DIGBOI COLLEGE (AUTONOMOUS)

ডিগবৈ মহাবিদ্যালয় (স্বায়ত্তশাসিত)

SYLLABUS FRAMED ACCORDING TO THE
NATIONAL EDUCATIONAL POLICY (NEP 2020)
& AS PER DCA-CCFF REGULATIONS 2025

UG Framework under FYUGP

(Effective from Academic Year 2025-26)

MATHEMATICS

ESTD 1965

[Recommended and approved by B.O.S. in Mathematics, Digboi College (Autonomous) in its meeting held on 05/06/2025 and passed by the Academic Council meeting held on 26/06/2025]

1. PREAMBLE

In alignment with the recommendations of the University Grants Commission (UGC) and in accordance with the proposed implementation framework of the New Education Policy (NEP) 2020, the Department of Mathematics, Digboi College (Autonomous), is committed to structuring its Four-Year Undergraduate Programme (FYUGP) in Mathematics in a manner that reflects the foundational principles and transformative goals of the policy.

The design of the undergraduate curriculum is guided by the following key considerations:

1. **Academic Flexibility**: Provision for students to transition between different academic disciplines, promoting intellectual mobility and academic exploration.
2. **Interdisciplinary Course Selection**: Enabling students to exercise autonomy in selecting courses across diverse fields of study based on their interests and career aspirations.
3. **Multiple Entry and Exit Points**: Incorporation of a credit-based system that allows for flexible exit options, wherein students may earn an Undergraduate Certificate, Diploma, or Degree depending on the total number of credits accumulated.
4. **Institutional Mobility**: Facilitating seamless transition of students between institutions to promote inter- and multi-disciplinary learning experiences.
5. **Alternative Learning Pathways**: Flexibility to engage in varied modes of learning, including online, blended, and experiential formats.
6. **Entrepreneurial and Vocational Preparedness**: Equipping students with the knowledge and skills essential for self-employment and fostering an entrepreneurial mindset.
7. **Critical and Analytical Thinking**: Fostering advanced cognitive abilities such as critical thinking and complex problem-solving in real-world contexts.
8. **Global and Digital Competence**: Nurturing students' awareness of global challenges, multicultural understanding, and proficiency in digital tools and platforms.
9. **Holistic Skill Development**: Emphasizing the development of research aptitude, effective communication skills, community engagement, environmental consciousness, and a strong sense of responsibility and accountability.

This holistic approach aims to create a learner-centric, flexible, and inclusive academic environment that not only supports individual aspirations but also contributes meaningfully to societal and national development.

2. INTRODUCTION

In accordance with the New Education Policy (NEP) 2020, the undergraduate (UG) curriculum in Mathematics at Digboi College (Autonomous) has been comprehensively restructured to ensure

a learner-centric, multidisciplinary, and holistic educational experience. The programme is designed to integrate a wide range of academic components that promote intellectual flexibility, skill development, ethical orientation, and research aptitude.

The curriculum framework encompasses the following core elements:

- **Major (Core) Disciplines**
- **Minor Disciplines (2nd Major, if opted)**
- **Multi-Disciplinary Courses (MDC)**
- **Ability Enhancement Courses (AEC)**
- **Value Added Courses (VAC)**
- **Skill Enhancement Courses (SEC)**
- **Internship/Apprenticeship/Project/Community Outreach (IAPC)**
- **Research Ethics and Methodology**
- **Dissertation (including data collection, analysis, and report preparation)**
- **Discipline-Specific Electives (DSE)**

The programme offers flexible academic pathways with multiple entry and exits options, allowing students to earn certifications commensurate with the credits accumulated over the course of study:

- **Undergraduate Certificate** (after 1 year & 40 Credits): Comprises two Major disciplines, two Minor disciplines, two MDGECs, two AECs, two VACs, and two SECs. Additionally, students must complete 1 IAPC (4 Credits) within 1st year of last Even End Sem exam.
- **Undergraduate Diploma** (after 2 years & 80 Credits): Includes eight Major disciplines, four Minor disciplines, three MDGECs, two AECs, three VACs, and three SECs. Additionally, students must complete 1 IAPC (4 Credits) within 1st year of last Even End Sem exam.
- **3-Year UG Degree** (120 Credits): Consists of fifteen Major disciplines, six Minor disciplines, three MDGECs, two AECs, three VACs, three SECs, along with mandatory **Community Engagement** activities (such as NCC, NSS, Adult Education, Student Mentoring, involvement with NGOs or Government Institutions), and **Internship**.
- **4-Year UG Degree (Honours)** (160 Credits): Comprises twenty Major disciplines, eight Minor disciplines, three MDGECs, two AECs, three VACs, three SECs, **Community Engagement**, **Internship**, **Research Ethics and Methodology**, and two **Discipline Specific Electives (DSEs)**. A **Dissertation** involving research design, data collection, analysis, and report writing is also a key component.

- **4-Year UG Degree (Honours with Research)** (160 Credits including 12 research credits): In addition to 4-Year UG Degree (Honours), students must obtain 75% marks in first 3 years and complete a Research project.

3. AIM

The Undergraduate Programme in Mathematics is designed to help students think critically, logically, and analytically, giving them the tools to apply mathematical reasoning to real-life situations. Through this programme, students explore a wide range of engaging and useful mathematical ideas that prepare them for careers in industry, government, business, commerce, finance, and research.

The curriculum covers both pure and applied mathematics, ensuring a strong foundation in theory along with practical applications. Students also gain hands-on experience in the computer lab using tools like MATLAB, C, and other mathematical software. These sessions help them connect classroom learning with current trends and technologies used around the world in various fields of mathematics.

In addition to strengthening their mathematical skills, the programme encourages students to explore related areas such as commerce, physics, computer science, economics, and statistics. Following the vision of the New Education Policy (NEP) 2020, the programme also offers flexibility—allowing students to move between disciplines, institutions, or even different modes of learning. This adaptability equips them to thrive in a rapidly changing academic and professional landscape.

4. PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

1. **PEO 1: Strong Foundation in Mathematical Knowledge**
   Graduates will develop a solid understanding of core mathematical theories, principles, and techniques, preparing them to solve complex problems and pursue higher studies or professional opportunities in mathematics and related disciplines.
2. **PEO 2: Critical and Analytical Thinking**
   Graduates will build strong analytical and logical reasoning skills, enabling them to model, analyse, and solve real-world problems using mathematical approaches and critical thinking.
3. **PEO 3: Practical Application of Mathematics**
   Graduates will be proficient in applying mathematical tools and computational methods to solve practical problems across various domains such as science, technology, engineering, and economics.

4. **PEO 4: Effective Communication and Teamwork**
   Graduates will be able to communicate mathematical ideas clearly and confidently—both verbally and in writing—and work collaboratively in diverse, interdisciplinary teams to address complex challenges.
5. **PEO 5: Ethical and Social Responsibility**
   Graduates will understand the ethical dimensions of mathematical applications and demonstrate a sense of professional responsibility, considering the societal impact of their work.
6. **PEO 6: Lifelong Learning and Adaptability**
   Graduates will embrace lifelong learning, staying current with emerging trends and technologies in mathematics, and adapting to the evolving demands of academia and the professional world.
7. **PEO 7: Research and Innovation**
   Graduates will be encouraged to engage in independent research, developing innovative approaches and deepening their mathematical insight to address both theoretical and applied problems.

5. PROGRAMME OUTCOMES (GRADUATE ATTRIBUTES)

1. **PO1: Disciplinary Knowledge**
   Demonstrate comprehensive knowledge and a coherent understanding of both theoretical and applied aspects of mathematics, as well as interdisciplinary subjects, within a broad multidisciplinary framework.
2. **PO2: Communication Skills**
   Effectively communicate mathematical ideas using computational techniques, graphical methods, illustrative examples, and geometric representations. Use mathematics as a precise and universal language across various fields of study.
3. **PO3: Moral and Ethical Awareness/Reasoning**
   Identify ethical issues relevant to academic and professional practice, and commit to upholding integrity by avoiding plagiarism, respecting copyrights, and adhering to intellectual property rights.
4. **PO4: Multicultural Competence**
   Recognize and relate contemporary developments in various branches of mathematics across global organizations. Demonstrate respect, sensitivity, and effective communication within multicultural and diverse social or professional settings.
5. **PO5: Information and Digital Literacy**
   Access, evaluate, and utilize Information and Communication Technology (ICT) tools effectively. Acquire proficiency in computational tools and programming languages such as MATLAB and C for simulation, data analysis, graphing, and problem-solving.

6. **PO6: Reflective Thinking**
   Pose meaningful questions within mathematical contexts and propose innovative solutions. Apply domain-specific knowledge to interpret results and solve both theoretical and real-life mathematical problems.
7. **PO7: Cooperation and Teamwork**
   Collaborate respectfully and effectively in diverse teams. Exhibit interpersonal skills and a cooperative attitude to work collectively towards shared academic or professional objectives.
8. **PO8: Research-Related Skills**
   Formulate research questions and hypotheses based on mathematical theories and concepts. Demonstrate the ability to analyse, synthesise, and present findings using appropriate mathematical tools and logical structures.
9. **PO9: Problem Solving**
   Engage in independent inquiry and critical analysis to identify mathematical applications in industry, academia, and daily life. Develop innovative, lateral-thinking strategies and apply emotional intelligence to address challenges in familiar and novel contexts.
10. **PO10: Critical Thinking**
    Acquire and apply knowledge through analytical reasoning and logical evaluation. Identify inconsistencies in arguments, assess evidence critically, and foster a mindset geared toward lifelong learning and intellectual growth.

6. PROGRAMME SPECIFIC OUTCOMES

Upon successful completion of the Four-Year Undergraduate Programme (FYUGP) in Mathematics, students will be able to:

1. **PSO 1: Mathematical Knowledge**
   Demonstrate a thorough understanding and in-depth knowledge of core and elective areas within mathematics, reflecting both theoretical insight and practical application.
2. **PSO 2: Application of Mathematical Tools**
   Apply mathematical methods—including modelling techniques, computational tools, and statistical analysis—to address and solve real-world problems across a range of disciplines.
3. **PSO 3: Analytical and Critical Thinking**
   Exhibit advanced analytical abilities and critical thinking skills to construct logical arguments, formulate proofs, and tackle complex mathematical problems with precision.
4. **PSO 4: Proficiency in Computational Tools**
   Use modern mathematical software and programming tools such as MATLAB, C, and other relevant technologies effectively for problem-solving, data analysis, and simulations.

5. **PSO 5: Communication of Mathematical Ideas**
   Clearly and effectively communicate mathematical concepts, solutions, and results to diverse audiences—including peers, researchers, professionals, and non-specialists—both verbally and in written form.
6. **PSO 6: Research Aptitude and Lifelong Learning**
   Demonstrate the ability to engage in research by formulating relevant questions, conducting literature reviews, applying appropriate methodologies, and presenting findings, while also embracing continuous learning and professional growth.
7. **PSO 7: Career and Competitive Readiness**
   Utilize the knowledge and skills acquired to succeed in national-level competitive examinations, pursue higher studies including doctoral research, and contribute effectively in careers such as teaching, research, and analytics.

7. TEACHING LEARNING PROCESS

The outcome-based education (OBE) framework emphasizes a paradigm shift from traditional teacher-centric methods to learner-centric and participatory pedagogies, particularly at the undergraduate level. This approach fosters active engagement, critical inquiry, and independent thinking, aligning with the objectives of the Four-Year Undergraduate Programme (FYUGP) in Mathematics.

The teaching–learning process is structured to ensure the systematic and progressive acquisition of knowledge, conceptual clarity, and practical skills. It also encourages students to understand the interconnections between theoretical concepts and their real-world applications.

A variety of teaching strategies are employed to cater to diverse learning styles and to promote deep learning. These include:

- Interactive lectures and discussions
- Student presentations and peer learning
- Problem-solving sessions and collaborative activities
- Use of prescribed textbooks and reference materials
- Integration of e-learning platforms and digital tools
- Guided self-study and flipped classroom models
- Field-based learning, projects, and internships
- Exposure to industry needs and contemporary research trends

This blended approach aims to equip students with domain knowledge, technical proficiency, critical thinking, ethical awareness, and readiness for both academic progression and professional engagement.

