SYLLABUS

DIBRUGARH UNIVERSITY

FOUR YEARS UNDER GRADUATE PROGRAMME (FYUGP)
[AS PER NEP 2020]

MATHEMATICS

(Recommended by B.O.S. in Mathematics, D.U. in its meetings held on 18.11.2022, 10.02.2023 & 09.02.2024 and approved by Joint UG-PG Board meeting held on 06/06/2024 and passed by the Academic Council meeting held on 13/06/2024 and effective from the session 2023-24)

PREAMBLE

As recommended by the University Grants Commission (UGC) and proposed for implementation by Dibrugarh University, the Department of Mathematics works to implement the relevant components of New Education Policy (NEP), 2020 for Four Year Under Graduate Programme (FYUGP). The following facts are taken into consideration when designing the basic structure of the Under Graduate (UG) programme:

i. Flexibility to switch between disciplines of study,
ii. Opportunity for learners to select the courses of their interest across all disciplines,
iii. Flexible entry and exit options with UG certificates, UG diplomas, or UG degrees depending on the number of credits earned,
iv. Flexibility for students to switch between institutions so they can engage in multi- and/or interdisciplinary learning,
v. Flexibility to switch to alternative modes of learning,
vi. Knowledge required for self-employment initiatives and entrepreneurship mindset,
vii. Ability for complex critical thinking and real-life problem solving,
viii. Capability to understand global issues, multicultural competence and digital literacy,
ix. Capable on research skills, communication skills, community based engagement, environment awareness, responsibility and accountability.

INTRODUCTION

The Under Graduate (UG) syllabus of Mathematics in light of New Education Policy (NEP), 2020 consists of Major (Core) disciplines, Minor disciplines, Multi-Disciplinary Generic Elective Courses (MDGEC), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Research Ethics and Methodology, Dissertation (Collection of Data, Analysis and Preparation of Report) and Discipline Specific Electives (DSE).

The UG degree programme offers certificates, diplomas and degrees as follows:

UG Certificate: Certificate course consists of two Major disciplines, two Minor disciplines, two MDGEC, two AEC, two VAC and two SEC.

UG Diploma: Diploma course consists of eight Major disciplines, four Minor disciplines, three MDGEC, two AEC, three VAC, three SEC.

3-year UG Degree: 3-year UG degree course consists of fifteen Major disciplines, six Minor disciplines, three MDGEC, two AEC, three VAC, three SEC, Community engagement (NCC/NSS/Adult Education/Student mentoring/ NGO/ Govt. Institutions, etc.) and Internship.

4-year Honours Degree: 4-year honours degree course consists of twenty Major disciplines, eight Minor disciplines, three MDGEC, two AEC, three VAC, three SEC, Community engagement (NCC/NSS/Adult Education/Student mentoring/ NGO/ Govt. Institutions, etc.), Internship, Research Ethics and Methodology/ two DSE.

AIM

The UG Programme in mathematics is designed to teach students how to think critically, logically, and analytically, which enables them to employ mathematical reasoning in real-world situations. A UG degree in mathematics will expose students to a variety of intriguing and practical concepts that will help them in their preparation for a variety of mathematics-oriented jobs in industry, government, business, commerce, finance and research.

The programme covers broad range of topics on pure and applied mathematics. Also covers hands-on sessions in Computer Lab using various software, MATLAB, C etc. which enables students to corelate and compare with recent developments in various branches of mathematics in a variety of organisations worldwide.

The programme aims to increase students' skill in mathematics as well as other cross-disciplinary subjects like commerce, physics, computer sciences, economics, and statistics etc. Also aims students' flexibility to move from one discipline to another, to move one institution to another, to switch alternative modes of learning.

Programme Educational Objectives (PEO):

PEO 1: Fundamental Knowledge and Skills

Graduates will be well-versed in mathematical theories, concepts, and techniques, enabling them to solve challenging problems and pursue advanced study in mathematics or related fields.

PEO 2: Analytical and Critical Thinking

Graduates will acquire the analytical and critical thinking abilities needed to formulate, evaluate, and resolve real-world issues using logical reasoning and mathematical modelling.

PEO 3: Application of Mathematics

Graduates will be adept at using computational tools and mathematical concepts to solve problems in a variety of sectors, including science, engineering, technology, and economics.

PEO 4: Communication and Collaboration

Graduates will be able to effectively convey mathematical concepts, both orally and in writing, as well as collaborate in multidisciplinary teams to solve challenging problems.

PEO 5: Ethical and Professional Responsibilities

Graduates will exhibit a dedication to moral behaviour and professional obligations, which include comprehending how mathematical solutions affect society and maintaining a high standard of professional development.

PEO 6: Lifelong Learning and Adaptability

Graduates will pursue lifelong learning in order to keep up with new developments and trends in the mathematics and to adjust to the changing needs of both academia and the workforce.

PEO 7: Research and Innovation

Graduates will be equipped with the capacity to carry out autonomous research, enhancing their understanding of mathematics and stimulating their imagination in addressing abstract and practical issues.

PROGRAMME OUTCOMES ARE GRADUATE ATTRIBUTES STATED AS FOLLOWS:

PO1: Disciplinary Knowledge

Being able to demonstrate comprehensive knowledge and coherent understanding of both the theoretical and applied components of mathematics as well as chosen interdisciplinary areas of study in a broad multidisciplinary context.

PO2: Communication Skills

Capability to express various mathematical ideas clearly through computational methods, graphical methods, examples and their geometrical representations; ability to use mathematics effectively as a precise language of communication in other fields.

PO3: Moral and Ethical Awareness/Reasoning

Ability to recognise ethical issues that are pertinent to one's work and pledge not to engage in unethical behaviour such as plagiarism, copyright and infringement of intellectual property rights.

PO4: Multicultural Competence

Ability to corelate and compare recent developments in various branches of mathematics in a variety of organisations worldwide; ability to effectively participate in a multicultural group or society and interact politely with diverse groups.

PO5: Information/Digital Literacy

Ability to access, asses and utilize Information and Communications Technology (ICT) tools. Ability to understand, read and write programming language/packages/modules (MATLAB; C) for computation, simulation, graphs and solutions.

PO6: Reflective Thinking

Ability to formulate appropriate questions pertaining to the ideas in various branches of mathematics in order to propose new solutions using the domain knowledge of mathematics; ability to interpret the findings and use them to solve a variety of problems found in numerous fields of mathematics and real-life.

PO7: Cooperation/Team Work

Ability to collaborate with diverse teams in an effective and respectful manner; capacity to cooperate with people from varied backgrounds in the interests of a common goal.

PO8: Research Related Skills

The ability to formulate appropriate questions, problems, and hypotheses by analysing and interpreting the ideas from various branches of mathematics; ability to demonstrate the results, theories, techniques and proofs using the concepts of various fields of mathematics.

PO9: Problem Solving

Ability to work independently and do in-depth study to find ways that mathematics is used in various industries and in daily life to improve job possibilities in a wide range of fields and academic study; ability to use innovative, imaginative, lateral thinking, interpersonal skills, and emotional intelligence; ability to tackle various challenges in both familiar and unfamiliar circumstances, then apply what they've learned to actual scenarios.

PO10: Critical Thinking

Capability to analyse and synthesise theoretical and applied problems, as well as acquire knowledge and skills through logical reasoning, analytical thinking and evaluations; ability to find gaps and logical faults in arguments; inculcate a healthy attitude to be a lifelong learner.

Programme Specific Outcomes:

The Programme Specific Outcomes of FYUGP programme in Mathematics are listed in the following. After completing the programme the students will be able to-

PSO1: Demonstrate the acquisition of comprehensive knowledge and coherent understanding in chosen elective and core subjects in mathematics.

PSO2: Apply mathematical techniques and tools, such as mathematical modeling, computational methods, and statistical analysis, to solve real-world problems in various fields.

PSO3: Possess strong analytical and critical thinking skills, enabling them to construct rigorous logical arguments, develop proofs, and solve complex mathematical problems.

PSO4: Proficient in using modern mathematical software and computational tools such as MATLAB, C, and other relevant technologies to analyze data and solve mathematical problems.

PSO5: Communicate mathematical ideas and solutions to a variety of audiences, including mathematicians, scientists, engineers, and non-specialists, both orally and in writing.

PSO6: Formulate research questions, literature review, methodology, presentation of findings, and demonstrate dedication to lifelong learning and professional development.

PSO7: Utilize the skills that necessary for success in national level competitive exams, pursuing doctoral research degree, teaching and others.

Teaching Learning Process:

The outcome-based approach demands a considerable transition from teacher centric to learner centric pedagogies, as well as from passive to active/participatory pedagogies, especially in the context of undergraduate study. This course promotes the systematic and sequential acquisition of knowledge and skills. It also focuses on practical abilities, as well as an awareness of the link between theory and practice. Teaching strategies involve discussions, presentations, use of required textbooks, e-learning tools, other self-study materials; project, internship, exploring industrial needs and other research activities and so on.

Assessment Methods:

A variety of assessment procedures appropriate for the Mathematics discipline will be used to determine how well students are progressing keeping in view of the programme outcomes. Continuous evaluation will decide the final grade which include both in-semester evaluation and the final exam. In-semester evaluation will consist of class exams, mid-term exams, homework assignments, etc. as determined by the concerned teacher of the course of study. The following techniques will be used to evaluate how successfully students are meeting their goals: tutorials, timed exams, problem-based assignments, lab reports for practical assignments, observations of practical skills, individual project reports, team project reports, oral presentations, including seminar presentations, viva voce interviews, group discussions, quiz and so on.

STRUCTURE OF FOUR YEAR UNDER GRADUATE PROGRAMMES (FYUGP) IN MATHEMATICS FOR DIBRUGARH UNIVERSITY AND ITS AFFILIATED COLLEGES (AS PER NEP-2020 GUIDELINES)

Semester	Course	Title of the Paper &Paper Code	Credit
I (FIRST)	**C-1**	Calculus and Classical Algebra	4
	Minor 1	Differential Calculus	4
	GEC-1	**(Any one)** • Foundation in Mathematics-I • History of Mathematics	3
	AEC 1	AEC Language: MIL/ Regional Language	4
	SEC 1	Computer Laboratory-I	3
	VAC 1	Value Added Course 1	2
	Total Credit		**20**
II (SECOND)	**C-2**	Real Analysis & Differential Equation	4
	Minor 2	Real Analysis	4
	GEC 2	**(Any one)** • Foundation in Mathematics-II • Business Mathematics	3
	AEC 2	AEC: Language and Communication Skills (English) II	4
	SEC 2	Computer Laboratory-II	3
	VAC 2	Value Added Course 2	2
	Total Credit		**20**
III (THIRD)	**C-3**	Theory of Real functions	4
	C-4	Group Theory I	4
	Minor 3	Differential Equations	4
	GEC-3	**(Any one)** • Financial Mathematics • Combinatorial Mathematics	3
	SEC-3	Mathematical Logic	3
	VAC 3	Value Added Course 3	2
	Total Credit		**20**

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Semester	Course	Title of the Paper &Paper Code	Credit
IV (FOURTH)	**C-5**	Numerical Methods	4
	C-6	Riemann Integration & Series of Functions	4
	C-7	Ring Theory and Linear Algebra I	4
	C-8	PDE and Systems of ODE	4
	Minor 4	Algebra	4
	Total Credit		**20**
V (FIFTH)	**C-9**	Multi-Variate Calculus	4
	C-10	Group theory-II	4
	C-11 (any one)	Linear Programming	4
		Mathematical Methods	
		Financial Mathematics	
		Computer Programming	
	Minor 5	Computer Programming	4
	Internship or Community Engagement	Internship or	4
		Community Engagement (NCC/NSS/Adult Education/ Student Mentoring/NGO/Govt. Institutions, etc.)	
	Total Credit		**20**
VI (SIXTH)	**C-12**	Metric Spaces & Complex Analysis	4
	C-13	Ring Theory & Linear Algebra II	4
	C-14 (any one)	Number Theory	4
		Mechanics	
		Hydro-Mechanics	
	C-15 (any one)	Discrete Mathematics	4
		Probability and Statistics	
	Minor 6	Numerical Methods	4
	Total Credit		**20**

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Semester	Course	Title of the Paper &Paper Code	Credit
VII (SEVENTH)	**C-16**	Abstract Algebra	4
	C-17	Tensor Analysis	4
	C-18	Information Security	4
	Minor 7	Graph Theory	4
		Research Ethics and Methodology	4
	Total Credit		**20**
VIII (EIGHTH)	**C-19**	Functional Analysis	4
	C-20	Non-linear Dynamical System & Chaos	4
	Minor 8	Bio-Mathematics	4
	DISSERTATION OR 2 DSE OF 4 CREDITS	DISSERTATION	8
		OR	
	DSE-1	Theory of Equations	4
	DSE-2	Dynamical Systems	4
	Total Credit		**20**

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Calculus and Classical Algebra**
Course Code	**:**	**MTHC1**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Pre-requisite:

- Ideal of fundamentals of differentiation and integration,
- Trigonometric and logarithmic functions,
- Arithmetic.

Course Objectives: The course will introduce to the learners the concept of De Moivre's Theorem and its application in the expansion of some trigonometric functions. Students will learn the techniques of successive differentiation, Leibnitz theorem, and L'Hospital rule for evaluation of limit. It will explain various types of reduction formula for integration of trigonometric function and applications in finding the volume and surface area of revolution of curve. The course will also introduce the system of linear equation and how to solve such systems.

Course outcomes: After completing the course a learner will be able to

CO1: Apply De'Moivre theorem to different problems.

ILO 1.1: Demonstrate the use of De'Moivre's theorem in raising complex numbers to powers and extracting roots.
ILO 1.2: Solve problems involving the trigonometric form of complex numbers using De'Moivre's theorem.

CO2: Discuss expansion of trigonometric and hyperbolic functions.

ILO 2.1: Derive the series expansions for sine, cosine, and hyperbolic sine, and cosine functions.
ILO 2.2: Analyze the convergence of trigonometric and hyperbolic function expansions.

CO3: Apply Leibniz theorem to obtain successive differentiation.

ILO 3.1: Utilize Leibniz's theorem to find higher-order derivatives of product functions.
ILO 3.2: Solve problems involving successive differentiation using Leibniz's rule.

CO4: Utilize L'Hospital rule in finding limit of quotient of functions.

ILO 4.1: Apply L'Hospital's rule to evaluate limits of indeterminate forms such as 0/0 and ∞/∞.
ILO 4.2: Analyze and solve problems involving limits where L'Hospital's rule is applicable.

CO5: Evaluate maxima and minima of functions.

ILO 5.1: Determine the critical points of a function and classify them as maxima, minima, or saddle points.
ILO 5.2: Apply the first and second derivative tests to find and verify local maxima and minima of functions.

