals, fundamental theorems of calculus (I and II).

Unit – III (13 Hours)

Volume by slicing and cylindrical shells, length of a curve in the plane and the area of surfaces of revolution. improper integrals of type-I, type-II and mixed type, convergence of improper integrals, test for convergence,The beta and gamma functions, their properties and convergence, integration on R^2, integration on R^3.

Text Books:

1. Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer.
2. Anton, Howard, Bivens Irl and Davis Stephens (2012). Calculus (10th edn.). John Wiley & Sons, Inc.
3. Denlinger, Charles G. (2011). Elements of Real Analysis, Jones & Bartlett India Pvt. Ltd., Indian Reprint.

4. Ghorpade, Sudhir R. and Limaye, B. V. (2006). A Course in Calculus and Real Analysis. Undergraduate Texts in Mathematics, Springer (SIE). Indian Reprint.

Reference Books:

- Bartle, Robert G., & Sherbert, Donald R. (2015). Introduction to Real Analysis (4th ed.).Wiley, Indian Edition.
- Malik, S.C., Arora, S., (2021), Mathematical analysis (4th Edition), New Age Intrnational Pvt. Ltd.

3. Kumar Ajit and Kumaresan S. (2014). A Basic Course in Real Analysis. CRC Press, Taylor & Francis Group, Special Indian Edition.

PAPER TITLE:MULTIVARIATE CALCULUS
PAPER CODE:MTH23C502
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables, the geometry and visualization of curves and surfaces in two dimensions (plane) and three dimensions (space), the techniques of integration to functions of two and three independent variables, the applications of multivariate calculus tools to physics, economics, optimization etc.

Course Learning Outcomes: This course will enable the students to :

CO1: Understand the conceptual variations when advancing in calculus from one variable to multi-variable discussion.
CO2: Understand the maximization and minimization of multi-variable functions subject to the given constraints on variables,.
CO3: Learn about inter-relationship among the line integral, double, and triple integral. Formulations.
CO4: Familiarize with Green's, Stokes' and Gauss divergence theorems, and learn applications.

Unit – I (19 Hours)

Basic concepts, limits and continuity, partial derivatives, tangent planes, total differential, differentiability, chain rules, directional derivatives and the gradient, extrema of functions of two variables, method of Lagrange multipliers with one constraint.

Unit – II (16 Hours)

Double integration over rectangular and non-rectangular regions, double integrals in polar coordinates, triple integrals over a parallelopiped and solid regions, volume by triple integrals, triple integration in cylindrical and spherical coordinates, change of variables in double and triple integrals.

Unit – III (13 Hours)

Vector field, divergence and curl, line integrals and applications to mass and work, fundamental theorem for line integrals, conservative vector fields, green's theorem, area as a line integral, surface integrals, stokes' theorem, Gauss divergence theorem.

Text Books:

1. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). Calculus (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. Pearson Education. Indian Reprint.

Reference Books:

1.Marsden, J. E., Tromba, A., & Weinstein, A. (2004). Basic Multivariable Calculus. Springer(SIE). Indian Reprint.

PAPER TITLE: NUMBER THEORY
PAPER CODE:MTH23C503
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives : The primary objective of this course is to introduce the number theoretic techniques of computations with the flavour of abstraction, the euclidean algorithm, linear Diophantine equations, congruence equations, arithmetic functions and their applications, Fermat's little, Euler's and Wilson's theorems, primitive roots, quadratic residues and non-residues, the Legendre symbol and the law of quadratic reciprocity.

Course Learning Outcomes: This course will enable the students to :
CO1: Use modular arithmetic in solving linear and system of linear congruence equations.
CO2: Work with the number theoretic functions, their properties and their use.
CO3: Learn the forms of positive integers that possess primitive roots.
CO4: Learn the Quadratic Reciprocity Law which deals with the solvability of quadratic congruences.

Unit – I (14 Hours)

The euclidean algorithm and linear Diophantine equation; least non-negative residues and complete set of residues modulo *n*; linear congruences, the Chinese remainder theorem and system of linear congruences in two variables; Fermat's little theorem, Wilson's theorem and its converse, application to solve quadratic congruence equation modulo odd prime *p*.

Unit – II (12 Hours)

Number-theoretic functions for the sum and number of divisors, multiplicative function, Möbius inversion formula and its applications; greatest integer function with an application to the calendar; Euler’s phi-function, Euler’s theorem and some properties of the phi-function.

Unit – III (14 Hours)

the order of an integer modulo n and primitive roots for primes, primitive roots of composite numbers n: when n is of the form 2_k, and when n is a product of two co-prime numbers, the quadratic residue and non-residue of an odd prime and Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity law and its application.

Unit – IV (08 Hours)

Certain non-linear Diophantine equations, $x^2+y^2=z^2$, Fermat's last theorem, representation of integers as sums of squares, sum of two squares, sum of four squares.

Text Books:

1. Burton, David M. (2011). Elementary Number Theory (7th ed.). McGraw-Hill Education Pvt. Ltd. Indian Reprint 2017.

Reference Books:

1. Andrews, George E. (1994). Number Theory. Dover publications, Inc. New York.
2. Robbins, Neville (2007). Beginning Number Theory (2nd ed.). Narosa Publishing House Pvt. Ltd. Delhi.
3. Rosen, Kenneth H. (2011). Elementary Number Theory and its Applications (6th ed.). Pearson Education. Indian Reprint 2015.