8. ASSESSMENT METHODS

The assessment framework for the Undergraduate Programme in Mathematics is designed to measure student learning outcomes effectively and comprehensively. A variety of assessment methods, aligned with the nature of the discipline and the stated Programme Outcomes (POs), will be employed to monitor and evaluate students' academic progress.

The evaluation process follows a continuous and comprehensive assessment model, incorporating both in-semester (formative) and end-semester (summative) assessments. The final grade awarded to a student will be determined by their performance across these components.

In-semester evaluation will be conducted through:

- Class tests and mid-term examinations
- Homework assignments and problem sets
- Tutorials and concept-based exercises
- Participation in classroom activities and group discussions
- Other activities determined by the concerned teacher

Summative and skill-based assessments may include:

- Written examinations (short and long-answer formats)
- Problem-based assignments and analytical tasks
- Lab reports and observations for computational/practical courses
- Oral presentations and seminar talks
- Individual and group project reports
- Viva voce and reflective interviews
- Quizzes and surprise tests
- Participation in research-based or industry-linked projects

This multifaceted assessment strategy ensures that students are evaluated not only on content knowledge but also on their ability to apply mathematical reasoning, communicate effectively, collaborate with peers, and engage with real-world problems in a meaningful way.

STRUCTURE OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)
IN MATHEMATICS FOR DIGBOI COLLEGE (AUTONOMOUS)
(AS PER NEP-2020 GUIDELINES)

Semester	Course	Title of the Paper & Paper Code		Credit
I (FIRST)	C-MAT-101	Calculus and Differential Equation		4
	MIN-MAT-101	Calculus and Differential Equation		4
	MDC-MAT-101A	Foundation in Mathematics	ANY ONE	3
	MDC-MAT-101B	History of Mathematics		
	AEC 1	AEC Language: MIL/ Regional Language		4
	SEC-MAT-101	MatLab I		3
	VAC 1	Value Added Course 1		2
	Total Credit			**20**
II (SECOND)	C-MAT-201	Real Analysis & Classical Algebra		4
	MIN-MAT-201	Real Analysis & Classical Algebra		4
	MDC-MAT-201A	Combinatorial Mathematics	ANY ONE	3
	MDC-MAT-201B	Business Mathematics		
	AEC 2	AEC: Language and Communication Skills (English) II		4
	SEC-MAT-201	MatLab II		3
	VAC 2	Value Added Course 2		2
	Total Credit			**20**
III (THIRD)	C-MAT-301	Theory of Real functions		4
	C-MAT-302	Group Theory I		4
	MIN-MAT-301	Differential Calculus		4
	MDC-MAT-301A	Introduction to Mathematical Analysis	ANY ONE	3
	MDC-MAT-301B	Introduction to Discrete Mathematics		
	SEC-MAT-301	Mathematical Logic		3
	VAC 3	Value Added Course 3		2
	Total Credit			**20**

STRUCTURE OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP)
IN MATHEMATICS FOR DIGBOI COLLEGE (AUTONOMOUS)
(AS PER NEP-2020 GUIDELINES)

Semester	Course	Title of the Paper & Paper Code		Credit
IV (FOURTH)	C-MAT-401(T)	Numerical Methods (Theory)		3
	C-MAT-401(P)	Numerical Methods (Practical)		1
	C-MAT-402	Riemann Integration & Series of Functions		4
	C-MAT-403	Ring Theory and Linear Algebra I		4
	C-MAT-404	PDE and Systems of ODE		4
	MIN-MAT-401(T)	Numerical Methods (Theory)		3
	MIN-MAT-401(P)	Numerical Methods (Practical)		1
	Total Credit			**20**
V (FIFTH)	C-MAT-501	Multi-Variate Calculus		4
	C-MAT-502	Group theory II		4
	C-MAT-503A	Linear Programming	ANY ONE	4
	C-MAT-503B(T)	Computer Programming (Theory)	ANY ONE	3
	C-MAT-503B(P)	Computer Programming (Practical)	ANY ONE	1
	MIN-MAT-501A	Linear Programming	ANY ONE	4
	MIN-MAT-501B(T)	Computer Programming (Theory)	ANY ONE	3
	MIN-MAT-501B(P)	Computer Programming (Practical)	ANY ONE	1
	INTERNSHIP OR COMMUNITY ENGAGEMENT	Internship OR Community Engagement (NCC/NSS/Adult Education/ Student Mentoring/NGO/Govt. Institutions, etc.)		4
	Total Credit			**20**
VI (SIXTH)	C-MAT-601	Metric Spaces & Complex Analysis		4
	C-MAT-602	Ring Theory & Linear Algebra II		4
	C-MAT-603A	Number Theory	ANY ONE	4
	C-MAT-603B	Hydro-Mechanics	ANY ONE	4
	C-MAT-604A	Mathematical Methods	ANY ONE	4
	C-MAT-604B	Probability and Statistics	ANY ONE	4
	MIN-MAT-601	Mathematical Methods		4
	Total Credit			**20**

STRUCTURE OF FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS FOR DIGBOI COLLEGE (AUTONOMOUS) (AS PER NEP-2020 GUIDELINES)

Semester	Course	Title of the Paper & Paper Code		Credit
VII (SEVENTH)	C-MTH-701	Field Theory		4
	C-MAT-702	Tensor Analysis		4
	C-MAT-703	Theory of Equations		4
	MIN-MAT-701	Advanced Mathematical Logic		4
		Research Ethics and Methodology		4
	Total Credit			**20**
VIII (EIGHTH)	C-MAT-801	Functional Analysis		4
	C-MAT-802	Non-linear Dynamical System & Chaos		4
	DISSERTATION OR ANY TWO FROM D-MAT803A, D-MAT803B, D-MAT803C & D-MAT803D			
	D-MAT-803	DISSERTATION		8
	D-MAT-803A	Finite Element Methods	ANY TWO	4
	D-MAT-803B	Fluid Dynamics		4
	D-MAT-803C	Information Security		4
	D-MAT-803D	Fuzzy Set Theory		4
	MIN-MAT-801	Probability and Statistics		4
	Total Credit			**20**

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 1st SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Calculus and Differential Equations**
Course Code	**: C-MAT-101**
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:

This course focuses on the foundational concepts of calculus, including differentiation and integration, and their application to solving differential equations.

Pre Requisites:

- 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's 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. This course also 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.

Course Outcomes (COs):

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: Execute various solution concepts of differential equations.

ILO 8.1: Classify the general, particular, explicit, implicit and singular solutions of differential equations.

ILO 8.2: Solve Exact differential equations, linear equations and Bernoulli equations.

ILO 8.3: Apply the solution methods of differential equations to solve problems.

CO9: Describe the solution techniques of homogeneous and non-homogeneous differential equations of second order.

ILO 9.1: Solve homogeneous and non-homogeneous linear differential equations.

ILO 9.2: Solve Euler equations.

ILO 9.3: Solve differential equations using method of undetermined coefficients and method of variation of parameters.

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.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO2	X	X	CO6	X
Conceptual Knowledge	X	CO8	CO3	X	CO5	X
Procedural Knowledge	X	CO1, CO4, CO8, CO9	CO8, CO9	CO8, CO9	CO7	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (10 Marks)	De Moivre's Theorem with rational indices and its application to various problems, Expansion of $\sin x$, $\cos x$, $\sin hx$, $\cos hx$ and related problems.	07	03	-	10
II (10 Marks)	Successive Differentiation, Leibnitz Theorem and its application, L'Hospital's Rule, Applications of maxima & minima, Definition of partial differentiation and examples.	08	02	-	10
III (10 Marks)	Reduction Formulae of the types $\int \sin^n x\, dx$, $\int \cos^n x\ dx$, $\int \tan^n x\, dx$, $\int (logx)^n dx$ and $\int \sin^n x \cos^n xdx$ and their derivations, Rectification, volume and surface area of revolution of a curve.	08	02	-	10
IV (12 Marks)	Concepts and definition of General and particular 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
V (18 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.	13	05	-	18
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations - 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. Ross S. L., Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.

REFERENCES:

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. Coddington E. A., An Introduction to Ordinary Differential Equation, Dover Publications, 1989.
4. Raisinghania M. D., Ordinary and Partial Differential Equations, S Chand and Publications.

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 1ST SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Calculus and Differential Equations**
Course Code	**: MIN-MAT-101**
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:

This course focuses on the foundational concepts of calculus, including differentiation and integration, and their application to solving differential equations.

Pre Requisites:

- 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. This course also 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.

Course Outcomes (COs):

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.

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ILO 3.1: Utilize Leibniz's theorem to find higher-order derivatives of product functions.

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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 ∞/∞.

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CO6: Describe reduction formula involving both trigonometric and logarithmic functions

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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: Execute various solution concepts of differential equations.

ILO 8.1: Classify the general, particular, explicit, implicit and singular solutions of differential equations.

ILO 8.2: Solve Exact differential equations, linear equations and Bernoulli equations.

ILO 8.3: Apply the solution methods of differential equations to solve problems.

CO9: Describe the solution techniques of homogeneous and non-homogeneous differential equations of second order.

ILO 9.1: Solve homogeneous and non-homogeneous linear differential equations.

ILO 9.2: Solve Euler equations.

ILO 9.3: Solve differential equations using method of undetermined coefficients and method of variation of parameters.

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.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO2	X	X	CO6	X
Conceptual Knowledge	X	CO8	CO3	X	CO5	X
Procedural Knowledge	X	CO1, CO4, CO8, CO9	CO8, CO9	CO8, CO9	CO7	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (10 Marks)	De Moivre's Theorem with rational indices and its application to various problems, Expansion of $\sin x$, $\cos x$, $\sin hx$, $\cos hx$ and related problems.	07	03	-	10
II (10 Marks)	Successive Differentiation, Leibnitz Theorem and its application, L'Hospital's Rule, Applications of maxima & minima, Definition of partial differentiation and examples.	08	02	-	10
III (10 Marks)	Reduction Formulae of the types $\int \sin^n x\, dx$, $\int \cos^n x\ dx$, $\int \tan^n x\, dx$, $\int (logx)^n dx$ and $\int \sin^n x \cos^n x dx$ and their derivations, Rectification, volume and surface area of revolution of a curve.	08	02	-	10
IV (12 Marks)	Concepts and definition of General and particular 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
V (18 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.	13	05	-	18
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations - 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. Ross S. L., Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.

REFERENCES:

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. Coddington E. A., An Introduction to Ordinary Differential Equation, Dover Publications, 1989.
4. Raisinghania M. D., Ordinary and Partial Differential Equations, S Chand and Publications.

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 1ST SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Foundation in Mathematics**
Course Code	**: MDC-MAT-101A**
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, matrix and determinant. This course prepares students for advanced studies in mathematical logic, matrix and determinant, fundamental arithmetic operations & mensuration 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 matrices, determinant and its application
- Key concepts of relation and functions

Course Objectives:

The course on Foundation in Mathematics 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.

ILO 1.1: Achieve a solid understanding of using estimation skills and when to estimate results.

ILO 1.2: Read, interpret, and make decisions about data summarized numerically.

ILO 1.3: 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.

ILO 2.1: Analyze the logical structure of statements symbolically, including the proper use of logical connectives, predicates, and quantifiers.

ILO 2.2: Evaluate the truth of a statement using the principles of logic.

ILO 2.3: 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.

ILO 3.1: Identify and differentiate between reflexive, symmetric, transitive and equivalence relations.

ILO 3.2: Define one-to-one and onto functions and apply them in real-life scenarios.

ILO 3.3: Analyze and interpret real-life examples such as in social networks, transportation systems, etc.

CO4: Understand the basic concept of matrix and determinant and its applications.

ILO 4.1: Identify and differentiate between of matrix and determinant.

ILO 4.2: Apply to solve linear equations upto three variables.

ILO 4.3: Analyze and interpret real-life examples and applications in real life such as in Physics, Computer science, Geology etc.

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

ILO 5.1: Understand the basic fundamental arithmetic operations for real-life problem such as in financial management, and various everyday tasks. These operations enable individuals to calculate budgets, manage expenses, make informed purchasing decisions, and understand concepts like discounts, percentages, and time.

ILO 5.2: Understand and apply concepts related to measuring geometric figures, including area, perimeter, surface area, and volume.