CO6: Describe reduction formula involving both trigonometric and logarithmic functions

ILO 6.1: Develop reduction formulas for integrals involving trigonometric functions.
ILO 6.2: Apply reduction formulas to solve integrals involving logarithmic functions.

CO7: Evaluate length of curves and area & volume of revolution of curves.

ILO 7.1: Calculate the arc length of a given curve using integral formulas.
ILO 7.2: Evaluate the area and volume generated by rotating a curve around an axis using integral methods.

CO8: State well ordering property of positive integers and fundamental theorem of Algebra.

ILO 8.1: Explain the well-ordering property of positive integers and its implications.
ILO 8.2: State and apply the fundamental theorem of algebra in solving polynomial equations.

CO9: Apply Division and Euclidean Algorithm to find GCD.

ILO 9.1: Use the Division Algorithm to express the gcd of two integers as a linear combination.
ILO 9.2: Implement the Euclidean Algorithm to determine the greatest common divisor of two integers.

CO10: Describe congruence relation between integers.

ILO 10.1: Explain the concept of congruence relations and their properties.
ILO 10.2: Solve problems involving modular arithmetic using congruence relations.

CO11: Demonstrate row reduction and echelon form of matrix.

ILO 11.1: Perform row operations to transform a matrix into row echelon form.
ILO 11.2: Demonstrate the process of reducing a matrix to its reduced row echelon form.

CO12: Solve system of linear equations.

ILO 12.1: Apply matrix methods, such as Gaussian elimination, to solve systems of linear equations.
ILO 12.2: Utilize the inverse matrix method and Cramer's rule to find solutions to systems of linear equations.

Mapping of Cos with Bloom's Taxonomy.

COGNITIVE KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	REMEMBERING	UNDERSTANDING	APPLY	ANALYZE	EVALUATE	CREATE
FACTUAL	CO8	CO2	X	X	CO6	X
CONCEPTUAL	C10	X	CO3, CO11, CO12	X	CO5	X
PROCEDURAL	X	CO1, CO4	CO9	X	CO7	X
METACOGNITIVE	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (11 Marks)	De Moivre's Theorem with rational indices and its application to various problems, Expansion of sinx, cosx, sinhx and coshx and related problems.	09	03	-	12
II (11 Marks)	Successive Differentiation, Leibnitz Theorem and its application, L'Hospital's Rule, Applications of maxima & minima.	09	03	-	12
III (11 Marks)	Reduction Formulae of the types $\int \sin^n x dx, \int \cos^n x dx, \int \tan^n x dx, \int (\log x)^n dx$ and $\int \sin^m x \cos^n x dx$ and their derivations. Rectification, volume and surface area of revolution of a curve.	09	03	-	12
IV (11 Marks)	Composite and invertible functions, well ordering property of positive integers, Division algorithm, Divisibility & Euclidean algorithm, Congruence relation between integers, Statement of the Fundamental Theorem of Arithmetic.	09	03	-	12
V (16 Marks)	System of Linear Equations, Row Reduction and Echelon Form, Vector Equation and matrix equation $Ax = b$. Solution set of a linear system, Linear Dependence and Independence of vectors.	09	03	-	12
	Total	**45**	**15**	**-**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Das B.C.& Mukherjee B.N., Higher Trigonometry, U N Dhur & Sons, 1933.
2. Thomas G.B. & Finney R.L., Calculus, Pearson Education, 2007.
3. Burton, D.M. Elementary Number Theory, McGraw Hill, 7th Ed., 2023.

REFERENCE BOOKS:

1. Arumugam S., Somasundaram A., & Isaac A.T., Differential Calculus, CBS Publishers, 2021.
2. Greenhill A.G., Differential and Integral Calculus, Alpha Edition, 2020.
3. Khanna V.K.& Bhambri S.K., Abstract Algebra, Vikash Publishing, 2017.
4. Lay David C., Lay S.R., & McDonald J.J., Linear Algebra and Its Application, Pearson, 2015.

Mapping of Course outcome to Programme outcome.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	L	L	M	L	M	S	S
CO2	S	S	L	L	L	S	M	S	S	S
CO3	S	S	L	L	L	M	L	M	S	S
CO4	S	S	L	L	L	M	L	M	S	S
CO5	S	S	L	M	L	S	M	S	S	S
CO6	S	S	L	L	L	S	M	M	S	S
CO7	S	S	L	L	L	M	L	M	S	S
CO8	S	S	L	L	L	M	L	M	S	S
CO9	S	S	L	L	L	M	L	M	M	S
CO10	S	S	L	L	L	S	M	M	S	S
CO11	S	S	L	L	L	S	M	S	S	S
CO12	S	S	L	M	L	S	S	S	S	S

S= Strong. M= Medium, L= Low

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Differential Calculus**
Course Code	**:**	**MINMTH 1**
Nature of the Course	**:**	**MINOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

The course on Differential Calculus deals with the outline of basic concepts of differential calculus and its application in solving various problems.

COURSE OBJECTIVE:

The objectives of the course are

i. To introduce the important concept of calculus and their applications
ii. To apply Rolles theorem, mean value theorem etc. in various problems

Course Outcome:

Students will be able to

CO1: define limit, continuity and differentiability and solve the problems

ILO 1.1: Analyse the continuity and differentiability of a function

ILO 1.2: Use Leibinitz theorem to find the higher order differentiation of products of functions.

CO2: get the knowledge of partial differentiations and evaluate partial differentials

ILO 2.1: Evaluate the partial differentials of a function

ILO 2.2: Discuss and use Euler's theorem on homogeneous functions.

CO3: apply differential calculus in finding tangent, normal etc. and trace a curve

ILO 3.1: find the equation of tangent and normal of any curve

ILO 3.2: Use calculus to determine the curvature of a curve

ILO 3.3: Discuss the steps to trace a curve.

CO 4: analyse Rolle's theorem, mean value theorem etc. and interpret them

ILO 4.1: Give a geometrical interpretation of Rolle's theorem.

ILO 4.2: Construct the Taylor/ Maclaurin series of a given function.

ILO 4.3: Assess the maxima and minima of a function.

Cognitive Map

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge	CO1					
Conceptual Knowledge			CO1	CO4		
Procedural Knowledge	CO3		CO2		CO4	
Metacognitive Knowledge						

UNITS	CONTENTS	L	T	P	Total Hours
I (11 Marks)	Limit and Continuity (ε- δ definition), Types of discontinuity, Differentiability of functions, Successive differentiation.	09	03	-	12
II (11 Marks)	Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions.	09	03	-	12
III (19 Marks)	Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.	12	04	-	16
IV (19 Marks)	Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cos x, e^x, log(l+x), $(l+x)^m$, Maxima and Minima, Indeterminate forms.	15	05	-	20
	Total	**45**	**15**	**-**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Anton H., Bivens I. & Davis S., Calculus, John Wiley and Sons Inc., 2002.
2. Thomas G.B. & Finney R.L., Calculus, Pearson Education, 2007.

REFERENCE BOOK:

1. Arumugam S., Somasundaram A., & Isaac A.T., Differential Calculus, CBS Publishers, 2021.

Mapping of Course Outcome to Program Outcome

CO/PO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	S	S	M
CO2	S	S	M	M	M	M	M	S	S	M
CO3	S	S	M	M	M	M	M	S	S	M
CO4	S	S	M	M	M	M	M	S	S	M

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Foundation in Mathematics-I**
Course Code	**:**	**GECMTH1A**
Nature of the Course	**:**	**Generic Elective Course (GEC)**
Total Credits	**:**	**03 (L=2, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

Foundation in Mathematics is a unique course to initiate the students to some fundamental topics of Mathematics. This course equips students with mathematical tools and techniques, the study of the logical and philosophical basis of mathematics, including whether the axioms of a given system ensure its completeness and its consistency. Topics include sets and logic, relation and functions, calculus and differential equations. This course prepares students for advanced studies in mathematical logic, calculus and their various applications by developing skills, strategies and reasoning needed to succeed in mathematics.

Pre-Requisites:

- Introduction to Sets and Logic.
- Basic concepts of calculus.
- Key concepts of relation and functions.

Course Objectives:

The course on Foundation in Mathematics-I aims the students to achieve in a more practical and definite ways. This sets the stage for more advanced mathematical concepts and real-world applications. The goal is to capture from specific and numeric reasoning to general and abstract reasoning using the language and structure of algebra to investigate, represent, and solve problems.

Course Outcomes (Cos):

On successful completion of the course, the students will be able to

CO1: Interpret and communicate quantitative information and mathematical and statistical concepts.
ILO1.1: Achieve a solid understanding of using estimation skills and when to estimate results.
ILO1.2: Read, interpret, and make decisions about data summarized numerically.
ILO1.3: Demonstrate proficiency in using basic terminology and principles.

CO2: Understanding the fundamental concepts of logic and set theory and apply the knowledge to everyday matters.
ILO2.1: Analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.
ILO2.2: Evaluate the truth of a statement using the principles of logic.
ILO2.3: Properly use the vocabulary and symbolic notation of higher mathematics in definitions, theorems, and problems.

CO3: Explore how relations and functions are applicable in daily life.

ILO3.1: Identify and differentiate between reflexive, symmetric, transitive and equivalence relations.

ILO3.2: Define one-to-one and onto functions and apply them in real-life scenarios.

ILO3.3: Analyze and interpret real-life examples such as in social networks, transportation systems, etc.

CO4: Understand the foundation of calculus and its applications in mathematics and physics.

ILO4.1: Interpret equations and graphs of the basic classes of functions.

ILO4.2: Evaluate limits by using limit laws and other evaluation techniques.

ILO4.3: Apply differentiation to geometric application, physical application, and modelling problems.

CO5: Systematic approach for solving problems and finding solutions in various fields, from physics to finance.

ILO5.1: Recognise differential equations and use the appropriate method to solve them.

ILO5.2: Use an initial condition to find a particular solution of a differential equation.

ILO5.3: Solve problems involving exponential growth and decay.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

This cognitive map aligns the key Course Outcomes (COs) with Bloom's Taxonomy across various knowledge dimensions. The map illustrates how each outcome engages different cognitive processes and types of knowledge, providing a comprehensive view of the educational objectives in the curriculum.

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual Knowledge		CO1, CO2				
Conceptual Knowledge		CO1, CO2	CO3	CO5		CO4
Procedural Knowledge			CO1, CO2	CO3	CO4	CO5
Metacognitive Knowledge					CO5	

UNITS	**CONTENTS**	**L**	**T**	**P**	**Total Hours**
I (11 Marks)	**Sets and Logic** Sets, subsets, types of set, operations on sets, Cartesian product, Statements, truth values and truth table, negation, conjunction and disjunction, Statements with quantifiers, compound statements, implications, biconditional proposition, converse, contrapositive and inverse proposition, propositional equivalence, predicates and quantifier, tautology and contradiction.	06	03	-	9
II (19 Marks)	**Relation and Functions** Relation and functions, types of relation and functions, graphs of functions, compositions of functions and invertible function, Binary operations.	08	04	-	12

III (15 Marks)	**Calculus** Limits, continuity, Differentiability of function, Derivatives of different types of functions, second order derivatives, rate of change of quantities, increasing and decreasing function, Maxima and Minima, introduction to Integrals, Applications of integrals.	08	04	-	12
IV (15 Marks)	General and particular solutions of differential equations, separation of variables, Homogeneous equations, Linear Differential Equations of first order, General and particular solutions of homogeneous and non-homogeneous linear differential equations of second order with constant coefficients.	08	04	-	12
	Total	**30**	**15**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Kumar A., Kumaresan S., &Sarma, B.K., A Foundation Course in Mathematics, Narosa Publishing House, 2018.
2. Stewart I., Tall D., The Foundations of Mathematics. Oxford University Press, 2nd Ed., 2015.

Mapping of Course Outcomes to Program Outcomes

This table illustrates the alignment between the key Course Outcomes (COs) and the Programme Outcomes (POs), highlighting the significant ('Strong') and moderate ('Medium') contributions of each course outcome toward achieving the broader educational goals of the program.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	M	S	M	M	S
CO2	S	S	S	S	S	M	M	S	S	M
CO3	S	S	S	S	S	M	M	S	S	M
CO4	S	M	S	S	S	M	S	M	S	S
CO5	S	M	S	S	S	M	S	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**History of Mathematics**
Course Code	**:**	**GECMTH1B**
Nature of the Course	**:**	**Generic Elective Course (GEC)**
Total Credits	**:**	**03 (L=2, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

The History of Mathematics course explores the development of mathematical concepts, theories, and practices from ancient civilizations to modern times. This course examines the contributions made by important historical eras and individuals to a variety of mathematical disciplines, including number theory, calculus, geometry, and algebra. The cultural and historical settings in which these mathematical concepts originated and developed will become more clear to the students. Students will understand mathematics' influence on science, technology, and society as well as its continuing influence on modern mathematical thought by exploring the discipline's historical development.

Pre-Requisites:

- Basic concepts of arithmetic operations.
- Introduction to geometry.

COURSE OBJECTIVE:

1. To develop a comprehensive understanding of the origins and development of mathematics in ancient India, medieval India, including the contributions of Hindu and Greek mathematicians.
2. To study the evolution of major mathematical concepts and theories in areas like algebra, geometry, calculus, and number theory.
3. To analyze how the technological, social, and cultural environments shaped the conceptualization of mathematics.
4. To gain an understanding of how mathematical discoveries have impacted society, science, and technology.

COURSE OUTCOME:

After going through this course, the students will be able to

CO1: describe the development and significance of mathematics in ancient India, focusing on Hindu contributions and their historical context.

ILO1: Identify and describe significant mathematical contributions from ancient India, such as advancements in algebra, trigonometry, and arithmetic.

ILO2: Examine the cultural, religious, and intellectual environment in which Hindu mathematicians made their contributions.

ILO3: Highlight the lives and works of prominent Hindu mathematicians such as Aryabhata, Brahmagupta, and Bhaskara II.

ILO4: Explain how Hindu mathematical discoveries influenced later mathematical developments in India and other regions.

CO2: analyze the development of numeral systems, including the decimal place-value system, zero symbol, and various numerical notations in Hindu literature.

ILO1: Describe the progression from early numerical notations to the development of the decimal place-value system.

ILO2: Discuss the introduction and impact of the zero symbol and its role in the decimal place-value system.

ILO3: Explain how the Hindu numeral system, including the concept of zero, spread and influenced other cultures and mathematical systems.

ILO4: Analyze different numerical notations used in ancient Hindu texts and their applications.

CO3: apply Euclidean geometry principles by exploring Euclid's "Elements," including the Pythagorean Theorem and geometric algebra.

ILO1: Describe the foundational principles and axioms of Euclidean geometry as presented in Euclid's "Elements."

ILO2: Detail the Pythagorean Theorem and various proofs, including those found in Euclid's "Elements."

ILO3: Discuss how Euclid applied geometric methods to solve algebraic problems, demonstrating the concept of geometric algebra.