PAPER TITLE:ALGEBRA-III
PAPER CODE:MTH23C504
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the fundamental theory of rings, and their homomorphisms, develop the basic concepts of polynomial rings and irreducibility tests for polynomials over the ring of integers, and rational numbers, introduce polynomial analog of a prime number, describe polynomial rings, principal ideal domains, euclidean domains and unique factorization domains, and their relationships.

Course Learning Outcomes: This course will enable the students to:

CO1: Understand the fundamental concept of rings, integral domains, and fields.
CO2: Learn about ring homomorphisms and isomorphisms theorems of rings, and construct quotient fields for integral domains,
CO3: Appreciate the significance of unique factorization in rings and integral domains.
CO4: Apply several criteria for determining when polynomials with integer coefficients have rational roots or are irreducible over the field of rational numbers.

Unit – I (19 Hours)

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring; ideals, operations on ideals, ideal generated by a set and properties, factor rings, prime ideals and maximal ideals, principal ideal domains.

Unit – II (16 Hours)

Definition, examples and properties of ring homomorphisms; first, second and third isomorphism theorems for rings; The field of quotients; Polynomial rings over commutative rings, Division algorithm and consequences.

Unit–III (13 Hours)

Factorization of polynomials, reducibility tests, mod p irreducibility test, eisenstein's criterion, unique factorization in $\mathbb{Z}[x]$; divisibility in integral domains, irreducibles, primes, unique factorization domains, euclidean domains.

Text Books:

1. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint 2021.
2. Dummit, David S. & Foote, Richard M. (2016). Abstract Algebra (3rd ed.). Student Edition. Wiley India.

Reference Books:

1. Herstein, I. N. (2006). Topics in Algebra (2nd ed.). Wiley Student Edition. India.
2. Hungerford, Thomas W. (2012). Abstract Algebra: An Introduction (3rd ed.). Cengage Learning.
3. Singh, S. and Qazi, Z. (2022), Modernj Algebra(6th Ed.), S. Chand and Company Ltd.

PAPER TITLE:DIFFERENTIAL EQUATIONS
PAPER CODE:MTH23M501
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives : The primary objective of this course is to introduce ordinary and partial differential equations. Basic theory of higher order linear differential equations, Wronskian and its properties. Various techniques to find the solutions of above differential equations which provide a basis to model complex real-world situations.

Course Learning Outcomes : This course will enable the students to:

CO1: Solve the exact, linear, Bernoulli equations, find orthogonal trajectories and solve rate problems.
CO2: Apply the method of undetermined coefficients and variation of parameters to solve linear differential equations.
CO3: Solve Cauchy-Euler equations and System of linear differential equations.
CO4: Formulate and solve various types of first and second order partial differential equations.

Unit – I (16 Hours)

First order ordinary differential equations: basic concepts and ideas, first order exact differential equations, integrating factors and rules to find integrating factors, linear equations and Bernoulli equations, initial value problems, applications of first order differential

equations: orthogonal trajectories and rate problems; basic theory of higher order linear differential equations, Wronskian and its properties.

Unit – II (13 Hours)

Linear homogeneous equations with constant coefficients, linear non-homogeneous equations,method of undetermined coefficients, method of variation of parameters, two-point boundary value problems, Cauchy-Euler equations, system of linear differential equations.

Unit – III (19 Hours)

Classification and construction of first-order partial differential equations, method of characteristics and general solutions of first-order partial differential equations, canonical forms and method of separation of variables for first order partial differential equations;classification and reduction to canonical forms of second-order linear partial differential equations and their general solutions.

Text Books :

1. Myint-U, Tyn and Debnath, Lokenath (2007). Linear Partial Differential Equations for Scientist and Engineers (4th ed.). Birkhäuser. Indian Reprint.
2. Ross, Shepley L. (1984). Differential Equations (3rd ed.). John Wiley & Sons.

Reference Books :

1. Edwards, C. Henry, Penney, David E., & Calvis, David T. (2015). Differential Equations and Boundary Value Problems: Computing and Modeling (5th ed.). Pearson Education.
2. Kreyszig, Erwin. (2011). Advanced Engineering Mathematics (10th ed.). Wiley India.
3. Sneddon I. N. (2006). Elements of Partial Differential Equations. Dover Publications.

UG 6th SEMESTER

PAPER TITLE:METRIC SPACE
PAPER CODE:MTH23C601
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The objective of the course is to introduce the usual idea of distance into an abstract form on any set of objects, maintaining its inherent characteristics, and the resulting consequences, the two important topological properties, namely connectedness and compactness of metric spaces with their characterizations.

Course Learning Outcomes: This course will enable the students to:
CO1: Understand various natural and abstract formulations of distance on the sets of usual or unusual entities. Become aware one such formulations leading to metric spaces.
CO2: Understand various geometrical concepts, viz. balls or connected sets etc.
CO3: Know about Banach fixed point theorem, whose far-reaching consequences have resulted into an independent branch of study in analysis.
CO4: Learn fixed point theory and apply.

Unit – I (19 Hours)

Definition, examples of metric spaces, sequences and Cauchy sequences in metric spaces, convergence, complete metric space; open and closed balls, neighborhood, open set, interior of a set, limit point of a set, derived set, closed set, closure of a set, diameter of a set, Cantor's theorem, subspaces.

Unit – II (16 Hours)

Continuous mappings, sequential criterion and other characterizations of continuity, uniform continuity; homeomorphism, isometry and equivalent metrics, contraction mapping, Banach fixed point theorem.

Unit – III (13 Hours)

Connectedness, connected subsets of $\mathbb{R}$, connectedness and continuous mappings, compactness and boundedness, characterizations of compactness, continuous functions on compact spaces.