ILO 5.3: Analize and apply to calculate these measurements for various 2D and 3D shapes, as well as solve real-world problems.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1, CO2	X	X	X	X
Conceptual Knowledge	X	CO1, CO2	CO3	CO5		CO4

Procedural Knowledge	X	X	CO1, CO2	CO3	CO4	CO5
Metacognitive Knowledge	X	X	X	X	CO5	X

UNITS	CONTENTS	L	T	P	Total Hours
I (10 Marks)	**Sets and Logic** 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, Sets, subsets, types of set, operations on sets, Cartesian product.	06	03	-	09
II (15 Marks)	**Relation and Functions** Relation and functions, types of relation and functions, Domain and range of functions, graphs of functions, compositions of functions and invertible function, Binary operations.	08	04	-	12
III (20 Marks)	**Matrices and Determinant** Matrix, types of matrices,operations on matrices, transpose of a matrix, symmetric and skew symmetric matrices, Elementary operations of a matrix, invertible matrices, Determinant, properties of determinant, minor and cofactors, adjoint and inverse of a matrix, Application of determinant and matrices, solution of system of linear equations (not more than three variables) using matrix inversion method.	10	05	-	15
IV (15 Marks)	**Fundamental Arithmetic operations & Mensuration** Percentages Ratio and Proportion, Interest (Simple and Compound) Profit and Loss, Time and distance, Time and work ` Area and volume of Triangles, Quadrilaterals, Regular Polygons, Circle, Right Prism, Right Circular Cone, Right Circular Cylinder, Sphere, Hemispheres, Rectangular Parallelepiped, Regular Right Pyramid with triangular or square Base and its application.	06	03	-	09
	Total	30	15	-	45

Where: **L: Lectures** **T: Tutorials** **P: Practicals**

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

- **Two Internal Examinations** - **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, 2ndEd., 2015.
3. Mensuration and Geometry Book for CAT, SSC, OMET by Er. Bharat Gupta.
4. An Introduction to Mensuration and Practical Geometry by James Ryan.

REFERENCES:

1. Fundamental of mathematical statistics by GUPTA, V. K. KAPOOR, Published by Sultan Chand & Sons 23, Darya Ganj, New Delhi-110002.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEARUNDER GRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 1ST SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: History of Mathematics**
Course Code	**: MDC-MAT-101B**
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 clearer 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 Objectives:

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 Outcomes (COs):

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

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

ILO 1.1: Identify and describe significant mathematical contributions from ancient India, such as advancements in algebra, trigonometry, and arithmetic.

ILO 1.2: Examine the cultural, religious, and intellectual environment in which Hindu mathematicians made their contributions.

ILO 1.3: Highlight the lives and works of prominent Hindu mathematicians such as Aryabhata, Brahmagupta, and Bhaskara II.

ILO 1.4: 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.

ILO 2.1: Describe the progression from early numerical notations to the development of the decimal place-value system.

ILO 2.2: Discuss the introduction and impact of the zero symbol and its role in the decimal place-value system.

ILO 2.3: Explain how the Hindu numeral system, including the concept of zero, spread and influenced other cultures and mathematical systems.

ILO 2.4: 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.

ILO 3.1: Describe the foundational principles and axioms of Euclidean geometry as presented in Euclid's "Elements."

ILO 3.2: Detail the Pythagorean Theorem and various proofs, including those found in Euclid's "Elements."

ILO 3.3: 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.

ILO 4.1: Explain the techniques Archimedes used to approximate the value of pi, including the method of exhaustion.

ILO 4.2: Discuss key geometric discoveries and theories proposed by Archimedes, such as the area of a circle and the surface area of a sphere.

ILO 4.3: 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.

ILO 5.1: Describe important arithmetic algorithms, such as those for multiplication and division, used in ancient India.

ILO 5.2: Detail how linear congruences were formulated and solved in ancient Indian mathematical texts.
ILO 5.3: Examine the development of sine tables and their importance in the work of Indian mathematicians like Aryabhata.
ILO 5.4: Investigate the techniques and algorithms used by Indian mathematicians to solve Diophantine equations and their impact on number theory.
ILO 5.5: Explore how mathematical discoveries from ancient and medieval India were transmitted to other cultures and influenced global mathematics.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO1	CO3	X	CO4	X
Conceptual Knowledge	CO1	X	CO3	CO2	CO4	X
Procedural Knowledge	X	X	CO3	CO1, CO2	CO4	X
Metacognitive Knowledge	X	X	X	X	CO5	X

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)**

- **Two Internal Examinations** - **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 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 Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 1ST SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: MatLab I**
Course Code	**: SEC-MAT-101**
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 Skill Enhancement Course is designed to provide undergraduate students with practical training in computational problem-solving using MatLab, a high-performance programming platform widely used in science, engineering, and mathematics. The course covers a range of topics including evaluation of mathematical expressions, solutions of algebraic equations, and techniques for sketching conics. Students will also gain hands-on experience with fundamental and advanced MatLab commands, matrix operations, and visualization techniques. Through structured laboratory sessions, the course aims to reinforce theoretical knowledge while building computational and problem-solving skills relevant to real-world applications.

Pre Requisites:

- Basic understanding of high school mathematics including algebra, calculus, trigonometry and matrix
- Familiarity with fundamental mathematical functions and graphing
- Basic computer literacy

Course Objectives:

1. To introduce students to MatLab software for mathematical computations and visualizations.
2. To enhance computational thinking and practical problem-solving skills.
3. To develop hands-on experience with numerical methods, plotting, and matrix operations.
4. To gain proficiency in using MatLab for evaluating mathematical expressions and solving algebraic equations.
5. To provide foundational training for using MatLab in academic and research contexts.

Course Outcomes (COs):

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

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

ILO 1.1: explain the function of basic commands in MatLab 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.

ILO 1.2: Apply basic commands in MatLab 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 to understand their properties.

ILO 2.1: Explain the use of graph plotting commands in MatLab, such as plot, title, legend, hold on, axis, grid on, figure, clf, and close all.

ILO 2.2: Apply MatLab 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 2.3: Analyze the Behavior of Various Functions.

CO3: Utilize techniques for sketching conics and parametric curves using MatLabto explore their geometric properties.

ILO 3.1: explain the use of commands in MatLab for sketching conics and parametric curves, such as ezplot, fplot, plot, and other relevant plotting functions.

ILO 3.2: Apply MatLab 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 to obtain surfaces and volumes of revolution and perform matrix operations.

ILO 4.1: Use MatLab to calculate and visualize surfaces and volumes of revolution for given functions.

ILO 4.2: Utilize MatLab to perform matrix operations, including addition, multiplication, inversion, and transposition.

CO5: Interpret the procedural steps involved in using MatLab for various mathematical computations.

ILO 5.1: Explain the procedural steps for performing basic mathematical computations in MatLab, such as evaluating expressions, solving equations, and plotting graphs.

ILO 5.2: Demonstrate interpreting of the procedural steps for advanced mathematical computations in MatLab, including matrix operations, solving systems of equations, and performing calculus operations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	X	X	X	X

Conceptual Knowledge	X	X	X	CO2	X	X
Procedural Knowledge	X	CO5	CO1, CO3, CO4	X	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**Introduction to MatLab** **Topics covered:** Introduction to MatLab environment and workspace, basic arithmetic and built in functions, vectors, matrices, and array creation, script files and command window **Key MatLab Commands:** clc, help, clear all, disp, zeros, ones, eye, rand, real, imag, length, size, linspace, reshape etc. **List of Practicals:** 1. Basic arithmetic calculations and usage of built-in functions (sqrt, exp, log, mod, abs). 2. Writing and executing script files. 3. Creating and manipulating vectors and matrices.	-	-	**7x2**	**14**
II (15 Marks)	**Functions, Plotting & Visualization** **Topics covered:** User defined functions, 2D plotting, multiple plots in a single frame, graph customization **Key MatLab Commands:** plot, subplot, hold on, xlabel, ylabel, legend, axis, grid on, figure, diff **List of Practicals:** 1. Plotting standard mathematical functions: linear, quadratic, exponential, logarithmic, trigonometric. 2. Comparing graphs with changing parameters. 3. Creating multiple plots and customizing them.	-	-	**15x2**	**30**
III (15 Marks)	**Algebraic Equations & Matrix Operations** **Topics covered:** Solving algebraic and polynomial equations, solving system of linear equations, matrix operations: addition, multiplication, transpose, inverse, determinant. Key MatLab Commands:	-	-	**8x2**	**16**

	roots, solve, inv, det, eig, rref, diff, linsolve, \ (backslash operator) **List of Practicals:** 1. Solving polynomials of degree 4 and 5, the derivative graph, (higher order derivative), comparison of graphs. 2. Solving algebraic equation, system of linear equations 3. Matrix operations: addition, multiplication, transpose, determinant, inverse.				
IV **(15 Marks)**	**Curve Sketching** **Topics covered:** Plotting parametric curves, Surface and volume of revolution, polar equation of conics, standard 3D surfaces. **Key MatLab Commands:** syms, ezplot, surf, meshgrid, mesh, grid on **List of Practicals:** 1. Sketching parametric curves (E.g., Trochoid, cycloid, epicycloids, hypocycloid) 2. Obtaining surface of revolution of curves 3. Tracing conics in cartesian/polar coordinates Visualizing 3D surfaces: ellipsoid, paraboloid, hyperboloid	-	-	**15x2**	**30**
	Total	-	-	**45x2**	**90**

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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.

REFERENCES:

1. Attaway, Stormy. MATLAB: A Practical Introduction to Programming and Problem Solving. 6th ed., Butterworth-Heinemann, 2022.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 2ND SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Real Analysis and Classical Algebra**
Course Code	**: C-MAT-201**
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 & Classical Algebra 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, and sequences and their types with their convergence and divergence properties. The second part includes the basics required for the course in Number Theory and Linear Algebra. The whole course is so designed that the students will learn the theories and concepts used in the real analysis and also the tools required to solve system of equations. It will give initial insight for the course Number Theory and Linear Algebra. The course will also introduce the system of linear equation and how to solve such systems.

Pre Requisites:

- Introduction to Set Theory
- Arithmetic.

Course Objectives:

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

Course Outcomes (COs):

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

CO1: Understand the algebraic, order, and structure/properties of the real number system.

ILO 1.1: Define bounded sets, supremum, infimum, and neighborhoods in R.

ILO 1.2: Explain the Completeness Property, Archimedean Property, and density of Q in R.

ILO 1.3: Identify and classify limit points, isolated points, and types of intervals.

ILO 1.4: Analyze the concept of countability and the uncountability of R using set-theoretic tools.

CO2: Develop the theory of sequences and series using rigorous analytical tools.

ILO 2.1: Define convergence, divergence, Cauchy sequences, and monotone sequences.

ILO 2.2: Explain and apply limit theorems, monotone convergence theorem, and Cauchy's convergence criterion.

ILO 2.3: Analyze the convergence properties of subsequences using the Bolzano-Weierstrass theorem.

ILO 2.4: Evaluate the convergence or divergence of infinite series using appropriate criteria.

CO3: Apply classical number-theoretic results in the context of integers and divisibility.

ILO 3.1: State and apply the division algorithm, Euclidean algorithm, and concept of primes.

ILO 3.2: Solve problems using congruence relations between integers.

ILO 3.3: Analyze the Fundamental Theorem of Arithmetic and its implications on prime factorization.

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

ILO 4.1: Perform row operations and transform matrices into echelon forms.

ILO 4.2: Solve systems of equations using matrix representations and analyze solution sets.

ILO 4.3: Interpret vector equations and identify linearly independent/dependent sets in $\mathbb{R}^n$.

ILO 4.4: Evaluate invertibility of matrices and apply it to solve matrix equations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	CO1, CO2	CO1, CO3	CO3	CO3	X	X
Conceptual Knowledge	X	CO1, CO2	CO4	CO4	CO4	X
Procedural Knowledge	X	X	CO2, CO3	CO1, CO2	CO2	X
Metacognitive Knowledge	X	X	X	X	CO4	X

UNITS	CONTENTS	L	T	P	Total Hours
	(A) Real Analysis				
I (15 Marks)	Algebraic and Order Properties of R, neighborhood of a point in 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, Idea of countable sets, uncountable sets and uncountability of R.	12	04	-	16
II (15 Marks)	Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion. Infinite series, convergence and divergence of infinite series, p-series, Tests for convergence: Comparison Test, Root Test, Ratio Test, Cauchy Criterion.	12	04	-	16
	(B) Classical Algebra				
III (12 Marks)	Well ordering property of positive integers, Division algorithm, Divisibility & Euclidean algorithm, Primes and their distribution, Congruence relation between integers, Statement of the Fundamental Theorem of Arithmetic.	09	03	-	12
IV (18 Marks)	Inverse of an $n \times n$ matrix, 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 as elements in $\mathbb{R}^n$.	12	04	-	16
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations** - **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. & Kumaresan S., A Basic Course in Real Analysis, CRC Press, Reprint 2021.
3. Burton D. M., Elementary Number Theory, McGraw Hill, 7th Ed., 2023.