CO4: evaluate Archimedes' methods for estimating pi and his contributions to geometry.

ILO1: Explain the techniques Archimedes used to approximate the value of pi, including the method of exhaustion.

ILO2: Discuss key geometric discoveries and theories proposed by Archimedes, such as the area of a circle and the surface area of a sphere.

ILO3: Investigate how Archimedes' work in geometry and pi estimation influenced later mathematicians and the development of mathematics.

CO5: synthesize knowledge of arithmetic algorithms, geometry, linear congruences, sine tables, and Diophantine equations, tracing their development and transmission in ancient and medieval India.

ILO1: Describe important arithmetic algorithms, such as those for multiplication and division, used in ancient India.

ILO2: Detail how linear congruences were formulated and solved in ancient Indian mathematical texts.

ILO3: Examine the development of sine tables and their importance in the work of Indian mathematicians like Aryabhata.

ILO4: Investigate the techniques and algorithms used by Indian mathematicians to solve Diophantine equations and their impact on number theory.

ILO5: Explore how mathematical discoveries from ancient and medieval India were transmitted to other cultures and influenced global mathematics.

Cognitive Map of Course Outcomes with Bloom's Taxonomy:

This cognitive map aligns the key Course Outcomes (COs) with Bloom's Taxonomy across various knowledge dimensions. The map illustrates how each outcome engages different cognitive processes and types of knowledge, providing a comprehensive view of the educational objectives in the curriculum.

COGNITIVE KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	REMEMBER	UNDERSTANDING	APPLY	ANALYZE	EVALUATE	CREATE
FACTUAL KNOWLEDGE		CO1	CO3		CO4	
CONCEPTUAL KNOWLEDGE	CO1		CO3	CO2	CO4	
PROCEDURAL KNOWLEDGE			CO3	CO2	CO4	
METACOGNITIVE KNOWLEDGE					CO5	

UNITS	CONTENTS	L	T	P	Total Hours
I (9 Marks)	A glimpse of ancient India; Hindus and mathematics; Scope and development of Hindu mathematics.	06	03	-	09
II (15 Marks)	Numeral terminology; The development of Numerical Symbol; The decimal place-value system; Persistence of the old system; Word numerals; Alphabetic notations; The zero symbol; The place-value notation in Hindu literature.	08	04	-	12
III (18 Marks)	Euclid: Introduction to the Elements; Book I and Pythagorean Theorem; Book II and Geometric Algebra. Archimedes; Estimating the values of pi. Ramanujan's view on Magic square.	08	04	-	12

IV (18 Marks)	Ancient and Medieval India: Arithmetic algorithms; Geometry; Linear congruence; Construction of Sine tables; Transmission to and from India. Diophantine Equations in Greece and India; Early Mathematics in India. Linear Equations in One and Two unknown. The Rule of three.	08	04	-	12
	Total	**30**	**15**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Datta B., Narayan Singh A., History of Hindu Mathematics (Part I), Gyan Publishing House, 2021.
2. Kartz Victor J., A History of Mathematics: An Introduction, Pearson, 2009.
3. Burton David M., The History of Mathematics: An Introduction, Mc Graw Hill, 2011.
4. Berndt Bruce C., Ramanujan's Notebooks: Part I, Springer, 1985.

Mapping of Course Outcomes to Program Outcomes:

This table illustrates the alignment between the key Course Outcomes (COs) and the Programme Outcomes (POs), highlighting the significant ('Strong') and moderate ('Medium') contributions of each course outcome toward achieving the broader educational goals of the program.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	L	M	M	M	M	M
CO2	S	S	M	M	L	M	M	M	M	M
CO3	S	S	M	M	L	S	M	M	S	S
CO4	S	S	M	M	L	M	M	M	S	S
CO5	S	S	M	M	L	S	M	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 1st SEMESTER

Title of the Course	**:**	**Computer Laboratory-I**
Course Code	**:**	**SEC115**
Nature of the Course	**:**	**Skill Enhancement Course (SEC)**
Total Credits	**:**	**03 (L=0, T=0, P=6)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

This course provides an in-depth understanding of advanced mathematical concepts and techniques, with a focus on practical applications using Matlab or Mathematica. The course covers fuzzy sets, basic commands and operations in Matlab/Mathematica, solutions of algebraic equations, evaluation of mathematical expressions, techniques of sketching conics, and matrix operations. Students will engage in hands-on practical sessions to reinforce theoretical knowledge and develop problem-solving skills in real-world contexts.

Prerequisites

- Basic understanding of high school mathematics, including algebra, trigonometry, and calculus.
- Introductory knowledge of programming or computational tools is recommended.

Course Objectives

1. **Develop Mathematical Reasoning:** Enhance students' ability to reason mathematically and understand fundamental mathematical axioms.
2. **Comprehend and Expand Mathematical Concepts:** Enable students to comprehend and build upon basic and advanced mathematical concepts.
3. **Logical Analysis and Theorem Crafting:** Equip students with skills to analyze and craft logical arguments to substantiate mathematical theorems.
4. **Advanced Mathematical Knowledge:** Provide deep insights into various mathematical domains, including fuzzy sets and parametric curves.
5. **Problem-Solving Methodologies:** Master diverse problem-solving methodologies applicable to mathematical issues.
6. **Effective Communication:** Develop proficiency in communicating mathematical ideas with precision and clarity.
7. **Professional and Applied Mathematics Skills:** Enhance professional mathematical skills and gain expertise in specialized areas of applied mathematics.
8. **Computational and Research Skills:** Acquire necessary mathematical and computational skills for engaging in independent research.
9. **Real-Life Problem-Solving:** Prepare students to address real-life and complex mathematical problems using advanced techniques.
10. **Technical Report Preparation:** Train students to prepare clear and precise technical mathematical reports, such as dissertations and theses.

Course Outcomes (COs)

CO1: Demonstrate proficiency in using basic commands in Matlab/Mathematica to evaluate mathematical expressions and solve algebraic equations.

ILO1: explain the function of basic commands in Matlab/Mathematica such as clc, help, clear, format, exit, linspace, zeros, ones, meshgrid, eye, rand, real, imag, angle, conj, and commands for trigonometric and inverse trigonometric functions.

ILO2: Apply basic commands in Matlab/Mathematica to evaluate mathematical expressions, including arithmetic operations, exponential and logarithmic functions, trigonometric functions, and computation of complex numbers.

CO2: Analyze graphs of various functions and polynomials using Matlab/Mathematica to understand their properties.

ILO1: Explain the use of graph plotting commands in Matlab/Mathematica, such as plot, title, legend, hold on, axis, grid on, figure, clf, and close all.

ILO2: Apply Matlab/Mathematica commands to plot and analyze graphs of various functions and polynomials, including linear, quadratic, exponential, logarithmic, trigonometric functions, and polynomials of degrees 4 and 5.

ILO 3: Analyze the Behavior of Various Functions

CO3: Utilize techniques for sketching conics and parametric curves using Matlab/Mathematica to explore their geometric properties.

ILO1: explain the use of commands in Matlab/Mathematica for sketching conics and parametric curves, such as ezplot, fplot, plot, and other relevant plotting functions.

ILO2: Apply Matlab/Mathematica commands to sketch and analyze the geometric properties of conics (e.g., ellipses, hyperbolas) and parametric curves (e.g., cycloids, epicycloids, hypocycloids).

CO4: Apply Matlab/Mathematica to obtain surfaces and volumes of revolution and perform matrix operations.

ILO1: Use Matlab/Mathematica to calculate and visualize surfaces and volumes of revolution for given functions.

ILO2: Utilize Matlab/Mathematica to perform matrix operations, including addition, multiplication, inversion, and transposition.

CO5: Interpret the procedural steps involved in using Matlab/Mathematica for various mathematical computations.

ILO1: Explain the procedural steps for performing basic mathematical computations in Matlab/Mathematica, such as evaluating expressions, solving equations, and plotting graphs.

ILO2: Demonstrate interpreting of the procedural steps for advanced mathematical computations in Matlab/Mathematica, including matrix operations, solving systems of equations, and performing calculus operations.

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge						
Conceptual Knowledge				CO2		
Procedural Knowledge		CO5	CO1, CO3, CO4			
Metacognitive Knowledge						

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Basic commands of Matlab or Mathematica, Evaluation of different mathematical Expressions, Solutions of algebraic equation. **List of Practicals** 1. Basic commands of Matlab or Mathematica: clc, help, clear, format, exit, line space, zeros, ones, meshgrid, eye, rand, real, imag, angle, conj, commands for trigonometric and inverse trigonometric function, abs, exp, sqrt, log, log2, log10, mod, plot, title, legend, hold on, axis, grid on, figure, clf, close all. 2. Evaluation of arithmetic expression, exponential and logarithms, trigonometric functions, computation of complex numbers. 3. Solution of algebraic equation, simultaneous linear equations.	-	00	15x2	30
II (11 Marks)	Parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution. **List of Practicals** 5. Plotting of graphs of function $e^{ax + b}$, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax +b), |ax + b| and to illustrate the effect of a and b on the graph. 6. Plotting the graphs of polynomials of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.	-	00	07x2	14
III (11 Marks)	Techniques of sketching conics, polar equation of conics 1. Sketching parametric curves (E.g., Trochoid, cycloid, epicycloids, hypocycloid).	-	00	08x2	16

IV (19 Marks)	2. Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic paraboloid, hyperbolic paraboloid using cartesian coordinates. Surface and volume of revolution, polar equation of conics, Matrix operations. **List of Practicals** 1 Obtaining surface of revolution of curves. 2 Tracing of conics in Cartesian coordinates/ polar coordinates. 3 Matrix operations (addition, multiplication, inverse, transpose).	-	00	15x2	30
	Total			**45X2**	**90**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Pratap Rudra, Getting started with MATLAB: A quick Introduction for Scientist and Engineers, Oxford University Press, 2010.
2. Wolfram S., The Mathematica, Cambridge University Press, 2003.
3. Thomas G.B. & Finney R.L., Calculus, 9th Ed., Pearson Education, Delhi, 2005.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	M	S	M	S	S	S	S
CO2	M	S	S	M	S	S	S	S	S	S
CO3	M	M	S	S	S	M	S	S	S	S
CO4	M	M	M	S	S	M	S	S	S	S
CO5	M	M	M	S	S	S	S	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Real Analysis and Differential Equations**
Course Code	**:**	**MTHC2**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

The course on Real Analysis & Differential Equations has two parts. The first part includes axioms of real number systems, review of the algebraic and order properties of the set R of real numbers. Sequences and their types with their convergence and divergence properties. The second part includes the various solution concepts of differential equations and their properties. The whole course is so designed that the students will learn the theories and concepts used in the real analysis and also the tools to solve differential equations.

Prerequisites:

- Introduction to Set Theory
- Calculus

Course Objectives:

The course on Real Analysis & Differential Equations is designed for the students to demonstrate theoretical knowledge and have problem solving skills on topics of Real Analysis & Differential Equations. The course will describe appropriate theorems, principles and concepts relevant to Real Analysis in the first section and Differential Equations in the second section. Both these sections provide a background for the study of mathematical analysis and also the application of differential equations in other branches of studies.

Course Outcomes (COs):

Students will be able to

CO1: Demonstrate the Algebraic, Order and the Completeness properties of the real numbers.

ILO1.1: List the algebraic and order properties of real numbers.

ILO1.2: Find supremum and infimum of sets.

ILO1.3: Describe Archimedean principle and its corollaries.

ILO1.4: Explain the properties of countable and uncountable sets.

CO2: Examine the convergence of real sequences and series.

ILO 3.1: Discuss the basic convergence properties of sequences and series.

ILO 3.2: Determine convergence and divergence of sequences and series.

ILO 3.3: Apply Archimedean principle in obtaining convergence of sequences and series.

CO3: Execute various solution concepts of differential equations

ILO 3.1: Classify the general, particular, explicit, implicit and singular solutions of differential equations.

ILO 3.2: Solve Exact differential equations, linear equations and Bernoulli equations.

ILO 3.3: Apply the solution methods of differential equations to solve problems.

CO4: Describe the solution techniques of homogeneous and non-homogeneous differential equations of second order

ILO 4.1: Solve homogeneous and non-homogeneous linear differential equations.

ILO 4.2: Solve Euler equations.

ILO 4.3: Solve differential equations using method of undetermined coefficients and method of variation of parameters.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO2	CO1, CO2				
Conceptual Knowledge		CO3	CO1,CO2	CO2		
Procedural Knowledge		CO3, CO4	CO1, C03, CO4	CO3, CO4		
Metacognitive Knowledge						

UNITS	CONTENTS	L	T	P	Total Hours
	(A) Real Analysis				
I (15 Marks)	Review of Algebraic and Order Properties of R, -neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.	12	04	-	16
II	Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences,	12	04	-	16

(15 Marks)	Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion. Statements of Infinite series, convergence and divergence of infinite series, Cauchy Criterion.				
	(B) Differential Equations				
III (11 Marks)	Concepts and definition of General, particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.	09	03	-	12
IV (19 Marks)	General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation, method of undetermined coefficients, method of variation of parameters.	12	04	-	16
	Total	**45**	**15**	**-**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Bartle R.G. & Sherbert D.R., Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2002.
2. Kumar A.& Kumarasen S., A Basic Course in Real Analysis, CRC Press, Reprint 2021.
3. Ross S.L., Differential Equations, 3rd Ed., John Wiley and Sons, India,2004.

REFERENCE BOOKS:

1. Thomas G.B. & Finney R.L., Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. Coddington E. A., An Introduction to Ordinary Differential Equation, Dover Publications, 1989.

Mapping of Course Outcomes to Program Outcomes:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	M	M	S	S	S
CO2	S	S	M	S	M	S	S	M	M	S
CO3	S	M	M	S	M	S	M	S	S	S
CO4	M	S	S	M	S	S	M	M	M	M

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Real Analysis**
Course Code	**:**	**MINMTH2**
Nature of the Course	**:**	**MINOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

The course on Real Analysis includes axioms of real number systems, sequence and series and their convergence. It is so designed that the students will learn the theories and concepts used in the real analysis. It also recognizes the contribution and impacts of real analysis in different areas of science.

Prerequisites:

- Introduction to Set Theory
- Calculus

Course Objectives:

The course on Real Analysis is designed for the students to demonstrate theoretical knowledge and have problem solving skills on topics of Real Analysis. The course will describe appropriate theorems, principles and concepts relevant to Real Analysis and provide a background for the study of Functional Analysis, Measure Theory, Topology, etc. It will deal with problems relevant to topics related to Real Analysis using ideas and techniques some of which are at the forefront of the discipline.

Course Outcomes (COs):

Students will be able to

CO1: Demonstrate the Algebraic, Order and the Completeness properties of the real numbers.

ILO1.1: List the algebraic and order properties of real numbers.

ILO1.2: Find supremum and infimum of sets.

ILO1.3: Deduce results as corollaries to the properties of the real numbers.