Text Books:

Shirali, Satish & Vasudeva, H. L. (2009). Metric Spaces. Springer. Indian Reprint 2019.

Reference Books:

1. Kumaresan, S. (2014). Topology of Metric Spaces (2nd ed.). Narosa Publishing House. New Delhi.
2. Rudin, Walter. Principles of mathematical Analysis (3rd ed.).
3. Simmons, George F. (2004). Introduction to Topology and Modern Analysis. McGraw-Hill Education. New Delhi.

PAPER TITLE:COMPLEX ANALYSIS
PAPER CODE:MTH23C602
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The main objective of this course is to acquaint with the basic ideas of complex analysis, learn complex-valued functions with visualization through relevant practicals, emphasize on Cauchy's theorems, series expansions and calculation of residues.

Course Learning Outcomes: This course will enable the students to:
CO1: Understand the significance of differentiability of complex-valued functions leading to the understanding of Cauchy-Riemann equations.
CO2: Understand some elementary functions and evaluate the contour integrals, Learn the role of Cauchy-Goursat theorem and the Cauchy integral formula.
CO3: Expand some simple functions as their Taylor and Laurent series.
CO4: Classify the nature of singularities, find residues, and apply Cauchy Residue theorem to evaluate integrals.

Unit – I (16 Hours)

Functions of a complex variable and mappings, limits, theorems on limits, limits involving the point at infinity, continuity and differentiation, Cauchy-Riemann equations and examples, sufficient conditions for differentiability, analytic functions and their examples; exponential, logarithmic, and trigonometric functions.

Unit – II (16 Hours)

Derivatives of functions, definite integrals of functions; contours, contour integrals and examples, upper bounds for moduli of contour integrals; antiderivatives; Cauchy-Goursat theorem; Cauchy integral formula and its extension with consequences; Liouville's theorem and the fundamental theorem of algebra.

Unit – III (16 Hours)

Taylor and Laurent series with examples; absolute and uniform convergence of power series, integration, differentiation and uniqueness of power series; isolated singular points, residues, Cauchy's residue theorem, residue at infinity; types of isolated singular points, residues at poles and its examples, an application to evaluate definite integrals involving sines and cosines.

Text Books:

1. Brown, James Ward, & Churchill, Ruel V. (2014). Complex Variables and Applications (9th ed.). McGraw-Hill Education. Indian Reprint.

Reference Books:

1. Bak, Joseph & Newman, Donald J. (2010). Complex Analysis (3rd ed.). Undergraduate Texts in Mathematics, Springer.
2. Mathews, John H., & Howell, Rusell W. (2012). Complex Analysis for Mathematics and Engineering (6th ed.). Jones & Bartlett Learning. Narosa, Delhi. Indian Edition.
3. Zills, Dennis G., & Shanahan, Patrick D. (2003). A First Course in Complex Analysis with Applications. Jones & Bartlett Publishers.

4. Arumugam, S., Isaac, A.T., Somasundaram, A.,Comples Analysis, Scitech Publications(India) Pvt Ltd.

PAPER TITLE:DIFFERENTIAL EQUATIONS-II
PAPER CODE:MTH23C603
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The main objective of this course is to introduce the power series solutions of second order ordinary differential equations (ODE), partial differential equations (PDE) and their applications.

Course Learning Outcomes: The course will enable the students to:

CO1: Solve Bessel's equation, Lagrange's equation.
CO2: Understand and apply different methods to solve first and second order linear/nonlinear PDEs.
CO3: Study reduction of PDEs to canonical forms.
CO4: Apply different techniques to solve and analyze various mathematical models.

Unit – I (12 Hours)

Regular and singular points of second order ordinary differential equations. Series solutions about ordinary and singular points. Bessel and Legendre differential equations. Bessel functions and their properties; Legendre polynomials and their properties.

Unit – II (13 Hours)

Partial differential equations(PDE): order and degree of PDE. Classification of first order PDEs. Cauchy problem for first-order PDEs, Lagrange's equation and the method, method of separation of variables; charpit's and jacobi's method for solving non-linear PDEs.

Unit – III (13 Hours)

Classification of second order PDEs: hyperbolic, parabolic and elliptic equations. Characteristic equations and characteristic curve. Reduction to canonical forms and general solutions of second-order linear PDEs; higher order linear partial differential equations with constant coefficients.

Practical (30 hours)- Practical / Lab work to be performed in a Computer Lab:
Modeling of the following similar problems using SageMath/ Python/ Mathematica/ MATLAB/ Maple/ Maxima/ Scilab:

1. General solution of first and second order partial differential equations.
2. Solution and plotting of Cauchy problem for first order PDEs.
3. Plotting the characteristics for the first order partial differential equations.
4. Solution of vibrating string problem using D'Alembert formula with initial conditions.
5. Solution of heat equation $u_t = ku_{xx}$with initial conditions.
6. Solution of one-dimensional wave equation with initial conditions:

i. $u(x,0) = f(x), u_t(x,0) = g(x), x \in R, t > 0$
ii. $u(x,0) = f(x), u_t(x,0) = g(x), u(0,t) = 0, x \in R, t > 0$
iii. $u(x,0) = f(x), u_t(x,0) = g(x), u_x(0,t) = 0, x \in R, t > 0$

Text Books:

1 Myint-U, Tyn & Debnath, Lokenath. (2007). Linear Partial Differential Equations for Scientists and Engineers (4th ed.). Birkhäuser. Indian Reprint.
2 Sneddon, Ian N. (2006). Elements of Partial Differential Equations, Dover Publications. Indian Reprint.
3. Ross, Shepley L. (2014). *Differential Equations* (3rd ed.). Wiley India Pvt. Ltd.