REFERENCES:

1. Thomas G. B. & Finney R. L., Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. Lipschutz S., 3000 Solved Problems in Linear Algebra, SCHAUM's Outline Series, McGraw Hill, 1988.
3. 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	M	L	L	M	S	L	M	M	S
CO2	S	M	L	L	M	S	L	S	S	S
CO3	S	M	M	M	M	M	L	M	S	S
CO4	S	M	L	L	S	S	M	M	S	S

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 2ND SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Real Analysis and Classical Algebra**
Course Code	**: MIN-MAT-201**
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 & Classical Algebra 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, and sequences and their types with their convergence and divergence properties. The second part includes the basics required for the course in Number Theory and Linear Algebra. The whole course is so designed that the students will learn the theories and concepts used in the real analysis and also the tools required to solve system of equations. It will give initial insight for the course Number Theory and Linear Algebra. The course will also introduce the system of linear equation and how to solve such systems.

Pre Requisites:

- Introduction to Set Theory
- Arithmetic.

Course Objectives:

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

Course Outcomes (COs):

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

CO1: Understand the algebraic, order, and structure/properties of the real number system.

ILO 1.1: Define bounded sets, supremum, infimum, and neighborhoods in R.

ILO 1.2: Explain the Completeness Property, Archimedean Property, and density of Q in R.

ILO 1.3: Identify and classify limit points, isolated points, and types of intervals.

ILO 1.4: Analyze the concept of countability and the uncountability of R using set-theoretic tools.

CO2: Develop the theory of sequences and series using rigorous analytical tools.

ILO 2.1: Define convergence, divergence, Cauchy sequences, and monotone sequences.

ILO 2.2: Explain and apply limit theorems, monotone convergence theorem, and Cauchy's convergence criterion.

ILO 2.3: Analyze the convergence properties of subsequences using the Bolzano-Weierstrass theorem.

ILO 2.4: Evaluate the convergence or divergence of infinite series using appropriate criteria.

CO3: Apply classical number-theoretic results in the context of integers and divisibility.

ILO 3.1: State and apply the division algorithm, Euclidean algorithm, and concept of primes.

ILO 3.2: Solve problems using congruence relations between integers.

ILO 3.3: Analyze the Fundamental Theorem of Arithmetic and its implications on prime factorization.

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

ILO 4.1: Perform row operations and transform matrices into echelon forms.

ILO 4.2: Solve systems of equations using matrix representations and analyze solution sets.

ILO 4.3: Interpret vector equations and identify linearly independent/dependent sets in $\mathbb{R}^n$.

ILO 4.4: Evaluate invertibility of matrices and apply it to solve matrix equations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	CO1, CO2	CO1, CO3	CO3	CO3	X	X
Conceptual Knowledge	X	CO1, CO2	CO4	CO4	CO4	X
Procedural Knowledge	X	X	CO2, CO3	CO1, CO2	CO2	X
Metacognitive Knowledge	X	X	X	X	CO4	X

UNITS	CONTENTS	L	T	P	Total Hours
	(A) Real Analysis				
I (15 Marks)	Algebraic and Order Properties of R, neighborhood of a point in 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, Idea of countable sets, uncountable sets and uncountability of R.	12	04	-	16
II (15 Marks)	Sequences, Bounded sequence, Convergent sequence, Limit of a sequence, Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Monotone Subsequence Theorem (statement only), Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion. Infinite series, convergence and divergence of infinite series, p-series, Tests for convergence: Comparison Test, Root Test, Ratio Test, Cauchy Criterion.	12	04	-	16
	(B) Classical Algebra				
III (12 Marks)	Well ordering property of positive integers, Division algorithm, Divisibility & Euclidean algorithm, Primes and their distribution, Congruence relation between integers, Statement of the Fundamental Theorem of Arithmetic.	09	03	-	12
IV (18 Marks)	Inverse of an $n \times n$ matrix, 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 as elements in $\mathbb{R}^n$.	12	04	-	16
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations** - **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. & Kumaresan S., A Basic Course in Real Analysis, CRC Press, Reprint 2021.
3. Burton D. M., Elementary Number Theory, McGraw Hill, 7th Ed., 2023.

REFERENCES:

1. Thomas G. B. & Finney R. L., Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. Lipschutz S., 3000 Solved Problems in Linear Algebra, SCHAUM's Outline Series, McGraw Hill, 1988.
3. 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	M	L	L	M	S	L	M	M	S
CO2	S	M	L	L	M	S	L	S	S	S
CO3	S	M	M	M	M	M	L	M	S	S
CO4	S	M	L	L	S	S	M	M	S	S

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 2ND SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Combinatorial Mathematics**
Course Code	**: MDC-MAT-201A**
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:

This course offers a thorough introduction to fundamental ideas of Mathematical Induction, Counting Principles including permutations, combinations, and the Binomial Theorem. The course also provides an introductory and axiomatic knowledge of Probability Theory. The fundamental ideas in Elementary Number Theory including congruences, the Euclidean algorithm, divisibility, and Diophantine equations are also covered in this course. This course emphasizes on acquiring logical thinking and problem-solving abilities through a range of examples and applications.

Pre Requisites:

- Basic Algebra
- Basic arithmetic of natural numbers
- Introduction to Probability

Course Objectives:

The course on Combinatorial Mathematics 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 introductory discrete mathematics, probability and basic number theory to investigate, think, and solve problems logically.

Course Outcomes (COs):

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

CO1: Understand and apply the principle of mathematical induction to prove fundamental results.

ILO 1.1: Define the well-ordering property and the principle of mathematical induction.

ILO 1.2: Explain how mathematical induction establishes the truth of statements over $\mathbb{N}$.

ILO 1.3: Apply the principle of mathematical induction to prove simple identities.

CO2: Apply combinatorial principles to solve counting problems and explore properties of binomial expressions.

ILO 2.1: State and use the fundamental principle of counting.

ILO 2.2: Calculate permutations and combinations of discrete objects.

ILO 2.3: Expand binomial expressions and identify general and middle terms using binomial theorem.

ILO 2.4: Analyze patterns in binomial coefficients and their symmetry.

CO3: Understand basic probability theory and solve problems involving compound and conditional events.

ILO 3.1: Define random experiments, sample space, events, and classical probability.

ILO 3.2: Explain and apply the axiomatic approach to probability.

ILO 3.3: Solve problems using conditional probability and independence of events.

ILO 3.4: Analyze multiple events using addition and multiplication theorems on probability.

CO4: Demonstrate an understanding of divisibility, congruences, and fundamental properties of integers.

ILO 4.1: Apply the division and Euclidean algorithms to solve integer problems.

ILO 4.2: Solve linear Diophantine equations and analyze their integer solutions.

ILO 4.3: Use modular arithmetic and congruence relations in proofs and computations.

ILO 4.4: State the Fundamental Theorem of Arithmetic and calculate number/sum of divisors of a natural number.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	CO1, CO2, CO3, CO4	CO1, CO3	CO2, CO4	X	X	X
Conceptual Knowledge	CO3, CO4	CO1, CO2, CO3	CO1, CO2, CO3, CO4	CO2, CO3, CO4	X	X
Procedural Knowledge	X	X	CO1, CO2, CO3, CO4	CO2, CO3, CO4	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (5 Marks)	**Mathematical Induction** Well Ordering Property of ℕ, Principle of Mathematical Induction.	04	02	-	06
II (15 Marks)	**Permutation and Combination** Introduction, Fundamental Principle of Counting, Permutations and Combinations, Binomial Theorem for positive integral indices, General and Middle Terms.	08	04	-	12
III (15 Marks)	**Probability** Introduction to probability, Random experiment, event, axiomatic approach to probability, conditional probability and properties, Multiple theorem on probability, Independent Events.	08	04	-	12
IV (25 Marks)	**Basic Number Theory** Division Algorithm, Divisibility and Euclidean Algorithm, Congruence Relation between integers and Applications, Linear Diophantine Equations, Statement of the Fundamental Theorem of Arithmetic, Sum and Number of divisors of a natural number.	10	05	-	15
	Total	30	15	-	45

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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. Brualdi R. A., Introductory Combinatorics, 5th Ed., Pearson Education Inc., 2009.
2. Bartle R. G. & Sherbert D. R., Introduction to Real Analysis, 4th Ed., Wiley, 2021.

3. Ross S. M., Introduction to probability and statistics for engineers and scientists, Elsevier, 2021.
4. Burton D. M., Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 2ND SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Business Mathematics**
Course Code	**: MDC-MAT-201B**
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 Objectives:

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 Outcomes (COs):

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

CO1: Understand the structure and operations of matrices and apply them to solve basic business problems.

ILO 1.1: Define different types of matrices and matrix operations.

ILO 1.2: Compute determinants and adjoints of matrices up to order 3.

ILO 1.3: Find the inverse of a matrix using adjoint method.

ILO 1.4: Solve simple business and economic problems using matrix methods.

CO2: Apply Differential Calculus to analyze business-related mathematical functions.

ILO 2.1: Identify different types of functions used in business analysis.

ILO 2.2: Explain the concepts of limit, continuity, and basic differentiation rules.

ILO 2.3: Apply rules of differentiation to standard business functions.

ILO 2.4: Analyze cost, revenue, and profit functions to find elasticity, maxima, and minima.

CO3: Understand and apply basic mathematical concepts of finance including interest and discounting.

ILO 3.1: Define and distinguish between simple and compound interest.

ILO 3.2: Compute effective, nominal, and continuous interest rates and understand their relationships.

ILO 3.3: Apply discounting and compounding techniques in business contexts.

ILO 3.4: Evaluate the present and future value of a sum under different compounding conditions.

CO4: Formulate and solve linear programming problems graphically in business decision-making.

ILO 4.1: Sketch graphs of linear equations and inequalities.

ILO 4.2: Formulate linear programming problems based on business constraints.

ILO 4.3: Solve LPPs using the graphical method.

ILO 4.4: Interpret feasible and optimal solutions for decision-making.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	CO1, CO2, CO3	CO2	CO1, CO3	X	X	X
Conceptual Knowledge	CO2, CO3	CO2, CO3	CO2, CO3, CO4	CO2	CO3, CO4	CO4
Procedural Knowledge	X	X	CO1, CO2, CO3, CO4	CO1, CO2	CO3, CO4	CO4
Metacognitive Knowledge	X	X	X	X	X	X

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 (18 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 (12 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)

- **Two Internal Examinations** - **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.

REFERENCES:

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 Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 2ND SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: MatLab II**
Course Code	**: SEC-MAT-201**
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 aims to equip students with the tools and techniques to solve differential equations and apply them in real-life mathematical modelling scenarios. Through the use of MATLAB programming language, students will explore models related to population dynamics, environmental science, medicine, epidemiology, and more. Emphasis is placed on understanding real-world systems through the lens of mathematical structures and gaining hands-on experience by implementing and visualizing models computationally.

Pre Requisites:

- Basic understanding of differential equations, calculus, and introductory programming concepts
- Basic computer literacy

Course Objectives:

The various objectives of this course are:

1. To model various real-life problems, such as exponential decay models, lake pollution models, etc., using MatLab software.
2. To plot recursive sequences and sequences of partial sums using MatLab.

Course Outcomes (COs):

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

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

ILO 1.1: Explain the steps to model exponential growth and decay problems using MatLab.

ILO 1.2: 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.

ILO 2.1: Use MatLab to plot recursive sequences and study their convergence.

ILO 2.2: 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.

ILO 3.1: Interpret drug assimilation into the blood using MatLab.

ILO 3.2: Apply modeling techniques to limited growth population models and analyze the impact of harvesting.

CO4: Apply ecological and epidemiological models.

ILO 4.1: Implement predatory-prey models and analyze the population dynamics.

ILO 4.2: Utilize epidemic scenarios using MatLab and interpret the spread of disease.