CO2: Examine the convergence of real sequences and series.

ILO2.1: Deduce Cauchy's convergence criterion and apply it to determine whether a sequence is convergent or not.

ILO2.2: Deduce monotone convergence theorem and apply it determine whether a sequence is convergent or not.

ILO2.3 Apply Archimedean principle in obtaining convergence of sequences.

CO3: Apply standard tests for convergence of sequences and series.

ILO 3.1: Describe Comparison test, Root test, Ratio test, Leibnitz's test of convergence.
ILO 3.2: Apply Comparison test, Root test, Ratio test, Leibnitz's test to determine whether a sequence is convergent or not.
ILO 3.3: Define absolute and conditional convergence with examples.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO2	CO1, CO2				
Conceptual Knowledge		CO3	CO1	CO1, CO3		
Procedural Knowledge		CO3	CO1, CO2, CO3			
Metacognitive Knowledge						

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	Finite and infinite sets, examples of countable and uncountable sets, Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.	09	03	-	12
II (19 Marks)	Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences, Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof).	15	05	-	20
III (11 Marks)	Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, convergence of p-series, alternating series,	09	03	-	12

IV (15 Marks)	Comparison test, Root test, Ratio test, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional convergence.	12	04	-	16
	Total	**45**	**15**	**-**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Kumar A. & Kumarasen S., A Basic Course in Real Analysis, CRC Press, Reprint, 2021.
2. Bartle R.G. & Sherbert D.R., Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2002.

REFERENCE BOOKS:

1. Fischer E., Intermediate Real Analysis, Springer Verlag,1983.
2. Ross K.A., Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

Mapping of Course Outcomes to Program Outcomes:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	M	M	S	S	S
CO2	S	S	M	S	M	S	S	M	M	S
CO3	S	M	M	S	M	S	M	S	S	S

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**

- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics
    - Assignment
    - Group Discussion
    - Quiz
    - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Analyse the properties of the number line
- Describe various analytical properties of the real number system

TEXTBOOKS:

3. Kumar A. & Kumarasen S., A Basic Course in Real Analysis, CRC Press, Reprint, 2021.
4. Bartle R.G. & Sherbert D.R., Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2002.

REFERENCE BOOKS:

3. Fischer E., Intermediate Real Analysis, Springer Verlag,1983.
4. Ross K.A., Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer Verlag, 2003.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Foundation in Mathematics-II**
Course Code	**:**	**GECMTH2A**
Nature of the Course	**:**	**Generic Elective Course (GEC)**
Total Credits	**:**	**03 (L=2, P=0, T=1)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

Foundation in Mathematics is a unique course to initiate the students to some fundamental topics of Mathematics. This course equips students with mathematical tools and techniques, the study of the difference operator with their relation and interpolation of function for the set of tabulated points. Topics include counting principles, numerical and probability. This course prepares students for advanced studies by developing skills, strategies and reasoning needed to succeed in mathematics.

Pre-Requisites:

- Introduction to Permutation and Combination.
- Basic concepts of operators.
- Introduction to Probability.

Course Objectives:

The course on Foundation in Mathematics-II aims the students to achieve in a more practical and definite ways. This sets the stage for more advanced mathematical concepts and real-world applications. The goal is to capture from specific and numeric reasoning to general and abstract reasoning using the language and structure of algebra to investigate, represent, and solve problems.

Course Outcomes (Cos):

On successful completion of the course, the students will be able to

CO1: Apply systematic strategies to count possible outcomes.
ILO1.1. Apply counting principles in a fair and unbiased manner.
ILO1.2: Read, interpret, and make decisions about data summarized numerically.
ILO1.3: Evaluate skills for both academic and real-world problem solving.

CO2: Understanding the fundamental concepts of interpolation methods.
ILO2.1: Use of various interpolation methods, including linear, polynomial, and spline interpolation.
ILO2.2: Understand their applications and limitations.
ILO2.3: Evaluate the accuracy and sources of interpolation error.

CO3: Understand the basic concepts of probability, random variables.
ILO3.1: Concept of random variables and distinguish between discrete and continuous types.
ILO3.2: Calculate the expected value, and variance of random variables.

ILO3.3: Analyze and interpret uncertain or random phenomena in real-world situations.

CO4: Understand the foundation of economic models, market analysis, and final forecasting.
ILO4.1: Develop critical thinking and data literacy skills.
ILO4.2: Evaluate data critically, discerning between reliable and unreliable information.
ILO4.3: Make predictions based on statistical models.

CO5: Use moment generating functions to find moments.

ILO5.1: Apply probability models to real-world problems in fields.

ILO5.2: Construct and interpret confidence intervals for parameter estimates.

ILO5.3: Stochastic processes, statistical learning and actuarial science.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

This cognitive map aligns the key Course Outcomes (COs) with Bloom's Taxonomy across various knowledge dimensions. The map illustrates how each outcome engages different cognitive processes and types of knowledge, providing a comprehensive view of the educational objectives in the curriculum.

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual Knowledge		CO1, CO2				
Conceptual Knowledge		CO1, CO2	CO3	CO5		CO5
Procedural Knowledge			CO1, CO2	CO3		CO5
Metacognitive Knowledge					CO5	

UNITS	**CONTENTS**	**L**	**T**	**P**	**Total Hours**
I (18 Marks)	**Counting Principles** Sum and Product rule of counting, permutation and combination, multinomial theorem, Pigeon hole principle, inclusion-exclusion principle, set partitions.	08	04	-	12
II (18 Marks)	**Finite Differences and Interpolation** Introduction, forward difference operator, Operators E & D, backward differences, central differences, Newton' forward and backward interpolation formulae, Lagrange's interpolation formula.	10	05	-	15
III (15 Marks)	**Probability** Introduction to probability, Random experiment, event, axiomatic approach to probability, conditional probability, Multiple theorem on probability, Bayes' theorem (Statement Only with Applications), random variables and distributions.	08	04	-	12

IV (9 Marks)	**Statistics** Introduction to statistics, Measure of Central Tendency.	04	02	-	06
	Total	**30**	**15**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Rao, G. S., Numerical Analysis. New Age International Publishers, 2003.
2. Berge, C., Principles of Combinatorics. New York, 1971.
3. Stewart I., Tall D., The Foundations of Mathematics. Oxford University Press, 2015.
4. Shastry S.S., Introductory Methods of Numerical Analysis, PHI, 2012.
5. Ross, S. M., Introduction to probability and statistics for engineers and scientists, Elsevier, 2021.

Mapping of Course Outcomes to Program Outcomes

This table illustrates the alignment between the key Course Outcomes (COs) and the Programme Outcomes (POs), highlighting the significant ('Strong') and moderate ('Medium') contributions of each course outcome toward achieving the broader educational goals of the program.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	M	S	M	M	S
CO2	S	S	M	S	S	S	M	S	S	M
CO3	S	S	S	S	S	S	M	S	M	M
CO4	S	M	S	S	M	S	S	M	S	S
CO5	S	M	S	S	S	S	S	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Business Mathematics**
Course Code	**:**	**GECMTH2B**
Nature of the Course	**:**	**Generic Elective Course (GEC)**
Total Credits	**:**	**03 (L=2, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

Business Mathematics is a vital subject that equips students with mathematical tools and techniques used in business and finance. The course covers fundamental concepts such as matrices, calculus, and finance, with a focus on their applications in business scenarios. Topics include linear equations, functions, matrices, differential calculus, and financial mathematics. This course prepares students for advanced studies in finance, business, and economic challenges by honing their analytical and mathematical skills, which are required for a successful career in business.

Pre-Requisites:

- Introduction to Real Analysis.
- Basic concepts of matrices.
- Basic concepts of financial mathematics.

COURSE OBJECTIVE:

1. To develop a solid understanding of fundamental mathematical concepts, including algebra, calculus, and finance, and their relevance to business applications.
2. To develop mathematical skills to solve real-world business problems using linear equations, functions, and matrices.
3. To enhance computational skills in differential calculus to optimize business functions and analyze changes in business environments.
4. To develop analytical and problem-solving skills by working through practical business scenarios and mathematical models.
5. To enhance mathematical and analytical skills to prepare for further studies in business, finance, and economics.

COURSE OUTCOME:

After going through this course, the students will be able to

CO1: apply matrix algebra, including calculating determinants, adjoints, and inverses, to solve simple business and economic problems.

ILO1: Compute the determinant of a matrix and explain how it can be used to determine the solvability of a system of linear equations in business applications.

ILO2: Calculate the adjoint of a given matrix and demonstrate its use in finding the inverse of the matrix for business problem-solving.

ILO3: Find the inverse of a matrix and use it to solve linear systems related to business and economic problems.

ILO4: Apply matrix operations such as addition, subtraction, multiplication, and inversion to model and solve business and economic problems.

CO2: analyze mathematical functions, including linear, quadratic, and polynomial, by applying the concepts of limits, continuity, and differentiation.

ILO1: Analyze the limits of linear, quadratic, continuity and polynomial functions in business contexts.

ILO2: Apply differentiation to linear, quadratic, and polynomial functions to determine marginal costs, revenues, and other rates of change in business scenarios.

ILO3: Apply differentiation techniques to solve optimization problems in business, such as maximizing profit or minimizing cost.

CO3: apply concepts of simple and compound interest, and different types of interest rates to perform compounding and discounting of sums.

ILO1: Apply the simple interest formula to determine interest amounts and total sums for different business investments and loans.

ILO2: Use the compound interest formula to calculate future values and present values of business investments and savings accounts.

ILO3: Calculate the compounded amount of investments over multiple periods using different interest rates.

CO4: formulate linear programming problems (LPP) based on business scenarios and sketch graphs of linear equations and inequalities.

ILO1: Define the decision variables and constraints for a given business problem to formulate a linear programming model.

ILO2: Express business constraints as linear inequalities and incorporate them into the linear programming model.

ILO3: Draw graphs of linear equations and inequalities to visually represent the feasible region of a linear programming problem.

CO5: evaluate and solve linear programming problems using graphical methods to find optimal solutions.

ILO1: Plot the feasible region of a linear programming problem on a graph based on the given constraints.

ILO2: Determine the coordinates of the corner points (vertices) of the feasible region and understand their significance in finding the optimal solution.

ILO3: Calculate the value of the objective function at each corner point to identify the optimal solution for the linear programming problem.

Cognitive Map of Course Outcomes with Bloom's Taxonomy:

This cognitive map aligns the key Course Outcomes (COs) with Bloom's Taxonomy across various knowledge dimensions. The map illustrates how each outcome engages different cognitive processes and types of knowledge, providing a comprehensive view of the educational objectives in the curriculum.

COGNITIVE KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	REMEMBER	UNDERSTANDING	APPLY	ANALYZE	EVALUATE	CREATE
FACTUAL KNOWLEDGE			CO1, CO3		CO5	CO4
CONCEPTUAL KNOWLEDGE			CO1, CO3	CO2	CO5	CO4
PROCEDURAL KNOWLEDGE			CO1, CO3	CO2	CO5	
METACOGNITIVE KNOWLEDGE						

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**Matrices** Definition of a matrix. Types of matrices; Algebra of matrices. Calculation of values of determinants up to third order; Adjoint of a matrix; Finding inverse of a matrix through ad joint; Applications of matrices to solution of simple business and economic problems	08	04	-	12
II (19 Marks)	**Differential Calculus** Mathematical functions and their types – linear, quadratic, polynomial; Concepts of limit and continuity of a function; Concept of differentiation; Rules of differentiation – simple standard forms. Applications of differentiation – elasticity of demand and supply; Maxima and Minima of functions (involving second or third order derivatives) relating to cost, revenue and profit.	08	04	-	12

III (15 Marks)	**Basic Mathematics of Finance** Simple and compound interest Rates of interest – nominal, effective and continuous – their inter relationships; Compounding and discounting of a sum using different types of rates.	08	04	-	12
IV (11 Marks)	**Linear Programming** Sketching of graphs of (i) Linear equation ax + by + c=0 and (ii) Linear inequalities. Formulation of linear programming problem (LPP). Graphical solution to LPP.	06	03		09
	Total	**30**	**15**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Vohra N.D., Business Mathematics and Statistics, McGraw Hill Education (India) Pvt. Ltd, 2012.
2. Singh J. K., Business Mathematics, Himalaya Publishing House, 2021.

REFERENCE BOOKS:

1. Mizrahi A., Sullivan M., Mathematics for Business and Social Sciences: Applied approach. Wiley and Sons, 1976.
2. Thukral J.K., Mathematics for Business Studies, Mayur Publications, 2009.

Mapping of Course Outcomes to Program Outcomes:

This table illustrates the alignment between the key Course Outcomes (COs) and the Programme Outcomes (POs), highlighting the significant ('Strong') and moderate ('Medium') contributions of each course outcome toward achieving the broader educational goals of the program.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	L	S	S	S	S	S
CO2	S	S	M	M	L	S	M	M	S	S
CO3	S	S	M	M	L	S	S	M	S	S
CO4	S	S	M	M	L	S	M	S	S	S
CO5	S	S	M	M	L	S	S	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 2nd SEMESTER

Title of the Course	**:**	**Computer Laboratory-II**
Course Code	**:**	**SEC214**
Nature of the Course	**:**	**Skill Enhancement Course (SEC)**
Total Credits	**:**	**03 (L=0, T=0, P=6)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Prerequisites

• Basic understanding of differential equations, calculus, and programming concepts.

Course Objectives:

The objectives of this course are:

- To model various real-life problems, such as exponential decay models, lake pollution models, etc., using MATHEMATICA/MATLAB/Open-source software.

- To plot recursive sequences and sequences of partial sums using MATHEMATICA/MATLAB.

Course Outcomes (COs)

CO1: Utilize modeling techniques to solve real-life problems such as exponential decay and lake pollution using MATHEMATICA/MATLAB.

ILO1: Explain the steps to model exponential growth and decay problems using MATHEMATICA/MATLAB.

ILO2: Apply modeling techniques to solve the lake pollution model and interpret the results.

CO2: Interpret recursive sequences and sequences of partial sums to understand their convergence properties.

ILO1: Use MATHEMATICA/MATLAB to plot recursive sequences and study their convergence.

ILO2: Interpret the behavior of sequences of partial sums to determine convergence or divergence.

CO3: Implement and study drug assimilation models and limited growth population models.

ILO1: Interpret drug assimilation into the blood using MATHEMATICA/MATLAB.

ILO2: Apply modeling techniques to limited growth population models and analyze the impact of harvesting.

CO4: Apply ecological and epidemiological models.

ILO1: Implement predatory-prey models and analyze the population dynamics.

ILO2: Utilize epidemic scenarios using MATHEMATICA/MATLAB and interpret the spread of disease.

CO5: Verify mathematical theorems and concepts through plotting and analysis.

ILO1: Explain MATHEMATICA/MATLAB to verify the Bolzano-Weierstrass theorem through plotting.