Reference Books:

1. Abell, Martha & Braselton, J.P. (2004) Differential Equations with Mathematica, Elsevier, Academic Press, Third Edition.
2. Stavroulakis, Ioannis P & Tersian, Stepan A. (2004). Partial Differential Equations: An Introduction with Mathematica and MAPLE (2nd ed.). World Scientific.

PAPER TITLE:NUMERICAL ANALYSIS
PAPER CODE: MTH23C604
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The main objective of this course is to study numerical methods tosolve algebraic and transcendental equations, systems of linear algebraic equations and differential equations. This course will also help to find derivatives and integrals numerically.

Course Learning Outcomes: This course will enable the students to learn:
CO1: Understand and apply numerical techniques to solve equations.
CO2: Find derivatives of some functions where classical methods fail.
CO3: Find integrals of some functions where classical methods fail.
CO4: Understand direct method and iterative method.

Unit – I (10 Hours)

A brief introduction to algebraic and transcendental equations. Solutions by iterative methods: Bisection method, method of false position, secant method, fixed point iteration method and Newton-Raphson method. Convergence of the methods.

Unit – II (14 Hours)

Calculus of finite difference: newton’s forward, newton’s backward, Stirling's, Bessel's, Lagrange's interpolation formula. Numerical differentiation with the help of different interpolation formulae.

Unit – III (14 Hours)

Numerical integration: general quadrature formula, trapezoidal rule, Simpson's one third and three eighth rule and Weddel's rule. Euler's method to solve ODE's, modified Euler method, Runge−Kutta method (fourth-order).

Unit – IV (10 Hours)

System of linear algebraic equations and their solutions by direct and iterative (or indirect) methods. Direct method: Gauss elimination, Gauss-Jordan and LU decomposition methods. iterative methods: Gauss−Jacobi and Gauss−Seidel methods.

Practical (30 Hours)- Practical / Lab work to be performed in Computer Lab: Use of computer
algebra system (CAS) software: Python/SageMath/Mathematica/MATLAB/Maple/Maxima/ Scilab etc., for developing the following numerical programs:

1. Bisection method.
2. Newton-Raphson method.
3. Secant method.
4. LU decomposition method.
5. Gauss−Jacobi method.
6. Gauss−Seidel method.
7. Lagrange interpolation.
8. Newton interpolation.
9. Trapezoidal rule.
10. Simpson's rule.
11. Euler's method.
12. Runge−Kutta Method (fourth-order).

Text Books:

1. Bradie, Brian. (2006). A Friendly Introduction to Numerical Analysis. Pearson Education India. Dorling Kindersley (India) Pvt. Ltd. Third impression 2011.

Reference Books:

1. Gerald, Curtis F., & Wheatley, Patrick O. (2007). Applied Numerical Analysis (7th ed.). Pearson Education. India.
2. Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). Numerical Methods for Scientific and Engineering Computation. (6th ed.). New Age International Publisher, India, 2016.

Note: Non programmable scientific calculator may be allowed in the University examination.

PAPER TITLE: LINEAR ALGEBRA
PAPER CODE:MTH23M601
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives:the objective of the course is to introduce Gauss elimination and matrices, Gauss-Jordan method, echelon forms, solution of equations,the basic idea of vector space, subspaces, linear span and linear independence, basis, dimension, dimension of sum of subspaces, quotient spaces and its dimension, linear maps, null space, range, rank and nullity of a linear map.

Course Learning Outcomes: This course will enable the students to:
CO1. Find the rank of a matrix and find solutions of system of linear equations
CO2. Understand vector space, subspaces, sums and direct sum of subspaces, complementary subspaces, quotient spaces.
CO3. Familiarize with linear span and linear independence, basis, dimensions.
CO4. Understand linear Maps, null space, range, rank and nullity of a linear map, linear Isomorphism, matrix of a linear map

Unit – I (14 Hours)

Gauss elimination and matrices, row echelon form and rank, normal form of matrices, consistency of linear equations, homogeneous systems and non-homogeneous systems.

Unit – II (20 Hours)

Definition, examples and some elementary properties of vector spaces; subspaces, span, linear independence and dependence; basis and dimension of a vector space;dimension of sum of subspaces, quotient spaces and its dimension.

Unit – III (14 Hours)

Linear maps, null space, range, rank and nullity of a linear map, linear isomorphism, matrix of a linear map, invertibility

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Text Books :

Gilbert Strang(2006): Linear Algebra and Its Applications, Cengage Learning
S. Axler(2015), Linear Algebra Done Right, Springer

Reference Books :

S. Kumaresan(2000), Linear Algebra A Geometric Approach, Prentice Hall of India
P.K.Saikia(2009), Linear Algebra, Pearson

UG 7th SEMESTER

PAPER TITLE:ANALYSIS-IV
PAPER CODE:MTH23C701
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The objective of the course is to introduce the sequences and series of real-valued functions as a generalization to the sequences and series of real numbers, convergence, the situations under which the process of convergence of a sequence and series of real-valued functions may commute with the processes of calculus while taking differentiation, or integration, an important class of series functions (i.e., power series), and the elementary functions exponential, logarithmic and trigonometric.

Course Learning Outcomes: This course will enable the students to:
CO1: Point wise convergence and uniform convergence of series of functions.
CO2: Cauchy criterion for uniform convergence and Weierstrass *M*-test for uniform convergence of series of real-valued functions.
CO3: Know about the constraints for the inter-changeability of differentiation, and integration with infinite sum of a series of functions, handle the convergence of power series and properties of the limit function, including differentiation and integration of power series.
CO4: Appreciate utility of polynomials in the space of continuous functions.