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

ILO 5.1: Explain MatLab to verify the Bolzano-Weierstrass theorem through plotting.

ILO 5.2: Implement the convergence and divergence of sequences and series through visualizations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	CO1	X	X	X
Conceptual Knowledge	X	X	X	CO2	X	X
Procedural Knowledge	X	X	CO3	X	X	X
Metacognitive Knowledge	X	X	CO4, CO5	X	X	X

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).	-	-	15x2	30

	5. Lake pollution model (with constant/seasonal flow and pollution concentration).				
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 cold pills. 2. Limited growth of population (with and without harvesting).	-	-	**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). 4. Plotting recursive sequences, convergence sequences, convergent subsequences, divergent sequences and infinite series	-	-	**10x2**	**20**
IV (18 Marks)	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.	-	-	**15x2**	**30**
	Total	-	-	**45x2**	**90**

Where: **L: Lectures** **T: Tutorials** **P: Practicals**

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

- **Two Internal Examinations** - **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. Pratap, Rudra. Getting Started with MATLAB: A Quick Introduction for Scientists and Engineers. 2nd ed., Oxford University Press, 2010.

REFERENCES:

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

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 3RD SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Theory of Real functions**
Course Code	**: C-MAT-301**
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:

This course on Theory of Real functions will introduce the students to the logical and analytical side of calculus. Through this course the students will learn a more analytical approach to limits of a functions, its continuity and differentiability. Besides, they will also learn the application of these concepts.

Pre Requisites:

- 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 (COs):

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

CO1: Understand and apply the concept of limit of a function and its associated theorems.

ILO 1.1: Define the limit of a function using ε–δ definition and sequential criterion.

ILO 1.2: Explain and apply standard limit theorems to evaluate limits.

ILO 1.3: Distinguish between one-sided limits, infinite limits, and limits at infinity with examples.

ILO 1.4: Apply limit theorems to solve real-valued function problems.

CO2: Analyze the continuity and uniform continuity of real functions and related theorems.

ILO 2.1: State and apply the sequential criterion for continuity.

ILO 2.2: Explain the algebra of continuous functions and test continuity over intervals.

ILO 2.3: Analyze the implications of the Intermediate Value Theorem and related results.

ILO 2.4: Evaluate whether a function is uniformly continuous using the non-uniformity criteria.

CO3: Demonstrate the concept of differentiability and apply key theorems involving derivatives.

ILO 3.1: Define differentiability at a point and over an interval.

ILO 3.2: Apply Caratheodory's Theorem and the algebra of differentiable functions to solve problems.

ILO 3.3: Analyze conditions for extrema using Interior Extremum Theorem.

ILO 3.4: Apply Rolle's and Mean Value Theorem to derive inequalities and functional properties.

CO4: Understand and apply Cauchy's Mean Value Theorem and Taylor's Theorem.

ILO 4.1: State and interpret Cauchy's Mean Value Theorem and Taylor's Theorem with Lagrange's and Cauchy's remainders.

ILO 4.2: Apply Taylor's theorem to analyze convexity and estimate function values.

ILO 4.3: Construct Taylor and Maclaurin series expansions of elementary functions.

ILO 4.4: Evaluate the accuracy and limitations of Taylor series approximations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1, CO3	X	X	X	X	X
Conceptual Knowledge	X	CO1, CO2, CO4	CO2, CO3, CO4	CO1, CO2, CO3	CO3, CO4	CO4
Procedural Knowledge	X	X	CO1, CO2, CO3, CO4	CO2, CO3	CO2, CO4	CO4
Metacognitive Knowledge	X	X	X	X	CO2, CO4	X

UNITS	CONTENTS	L	T	P	Total Hours
I (12 Marks)	Limit of a function, Sequential Criterion of limits, Limit theorems & their applications, Statements of the theorems of one-sided limits, Infinite Limits and limits at infinity and related theorems.	06	02	-	08
II (12 Marks)	Continuous Functions and sequential criterion of continuity and discontinuity. Algebra of continuous functions & their application to problems, Continuity on an interval, intermediate value theorem, Location Root Theorem, Preservation of interval theorem. Uniform	09	03	-	12

	Continuity, Non uniformity criteria, Uniform Continuity Theorem.				
III (18 Marks)	Differentiability of a function at a point and in an interval, Caratheodory's Theorem, Algebra of differentiable functions and their applications. Relative Extrema, Interior Extremum Theorem. Rolle's Theorem, Mean Value Theorem, Intermediate Value property of derivatives, Application of Mean Value Theorem to inequalities.	**15**	**05**	**-**	**20**
IV (18 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)

- **Two Internal Examinations - 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. & Kumaresan S., A Basic Course in Real Analysis, CRC Press, Reprint 2021.

REFERENCES:

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	M	L	L	M	S	L	M	S	S
CO2	S	M	L	L	M	S	L	M	S	S
CO3	S	M	L	L	M	S	L	M	S	S
CO4	S	M	L	L	M	S	M	S	S	S

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 3RD SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Group Theory I**
Course Code	**: C-MAT-302**
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:

This course provides a concise yet rigorous introduction to group theory, covering fundamental concepts such as abelian and non-abelian groups, cyclic and permutation groups, and matrix-based examples like general linear and quaternion groups. Topics include subgroups, cosets, Lagrange's theorem, and structural elements such as centralizers, normalizers, and the center of a group. The course also explores dihedral groups, classification of cyclic subgroups, and properties of permutations. Advanced topics include external direct products, normal and factor groups, Cauchy's theorem, group homomorphisms, isomorphisms, Cayley's theorem, and the three isomorphism theorems.

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, non-abelian group, cyclic group, $\mathbb{Z}_n$ group, $U(n)$ group, $GL(n, R)$, 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 (COs):

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

CO1: Identify groups like Klein4-group, symmetric group, Dihedral group.

ILO 1.1: Recognize and describe the structure and properties of the Klein4-group.

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

CO2: Identify groups like abelian group, non-abelian group, cyclic group, $\mathbb{Z}_n$ group, $U(n)$ group, $GL(n, R)$.

ILO 2.1: Recognize and describe the structure and properties of abelian group, non-abelian group, cyclic group, $\mathbb{Z}_n$ group, $U(n)$ group, $GL(n, R)$.

ILO 2.2: Identify and analyze the elements and properties of abelian group, non-abelian group, cyclic group, $\mathbb{Z}_n$ group, $U(n)$ group, $GL(n, R)$.

CO3: State Lagrange's theorem, Isomorphism theorems, Fundamental theorem of Abelian groups.

ILO 3.1: State and explain Lagrange's theorem and it simplications in group theory.

ILO 3.2: Describe the isomorphism theorems and the fundamental theorem of Abelian groups, providing examples of each.

CO4: Analyze permutation group.

ILO 4.1: Describe the structure and properties of permutation groups, including cycle notation and transpositions.

ILO 4.2: Solve problems involving the properties and operations of permutation groups.

CO5: Apply Lagrange's theorem to examine divisibility of a group by a subgroup.

ILO 5.1: Use Lagrange's theorem to determine the possible orders of subgroups within a finite group.

ILO 5.2: Apply Lagrange's theorem to analyze and solve problems involving the divisibility of the order of a group by the order of its subgroups.

CO6: Construct quotient group from a group and a normal subgroup.

ILO 6.1: Define and construct quotient groups given a group and a normal subgroup.

ILO 6.2: Demonstrate the process of forming quotient groups and solve related problems.

CO7: Solve problems applying properties of isomorphism.

ILO 7.1: Identify and prove isomorphisms between groups using the properties of group homomorphisms.

ILO 7.2: Solve problems involving group isomorphisms, including determining if two groups are isomorphic.

CO8: Explain direct product of groups.

ILO 8.1: Define and construct the direct product of two groups, explaining the resulting group's structure and properties.

ILO 8.2: Solve problems involving the direct product of groups and analyze its properties in various contexts.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1, CO2	X	X	X	X	X
Conceptual Knowledge	X	X	CO6	CO3	X	CO5
Procedural Knowledge	X	CO4, CO7	X	X	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (11 Marks)	Symmetries of a square, examples of abelian and non-abelian groups, the group $\mathbb{Z}_n$ of integers modulo n under addition modulo n and the group $U(n)$ of units under multiplication modulo n, cyclic group, the general linear group $GL(n, R)$, definition and examples of groups and quaternion groups (illustration through matrices), elementary properties of groups.	09	03	-	12
II (11 Marks)	Subgroups and examples of subgroups, Cosets, Lagrange's theorem and consequences including Fermat's Little theorem, centralizer, normalizer, Center of a group, product of two subgroups.	03	02	-	06
III (16 Marks)	Dihedral groups, Properties of cyclic groups, classification of subgroups of cyclic groups, Permutation Groups, Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group.	12	04	-	16
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
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)**

- **Two Internal Examinations** - **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. 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.

REFERENCES:

1. Fitzpatrick P. M., Advance Calculus, 2nd Edition, AMS Indian Edition, 2010
2. Dummit D. S.& Foote R. M., Abstract Algebra 3rd Ed., Wiley, 2011.
3. Rotman J. J., An Introduction to the Theory of Groups, 4th Ed., Springer Verlag,1995.
4. 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	M	L	L	L	M	L	M	M	S
CO2	S	M	L	M	M	S	L	M	S	S
CO3	S	M	L	L	L	S	L	S	S	S
CO4	S	M	L	L	L	M	M	M	S	S
CO5	S	M	L	L	L	S	L	M	S	S
CO6	S	M	L	L	M	S	M	S	S	S
CO7	S	M	L	L	M	S	M	S	S	S
CO8	S	M	L	L	M	S	M	M	S	S

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 3RD SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Differential Calculus**
Course Code	**: MIN-MAT-301**
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.

Pre Requisites:

- Ideal of fundamentals of limit, continuity and differentiation
- Exponential, trigonometric and logarithmic functions
- Arithmetic

Course Objectives:

The various objectives of this course are:

1. To model various real-life problems, such as exponential decay models, lake pollution models, etc., using MatLab software.
2. To plot recursive sequences and sequences of partial sums using MatLab.

Course Outcomes (COs):

On successful completion of the course, the 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.

CO4: Analyze 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.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1	X	X	X	X	X
Conceptual Knowledge	X	X	CO1	CO4	X	X
Procedural Knowledge	CO3	X	CO2	X	CO4	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (12 Marks)	Limit and Continuity (ε- δ definition), Types of discontinuity, Differentiability of functions, Successive differentiation.	09	03	-	12
II (12 Marks)	Leibnitz's theorem, Partial differentiation with examples, Euler's theorem on homogeneous functions.	09	03	-	12
III (18 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 (18 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 $\sin x, \cos x, e^x, \log(1+x)$, $(l+x)^m$, 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)**

- **Two Internal Examinations** - **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.

REFERENCES:

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

Mapping of Course Outcome to Programme Outcome:

CO/PO	PO1	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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 3RD SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Introduction to Mathematical Analysis**
Course Code	**: MDC-MAT-301A**
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:

This course introduces foundational concepts in Algebra, Calculus, Linear Programming, and Statistics. It covers logarithmic operations, partial fractions, and inequalities; basic differential and integral calculus including standard formulas and rules; formulation and graphical solution of linear programming problems; and key measures of central tendency such as mean, median, mode, along with their interrelationships. The course aims to build essential mathematical tools for analytical thinking and problem-solving in various applications.

Pre Requisites:

- Basic Mathematical skills taught upto the 10+2 level

Course Objectives:

This course aims to give students a solid foundation in essential mathematical concepts used in both academics and everyday problem-solving. It covers the basics of algebra, including logarithms, partial fractions, and inequalities, and introduces key ideas in calculus like differentiation and integration. Students will also learn how to formulate and solve simple linear programming problems using graphs, and understand measures of central tendency such as mean, median, and mode. The focus is on building practical skills and confidence in applying math to real-life situations.

Course Outcomes (COs):

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

CO1: Understand and apply the fundamental concepts of logarithms, partial fractions, and linear inequalities to solve algebraic problems and represent solutions effectively.

ILO 1.1: Explain the concept of logarithms, apply laws of logarithms, and use change of base formula to simplify and evaluate expressions involving logarithms (common and natural).

ILO 1.2: Solve logarithmic equations using appropriate techniques and interpret the solutions in relevant contexts.

ILO 1.3: Decompose algebraic rational expressions into partial fractions and identify the appropriate type of partial fraction for different kinds of rational expressions.