ILO2: Implement the convergence and divergence of sequences and series through visualizations.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Procedural Knowledge			CO1			
Conceptual Knowledge				CO2		
Procedural Knowledge			CO3			
Procedural Knowledge			CO4, CO5			
Procedural Knowledge						

UNITS	CONTENTS	L	T	P	Total Hours
I (18 Marks)	Introduction to compartmental model, exponential growth of population, exponential decay model, lake pollution model (case study of Lake Burley Griffin). **List of Practicals** 1. Plotting of second order solution family of differential equation. 2. Plotting of third order solution family of differential equation. 3. Growth model (exponential case only). 4. Decay model (exponential case only). 5. Lake pollution model (with constant/seasonal flow and pollution concentration).	-	00	15x2	30
II (9 Marks)	Drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), limited growth of population, limited growth with harvesting. **List of Practicals** 1. Case of single cold pill and a course of coldpills. 2. Limited growth of population (with and without harvesting).	-	00	5x2	10
III (15 Marks)	Predatory-prey model, epidemic model of influenza, battle model. **List of Practicals** 1. Predatory-prey model (basic Volterra model, with density dependence, effect of DDT, two preyone predator). 2. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers). 3. Battle model (basic battle model, jungle warfare, long range weapons).	-	00	10x2	20

IV (18 Marks)	Plotting recursive sequences, convergence sequences, convergent subsequences, divergent sequences and infinite series 1. Plotting of recursive sequences. 2. Study the convergence of sequences through plotting. 3. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot. 4. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.	-	00	15x2	30
	Total			**45X2**	**90**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Barnes B., Fulford Glenn R., Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and NewYork,2009.
2. Abell Martha L., Braselton James P., Differential Equations with MATHEMATICA, 3rd Ed., Elsevier AcademicPress,2004.

REFERENCE BOOK:

1. Edwards C.H.& Penny D.E., Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.

Mapping of Course Outcomes to Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	M	S	M	S	S	S	S
CO2	M	S	S	M	S	S	S	S	S	S
CO3	M	M	S	S	S	M	S	S	S	S
CO4	M	M	M	S	S	M	S	S	S	S
CO5	M	M	M	S	S	S	S	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS
DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Theory of Real Functions**
Course Code	**:**	**MTHC3**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Pre-requisite: Basic idea of differential calculus

Course Objectives: The course aims to equip the learners with an in-depth knowledge of the theory of real functions. Idea of limit, continuity, uniform continuity, differentiability and their application will be discussed. Rolle's theorem and other mean value theorem will also be introduced. Maclaurin series and Taylor series will be applied to different problems.

Course Outcomes:

CO1: Evaluate limit of functions.

ILO 1.1: Calculate the limit of a function at a point using algebraic simplification and limit laws.

ILO 1.2: Analyze and solve problems involving limits of functions using epsilon-delta definitions.

CO2: Examine continuity and uniform continuity of functions.

ILO 2.1: Determine the continuity of a function at a point and on an interval using the definition of continuity.

ILO 2.2: Distinguish between continuity and uniform continuity and apply these concepts to various functions.

CO3: Solve problems involving Rolle's theorem.

ILO 3.1: State and prove Rolle's theorem, and apply it to find points where the derivative of a function is zero.

ILO 3.2: Solve problems involving Rolle's theorem to verify the existence of roots within a given interval.

CO4: Apply mean value theorem to inequalities.

ILO 4.1: State and prove the mean value theorem and use it to establish inequalities involving derivatives.

ILO 4.2: Apply the mean value theorem to solve problems related to the behavior of functions on closed intervals.

CO5: Discuss Taylor series with different forms of remainder.

ILO 5.1: Derive the Taylor series expansion of a function and identify different forms of the remainder term.

ILO 5.2: Analyze the error in approximation using Taylor series with different forms of the remainder.

CO6: Apply Maclaurin series and Taylor series to mathematical problems

ILO 6.1: Utilize Maclaurin series to approximate functions and solve related mathematical problems.

ILO 6.2: Apply Taylor series to approximate functions and solve practical problems, considering the remainder term for accuracy.

Mapping of COs with Bloom's Taxonomy.

COGNITIVE KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	REMEMBERING	UNDERSTANDING	APPLY	ANALYZE	EVALUATE	CREATE
FACTUAL	X	X	X	CO2	X	X
CONCEPTUAL	X	X	CO3, CO4	X	X	X
PROCEDURAL	CO5	X	CO1, CO6	X	X	X
METACOGNITIVE	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (11 Marks)	Limit of a function, Sequential Criterion of limits, Divergence criteria, Statement of Limit theorems & their applications. Statements of the theorems of one sided limits, Infinite Limits and limits at infinity and statements of the related theorems.	06	02	-	08
II (11 Marks)	Continuous Functions and sequential criterion of continuity and discontinuity. Algebra of continuous functions (statements only) & their application to problems, Continuity on an interval, intermediate value theorem, Location Root Theorem, Preservation of interval theorem. Uniform Continuity, Statement of Non uniformity criteria, Uniform Continuity Theorem.	09	03	-	12
III (19 Marks)	Differentiability of a function at a point and in an interval, Caratheodory's Theorem, Algebra of differentiable functions (statements only) and their applications. Relative Extrema, Interior Extremum Theorem. Rolle's Theorem, Mean Value Theorem, Intermediate Value property of derivatives, Darboux's Theorem, Application of Mean Value Theorem to inequalities.	15	05	-	20

IV (19 Marks)	Cauchy's Mean Value Theorem, Taylor's Theorem with Lagrange's form of remainder & Cauchy's form of remainder, Application of Taylor's theorem to convex function. Taylor & Maclaurin series and their applications to simple problems.	15	05	-	20
	Total	**45**	**15**	**-**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

TEXTBOOKS:

1. Bartle R. G. & Sherbert D. R., Introduction to Real Analysis, 4th Ed., Wiley, 2021
2. Kumar A., Kumaresan S., A Basic Course in Real Analysis, Taylor & Francis Group, 2014.

REFERENCE BOOKS:

1. Fitzpatrick P. M., Advance Calculus, 2nd Edition, AMS Indian Edition, 2010
2. Fischer E., Intermediate Real Analysis, Springer Verlag, 1983.
3. Ross K.A., Elementary Analysis- The Theory of Calculus Series- Undergraduate Texts in Mathematics, Springer Verlag,2003.

Mapping of Course outcome to Programme outcome.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	M	L	S	M	S	S	S
CO2	S	S	L	M	L	S	M	S	S	S
CO3	S	S	L	M	L	S	M	S	S	S
CO4	S	S	L	M	L	S	M	S	S	S
CO5	S	S	L	M	L	S	M	S	S	S
CO6	S	S	L	M	L	S	M	S	S	S

S= Strong. M= Medium, L= Low

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Group Theory I**
Course Code	**:**	**MTHC4**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Pre-requisites: Set theory and basic knowledge of Arithmetic.

Course Objectives: The course intends to introduce to the learners the abstract structure called group. Besides various examples of group the learners will deal with different groups like abelian group, cyclic group, normal subgroup, quotient group. Important theorems like Lagrange's theorem, Caley's theorem, isomorphism theorems will also be discussed at length. Construction of new group from existing ones, viz., quotient group, direct product of groups is an important objective of this course.

Course Outcomes:

CO1: Identify groups like Klein 4-group, symmetric group, Dihedral group.

ILO 1.1: Recognize and describe the structure and properties of the Klein 4-group.

ILO 1.2: Identify and analyze the elements and properties of symmetric and dihedral groups.

CO2: State Lagrange's theorem, isomorphism theorems, fundamental theorem of Abelian groups.

ILO 2.1: State and explain Lagrange's theorem and its implications in group theory.

ILO 2.2: Describe the isomorphism theorems and the fundamental theorem of Abelian groups, providing examples of each.

CO3: Analyze permutation group.

ILO 3.1: Describe the structure and properties of permutation groups, including cycle notation and transpositions.

ILO 3.2: Solve problems involving the properties and operations of permutation groups.

CO4: Apply Lagrange's theorem to examine divisibility of a group by a subgroup.

ILO 4.1: Use Lagrange's theorem to determine the possible orders of subgroups within a finite group.

ILO 4.2: Apply Lagrange's theorem to analyze and solve problems involving the divisibility of the order of a group by the order of its subgroups.

CO5: Construct quotient group from a group and a normal subgroup.

ILO 5.1: Define and construct quotient groups given a group and a normal subgroup.

ILO 5.2: Demonstrate the process of forming quotient groups and solve related problems.

CO6: Solve problems applying properties of isomorphism.

ILO 6.1: Identify and prove isomorphisms between groups using the properties of group homomorphisms.

ILO 6.2: Solve problems involving group isomorphisms, including determining if two groups are isomorphic.

CO7: Explain direct product of groups.

ILO 7.1: Define and construct the direct product of two groups, explaining the resulting group's structure and properties.

ILO 7.2: Solve problems involving the direct product of groups and analyze its properties in various contexts.

Mapping of COs with Bloom's Taxonomy.

COGNITIVE KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	REMEMBERING	UNDERSTANDING	APPLY	ANALYZE	EVALUATE	CREATE
FACTUAL	CO1, CO2	X	X	X	X	X
CONCEPTUAL	X	X	CO6	CO3	X	CO5
PROCEDURAL	X	CO4, CO7	X	X	X	X
METACOGNITIVE	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (11 Marks)	Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.	09	03	-	12
II (11 Marks)	Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.	09	03	-	12

III (16 Marks)	Properties of cyclic groups, classification of subgroups of cyclic groups. Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.	09	03	-	12
Unit IV (11 Marks)	External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.	09	03		12
Unit V (11 Marks)	Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.	09	03		12
	Total	**45**	**15**	**-**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Describe various group structures onsets.
- Identify the group structures present in different branches of sciences.

TEXTBOOKS:

1. Gallian J.A., Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, NewDelhi,1999.
2. Fraleigh J. B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

REFERENCE BOOKS:

1. Dummit D.S. & Foote R. M., Abstract Algebra 3rd Ed., Wiley, 2011.
2. Rotman J. J., An Introduction to the Theory of Groups, 4th Ed., Springer Verlag,1995.
3. Herstein, I.N., Topics in Algebra, Wiley, India, 2006.

Mapping of Course outcome to Programme outcome.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	L	M	L	S	M	S	S	S
CO2	S	S	L	M	L	S	L	M	S	S
CO3	S	S	M	M	L	S	L	S	S	S
CO4	S	S	M	M	L	S	L	S	S	S
CO5	S	S	M	M	L	S	L	S	S	S
CO6	S	S	M	M	L	S	M	S	S	S
CO7	S	S	M	M	L	S	M	S	S	S

S= Strong. M= Medium, L= Low

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Differential Equations**
Course Code	**:**	**MINMTH3**
Nature of the Course	**:**	**MINOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

The course on Differential Equation focuses on the various methods for solving ODE and PDE.

COURSE OBJECTIVE:

The objectives of the course are

i. To introduce the concept of differential equations, mathematical modelling and their application
ii. To explain the solution techniques of ODE and PDE.
iii.

Course Outcome:

Students will be able to

CO1: understand exact differential equation and solve them

ILO 1.1: Construction of integrating factor.

ILO 1.2: Determine the solution of exact differential equations.

CO2: Explain the basic theory of linear differential equation, Wronskian and its properties.

ILO 2.1: Use of Wronskian in solving the differential equation

ILO 2.2: Discuss methods for solving higher order differential equations.

ILO 2.3: Solve the differential equations of first order and higher degree.

CO3: distinguish various techniques for solving linear homogeneous and non-homogeneous differential equations

ILO 3.1: discuss CF and PI in solving differential equations

ILO 3.2: Explain method of variation of parameter in solving differential equation and apply it.

ILO 3.3: give the significance of total differential equation

CO 4: introduce PDE and understand basic techniques of solving PDE

ILO 4.1: Construction of PDE

ILO 4.2: Differentiate various techniques of solving PDE

CO 5: Classify second order PDE

ILO 5.1: techniques of classification of PDE

ILO 5.2: Examples of elliptic, parabolic and hyperbolic PDE.

Cognitive Map

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge						CO1, CO4
Conceptual Knowledge	CO5	CO4	CO3			
Procedural Knowledge						
Metacognitive Knowledge		CO2				

UNITS	CONTENTS	L	T	P	Total Hours
I (12 Marks)	First order exact differential equations. Integrating factors, rules to find an integrating factor.	09	03	-	12
II (15 Marks)	First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order.	09	03	-	12
III (12 Marks)	Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations.	09	03	-	12
IV (12 Marks)	Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method.	09	03		12
V (9 Marks)	Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.	09	03		12
	Total	**45**	**15**	**-**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- One Internal Examination - 2**0 Marks**
- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics
    - Assignment
    - Group Discussion
    - Quiz
    - Viva-Voce

TEXTBOOKS:

1. Ross S. L., Differential Equations, 3rd Ed., John Wiley and Sons,1984.

2. Boyce, W. E. and DiPrima, R. C., Elementary Differential Equation and Boundary Value Problems, 7th Edition, John Wiley & Sons (Asia), 2001.

REFERENCE BOOKS:

1. Sneddon I.N., Elements of Partial Differential Equations, McGraw-Hill, International Edition, 1967.
2. Raisinghania M.D., Ordinary and Partial Differential Equations, 19thEd., S. Chand and Company, 2020.

Mapping of Course Outcome to Program Outcome

CO/PO	P01	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	M	S	S	S
CO2	S	S	M	M	S	M	M	S	S	S
CO3	S	S	M	M	S	M	M	S	S	S
CO4	S	S	M	M	s	M	M	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Mathematical Finance**
Course Code	**:**	**GECMTH3A**
Nature of the Course	**:**	**Generic Elective Course (GEC)**
Total Credits	**:**	**03 (L=2, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

Aim: The main motive of this course is to give students a basic introduction to finance and the applications of mathematics to it. The course focuses on the mathematical properties and relations between concepts of financial markets in investment and other economic activities. In the era of mathematical modelling being used in understanding stock market behaviour and large dynamic data, this introductory course in Mathematics of finance is well placed to prepare students interested in choosing a career in the field of mathematical finance.

Prerequisites:

(a) Basic Mathematical skills taught upto the 10+2 level.

Course Outcomes (COs):

Students will be able to

CO 1**:** Apply basic mathematical tools (functions, equations, inequalities) to construct and analyze economic models of markets including Supply and demand relationships, Market equilibrium conditions and the impact of government interventions (e.g., excise taxes) on market. outcomes.

ILO 1.1: Form economic models of markets using functions, equations, and inequalities.

ILO1.2: Calculate the future value of investments considering interest rates and compounding intervals.

ILO 1.3: Explain the impact of different compounding frequencies on investment growth.

CO 2: Analyze the stability of market equilibrium using the Cobweb model and its economic interpretations.