Unit – I (19 Hours)

Pointwise and uniform convergence of sequence of functions, the uniform norm, Cauchy criterion for uniform convergence, continuity of the limit function of a sequence of functions, interchange of the limit and derivative, and the interchange of the limit and integral of a sequence of functions, bounded convergence theorem.

Unit – II (13 Hours)

Pointwise and uniform convergence of series of functions, theorems on the continuity, differentiability and integrability of the sum function of a series of functions, cauchy criterion and the weierstrass *M*-test for uniform convergence.

Unit – III Power Series (16 Hours)

Definition of a power series, radius of convergence, absolute convergence (Cauchy-Hadamard theorem), differentiation and integration of power series, Abel's theorem, Weierstrass's approximation theorem; the exponential, logarithmic and trigonometric functions: definitions and their basic properties.

Text books:

1. Bartle, Robert G., & Sherbert, Donald R. (2011). Introduction to Real Analysis (4th ed.). Wiley India Edition. Indian Reprint.
2. Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian Reprint.

Reference Books:

1.Malik, S.C., Arora, S., (2021), Mathematical analysis (4th Edition), New Age Intrnational Pvt. Ltd.

- Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

2. Denlinger, Charles G. (2011). Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

PAPER TITLE:DIFFERENTIAL EQUATIONS-III
PAPER CODE:MTH23C702
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The objective of this course is to study Initial Value Problems (IVP), second order differential equations and few methods to solve Partial Differential Equations (PDE).

Course Learning Outcomes: This course will enable the students to:

CO1: Solve IVP, elliptic, parabolic and hyperbolic differential equations.
CO2: Understand Monge's method and apply to solve non-linear PDEs.,
CO3: Undestand and apply separation of variables method to solve second order PDEs.
CO4: Study Green's function for heat equation etc.

Unit – I (10 Hours)

Initial value problems(IVP) for first order equations. Lipschitz condition; existence and uniqueness theorem for first order equations. IVPs for second order equations: Existence and uniqueness theorem. Wronskian: linear dependence and independence of solutions.

Unit - II (10 Hours)

Partial Differential equations reducible to equations with constant coefficients. Second order PDE with variable coefficients. Monge's method of solution of non-linear PDE of second order. Solutions of PDEs of second order by the method of separation of variables.

Unit-III: (10 Hours)

Elliptic differential equations. Occurrence and detailed study of the Laplace and the Poisson equation. Maximum principle and applications, green's functions and properties.

Unit-IV (09 Hours)

Parabolic differential equations. Occurrence and detailed study of the heat equation. Maximum principle. Solutions of IVPs for heat conduction equation. Green's function for heat equation.

Unit-V (09 Hours)

Hyperbolic differential equations. Occurrence and detailed study of the wave equation. Solution of three dimensional wave equation. Solutions of equations in bounded domains and uniqueness of solutions. Duhamel's principle.

Text books:

1. E. A. Coddington, An Introduction to Ordinary Differential Equations ,Dover Publication, 1989
2. I.N. Sneddon, Partial Differential Equations ,Mc Graw-Hill, 1957
3. K.S.Rao, Introduction to partial differential equations ,Prentice Hall of India, New Delhi, 2006
4. Ross, Shepley L. (2014). *Differential Equations* (3rd ed.). Wiley India Pvt. Ltd.

Reference Books:

1. R. Haberman, Elementary Applied Partial Differential equations, Prentice-Hall, New Jersey, 1987
2.W.E. Willams, Partial Differential Equations, Oxford University Press, 1980
3. W.A.Strauss, Partial Differential Equations: An Introduction ,John Wiley, 1992

PAPER TITLE: ALGEBRA-IV
PAPER CODE:MTH23C703
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The objective of the course is to introduce the concept of group actions, sylow's theorem and its applications to groups of various orders, composition series and jordan-hölder theorem.

Course Learning Outcomes: This course will enable the students to:
CO1: Understand the concept of group actions and their applications.
CO2: Understand finite groups using Sylow's theorem.
CO3: Apply Sylow's theorem to determine whether a group is simple or not.
CO4: Understand and determine if a group is solvable or not.

Unit – I (19 Hours)

Definition and examples of group actions, permutation representations; centralizers and normalizers, stabilizers and kernels of group actions; groups acting on themselves by left multiplication and conjugation with consequences; Cayley's theorem, conjugacy classes, class equation, conjugacy in S_n, simplicity of A_n.

Unit – II (16 Hours)

p-groups, Sylow p-subgroups, Sylow's theorems, applications of Sylow's theorems, groups of order $pq$and p^2q(p and q both prime); finite simple groups, non simplicity tests.

Unit – III (13 Hours)

Solvable groups and their properties, commutator subgroups, nilpotent groups, composition series, Jordan-Hölder theorem.

Text books:

1.Singh, S. and Qazi, Z. (2022), Modern Algebra(6th Ed.), S. Chand and Company Ltd.

2. Dummit, David S., & Foote, Richard M. (2004). Abstract Algebra (3rd ed.). John Wiley & Sons. Student Edition, Wiley India 2016.
2. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint 2021.
3. Beachy, John A., & Blair, William D. (2019). Abstract Algebra (4th ed.). Waveland Press.

Reference books:

1. Fraleigh, John B., & Brand Neal E. (2021). A First Course in Abstract Algebra (8th ed.). Pearson.
2. Herstein, I. N. (1975). Topics in Algebra (2nd ed.). Wiley India. Reprint 2022.
3. Rotman, Joseph J. (1995). An Introduction to the Theory of Groups (4th ed.). Springer.