ILO 1.4: Solve linear inequalities in one variable algebraically and represent their solution sets accurately on a number line.

CO2: Understand the fundamental concepts of differentiation and integration, and apply basic techniques and formulas to solve problems involving rates of change and accumulation.

ILO 2.1: Define the derivative, explain its interpretation as a rate of change and the slope of a curve, and apply standard differentiation formulas and rules.

ILO 2.2: Differentiate standard functions using basic rules of differentiation including the sum, product, quotient, and chain rules.

ILO 2.3: Understand integration as the reverse process of differentiation, and apply basic integration formulas and rules to evaluate simple integrals.

CO3: Formulate linear programming problems (LPP) based on business scenarios and sketch graphs of linear equations and inequalities.

ILO 3.1: Define the decision variables and constraints for a given business problem to formulate a linear programming model.

ILO 3.2: Express business constraints as linear inequalities and incorporate them into the linear programming model.

ILO 3.3: Draw graphs of linear equations and inequalities to visually represent the feasible region of a linear programming problem.

CO4: Evaluate and solve linear programming problems using graphical methods to find optimal solutions.

ILO 4.1: Plot the feasible region of a linear programming problem on a graph based on the given constraints.

ILO 4.2: Determine the coordinates of the corner points (vertices) of the feasible region and understand their significance in finding the optimal solution.

ILO 4.3: Calculate the value of the objective function at each corner point to identify the optimal solution for the linear programming problem.

CO5: Understand and apply the concepts of measures of central tendency to analyze and interpret data using mean, median, mode, and their interrelationships.

ILO 5.1: Plot the feasible region of a linear programming problem on a graph based on the given constraints.

ILO 5.2: Determine the mode and median of a given data set and interpret their significance in data analysis.

ILO 5.3: Establish and interpret the relationship between AM, GM, and HM, and apply these relationships in solving statistical problems.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	CO1, CO3	X	CO5	CO4
Conceptual Knowledge	X	X	CO1, CO3	CO2	CO5	CO4
Procedural Knowledge	X	X	CO1, CO3	CO2	CO5	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (20 Marks)	**Algebra:** Logarithm, Common logarithm (base 10) and natural logarithm (base e), Solving logarithmic equations. Partial fractions, Types of partial fractions. Linear inequalities. Algebraic solutions of linear inequalities in one variable and their representation on the number line.	08	04	-	12
II (20 Marks)	**Calculus:** Definition of derivative, Derivative as a rate of change or slope of a curve, Basic formulas of derivative, Derivatives of some standard functions, Basic Rules of differentiation. Concept of Integration, Integration as the reverse process of differentiation, Basic Formulas, Rules of Integration.	08	04	-	12
III (10 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.	04	03	-	07
IV (10 Marks)	**Measures of central Tendency:** Introduction, Mean (AM, GM, HM), mode and Median. Relationship between AM, GM, HM.	04	03	-	07
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations** - **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. Business Mathematics by Dr. P.K. Mittal, P.P. Publications, Latest Edition 2023.
2. Business Mathematics and Statistics by B.M. Aggarwal, Ane Books/Sultan Chand, Reprint 2023, ISBN: 9789386761125.
3. Business Statistics by P.N. Arora & S. Arora, S. Chand & Company, 2021 Edition, ISBN: 9789355010314.
4. Fundamentals of Mathematical Statistics by S.C. Gupta & V.K. Kapoor, Sultan Chand & Sons, 2022.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 3RD SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Introduction to Discrete Mathematics**
Course Code	**: MDC-MAT-301B**
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.

Pre Requisites:

- Basics of Set Theory

Course Objectives:

The various objectives of this course are:

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):

On successful completion of the course, the 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.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO1, CO2	X	X	X	X
Conceptual Knowledge	X	CO1, CO2	CO3	CO5	X	X
Procedural Knowledge	X	X	CO1, CO2	CO3	CO4	X
Metacognitive Knowledge	X	X	X	X	CO5	X

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)

- **Two Internal Examinations - 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. Balakrishnan V. K., Introductory Discrete Mathematics, Dover Publications Inc., 2000.

REFERENCES:

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 Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 3RD SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Mathematical Logic**
Course Code	**: SEC-MAT-301**
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:

The course on Mathematical Logic aims to equip students with a comprehensive understanding of the principles and applications of formal logic. It delves into key areas such as propositional logic and predicate logic, emphasizing the process of formalizing logical arguments. The course also offers an introduction to set theory, highlighting its foundational role in logical reasoning. In addition, students will explore important concepts related to relations, including equivalence relations, partitions, and partially ordered relations, to develop a deeper insight into structured mathematical thinking.

Pre Requisites:

- High school algebra

Course Objectives:

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

Course Outcomes (COs):

On successful completion of the course, the students 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.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1, CO2	X	X	X	X
Conceptual Knowledge	X	CO1, CO2	CO4	CO5	X	X
Procedural Knowledge	X	X	CO1, CO2	X	X	X
Metacognitive Knowledge	CO2	CO3	CO4	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (18 Marks)	**Fundamentals of Propositional Logic:** Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contrapositive, and inverse.	10	05	-	15

II (15 Marks)	**Set Theory and Fundamental Operations:** Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Standard set operations, cartesian product. Classes of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections.	**08**	**04**	-	**12**
III (12 Marks)	**Functions:** Function: Definition and Examples, Algebra of functions, Types of functions, Composition of functions, Invertible functions.	**04**	**02**	-	**06**
IV (15 Marks)	**Relations and Their Properties:** 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)**

- **Two Internal Examinations** - **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, Alpha Science International, 2017.

REFERENCES:

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 Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 4TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Numerical Methods (Theory)**
Course Code	**: C-MAT-401(T)**
Nature of the Course	**: MAJOR**
Total Credits	**: 03 (L=2, T=1, P=0)**
Distribution of Marks	**: 45 (End Sem) + 40 (In-Sem)**

Course Description:

This course introduces numerical methods for solving mathematical problems commonly encountered in engineering and science. It covers root-finding algorithms, interpolation, numerical differentiation and integration, solutions of linear systems, and numerical approaches to solving ordinary differential equations. Emphasis is placed on the development of algorithms, error analysis, and practical implementation using computational tools. Programming software will be used throughout the course to implement and visualize numerical solutions to these problems.

Pre Requisites:

- Basic knowledge of calculus, linear algebra, and differential equations.

Course Objectives:

1. To Understand fundamental numerical techniques and their applications.
2. To Develop algorithms for solving mathematical problems computationally.
3. To Analyze the accuracy, stability, and efficiency of numerical methods.
4. To Implement numerical algorithms using programming tools.
5. To Apply numerical techniques to scientific problems.

Course Outcomes (COs):

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

CO1: Understand and analyze the concepts of numerical errors, convergence, and root-finding methods.

ILO 1.1: Explain types of numerical errors, their sources, and impact on computations.

ILO 1.2: Apply Bisection, Newton-Raphson, and Secant methods to solve nonlinear equations.

ILO 1.3: Analyze the rate of convergence of different root-finding techniques.

CO2: Solve linear system of equations using direct and iterative methods.

ILO 2.1: Implement Gaussian Elimination and Gauss-Jordan methods for system solutions.

ILO 2.2: Apply Gauss-Jacobi and Gauss-Seidel methods for iterative solutions.

ILO 2.3: Evaluate the convergence criteria for iterative methods.

CO3: Use interpolation techniques for estimating unknown values.

ILO 3.1: Apply Lagrange and Newton's interpolation methods.

ILO 3.2: Use finite difference operators for function approximation.

ILO 3.3: Implement Newton-Gregory forward and backward difference interpolation methods.

CO4: Perform numerical integration and solve ordinary differential equations numerically.

ILO 4.1: Apply Trapezoidal, Simpson's, and other numerical integration methods.

ILO 4.2: Analyze the accuracy of composite numerical integration techniques.

ILO 4.3: Solve first-order ODEs using Euler's and Runge-Kutta methods.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO1	X	X	X	X
Conceptual Knowledge	X	X	CO1, CO2, CO4	X	X	X
Procedural Knowledge	X	X	CO3	CO1, CO4	X	X
Metacognitive Knowledge	X	CO2	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (9 Marks)	**Introduction to Numerical Computation & Root Solving:** Algorithms & Flowcharts, Errors: Relative, Absolute, Round off, Truncation, Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method, Rate of convergence of these methods.	09	-	-	09
II (9 Marks)	**Numerical Solutions of Linear Systems:** System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods, Gauss Jacobi method, Gauss Seidel method and their convergence analysis.	09	-	-	09
III (9 Marks)	**Interpolation Techniques & Finite Differences:** Lagrange and Newton's interpolation methods, Error bounds, Finite difference operators, related properties,	09	-	-	09

	Newton Gregory forward and backward difference interpolation.				
IV (9 Marks)	**Numerical Integration:** General quadrature formula, trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Boole's and Midpoint Rule.	**09**	-	-	**09**
V (9 Marks)	**Numerical solution to ODE:** Ordinary Differential Equations: Euler's method, Runge-Kutta methods of orders two and four.	**09**	-	-	**09**
	Total	**45**	-	-	**45**

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 4TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Numerical Methods (Practical)**
Course Code	**: C-MAT-401(P)**
Nature of the Course	**: MAJOR**
Total Credits	**: 01 (L=0, T=0, P=1)**
Distribution of Marks	**: 15 (Practical)**

Course Description:

This course introduces numerical methods for solving mathematical problems commonly encountered in engineering and science. It covers root-finding algorithms, interpolation, numerical differentiation and integration, solutions of linear systems, and numerical approaches to solving ordinary differential equations. Emphasis is placed on the development of algorithms, error analysis, and practical implementation using computational tools. Programming software will be used throughout the course to implement and visualize numerical solutions to these problems.

Pre Requisites:

- Basic knowledge of calculus, linear algebra, and differential equations.

Course Objectives:

1. To Understand fundamental numerical techniques and their applications.
2. To Develop algorithms for solving mathematical problems computationally.
3. To Analyze the accuracy, stability, and efficiency of numerical methods.
4. To Implement numerical algorithms using programming tools.
5. To Apply numerical techniques to scientific problems.

Course Outcomes (COs):

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

CO1: Develop computational algorithms to implement numerical techniques.

ILO 1.1: Write programs for root-finding, interpolation, and numerical integration.

ILO 1.2: Implement iterative methods for solving linear equations using software tools.

ILO 1.3: Analyze the accuracy and efficiency of implemented numerical methods through practical applications.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	X	X	X	X	CO1
Procedural Knowledge	X	X	X	CO1	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**List of Practicals (using any software):** (i) Calculate the sum of harmonic series. (ii) Sum of first n numbers. (iii) To find the absolute value of an integer. (iv) Sorting arrays. (v) Bisection Method. (vi) Newton Raphson Method. (vii) Secant Method. (viii) Gauss-Jacobi Method. (ix) Gauss-Siedel Method. (x) Lagrange Interpolation or Newton Interpolation. (xi) 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, 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.	-	-	**30**	**30**
	Total	-	-	**30**	**30**

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations - 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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 4TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Riemann Integration & Series of Functions**
Course Code	**: C-MAT-402**
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:

This course provides an in-depth study of Riemann integration and the convergence of function series. Topics include Riemann integrability, fundamental theorems of calculus, improper integrals, sequences and series of functions, uniform convergence, power series, and applications to Fourier series. Emphasis is placed on rigorous proofs and theoretical understanding.

Pre Requisites:

- Real Analysis

Course Objectives:

This course aims to provide a comprehensive understanding of Riemann integration and its foundational properties, including conditions for integrability, improper integrals, and the Fundamental Theorem of Calculus. Students will explore convergence criteria for sequences and series of functions, focusing on uniform convergence and its implications for continuity, differentiability, and integrability. Additionally, the course introduces the theory of power series, including their convergence, differentiation, and integration, and concludes with applications of classical theorems such as Abel's Theorem.

Course Outcomes (COs):

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

CO1: Understand and apply the concepts of Riemann integration and its fundamental properties.

ILO 1.1: Define Riemann integration and interpret its conditions of integrability.

ILO 1.2: Analyze and compute upper and lower sums to evaluate Riemann integrals.

ILO 1.3: Prove the integrability of monotone and continuous functions.

ILO 1.4: Apply the Fundamental Theorem of Calculus and the Intermediate Value Theorem for integrals.