ILO 2.1: Identify the key factors influencing the stability of market equilibrium in the Cobweb model (e.g., slope of supply and demand curves).

ILO 2.2: Explain the economic interpretation of the Cobweb model's results, including its implications for real-world markets.

CO3: Apply the concept of the derivative to analyze and solve economic problems related to **Demand and Elasticity,** Production and Cost, **Market Structures, Firm Efficiency and Growth.**

ILO 3.1: **Define** key economic concepts like elasticity of demand, marginal cost, marginal revenue, and economic profit.

ILO 3.2: Utilize derivatives to calculate elasticity coefficients and interpret them to understand consumer behaviour.

ILO 3.3: Apply derivative analysis to identify production levels that maximize profit for firms.

ILO 3.4: Analyze the impact of market structures on pricing and output decisions using derivative tools.

ILO 3.5: Determine startup and breakeven points for firms using cost functions and derivative analysis.

CO4: Apply fundamental mathematical concepts and financial theories to analyze investment opportunities, make informed investment decisions, and evaluate financial instruments.

ILO 4.1: Utilize the time value of money concepts (present value, future value, internal rate of return) to assess the cash flow implications of various investment options.

ILO 4.2: Differentiate between pricing, hedging, and pure investment strategies and apply appropriate techniques for each, considering risk aversion and market conditions.

ILO 4.3: Demonstrate the characteristics, and risks associated with different investment instruments in the market for future cash, such as savings deposits, money market instruments, and various types of bonds, using metrics like yield and duration.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1,CO2		CO1, CO2			
Conceptual Knowledge		CO3	CO1, CO2	CO2, CO3		
Procedural Knowledge		CO3, CO4	CO1, CO3			
Metacognitive Knowledge						

UNITS	CONTENTS	L	T	P	Total Hours
I (12 Marks)	Mathematical models in economics: Introduction, A model of the market, Market equilibrium, Excise tax. The elements	06	03	-	09

	of finance: Interest and capital growth, Income generation, The Interval of compounding.				
II (12 Marks)	The Cobweb model: How stable is market equilibrium? An example, The general linear case, Economic interpretation.	06	03	-	09
III (12 Marks)	The derivative in economics: Elasticity of demand, profit maximization, Competition versus monopoly, The efficient small firm, startup and breakeven points.	06	03	-	09
IV (12 Marks)	Introduction to investment Science: Cash flow, investment and markets, comparison principle, arbitrage, risk aversion. Typical investment problems: Pricing, Hedging, pure investment.	06	03		09
V (12 Marks)	Basic theory of interest: Principal and interest, compound interest, compounding at various intervals, continuous compounding, present value, present and future values of streams, internal rate of return, Evaluation criteria. The market for future cash: Savings deposits, money market instruments, various bonds, Bond details, Yield, duration, Macaulay duration.	06	03		09
	Total	**30**	**15**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- apply models to financial mathematics/industries
- ability to use mathematical tools to market economy.

TEXTBOOKS:

1. Anthony M. & Biggs N., Mathematics for Economics and Finance: Methods and Modelling, Cambridge University Press: Reprinted 2009.

2. Chiang A. C. & Wainwright K., Fundamental Methods of Mathematical Economics, 4th Ed., McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. Luenberger David G., Investment Science, Stanford University: 1998.
2. Ross S., An elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA, 2003.

Mapping of Course Outcomes to Program Outcomes:

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	M	M	S	S	S
CO2	S	S	M	S	M	S	S	M	M	S
CO3	S	M	M	S	M	S	M	S	S	S
CO4	M	S	S	M	S	S	M	M	M	M

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Combinatorial Mathematics**
Course Code	**:**	**GECMTH3B**
Nature of the Course	**:**	**Generic Elective Course (GEC)**
Total Credits	**:**	**03 (L=2, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

Combinatorial Mathematics course covers a range of fundamental concepts and techniques used in combinatorics, as well as their applications in various fields.

Prerequisites:

- Basics of Set Theory

Course Objectives:

1. To develop problem-solving skills and logical thinking required for tackling combinatorial problems.
2. To enhance the ability to construct rigorous mathematical proofs, including combinatorial proofs and inductive reasoning.
3. To equip with a toolkit of methods and techniques that are widely applicable in various scientific and engineering disciplines.

Course Outcomes (COs):

Students will be able to

CO1: Apply basic counting principles such as the rule of sum, rule of product,

principles of inclusion-exclusion, permutations, and combinations.

ILO 1.1: Define and explain key combinatorial concepts, including sets,

permutations, and combinations.

ILO 1.2: Apply basic counting principles and principles of inclusion-exclusion

CO2: Investigate properties and applications of combinatorial structures such as partitions, permutations, and derangements. Solve problems involving the binomial theorem and Pascal's triangle.

ILO 2.1: Calculate permutations and combinations in various contexts,

including those with repetitions and restrictions.

ILO 2.2: Write detailed solutions and proofs for combinatorial problems,

demonstrating a thorough understanding of the concepts.

CO3: Solve problems using recurrence relations and generating functions.

ILO 3.1: Formulate and solve problems involving recurrence relations.

ILO 3.2: Utilize generating functions to approach and solve counting problems.

CO4: Apply advanced topics like Pólya's enumeration theorem and Burnside's lemma.

ILO 4.1: Understand and apply advanced topics such as Pólya's Enumeration Theorem and Burnside's Lemma to solve counting problems involving symmetries.

ILO 4.2: Use combinatorial reasoning to ensure the correctness and efficiency of solutions.

CO5: Construct combinatorial designs such as balanced incomplete block designs (BIBD) and Latin squares.

ILO 5.1: Understand and apply concepts of combinatorial design, including block designs and Latin squares.

ILO 5.2: Develop and employ strategies for solving complex combinatorial problems

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual Knowledge		CO1, CO2				
Conceptual Knowledge		CO1, CO2	CO3	CO5		
Procedural Knowledge			CO1, CO2	CO3	CO4	
Metacognitive Knowledge					CO5	

UNITS	**CONTENTS**	**L**	**T**	**P**	**Total Hours**
I (12 Marks)	Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions, Stirling numbers	06	03	-	09
II (12 Marks)	Principle of Inclusion and Exclusion, Derangements, Inversion formulae	06	03	-	09

III (12 Marks)	Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions, Exponential generating functions.	06	03	-	09
IV (12 Marks)	Recurrence relations: Recurrence relation models, Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions.	06	03	-	09
V (12 Marks)	Integer partitions, Systems of distinct representatives. Polya theory of counting: Necklace problem and Burnside's lemma, Polya's theorems and their immediate applications	06	03	-	09
	Total	**30**	**15**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - 2**0 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Use combinatorial approach in solving algebraic problems
- Explain counting principles.

TEXTBOOK:

1. Balakrishnan V. K., Introductory Discrete Mathematics, Dover Publications Inc., 2000.

REFERENCE BOOKS:

1. Lint J.H. van & Wilson R.M., A Course in Combinatorics, 2nd Ed., Cambridge University Press,2001.
2. Krishnamurthy V., Combinatorics, Theory and Applications, East-West Press 2008.
3. Brualdi R.A., Introductory Combinatorics, 5th Ed., Pearson Education Inc., 2009.
4. Cameron P. J., Combinatorics, Topics, Techniques, Algorithms, Cambridge University Press, 1995.

Mapping of Course Outcomes to Program Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	M	S	M	S	M
CO2	S	S	S	S	S	M	M	S	S	M
CO3	M	S	S	M	S	S	M	S	M	S
CO4	M	M	S	S	M	S	S	S	S	S
CO5	S	M	S	S	S	S	S	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 3rd SEMESTER

Title of the Course	**:**	**Mathematical Logic**
Course Code	**:**	**SEC315**
Nature of the Course	**:**	**Skill Enhancement Course (SEC)**
Total Credits	**:**	**03 (L=2, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Description:

The course on Mathematical Logic aims to provide students with a solid foundation in the principles and applications of formal logic. It covers key topics such as propositional logic, predicate logic, and the formalization of logical arguments. The course also includes an introduction to set theory and its role in logic, as well as an examination of relations, partitionsand partial ordered relation.

Course Objectives:

- To develop the ability to apply logical reasoning to solve complex problems inmathematics and computer science, enhancing their analytical and critical thinking skills through exercises and real-world applications.
- To be proficient in formal logical reasoning and prepared to engage in further study or professional work that involves mathematical logic.

Course Outcomes (COs):

Student will be able to

CO1: Understand Fundamental Concepts

ILO 1.1: Define and explain key concepts in mathematical logic, including propositions, logical connectives, truth tables, and logical equivalence.

ILO 1.2: Understand and explain the structure and elements of formal proofs, including axioms, theorems, lemmas, and corollaries.

CO2: Apply Propositional Logic

ILO 2.1: Construct and analyze truth tables for various logical statements.

ILO 2.2: Apply rules of inference and logical equivalences to simplify and manipulate logical expressions.

ILO 2.3: Use propositional logic to prove the validity of arguments.

CO3: Understand and Apply Predicate Logic

ILO 3.1: Define and explain the elements of predicate logic, including predicates, quantifiers, and domains of discourse.

ILO 3.2: Translate statements between natural language and predicate logic notation.

ILO 3.3: Apply rules of inference in predicate logic to prove the validity of arguments.

CO4: Analyze Logical Systems and Proof Techniques

ILO 4.1: Understand and apply various proof techniques, including direct proof, proof by contradiction, and proof by induction.

ILO 4.2: Analyze and construct formal proofs in both propositional and predicate logic.

ILO 4.3: Understand the concepts of consistency, completeness, and soundness in logical systems.

CO5: Develop Problem-Solving Strategies

ILO 5.1: Develop and implement strategies for solving complex problems in mathematical logic.

ILO 5.2: Use logical reasoning to analyze and solve problems in various mathematical contexts.

Cognitive Map of Course Outcomes with Bloom's Taxonomy

Knowledge Dimension	**Remember**	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Create**
Factual Knowledge		CO1, CO2				
Conceptual Knowledge		CO1, CO2	CO4	CO5		
Procedural Knowledge			CO1, CO2	CO3	CO4	
Metacognitive Knowledge						CO5

UNITS	**CONTENTS**	**L**	**T**	**P**	**Total Hours**
I (19 Marks)	Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse	10	05	-	15

	propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.				
II (15 Marks)	Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set.	08	04	-	12
III (11 Marks)	Standard set operations. Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.	04	02	-	06
IV (15 Marks)	Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, n-array relations.	08	04	-	12
	Total	**30**	**15**	**-**	**45**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Analyze the truth and falsity of a logical statement.
- Differentiate between a logical statement and an ordinary statement.
- Define and describe various properties of sets.

TEXTBOOK:

1. Kumar A., Kumaresan S., Sarma B. K., A Foundation Course in Mathematics, Alpha Science International, 2017.

REFERENCE BOOKS:

1. Srivastava S.M., A Course on Mathematical Logic, Springer, 2012
2. Halmos P.R., Naive Set Theory, Springer,1974.
3. Kamke E., Theory of Sets, Dover Publishers,1950.
4. Grimaldi R.P., Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.

Mapping of Course Outcomes to Program Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	M	S	M	M	M
CO2	S	S	S	S	S	M	M	S	S	M
CO3	M	S	M	M	S	S	M	S	S	M
CO4	M	M	S	S	M	S	S	S	S	S
CO5	S	M	S	S	S	S	S	S	S	S

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**Numerical Methods**
Course Code	**:**	**MTHC5**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=0, P=1)**
Distribution of Marks	**:**	**45 (End Sem) +15 (Practical) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Discuss various numerical methods and interpolation formulae
- Apply numerical techniques for solving differential equation.

UNITS	CONTENTS	L	T	P	Total Hours
I (10 Marks)	Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.	09	00	00	09
II (7 Marks)	System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.	06	00	00	06
III (7 Marks)	Interpolation: Lagrange and Newton's methods. Error bounds. Finite difference operators. NEWTON Gregory forward and backward difference interpolation.	06	00	00	06
IV (10 Marks)	Numerical Integration: Trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.	09	00	00	09
V (6 Marks)	Ordinary Differential Equations: Euler's method. Runge-Kutta methods of orders two and four.	06	00	00	06
VI (20 Marks)	**List of Practicals (using any software)** (i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ---+ 1/N. (ii) To find the absolute value of an integer. (iii) Enter 100 integers into an array and sort them in an ascending order. (iv) Bisection Method. (v) Newton Raphson Method. (vi) Secant Method. (vii) Regula Falsi Method. (viii) LU decomposition Method. (ix) Gauss-Jacobi Method. (x) Gauss-Siedel Method. (xi) Lagrange Interpolation or Newton Interpolation. (xii) Simpson's rule. Note: For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence,	-	-	24	24

	variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.				
	Total	**36**	**00**	**24**	**60**

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations numerically, up to a certain given level of precision.
- Apply interpolation techniques to compute the values for a tabulated function at points not in the table.
- Apply the numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

TEXTBOOKS:

1. Jain M. K., Iyengar S. R. K. and Jain R. K., Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
2. Atkinson K., An Introduction to Numerical Analysis (2nd Edition), Wiley Publications, 1978.
3. Bradie B., A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

REFERENCE BOOKS:

1. Gerald C. F. and Wheatley P.O., Applied Numerical Analysis, Pearson Education, India, 2008.
2. Ascher U.M. and Greif C., A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.
3. Mathews J. H. and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**Riemann Integration & Series of Functions**
Course Code	**:**	**MTHC6**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Obtain the concept on Riemann integration, improper integrals
- Learn differentiation and integration of power series

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorem of Calculus.	18	06	-	24
II (11 Marks)	Improper integrals; Convergence of Beta and Gamma functions.	06	02	-	08
III (19 Marks)	Pointwise and uniform convergence of sequence of functions. Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.	15	05	-	20
IV (11 Marks)	Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.	06	02	-	08
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics
    - Assignment
    - Group Discussion
    - Quiz
    - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Learn some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.
- Describe the Beta and Gamma functions and their related properties.
- Understand the valid situations for the inter-changeability of differentiability and integrability with infinite sum, and approximation of transcendental functions in terms of power series.

TEXTBOOKS:

1. Bartle R. and Sherbert D. R., Introduction to Real Analysis, John Wiley and Sons, 2003.
2. Kumar A. & Kumaresan S., A Basic Course in Analysis, CRC Press, 2014.

REFERENCE BOOKS:

1. Ghorpade S. R. and Limaye B. V., A Course in Calculus and Real Analysis, Springer, 2006.
2. Ross K. A., Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
3. Denlinger C. G., Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**Ring Theory and Linear Algebra I**
Course Code	**:**	**MTHC7**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Describe various ring structures on sets.
- Solve the system of linear equations.