PAPER TITLE:MECHANICS
PAPER CODE:MTH23C704
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The main objective of this course is to starting Newtonian laws, learning various technical notions which explains various states of motion under given forces, deals with the kinematics and kinetics of the rectilinear and planar motions of a particle and planetary orbits.

Course Learning Outcomes: This course will enable the students to:
CO1: Understand the idea of composition and resolution of forces , moments couples and necessary conditions for the equilibrium of particles acted upon by various forces and learn.**CO2:** Apply the concepts of center of gravity, laws of static and kinetic friction.
CO3: Learn that a particle moving under a central force describes a plane curve.
CO4: Know the Kepler's laws of the planetary motions.

Unit – I (12 Hours)

Composition and resolution of forces, parallelogram of forces, triangle of forces, converse of triangle of forces, Lami's theorem, converse of Lami's theorem. Parallel forces, moment of a force about a point and an axis, couple and couple moment, moment of a couple.

Unit – II (14 Hours)

Resultant of a force system of forces, conditions of equilibrium of a system of particles and of coplanar forces acting on a rigid body, friction and laws of friction and applications, centre of gravity of an arc, plane area, surface of revolution, solid of revolution.

Unit – III (10 Hours)

Motion in a straight line with variable acceleration, velocity and acceleration of a particle along a curve: tangential, normal, radial cross-radial components (plane curve), simple harmonic motion.

Unit – IV (12 Hours)

Conservative force field, central forces, inverse square law, Kepler's laws of planetary motion, resisting medium.

Text books:

1. I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics (4th Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. R.C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics (11th Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009
3. A.P. Roberts, Statics and Dynamics with Background in Mathematics, Cambridge University, 2003
4. B.C. Das, Statics, U.N. Dhur & Sons Private Ltd., 1947.
5. B.C. Das, Dynamics, U.N. Dhur & Sons Private Ltd., 1946.
6. M. R Spiegel, Theoretical Mechanics, McGraw Higher Ed, 1980.

Reference books:

1. Synge, J. L., & Griffith, B. A. (2017). Principles of Mechanics (3rd ed.). McGraw-Hill Education. Indian Reprint.
2. Ramsey, A. S. (2017). Hydrostatics. Cambridge University Press. Indian Reprint.
3. Roberts, A. P. (2003). Statics and Dynamics with Background Mathematics. Cambridge University Press.

PAPER TITLE: MULTIVARIATE CALCULUS
PAPER CODE:MTH23M701
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1) **Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the extension of the studies of single variable differential and integral calculus to functions of two or more independent variables, the geometry and visualisation of curves and surfaces in two dimensions (plane) and three dimensions (space), the techniques of integration to functions of two and three independent variables, the applications of multivariate calculus tools to physics, economics, optimization etc.

Course Learning Outcomes: This course will enable the students to :

CO1: Learn the conceptual variations when advancing in calculus from one variable to multi-variable discussion

CO2: Understand the maximization and minimization of multivariable functions subject to the given constraints on variables

CO3: Learn about inter-relationship amongst the line integral, double, and triple integral Formulations

CO4: Familiarize with Green's, Stokes' and Gauss divergence theorems, and learn applications.

Unit – I (19 Hours)

Basic concepts, limits and continuity, partial derivatives, tangent planes, total differential, differentiability, chain rules, directional derivatives and the gradient, extrema of functions of two variables, method of Lagrange multipliers with one constraint.

Unit – II (16 Hours)

Double integration over rectangular and non-rectangular regions, double integrals in polar coordinates, triple integrals over a parallelopiped and solid regions, volume by triple integrals,triple integration in cylindrical and spherical coordinates, change of variables in double and triple integrals.

Unit – III (13 Hours)

Vector field, divergence and curl, line integrals and applications to mass and work, fundamental theorem for line integrals, conservative vector fields, Green's theorem (statement and applications), area as a line integral, surface integrals, Stokes' theorem and gauss divergence theorem (statements and applications).

Text Books :

1. Strauss, Monty J., Bradley, Gerald L., & Smith, Karl J. (2007). Calculus (3rd ed.). Dorling Kindersley (India) Pvt. Ltd. Pearson Education. Indian Reprint.

Reference Books :

1.Marsden, J. E., Tromba, A., & Weinstein, A. (2004). Basic Multivariable Calculus. Springer(SIE). Indian Reprint.

UG 8th SEMESTER

PAPER TITLE: TOPOLOGY
PAPER CODE:MTH23C801
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The primary objective of this course is to introduce the basic concept oforder relations, dictionary order, well ordered set, minimal uncountable well ordered set, order topology, product topology, continuity and related concepts, product topology and box topology; Metric topology, Quotient topology, Connected spaces, local path-connectedness, compact spaces, countability and separation axioms.

Course Learning Outcomes: This course will enable the students to:
CO1: Familiarize with order relations, dictionary order, well ordered set, product topology, continuity.
CO2: Learn about homomorphism, connectedness, compactness, countability axioms.
CO3: Understand the concepts of basis and subbasis with examples, path connectedness and local path connectedness, limit point compactness and sequential compactness.
CO4: Apply pasting lemma to check the continuity of a function and tube lemma to prove compactness of product space.

Unit-I (12 Hours)

Order relations, dictionary order, well ordered set, minimal uncountable well ordered set Ω, Definition and examples of topological spaces; basis and sub basis; order topology; product topology on XxY, subspace topology; Closed sets and limit points, Hausdorff space.

Unit – II (10 Hours)

Continuity and related concepts; Homeomorphism; Pasting lemma, Product topology and Box topology; Metric topology.