CO2: Evaluate improper integrals and understand their convergence, including special functions.

ILO 2.1: Identify and analyze the convergence of improper integrals using appropriate techniques.

ILO 2.2: Demonstrate a comprehensive understanding of Beta and Gamma functions and their convergence.

CO3: Develop a strong foundation in the concepts of pointwise and uniform convergence of function sequences and series.

ILO 3.1: Differentiate between pointwise and uniform convergence and evaluate convergence using appropriate tests.

ILO 3.2: Apply theorems on the continuity, differentiability, and integrability of the limit functions of sequences and series.

ILO 3.3: Use the Cauchy criterion and Weierstrass M-Test to analyze the uniform convergence of series.

CO4: Explore topics in power series, and their applications in mathematical analysis.

ILO 4.1: Define and compute the radius of convergence using the Cauchy-Hadamard Theorem.

ILO 4.2: Perform differentiation and integration of power series and apply Abel's Theorem.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO2	X	X	X	X
Conceptual Knowledge	X	X	CO3	X	X	X
Procedural Knowledge	X	CO1, CO4	X	X	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (19 Marks)	Riemann integration, 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, Definitions and integrability of piecewise continuous and	18	06	-	24

	monotone functions, Intermediate Value theorem for Integrals, Fundamental theorem of Calculus.				
II (11 Marks)	Improper integrals of 1st and 2nd kind, Convergence of Beta and Gamma functions and their properties.	**06**	**02**	-	**08**
III (19 Marks)	Pointwise and uniform convergence of sequence of functions, Theorems on continuity, Derivability and integrability of some limit functions 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.	**06**	**02**	-	**08**
	Total	**45**	**15**	-	**60**

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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. 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.

REFERENCES:

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.Mathews J. H. and Kurtis D. Fink, Numerical Methods using MatLab, 4th Ed., PHI Learning Private Limited, 2012.

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 4TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Ring Theory and Linear Algebra I**
Course Code	**: C-MAT-403**
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:

This course introduces fundamental concepts in Ring Theory and Linear Algebra. Topics includes rings, ideals, homomorphisms, quotient rings, polynomial rings, vector spaces, linear transformations, eigen values, eigen vectors, and inner product spaces. Emphasizes placed on theoretical foundations and problem-solving techniques, preparing students for advanced studies in algebra and its applications.

Pre Requisites:

- Set theory, Group, subgroup and its properties
- Algebra, Matrices
- Co-ordinates

Course Objectives:

The objective of this course is to provide a comprehensive understanding of ring theory, covering concepts such as rings, subrings, integral domains, fields, ideals, factor rings, and prime/maximal ideals. It also focuses on ring homomorphisms, the First, Second, and Third Isomorphism Theorems, and the field of quotients. Additionally, the course explores linear transformations, including nullspace, range, rank, and matrix representation, along with isomorphisms, invertibility, and the change of coordinate matrix, equipping students with essential skills to apply these concepts in algebraic contexts.

Course Outcomes (COs):

After completing the course, the students will be able to

CO1: Understand and apply the fundamental concepts of rings, subrings, integral domains, and fields.

ILO 1.1: Construct the algebraic structures using various binary operations.

ILO 1.2: Utilize the notion of unit and unity element to categorize algebraic structures.

CO2: Demonstrate an understanding of the properties of rings and their significance in algebraic structures.

ILO 2.1: Analyze analgebraic structure with the help of properties of ring, subring and various associated structures.

ILO 2.2: Identify and demonstrate the properties of integral domains and fields, and explain their differences from general rings.

ILO 2.3: Calculate the characteristic of a ring and understand its influence on the ring's structure and operations.

CO3: Analyze the concept of ideals, including prime and maximal ideals, and factor rings.

ILO 3.1: Understand and prove the properties of ideals, including the ideal generated by a subset of a ring, and identify the structure of factor rings.

ILO 3.2: Explore and analyze operations on ideals such as intersection, sum, and product and understand their applications in ring theory.

ILO 3.3: Define and work with factor rings (quotient rings), and understand how they are formed by partitioning a ring using ideals. Explore their significance in simplifying ring structures.

CO4: Understand and apply the concept of ring homomorphisms, their properties and their role in the structural study of rings.

ILO 4.1: Define and provide examples of ring homomorphisms and analyze their properties.

ILO 4.2: Understand and apply the First, Second and Third Isomorphism Theorems for rings.

CO5: Apply isomorphism theorems for rings and the construction of the field of quotients to solve algebraic problems.

ILO 5.1: Demonstrate the process of constructing the field of quotients for an integral domain.

ILO 5.2: Solve problems involving ring homomorphisms, quotient rings and isomorphism theorems.

CO6: Understand the fundamental concepts of vector spaces, subspaces, quotient spaces and their algebraic structures.

ILO 6.1: Define and provide examples of vector spaces, subspaces, and their algebraic operations.

ILO 6.2: Understand the concepts of linear span, linear combinations and linear independence of vectors.

CO7: Analyze and apply concepts of linear dependence, basis and dimension to solve problems related to vector spaces and their subspaces.

ILO 7.1: Determine the basis and dimension of vector spaces and subspaces.

ILO 7.2: Construct and analyze quotients paces and explore their relationship with subspaces.

CO8: Understand and analyze the fundamental concepts of linear transformations, their properties and their representation using matrices.

ILO 8.1: Define and analyze linear transformations, their null space, range, rank and nullity.

ILO 8.2: Represent linear transformations using matrices and perform operations on them.

CO9: Apply theorems on isomorphisms, rank-nullity and coordinate changes to analyze and solve problems in linear algebra.

ILO 9.1: Understand and apply isomorphism theorems and conditions for invertibility in linear transformations.

ILO 9.2: Compute and interpret the change of coordinate matrix in different bases.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	X	X	X	CO1
Conceptual Knowledge	X	CO1, CO4, CO8;	X	X	X	CO7
Procedural Knowledge	X	CO6, CO9	CO1, CO5	CO2, CO3	X	X
Metacognitive Knowledge	CO4, CO7, CO8	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (12 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 (18 Marks)	Ring homomorphisms, Properties of ring homomorphisms, First, Second and Third Isomorphism theorems for rings, The Field of quotients.	12	04	-	16
III (12 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 (18 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)

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

REFERENCES:

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,2ndEd., 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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 4TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: PDE and Systems of ODE**
Course Code	**: C-MAT-404**
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:

This course covers fundamental concepts of partial differential equations (PDEs) and systems of ordinary differential equations (ODEs). Topics include classification of PDEs, solution methods such as separation of variables and Fourier series, and applications in physics and engineering. For ODE systems, phase plane analysis, stability, and numerical methods are explored. The course emphasizes analytical and computational techniques for solving differential equations.

Pre Requisites:

- Differential Equations, Linear Algebra

Course Objectives:

1. To Understand fundamental numerical techniques and their applications.
2. To Solve first- and second-order PDEs using analytical methods.
3. To Analyze systems of ODEs using phase portraits and stability theory.
4. To Apply Fourier series and numerical techniques to solve PDEs.
5. To Model physical systems using PDEs and ODE systems.

Course Outcomes (COs):

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

CO1: Understand and apply the fundamental concepts of first-order partial differential equations and solve them using appropriate methods.

ILO 1.1: Classify and construct first-order partial differential equations and interpret their geometrical significance.

ILO 1.2: Apply the method of characteristics to solve quasi-linear equations.

ILO 1.3: Utilize Charpit's and Jacobi's methods for solving nonlinear partial differential equations.

CO2: Apply separation of variables to solve first order partial differential equations.

ILO 2.1: Derive and identify the canonical forms of first-order linear equations.

ILO 2.2: Implement the method of separation of variables for solving first-order PDEs.

ILO 2.3: Analyze and formulate solutions to mathematical problems involving first-order PDEs.

CO3: Classify and solve second-order linear partial differential equations.

ILO 3.1: Differentiate between hyperbolic, parabolic, and elliptic equations.

ILO 3.2: Derive and solve the heat, wave, and Laplace equations.

ILO 3.3: Transform second-order linear equations into canonical forms.

CO4: Apply analytical methods to solve second-order PDEs arising in physical models.

ILO 4.1: Formulate mathematical models using heat, wave, and Laplace equations.

ILO 4.2: Solve second-order PDEs using appropriate analytical techniques.

ILO 4.3: Interpret the physical significance of solutions.

CO5: Solve boundary value problems using the method of separation of variables.

ILO 5.1: Develop solutions for the vibrating string problem using separation of variables.

ILO 5.2: Apply the separation of variables technique to the heat conduction problem.

CO6: Analyze and implement numerical approaches to solving PDEs.

ILO 6.1: Evaluate different numerical techniques for solving PDEs.

ILO 6.2: Compare analytical and numerical methods for solving PDE-related problems.

CO7: Solve systems of linear differential equations using analytical and numerical techniques.

ILO 7.1: Classify different types of linear differential systems and their properties.

ILO 7.2: Apply the operator method to solve linear systems with constant coefficients.

ILO 7.3: Develop solutions for homogeneous linear systems using mathematical techniques.

CO8: Implement numerical methods to approximate solutions of differential equations.

ILO 8.1: Apply the method of successive approximations to solve differential equations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	CO1, CO3, CO7	CO2	X	CO6	CO5, CO7
Procedural Knowledge	X	X	X	X	X	X
Metacognitive Knowledge	X	X	CO1, CO3, CO5, CO7	CO2, CO6	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (18 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 (09 Marks)	Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem.	09	03	-	12
IV (18 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.	12	04	-	16
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations - 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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 4TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Numerical Methods (Theory)**
Course Code	**: MIN-MAT-401(T)**
Nature of the Course	**: MINOR**
Total Credits	**: 03 (L=2, T=1, P=0)**
Distribution of Marks	**: 45 (End Sem) + 40 (In-Sem)**

Course Description:

This course introduces numerical methods for solving mathematical problems commonly encountered in engineering and science. It covers root-finding algorithms, interpolation, numerical differentiation and integration, solutions of linear systems, and numerical approaches to solving ordinary differential equations. Emphasis is placed on the development of algorithms, error analysis, and practical implementation using computational tools. Programming software will be used throughout the course to implement and visualize numerical solutions to these problems.

Pre Requisites:

- Basic knowledge of calculus, linear algebra, and differential equations.

Course Objectives:

1. To Understand fundamental numerical techniques and their applications.
2. To Develop algorithms for solving mathematical problems computationally.
3. To Analyze the accuracy, stability, and efficiency of numerical methods.
4. To Implement numerical algorithms using programming tools.
5. To Apply numerical techniques to scientific problems.

Course Outcomes (COs):

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

CO1: Understand and analyze the concepts of numerical errors, convergence, and root-finding methods.

ILO 1.1: Explain types of numerical errors, their sources, and impact on computations.

ILO 1.2: Apply Bisection, Newton-Raphson, and Secant methods to solve nonlinear equations.

ILO 1.3: Analyze the rate of convergence of different root-finding techniques.

CO2: Solve linear system of equations using direct and iterative methods.

ILO 2.1: Implement Gaussian Elimination and Gauss-Jordan methods for system solutions.

ILO 2.2: Apply Gauss-Jacobi and Gauss-Seidel methods for iterative solutions.

ILO 2.3: Evaluate the convergence criteria for iterative methods.

CO3: Use interpolation techniques for estimating unknown values.

ILO 3.1: Apply Lagrange and Newton's interpolation methods.

ILO 3.2: Use finite difference operators for function approximation.

ILO 3.3: Implement Newton-Gregory forward and backward difference interpolation methods.

CO4: Perform numerical integration and solve ordinary differential equations numerically.

ILO 4.1: Apply Trapezoidal, Simpson's, and other numerical integration methods.

ILO 4.2: Analyze the accuracy of composite numerical integration techniques.