UNITS	CONTENTS	L	T	P	Total Hours
I (11 Marks)	Definition and examples of rings, Properties of rings, Subrings, Integral domains and fields, characteristic of a ring. Ideals, Ideal generated by a subset of a ring, Factor rings, Operations on ideals, Prime and maximal ideals.	09	03	-	12
II (19 Marks)	Ring homomorphisms, Properties of ring homomorphisms, First, Second and Third Isomorphism theorems for rings, The Field of quotients.	12	04	-	16
III (11 Marks)	Vector spaces, Subspaces, Algebra of subspaces, Quotient spaces, Linear combination of vectors, Linear span, Linear independence, Basis and dimension, Dimension of subspaces.	12	04	-	16
IV (19 Marks)	Linear transformations, Null space, Range, Rank and nullity of a linear transformation, Matrix representation of a linear transformation, Algebra of linear transformations. Isomorphisms, Isomorphism theorems, Invertibility and the change of coordinate matrix.	12	04	-	16
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz

- Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Learn the fundamental concept of Rings, Fields, Subrings, Integral domains and the corresponding morphisms.
- Describe the concept of linear independence of vectors over a field, the idea of a finite dimensional vector space, basis of a vector space and the dimension of a vector space.
- build basic concepts of linear transformations, the Rank-Nullity Theorem, matrix of a linear transformation, algebra of transformations and the change of basis.

TEXTBOOKS:

1. Gallian J. A., Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
2. Kumaresan S., Linear Algebra- A Geometric Approach, Prentice Hall ofIndia,1999.
3. Friedberg S. H., Insel A. J., Spence L. E., Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

REFERENCE BOOKS:

1. Fraleigh J. B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. Strang G., Linear Algebra and its Applications, Thomson, 2007.
3. Hoffman K., Kunze R. A., Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
4. Artin M., Abstract Algebra, 2nd Ed., Pearson, 2011.
5. Lang S., Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
6. Wallace D. A. R., Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**PDE and Systems of ODE**
Course Code	**:**	**MTHC8**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- make mathematical formulations and their solutions of various physical problems.
- design mathematical models used in heat, wave.
- describe the Laplace equation and their solutions.

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First- Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Non-linear partial differential equations, Charpit's method & Jacobi's method Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.	12	04	-	16
II (15 Marks)	Classifications of second order linear equations as hyperbolic, parabolic or elliptic. Derivations of Heat equation, Wave equation and Laplace equation and their solutions Reduction of second order Linear Equations to canonical forms.	12	04	-	16
III (7 Marks)	Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem	09	03	-	12
IV (19 Marks)	Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method upto fourth order approximation	12	04	-	16
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics
    - Assignment
    - Group Discussion
    - Quiz
    - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Formulate, classify and transform partial differential equations into canonical form.
- Solve linear and non-linear partial differential equations using various methods, and apply these methods in solving some physical problems.

TEXTBOOKS:

1. Ross S. L., Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
2. Myint-U T. and Debnath L., Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.

REFERENCE BOOKS:

1. Sneddon I. N., Elements of Partial Differential Equations, Dover Publications, 2006.
2. W. E. Boyce W. E., DiPrima R. C., Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley, 2009.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 4th SEMESTER

Title of the Course	**:**	**Algebra**
Course Code	**:**	**MINMTH4**
Nature of the Course	**:**	**MINOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Describe various algebraic structures on sets.
- Identify the algebraic structures present in different branches of Sciences.

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers modulo n under addition modulo n and the group U(n) of units under multiplication modulo n. Complex roots of unity, circle group, the general linear group $GL(n, R)$, groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, symmetric groups, Group of quaternions.	12	04	-	16
II (11 Marks)	Subgroups, cyclic subgroups, order of an element, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup.	09	03	-	12
III (11 Marks)	Lagrange's theorem, Normal subgroups: their definition, examples, and characterizations, Quotient groups.	09	03		12
IV (19 Marks)	Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Z_p, Q, R, and C.	15	05	-	20
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**

- Seminar presentation on any of the relevant topics
- Assignment
- Group Discussion
- Quiz
- Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Describe the fundamental concept of Groups, Subgroups and related theorems.
- Apply the fundamental concept of Rings, Fields, Subrings, Integral domains.

TEXTBOOKS:

1. Gallian J. A., Contemporary Abstract Algebra, 4th Ed., Narosa, 1999.
2. Musili C., Introduction to Rings and Modules, Narosa Publishing House, 2nd Edition, 1997.

REFERENCE BOOK:

1. Fraleigh J. B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Multi-Variate Calculus**
Course Code	**:**	**MTHC9**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Extend the concepts from one variable calculus to function of several variables
- Demonstrate the ability to think critically and solving application of real-world problems involving double/ triple integrals.

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Functions of several variables, limit and continuity of functions of two variables, Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, Definition of vector field, divergence and curl.	15	05	-	20
II (16 Marks)	Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, cylindrical and spherical co-ordinates. Triple integrals, Triple integral over a parallelopiped and solid regions. Volume by triple integrals.	15	05	-	20
III (14 Marks)	Change of variables in double integrals and triple integrals. Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.	09	03	-	12
IV (11 Marks)	Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke's theorem, The Divergence theorem.	06	02		08
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics

- Assignment
- Group Discussion
- Quiz
- Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Describe the conceptual variations when advancing in calculus from one variable to multivariable discussions.
- Learn to establish the Inter-relationship amongst the line integral, double and triple integral formulations.
- Apply the multi variable calculus tools in physics, economics, optimization, and understand the architecture of curves and surfaces in plane and space etc.

TEXTBOOKS:

1. Thomas G. B. and Finney R. L., Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. Fitzpatrick P. M., Advanced Calculus, American Mathematical Society, 2005.

REFERENCE BOOKS:

1. Stewart J., Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.
2. Strauss M. J., Bradley G. L. and Smith K. J., Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. Marsden E., Tromba A. J. and Weinstein A., Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Group theory-II**
Course Code	**:**	**MTHC10**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Apply results from preliminary concepts to solve contemporary problems.
- Apply in communication theory, electrical engineering, computer science and cryptography.

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, Characteristic subgroups, Commutator subgroup and its properties.	15	05	-	20
II (15 Marks)	Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.	12	04	-	16
III (15 Marks)	Group action, Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n, p-groups	12	04	-	16
IV (11 Marks)	Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for n ≥ 5, non-simplicity tests.	06	02		08
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Analyze the Automorphisms for constructing new groups from the given group.
- Discuss the Group actions, Sylow theorems and their applications to check nonsimplicity.

TEXTBOOKS:

1. Bhattacharjee P. B., Jain S. K. & Nagpaul S. R., Basic Abstract Algebra, Cambridge University Press.
2. Gallian J. A., Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.

REFERENCE BOOKS:

1. Dummit D. S. and Foote R. M., Abstract Algebra, 3rd Ed., Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
2. Herstein I. N., Topics in Algebra, Wiley & Sons, 2006.
3. Fraleigh J. B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
4. Artin M., Abstract Algebra, 2nd Ed., Pearson, 2011.
5. Durbin J. R., Modern Algebra, John Wiley & Sons, New York Inc., 2000.
6. Wallace D. A. R., Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Linear Programming**
Course Code	**:**	**MTHC11A**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- describe various optimization techniques pertaining to linear programming.
- apply linear programming to problems arising out of real-life problems.

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two- phase method, Big- M method and their comparison. Practicum: One Case Study and Real-Life Problems.	15	05	-	20
II (11 Marks)	Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual.	06	02	-	08
III (15 Marks)	Transportation problem and its mathematical formulation, northwest- corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Practicum: One Case Study and Real-Life Problems.	12	04	-	16
IV (15 Marks)	Game theory: formulation of two-person zero sum games, solving two-person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games. Practicum: One Case Study and Real-Life Problems.	12	04		16
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Analyze and solve linear programming models of real-life situations.
- Find graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.
- Explain the relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.

TEXTBOOKS:

1. Sharma J. K., Operations Research: Theory and Applications, 5th Edition, 2012.
2. Taha H. A., Operations Research, An Introduction, 8th Ed., Prentice- Hall India, 2006.

REFERENCE BOOKS:

1. Bazaraa M. S., Jarvis J. J. and Sherali H. D., Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. Hillier F. S. and Lieberman G. J., Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hadley G., Linear Programming, Narosa Publishing House, New Delhi, 2002.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Mathematical Methods**
Course Code	**:**	**MTHC11B**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Construct mathematical models or real-world problems.
- Solve real world problems through the studied theories.

UNITS	CONTENTS	L	T	P	Total Hours
I (7 Marks)	**Fourier Series:** Fourier Series, Dirichlet conditions, Fourier series for even and odd functions Half range Fourier series.	06	02	-	08
II (15 Marks)	**Laplace Transform:** Definition of Laplace transform, Existence theorem for Laplace transform. Linearity property of Laplace transform, Laplace transform of some elementary functions. (algebraic functions, trigonometric functions, exponential functions, hyperbolic functions). First Shifting theorem, Second shifting theorem, Change of scale property, Laplace transform of derivatives, Laplace transform of Integrals.	12	04	-	16
III (8 Marks)	**Inverse Laplace Transform:** Definition of Inverse Laplace Transform, Linearity property, first and second shifting theorems, change of scale, Convolution theorem.	03	01	-	04
IV (19 Marks)	**Fourier Transform, and Inverse Fourier transform:** Dirichlet conditions, Definition of Fourier transform, Inverse theorem for Fourier transform, Fourier Sine and Fourier cosine transforms and their inversion formula, Linearity property, change of scale property, shifting property, modulation theorem, convolution theorem.	15	05		20
V (11 Marks)	**Applications of Fourier and Laplace transform:** Solution of Boundary value problems and initial value problems in 1-D and 2-D cases. Solution of Laplace and Poisson equations in 2-D cases.	09	03		12
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**

- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics
    - Assignment
    - Group Discussion
    - Quiz
    - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Find the Laplace transform of derivatives, integrals of functions.
- Use the Method of Laplace transforms to solve initial-value problems for linear differential equations with constant coefficients.
- To solve differential equation using Fourier Transform.

TEXTBOOKS:

1. Sreennadh S., Ranganatham S., Prasad M V S S N, Babu V. R., Fourier series and Integral transform, S. Chand, New Delhi, 2008.
2. Spigel M. R., Theory and Problems of Laplace Transform, Schaum Outline Series, 2018.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Financial Mathematics**
Course Code	**:**	**MTHC11C**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Build quantitative models of financial mathematics/industries
- Apply models to obtain information of practical value in the financial mathematics.

UNITS	CONTENTS	L	T	P	Total Hours
I (11 Marks)	Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR.	06	02	-	08
II (19 Marks)	Bonds, bond prices and yields, Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.	15	05		20
III (11 Marks)	Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).	09	03	-	12
IV (19 Marks)	One fund theorem, risk free assets, Two fund theorem, capital market line, Sharpe index. Capital Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen's index.	15	05	-	20
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz

- Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Learn the basic terms of financial markets and understand some computational and quantitative techniques required for working in the financial markets.

TEXTBOOKS:

1. Anthony M., Biggs N., Mathematics for Economics and Finance: Methods and Modelling, Cambridge University Press, Reprinted 2009.
2. Ross S. N., An Elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA, 2003.

REFERENCE BOOKS:

1. Luenberger D. G., Investment Science, Oxford University Press, Delhi, 1998.
2. Hull J. C., Options, Futures and Other Derivatives, 6th Ed., Prentice-Hall India, Indian reprint, 2006.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Computer Programming**
Course Code	**:**	**MTHC11D**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=0, P=1)**
Distribution of Marks	**:**	**45 (End Sem) +15(Practical)+ 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Develop logics which will help them to create programs, applications in C.
- Easily switch over to any other language in future by learning the basic programming concepts.

UNITS	CONTENTS	L	T	P	Total Hours
I (13 Marks)	Basic programming concept, programming approach to solving problem, flowcharts, algorithm, character set, C tokens, keywords and identifiers, constants, variables, data types, declaration of variables, declaration storage class, assigning values to variables. Operators and expressions: Arithmetic operators, relational operators, logical operators, assignment operators, arithmetic expression, precedence of arithmetic operators, type conversion in expressions operator precedence and associativity, mathematical functions. Inut output operations, Reading and writing a character, formatted input and formatted output, Character input/ Output functions: getchar(), Putchar() etc.	12	00	-	12
II (10 Marks)	Decision making and Branching, IF statement, IF...ELSE statement, nested IF, ELSE IF Ladder, WHILE statement, DO statement, FOR statement, Break, continue, go to statements, exit function	09	00	-	09
III (7 Marks)	Arrays, One dimensional arrays, declaration of one dimensional array, initialization of two dimensional arrays, multidimensional array.	06	00	-	06
IV (10 Marks)	User-defined functions, Elements of user defined functions, Definition of functions, return values and their types, function calls, function declaration, category of functions, no arguments and return values, arguments with return values, no arguments but returns a value, functions that return multiple values, Recursion, storage classes in C.	09	00	-	09
V (20 Marks)	**List of Practicals:** 1. Simple and compound interest 2. Sum of series, sum of first n natural numbers, sum of square of first n natural numbers, sum of cube of first n natural numbers. 3. Solution of quadratic equation	-	-	24	24

	4. Checking the Prime numbers 5. Sum of sine, cosine and Fibonacci numbers 6. Mean and standard deviation 7. Printing of a matrix 8. Matrix addition, subtraction, multiplication, transpose 9. Sorting of numbers (ascending and descending) 10. Computation of salary 11. Finding the largest numbers among the three and n numbers. 12. Finding the factorial of a numbers using functions and recursion 13. Printing of even numbers and odd numbers in a range. 14. Sum of digits of integer. 15. Checking of palindrome of a numbers 16. Printing of numbers in various forms, number tables.				
	Total	36	00	24	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Develop the understanding of an algorithm and its definition.
- Learn programming basics of C such as Data types, Mathematical and logical operations, if statement and loops etc.

TEXTBOOKS:

1. Jeyapoovan T., A First Course in Programming with C, Vikash Publishing House Pvt. Ltd.
2. Balagurusamy E., Programming in ANSI C; 4Ed, Tata McGrow-Hill Publishing Company Ltd, New Delhi.

REFERENCE BOOKS:

1. Kanetkar Y., Let us C, B.P. Publication.
2. Gottfried B. S., C- Programming, Tata McGrow Hill.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Computer Programming**
Course Code	**:**	**MINMTH5**
Nature of the Course	**:**	**MINOR**
Total Credits	**:**	**04 (L=3, T=0, P=1)**
Distribution of Marks	**:**	**45 (End Sem) +15(Practical)+ 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Develop logics which will help them to create programs, applications in C.
- Easily switch over to any other language in future by learning the basic programming concepts.