Unit – III (08 Hours)

Connected spaces, Connected subspace of the real space; component, path component; local connectedness, local path-connectedness.

Unit – IV (10 Hours)

Compact spaces; Tube lemma; Finite product of compact spaces; Compact subspaces of the real space; limit point compact and sequentially compact spaces; locally compact spaces; statement of Tychonoff's theorem.

Unit – V (08 Hours)

Countability axioms; Lindeloff spaces and separable spaces. Separation axioms; Normal Spaces; Statements of Urysohn’s lemma, Urysohn’s metrization theorem and Tietze’s extension theorem.

Text books:

1. J. R. Munkres, Topology:a first course , Prentice-Hall of India Ltd., New Delhi, 2000
2. J. L. Kelley, General Topology, Springer Verlag, New York, 1990.

Reference Books:

1. K.D. Joshi, An introduction to general topology (2nd edition), Wiley Eastern Ltd., New Delhi, 2002.
2. J. Dugundji, General Topology, Universal Book Stall, New Delhi, 1990.

PAPER TITLE: LINEAR ALGEBRA-II
PAPER CODE:MTH23C802
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives:

The objective of the course is to introduce Gauss Elimination and Matrices, Gauss-Jordan Method, Echelon forms, Solution of equations, Vector spaces and subspaces, basis and dimension of a vector space, Linear Transformation and matrix of change of basis, Orthogonal vectors, Gram-Schimdt Process, QR-Factorzation, Eigenvalues and Eigenvectors, Characteristic Polynomial and Equation, Cayley Hamilton theorem, Diagonalizable matrices.

CourseLearning Outcomes: This course will enable the students to:

CO1: Find the rank of a matrix and find solutions of system of linear equations
CO2: Learn about vector space and various subspaces associated with a matrix and find the basis and dimension of a vector space
CO3: Define a linear transformation and its matrix with respect to a given basis and to find the matrix of change of basis.
CO4: Find orthogonal vectors in R^n and to find orthogonal basis by Gram-Schimdt process**,** the eigenvalues and eigenvectors of a matrix and to identify the conditions under which the a matrix is diagonalizable.

Unit-I (10Hours)

Gauss Elimination and Matrices, Gauss-Jordan Method, Row Echelon form and Rank, Reduced row Echelon form, Normal Form of Matrices, Consistency of Linear Equations, Homogeneous systems and Non-homogeneous systems.

Unit-II (10Hours)

Vector spaces and subspaces, Column space and row space of a matrix, null space of a matrix, Linear Independence, Basis and dimension of a vector space.

Unit-III (8Hours)

Linear transformation and Isomorphisms, the Matrix of a linear transformation, Change of basis and similarity, rank and nullity theorem.

Unit-IV (10Hours)
Orthogonal vectors in R^n, Orthogonal projection, Orthogonal Complement, Gram-Schimdt Process , QR-Factorzation, Orthogonal Transformation and Orthogonal Matrices.

Unit-V: **(10Hours)**
Eigenvalues and Eigenvectors, Characteristic Polynomial and Equation, Cayley Hamilton theorem, Diagonalizable matrices, Spectral Properties of Diagonalizable matrices.

Text Books:

1. Gilbert Strang(2006): Linear Algebra and Its Applications, Cengage Learning
2. A.R. Rao, P. Bhimasankaram(2000): Linear Algebra, Hindustan Book Agency

Reference Books:

1. H. Anton(1995), Elementary Linear Algebra with Applications (8th Edition), John Wiley
   - Otto Bertscher(): Linear Algebra with Applications
   - S. Kumaresan(2000), Linear algebra - A Geometric Approach, Prentice Hall ofIndia

PAPER TITLE:INTEGRAL TRANSFORMS
PAPER CODE:MTH23C803
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: Primary objective of this course is to introduce the basic idea of integral equations, integral transforms of functions and their applications through an introduction to Fourier series expansion of a periodic function, Fourier transform and Laplace transform of functions of a real variable with applications to solve ODE's and PDE's.

Course Learning Outcomes: The course will enable the students to:
CO1: Understand the Fourier series associated with a periodic function, its convergence.
CO2: Compute Fourier and Laplace transforms of classes of functions.
CO3: Apply techniques of Fourier and Laplace transforms to solve ordinary and partial differential equations and initial and boundary value problems.
CO4: Solve the integral equations.

Unit – I (10 Hours)

Integral Equation: Definition of integral Equation and classifications, reduction of ordinary differential equations into integral equations. Fredholm integral equations with separable kernels, Eigen values and Eigen functions, method of successive approximation. Iterative scheme for Fedholm integral equations of second kind.

Unit - II (10 Hours)

Volterra integral equations of second kind, resolvent kernel of Volterra equation and its results, application of iterative scheme to Volterra equation of the second kind. Convolution type kernels, Regular, Cauchy singular and Hyper singular integral equations.

Unit - III (16 Hours)

Introduction to Fourier series; Dirichlet's conditions; Fourier series of even and odd functions; Half range Fourier sine series and cosine series. Fourier integral. Fourier Integral transform. Properties of Fourier transform, Fourier sine and cosine transforms, application of Fourier transform to partial differential equations of initial and boundary value problems. Evaluation of definite integrals.

Unit - IV (12 Hours)

Laplace Transform : Basic properties of Laplace transform, Convolution theorem and properties of convolution, inverse Laplace transform, application of Laplace transform to solution of ordinary equations of initial and boundary value problems. Evaluation of definite integrals.