UNITS	CONTENTS	L	T	P	Total Hours
I (13 Marks)	Basic programming concept, programming approach to solving problem, flowcharts, algorithm, character set, C tokens, keywords and identifiers, constants, variables, data types, declaration of variables, declaration storage class, assigning values to variables. Operators and expressions: Arithmetic operators, relational operators, logical operators, assignment operators, arithmetic expression, precedence of arithmetic operators, type conversion in expressions operator precedence and associativity, mathematical functions. Inut output operations, Reading and writing a character, formatted input and formatted output, Character input/ Output functions: getchar(), Putchar() etc.	12	00	-	12
II (10 Marks)	Decision making and Branching, IF statement, IF...ELSE statement, nested IF, ELSE IF Ladder, WHILE statement, DO statement, FOR statement, Break, continue, go to statements, exit function	09	00	-	09
III (7 Marks)	Arrays, One dimensional arrays, declaration of one dimensional array, initialization of two dimensional arrays, multidimensional array.	06	00	-	06
IV (10 Marks)	User-defined functions, Elements of user defined functions, Definition of functions, return values and their types, function calls, function declaration, category of functions, no arguments and return values, arguments with return values, no arguments but returns a value, functions that return multiple values, Recursion, storage classes in C.	09	00	-	09
V (20 Marks)	**List of Practicals:** 17. Simple and compound interest 18. Sum of series, sum of first n natural numbers, sum of square of first n natural numbers, sum of cube of first n natural numbers.	-	-	24	24

	19. Solution of quadratic equation 20. Checking the Prime numbers 21. Sum of sine, cosine and Fibonacci numbers 22. Mean and standard deviation 23. Printing of a matrix 24. Matrix addition, subtraction, multiplication, transpose 25. Sorting of numbers (ascending and descending) 26. Computation of salary 27. Finding the largest numbers among the three and n numbers. 28. Finding the factorial of a numbers using functions and recursion 29. Printing of even numbers and odd numbers in a range. 30. Sum of digits of integer. 31. Checking of palindrome of a numbers 32. Printing of numbers in various forms, number tables.				
	Total	36	00	24	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Develop the understanding of an algorithm and its definition.
- Learn programming basics of C such as Data types, Mathematical and logical operations, if statement and loops etc.

TEXTBOOKS:

1. Jeyapoovan T., A First Course in Programming with C, Vikash Publishing House Pvt. Ltd.
2. Balagurusamy E., Programming in ANSI C; 4Ed, Tata McGrow-Hill Publishing Company Ltd, New Delhi.

REFERENCE BOOKS:

1. Kanetkar Y., Let us C, B.P. Publication.
2. Gottfried B. S., C- Programming, Tata McGrow Hill.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**INTERNSHIP**
Course Code	**:**	**INTERNMTH**
Nature of the Course	**:**	**INTERNSHIP**
Total Credits	**:**	**04**
Total Marks	**:**	**100**

Internship:

Student may be provided teaching opportunities in schools; they may engage themselves in local industry to hone practicability of their theoretical knowledge; visit research institute/ universities with some research assignment under research supervisors, and any other assignments colleges may consider deem fit.

OR

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 5th SEMESTER

Title of the Course	**:**	**Community Engagement**
Course Code	**:**	**Community Engagement**
Nature of the Course	**:**	**Community Engagement**
Total Credits	**:**	**04**
Total Marks	**:**	**100**

Community Engagement (NCC/NSS/Adult Education/ Student Mentoring/NGO/Govt. Institutions, etc.)

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Metric Spaces & Complex Analysis**
Course Code	**:**	**MTHC12**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Describe the various properties of metrics spaces
- Understand complex number system, its differentiation and integration.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	Metric spaces: definition and examples. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, Subspaces, diameter of a set, Sequences in metric spaces, Cauchy sequences. Complete Metric Spaces. Cantor's theorem. dense sets, separable spaces.	15	05	-	20
II (11 Marks)	Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings, compactness Banach Fixed point Theorem. Connectedness, connected subsets of R.	09	03	-	12
III (11 Marks)	Limits, Limits involving the point at infinity, continuity. Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.	09	03	-	12
IV (11 Marks)	Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.	06	02	-	08
V (11 Marks)	Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series.	06	02	-	08
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics
    - Assignment
    - Group Discussion
    - Quiz
    - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Understand the basic concepts of metric spaces and correlate these concepts to their counter parts in real analysis.
- Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.
- Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.
- Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.

TEXTBOOKS:

1. Kumaresan S., Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
2. Simmons G. F., Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
3. Brown J. W. and Churchill R. V., Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.

REFERENCE BOOKS:

1. Shirali S. and Vasudeva H. L., Metric Spaces, Springer Verlag, London, 2006.
2. Bak J. and Newman D. J., Complex Analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Ring Theory & Linear Algebra II**
Course Code	**:**	**MTHC13**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Apply theorems proof/ solution techniques to solve real world problems
- Find the matrix associated with a linear transformation with respect to given bases and can understand the relationship between operations of linear transformations and corresponding matrices.

UNITS	CONTENTS	L	T	P	Total Hours
I (7 Marks)	Polynomial rings over commutative rings, division algorithm and consequences.	06	02	-	08
II (15 Marks)	Principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]**.** Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.	09	03	-	12
III (19 Marks)	Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability, invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.	15	05	-	20
IV (19 Marks)	Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.	15	05	-	20
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Understand the fundamental concept of commutative rings, principal ideal domain, integral domains, unique factorization domains, and Euclidean domains.
- Learn the concept of dual spaces, eigen spaces and the minimal polynomial for a linear operator.
- Acquire the basic concepts of inner product spaces, self-adjoint operators and orthogonal projections.

TEXTBOOKS:

1. Gallian J. A., Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
2. Kumaresan S., Linear Algebra- A Geometric Approach, Prentice Hall ofIndia,1999.
3. Friedberg S. H., A. J. Insel A. J., L. E. Spence L. E., Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

REFERENCE BOOKS:

1. Fraleigh J. B., A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. Strang G., Linear Algebra and its Applications, Thomson, 2007.
3. Hoffman K., Kunze R. A., Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
4. Artin M., Abstract Algebra, 2nd Ed., Pearson, 2011.
5. Lang S., Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
6. Wallace D. A. R., Groups, Rings and Fields, Springer Verlag London Ltd., 1998.
7. Bhattacharjee P. B., Jain S. K. & Nagpaul S. R. Basic Abstract Algebra, Cambridge University Press, 1994.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Number Theory**
Course Code	**:**	**MTHC14A**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- obtain solutions of Diophantine equations
- define number theoretic functions

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	A review on basic concepts of Number theory, Euler's theorem, Congruence Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.	09	03	-	12
II (19 Marks)	Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi- function, reduced set of residues, some properties of Euler's phi-function.	15	05	-	20
III (19 Marks)	Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli.	15	05	-	20
IV (7 Marks)	Public key encryption, RSA encryption and decryption, solution of the equation $x^2 + y^2 = z^2$, Fermat's Last theorem (Statement only without proof).	06	02	-	08
	Total	45	15	-	45

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Solve some of the open problems related to prime numbers, viz., Goldbach conjecture etc.
- Describe about number theoretic functions and modular arithmetic.
- Learn about Public crypto systems, in particular, RSA

TEXTBOOKS:

1. Burton D. M., Elementary Number Theory, 6th Ed., Tata McGraw- Hill, Indian reprint, 2007.
2. Niven I., Zuckerman H. S., Montgomery H. L., An Introduction to the Theory of Numbers, 5th Ed., Wiley, 2008.

REFERENCE BOOK:

1. Robbins N., Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2005.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Mechanics**
Course Code	**:**	**MTHC14B**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Describe Moment of a force and couple, general equation of equilibrium
- Solve Problems of translation and rotation of rigid bodies

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free body involving interior sections, general equations of equilibrium, two-point equivalent loading, problems arising from structures, static indeterminacy.	09	03	-	12
II (19 Marks)	Laws of Coulomb friction, application to simple and complex surface contact friction problems, transmission of power through belts, screw jack, wedge, first moment of an area and the centroid, other centers, Theorem of Pappus-Guldinus, second moments and the product of area of a plane area, transfer theorems, relation between second moments and products of area, polar moment of area, principal axes.	15	05	-	20
III (7 Marks)	Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass	06	02	-	08
IV (19 Marks)	Moment of momentum equation for a single particle and a system of particles, translation and rotation of rigid bodies, Chasles' theorem, general relationship between time derivatives of a vector for different references, relationship between velocities of a particle for different references, acceleration of particle for different references.	15	05	-	20
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics

- Assignment
- Group Discussion
- Quiz
- Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Explain the significance of mathematics involved in physical quantities and their uses;
- To study and to learn the cause-effect related to these; and
- Understand the applications in observing and relating real situations/structures.

TEXTBOOKS:

1. Shames I. H. and Rao G. K. M., Engineering Mechanics: Statics and Dynamics, (4th Ed.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
2. Hibbeler R. C. and Gupta A., Engineering Mechanics: Statics and Dynamics, 11th Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Hydro-Mechanics**
Course Code	**:**	**MTHC14C**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this course is to -

- describe basic properties of Fluid Mechanics

UNITS	CONTENTS	L	T	P	Total Hours
I (12 Marks)	Kinematics: Real and ideal fluid, velocity of a fluid at a point, Eulerian and Lagrangian method, stream lines and path lines, steady and unsteady flows, velocity potential, rotational and irrotational motions, local and particle rate of change, equation of continuity, examples, acceleration of a fluid at a point, General analysis of fluid motion.	09	03	-	12
II (9 Marks)	Equation of Motion: Euler's equation of motion, Bernoullis equation, steady motion under conservative forces, impulsive motion, circulation, Kelvin's circulation theorem.	06	02	-	08
III (9 Marks)	General theory of irrotational motion: Potential flow, deductions from Green's theorem, kinetic energy of a liquid, uniqueness theorems, Kelvin's minimum energy theorem, Mean value of velocity potential.	06	02	-	08
IV (9 Marks)	Fluid Pressure**:** Introduction, Fluid Pressure and related theorems, Density and specific gravity, Theorems on fluid pressure under gravity, Rate of variation of pressure, Differential equation of pressure, Condition of equilibrium, Equi-pressure surfaces and lines of force, Curves of equi-pressure and equi-density, Examples.	09	03	-	12
V (12 Marks)	Resultant Pressure and Centre of Pressure: Resultant fluid pressure and related theorems, Centre of pressure, Determination of centre of pressure of parallelogram, triangle, circle under different conditions, Examples, Thrust on curved surfaces, Examples.	09	03	-	12
VI (9 Marks)	Equilibrium and Stability of Floating Bodies: Condition of equilibrium of floating bodies, Examples, Unstable and Neutral equilibrium, Determination of Meta centre, Examples.	06	02	-	08
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: **(40 Marks)**

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
    - Seminar presentation on any of the relevant topics
    - Assignment
    - Group Discussion
    - Quiz
    - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Explain the basics of fluid dynamics and solve the problem of inviscid fluid flows.
- To analyse various hydrostatics problems.

TEXTBOOKS:

1. Chorlton F., Text Books of Fluid Dynamics; CBS Publishers & Distributors, 2005.
2. Raisinghania M. D., Fluid Dynamics; S. Chand & Company Ltd, 1995.
3. Ray M. and Sharma H. S., A Text Book of Hydrostatics; S. Chand & Company Ltd, New Delhi, 1989.

REFERENCE BOOK:

1. Thomson L. M., Theoretical Hydrodynamics, Dover Publications Inc., 1996.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Discrete Mathematics**
Course Code	**:**	**MTHC15A**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Explain various discrete structures.
- Design graph theoretic models of real-life problems.

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, complete lattices, lattices as algebraic structures, sublattices, products and homomorphisms.	12	04	-	16
II (19 Marks)	Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn- McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.	12	04	-	16
III (7 Marks)	Definitions, examples and basic properties of graph, pseudographs, complete graphs, bipartite graphs.	06	02	-	08
IV (15 Marks)	Isomorphism of graphs, Tree, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm	15	05	-	20
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Learn the concept of Lattices and their types;
- Build understanding of Boolean algebra, switching circuits and their applications;

- Familiarize with Graphs, their types and its applications in study of shortest path algorithms.

TEXTBOOKS:

1. Davey B. A. and Priestley H. A., Introduction to Lattices and Order, Cambridge University Press, Cambridge, 1990.
2. Goodaire E. G. and Parmenter M. M., Discrete Mathematics with Graph Theory (2nd Edition), Pearson Education (Singapore), Pte. Ltd., Indian Reprint, 2003.

REFERENCE BOOK:

1. Lidl R. and Pilz G., Applied Abstract Algebra (2nd Edition), Undergraduate Texts in Mathematics, Springer (SIE), Indian Reprint, 2004.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Probability and Statistics**
Course Code	**:**	**MTHC15B**
Nature of the Course	**:**	**MAJOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Characterize the statistical techniques.
- Define various statistical distributions and obtain their related properties
- Describe the mathematical theory of probability

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.	15	05	-	20
II (19 Marks)	Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient.	15	05	-	20
III (7 Marks)	Joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables (Matrix approach), Chebyshev's inequality.	03	01	-	04
IV (15 Marks)	Statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance.	12	04	-	16
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz

- Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- Apply distributions to study the joint behavior of two random variables.
- To establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.
- Central limit theorem, which helps to understand the remarkable fact that: the empirical frequencies of so many natural populations.

TEXTBOOKS:

1. Ross S., First Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
2. Mood A. M., Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007.

REFERENCE BOOKS:

1. Hogg R. V., McKean J. W. and Craig A. T., Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Miller I. and Miller M., Freund J. E., Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.

FOUR YEARS UNDER GRADUATE PROGRAMME IN MATHEMATICS

DETAILED SYLLABUS OF 6th SEMESTER

Title of the Course	**:**	**Numerical Methods**
Course Code	**:**	**MINMTH6**
Nature of the Course	**:**	**MINOR**
Total Credits	**:**	**04 (L=3, T=1, P=0)**
Distribution of Marks	**:**	**60 (End Sem) + 40 (In-Sem)**

Course Objectives: The objectives of this Course are to -

- Apply the numerical methods and interpolation formulae in solving algebraic equations;
- Solve differential equation using Numerical techniques.

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method	12	04	-	16
II (15 Marks)	LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods.	12	04	-	16
III (15 Marks)	Linear and higher order Lagrange and Newton interpolation: finite difference operators. Numerical differentiation: forward difference, backward difference and central Difference.	12	04	-	16
IV (15 Marks)	Integration: trapezoidal rule, Simpson's rule, Euler's method.	09	03	-	12
	Total	45	15	-	60

Where, L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 Marks)

- One Internal Examination - **20 Marks**
- Others (any two or more) - **20 Marks**
  - Seminar presentation on any of the relevant topics
  - Assignment
  - Group Discussion
  - Quiz
  - Viva-Voce

LEARNING OUTCOMES:

After the completion of this course, the learner will be able to:

- find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.
- Use Interpolation techniques to compute the values for a tabulated function at points not in the table.

- Apply numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.

TEXTBOOKS:

1. Bradie B., A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. Jain M. K., Iyengar S. R. K. and Jain R. K., Numerical Methods for Scientific and Engineering, Computation, 6th Ed., New age International Publisher, India, 2007.