Text Books :

23. R.P. Kanwal, Linear Integral Equations:Theory and Techniques, Academic Press, New York, 1971
24. F. B. Hilderbrand, Methods of Applied Mathematics, Dover Publications Inc., 1992.
25. I.N. Sneddon, Fourier Transforms, Dover Publications Inc., 2003
26. M.R. Spiegel ,Theory and problems of Laplace Transform, McGraw-Hill Education, 1965
27. F. G. Tricomi, Integral Equations, Dover Publications Inc, 1985.
28. Lokenath Debnath, Dambaru Bhatta, Integral Transforms and Their Applications, Chapman and Hall/CRC,, 2014

ReferenceBooks:

S. G. Mikhlin ,Linear Integral Equations (Translated from Russia), Hindustan Book Agency, 1960

PAPER TITLE: RIGID DYNAMICS AND HYDROSTATICS
PAPER CODE:MTH23C804
CREDIT:4(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The objective of this course is to study moment of inertia and product of inertia, D'Alembert's principle, the general equation of motion of a rigid body, Hydrostatic pressure equation, condition of equilibrium, lines of force, rotating fluids, Fluid pressure on plane surfaces, centre of pressure, Equilibrium of a floating body, curves of buoyancy,Gas law, mixture of gases, internal energy, adiabatic expansion etc.

Course Learning Outcomes: This course will enable the students to:

CO1: Understand and apply moment of inertia and product of inertia, D'Alembert's principle, the general equation of motion of a rigid body.
CO2: Understand and apply Hydrostatic pressure equation, condition of equilibrium, lines of force, rotating fluids.
CO3: Understand Fluid pressure on plane surfaces, centre of pressure.
CO4: Undesstand Gas law, mixture of gases, internal energy, adiabatic expansion etc.

Unit– I (08 Hours)

Moment of inertia and product of inertia, six constant theorems, the momental ellipsoid, equi-momental systems, principal axes.

Unit– II (10 Hours)

D'Alembert's principle, the general equation of motion of a rigid body, motion of the centre of inertia and motion relative to the centre of inertia, motion about fixed axis, compound pendulum.

Unit– III (12 Hours)

Hydrostatic pressure equation, condition of equilibrium, lines of force, homogeneous and heterogeneous fluids, elastic fluids, surface of equal pressure and equal density, fluid at rest under action of gravity, rotating fluids. Fluid pressure on plane surfaces, centre of pressure.

Unit– IV (10Hours)

Equilibrium of a floating body, curves of buoyancy, surface of buoyancy, stability of equilibrium of floating bodies, meta centre.

Unit– V (08Hours)

Gas law, mixture of gases, internal energy, adiabatic expansion, work done in compressing a gas, isothermal atmosphere.

Text books:

1. S. L. Loney, An elementary treatise on the Dynamics of a particle and of Rigid bodies, 2012.
2. F. Chorlton, Analytical Dynamics, CBS Publisher, 2002.
3. W. H. Besant, A Treatise on Hydromechanics: part-I: Hydrostatics, Trieste Publishing Pty Limited, 11-Sep-2017

Reference Books:

1. J. M. Kar, Hydrostatics, K. P. Basu Pub. Co. Calcutta, 2016
2. M. Ray& H.S. Sharma, Hydrostatics, Scand, 2000.
3. A. S. Ramsey, Dynamics part I , Cambridge University Press, 1932.
4. M. R. Spiegel, Theoretical Mechanics, McGraw Higher Ed, 2017

PAPER TITLE: ABSTRACT ALGEBRA AND NUMERICAL ANALYSIS
PAPER CODE:MTH23M801
CREDIT:(3+1+0)

Workload: 3 Lectures, 1 Tutorial (per week) **Credits:** 4 (3+0+1)**Total number of lectures:** 45

Course Objectives: The primary objective of the course of abstract algebra is to introduce cosets of a group and its properties, Lagrange's theorem, quotient groups and group homomorphisms, fundamental theory of rings, integral domains, and fields. the primary objective of the course of numerical analysis is to introduce finite difference operators, calculus of finite difference, different numerical differentiation and integral formulae.

Course Learning Outcomes: This course will enable the students to:

CO1: Explain the significance of the notion of permutation groups, cosets, normal subgroups and homomorphisms.
CO2: Understand the fundamental concepts of rings, subrings.
CO3: Understand fields, ideals, and factor rings.
CO4: Apply different numerical differentiation and integral formulae.

Unit - I (13 Hours)

Permutation groups, cyclic decomposition of permutations and its properties, even and odd permutations and the alternating group; cosets and Lagrange's theorem; definition and examples of normal subgroups, quotient groups; group homomorphisms and properties.

Unit - II: (13 Hours)

Definition, examples and properties of rings, subrings, integral domains, fields, ideals and factor rings; characteristic of a ring; ring homomorphisms and properties.

Unit – III: (22 Hours)

Finite difference operators and their operations on function of a single variable, calculus of finite difference: different interpolation formulae with remainder terms, interpolation with equal and unequal intervals, newton's formulae, Lagrange's formula, numerical differentiation and integration: numerical differentiation with the help of different interpolation formulae, general quadrature formula, trapezoidal rule, Simpson's one third and three eighth rule

Text Books :

1. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint (2021).
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition, 2007.
3. K. Atkinson, An Introduction to Numerical Analysis, John Wiley & Sons; 2nd Revised edition, 1989.

Reference Books :

1. Beachy, John A., & Blair, William D. (2006). Abstract Algebra (3rd ed.). Waveland Press.
2. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education,India,7th edition, 2008

3. R. L. Burden, J. D. Faires, Annette M. Burden, Numerical Analysis, Cengage Learning, 10 edition, 2015