ILO 4.3: Solve first-order ODEs using Euler's and Runge-Kutta methods.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO1	X	X	X	X
Conceptual Knowledge	X	X	CO1, CO2, CO4	X	X	X
Procedural Knowledge	X	X	CO3	CO1, CO4	X	X
Metacognitive Knowledge	X	CO2	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (9 Marks)	**Introduction to Numerical Computation & Root Solving:** Algorithms & Flowcharts, Errors: Relative, Absolute, Round off, Truncation, Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method, Rate of convergence of these methods.	09	-	-	09
II (9 Marks)	**Numerical Solutions of Linear Systems:** System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods, Gauss Jacobi method, Gauss Seidel method and their convergence analysis.	09	-	-	09
III (9 Marks)	**Interpolation Techniques & Finite Differences:** Lagrange and Newton's interpolation methods, Error bounds, Finite difference operators, related properties,	09	-	-	09

	Newton Gregory forward and backward difference interpolation.				
IV (9 Marks)	**Numerical Integration:** General quadrature formula, trapezoidal rule, Simpson's 1/3rd rule, Simpsons 3/8th rule, Boole's and Midpoint Rule.	**09**	-	-	**09**
V (9 Marks)	**Numerical solution to ODE:** Ordinary Differential Equations: Euler's method, Runge-Kutta methods of orders two and four.	**09**	-	-	**09**
	Total	**45**	-	-	**45**

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 4TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Numerical Methods (Practical)**
Course Code	**: MIN-MAT-401(P)**
Nature of the Course	**: MINOR**
Total Credits	**: 01 (L=0, T=0, P=1)**
Distribution of Marks	**: 15 (Practical)**

Course Description:

This course introduces numerical methods for solving mathematical problems commonly encountered in engineering and science. It covers root-finding algorithms, interpolation, numerical differentiation and integration, solutions of linear systems, and numerical approaches to solving ordinary differential equations. Emphasis is placed on the development of algorithms, error analysis, and practical implementation using computational tools. Programming software will be used throughout the course to implement and visualize numerical solutions to these problems.

Pre Requisites:

- Basic knowledge of calculus, linear algebra, and differential equations.

Course Objectives:

1. To Understand fundamental numerical techniques and their applications.
2. To Develop algorithms for solving mathematical problems computationally.
3. To Analyze the accuracy, stability, and efficiency of numerical methods.
4. To Implement numerical algorithms using programming tools.
5. To Apply numerical techniques to scientific problems.

Course Outcomes (COs):

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

CO1: Develop computational algorithms to implement numerical techniques.

ILO 1.1: Write programs for root-finding, interpolation, and numerical integration.

ILO 1.2: Implement iterative methods for solving linear equations using software tools.

ILO 1.3: Analyze the accuracy and efficiency of implemented numerical methods through practical applications.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	X	X	X	X	CO1
Procedural Knowledge	X	X	X	CO1	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	**List of Practicals (using any software):** (i) Calculate the sum of harmonic series. (ii) Sum of first n numbers. (iii) To find the absolute value of an integer. (iv) Sorting arrays. (v) Bisection Method. (vi) Newton Raphson Method. (vii) Secant Method. (viii) Gauss-Jacobi Method. (ix) Gauss-Siedel Method. (x) Lagrange Interpolation or Newton Interpolation. (xi) 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, 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.	-	-	30	30
	Total	-	-	30	30

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations** - **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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Multi-Variate Calculus**
Course Code	**: C-MAT-501**
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:

This course provides an introduction to multivariable calculus, covering the fundamental concepts and techniques used to analyze functions of multiple variables. Topics include limits, continuity, and differentiability of functions of two variables, partial derivatives, gradient vectors, and optimization methods. The course also explores multiple integrals in different coordinate systems, vector fields, and important integral theorems such as Green's, Stokes', and the Divergence theorem. Emphasis is placed on both theoretical understanding and practical applications in physics and engineering.

Pre Requisites:

- Limits, continuity, and differentiation of single-variable functions.
- Integration techniques, including substitution and integration by parts.
- Parametric equations and polar coordinates.
- Basic understanding of vectors and their properties.

Course Objectives:

1. To Apply differentiation techniques, including the chain rule and directional derivatives, to analyze functions of several variables.
2. To Utilize gradients, tangent planes, and optimization methods such as Lagrange multipliers to solve problems in constrained and unconstrained optimization.
3. To Evaluate double and triple integrals in Cartesian, polar, cylindrical, and spherical coordinate systems to compute areas, volumes, and other physical quantities.
4. To Apply Green's theorem, Stokes' theorem, and the Divergence theorem to solve problems involving vector fields and surface integrals.
5. To Develop problem-solving skills relevant to engineering, physics, and applied mathematics.

Course Outcomes (COs):

By the end of this course, students will be able to

CO1: Understand and analyze the concepts of multivariable functions, their continuity, differentiability, and optimization techniques.

ILO 1.1: Define and explain the limit, continuity, and differentiability of functions of multiple variables.

ILO 1.2: Apply the chain rule, directional derivatives, and gradient properties to solve problems in multivariable calculus.

CO2: Utilize optimization techniques and vector calculus concepts for constrained and unconstrained problems.

ILO 2.1: Solve extrema problems using first and second derivative tests, Lagrange multipliers, and constrained optimization techniques.

ILO 2.2: Define vector fields and compute divergence and curl in various applications.

CO3: Evaluate double and triple integrals in various coordinate systems and apply them to compute areas and volumes.

ILO 3.1: Compute double integrals over rectangular and non-rectangular regions using Cartesian and polar coordinates.

ILO 3.2: Apply triple integrals in Cartesian, cylindrical, and spherical coordinates to find volumes of solid regions.

CO4: Develop problem-solving skills in multi-integral calculus for real-world applications.

ILO 4.1: Determine the volume of solids using triple integrals over parallelepipeds and other regions.

ILO 4.2: Apply integral calculus techniques to physical and engineering problems.

CO5: Understand and apply the concept of change of variables in multiple integrals and evaluate line integrals.

ILO 5.1: Transform double and triple integrals using appropriate coordinate transformations.

ILO 5.2: Compute line integrals and apply them to determine mass and work in vector fields.

CO6: Analyze the properties of conservative vector fields and their applications.

ILO 6.1: Explain the fundamental theorem of line integrals and conditions for a vector field to be conservative.

ILO 6.2: Determine path independence in conservative fields and apply them in real-world scenarios.

CO7: Apply Green's theorem, Stokes' theorem, and the Divergence theorem to evaluate surface and flux integrals.

ILO 7.1: Use Green's theorem to convert line integrals into double integrals and solve related problems.

ILO 7.2: Compute surface integrals over parametrically defined surfaces.

CO8: Develop a conceptual and computational understanding of vector calculus theorems in physical applications.

ILO 8.1: Utilize Stokes' theorem to relate surface integrals to line integrals.

ILO 8.2: Apply the Divergence theorem to evaluate flux integrals in various vector fields.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	CO1	X	X	X	X
Conceptual Knowledge	X	CO2, CO5	CO1	X	X	CO4, CO8
Procedural Knowledge	X	X	CO2, CO4 CO8	CO1, CO6	CO3	X
Metacognitive Knowledge	X	X	CO3, CO5, CO7	X	X	X

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. Chain rule, directional derivatives. The gradient, maximal and normal property of the gradient, tangent planes, normal lines, Extrema of functions of two variables. Method of Lagrange multipliers, constrained optimization problems, vector field, divergence, gradient and curl.	15	05	-	20
II (16 Marks)	Double integration over rectangular and 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. Change of variables in double integrals and triple integrals.	15	05	-	20

III (14 Marks)	Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path, Area as a line integral.	**09**	**03**	-	**12**
IV (11 Marks)	Green's theorem, surface integrals, Stoke's theorem, The Gauss divergence theorem.	**06**	**02**	-	**08**
	Total	**45**	**15**	-	**60**

Where: L: Lectures T: Tutorials P: Practicals

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

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

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Group Theory II**
Course Code	**: C-MAT-502**
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:

This course explores advanced topics in group theory, including automorphisms, characteristic and commutator subgroups, and solvable groups. It covers direct products and the Fundamental Theorem of Finite Abelian Groups, along with group actions, conjugation, and the class equation. The course concludes with key results like Sylow's theorems, Cauchy's theorem, and the simplicity of alternating groups, providing a deeper understanding of group structure and classification.

Pre Requisites:

- Knowledge of Group Theory I (Third Semester)

Course Objectives:

The course is intended to equip the learners with a strong foundation on group theory in aspects like Automorphism, Class equation, Group action, Direct Product of Groups and Sylow's theorems.

Course Outcomes (COs):

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

CO1: Construct new groups using the concept of automorphism.

ILO 1.1: Define and differentiate between inner and outer automorphisms of a group.

ILO 1.2: Construct automorphism groups for finite and infinite cyclic groups and analyze their structure.

CO2: Define Characteristic Subgroups, Commutator Subgroup.

ILO 2.1: Identify and prove the characteristic property of a given subgroup.

ILO 2.2: Compute the commutator subgroup of a given group and verify its key properties.

CO3: Solve problems related to the class equation.

ILO 3.1: Apply the concept of group actions to derive and interpret the class equation.

ILO 3.2: Solve problems involving the class equation to determine the number of conjugacy classes and their sizes.

CO4: Apply group action to study Cayley's theorem and class equation.

ILO 4.1: Use group action concepts to prove and illustrate Cayley's theorem.

ILO 4.2: Analyze how the class equation helps in the study of p-groups and their properties.

CO5: Establish properties of direct product.

ILO 5.1: Differentiate between internal and external direct products and establish their key properties.

ILO 5.2: Verify the Fundamental Theorem of Finite Abelian Groups using direct product decomposition.

CO6: Establish relation between direct and indirect product.

ILO 6.1: Compare and contrast direct and indirect products of groups with examples.

ILO 6.2: Analyze conditions under which a group can be expressed as an internal or external direct product.

CO7: Execute direct product to group of units modulo n.

ILO 7.1: Compute the group of units modulo n and express it as an external direct product.

ILO 7.2: Apply properties of external direct products to solve problems related to modular arithmetic.

CO8: Demonstrate Sylow's theorems and apply them to different problems.

ILO 8.1: State and prove Sylow's theorems and derive their consequences.

ILO 8.2: Apply Sylow's theorems to classify groups of small orders.

CO9: Apply non-simplicity tests.

ILO 9.1: Explain and apply non-simplicity tests for finite groups.

ILO 9.2: Verify the simplicity of alternating groups A_n for $n \geq 5$.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	CO2	CO8	X	X	X	X
Conceptual Knowledge	X	CO1, CO5, CO6	CO3, CO9	X	X	X
Procedural Knowledge	X	X	CO4, CO7	X	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (18 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, solvable groups.	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 (12 Marks)	Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests.	06	02	-	08
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Linear Programming**
Course Code	**: C-MAT-503A**
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:

This course provides an in-depth introduction to Linear Programming and its applications in optimization. Students will explore the fundamental concepts of the Simplex Method, duality theory, transportation and assignment problems, and game theory. Practical applications and real-life problem-solving techniques will be emphasized through case studies. The course balances theoretical understanding with hands-on computational techniques to equip students with skills in decision-making and resource optimization.

Pre Requisites:

- Basic knowledge of Linear Algebra

Course Objectives:

1. To Formulate and solve Linear Programming Problems (LPP) using the Simplex Method.
2. To Understand and apply artificial variable techniques, including the Two-Phase and Big-M Methods.
3. To Interpret duality in linear programming and analyze primal-dual relationships.
4. To Solve transportation and assignment problems using various optimization methods.
5. To Apply game theory concepts to decision-making problems, including two-person zero-sum games.
6. To Utilize mathematical programming techniques to solve real-world optimization problems.

Course Outcomes (COs):

By the end of this course, the students will be able to

CO1: Understand and analyze the fundamentals of linear programming and various solution methods.

ILO 1.1: Define and explain the basic concepts of linear programming and formulate linear programming.

ILO 1.2: Apply the simplex method, including its tableau format, to find optimal solutions.

ILO 1.3: Compare the two-phase method and Big-M method in handling artificial variables.

ILO 1.4: Analyze real-life optimization problems and interpret results using case studies.

CO2: Analyze and apply duality principles to solve optimization problems.

ILO 2.1: Formulate the dual problem corresponding to a given primal problem.

ILO 2.2: Analyze the primal-dual relationships and interpret their economic significance.

ILO 2.3: Utilize duality theory to verify the optimality of solutions.

ILO 2.4: Apply duality concepts to solve real-world optimization problems.

CO3: Solve transportation and assignment problems using appropriate mathematical techniques.

ILO 3.1: Formulate and solve transportation and assignment problems mathematically.

ILO3.2: Implement initial feasible solution techniques such as the northwest-corner method, least-cost method, and Vogel's approximation method.

ILO 3.3: Develop an algorithmic approach for solving transportation and assignment problems.

ILO 3.4: Apply transportation and assignment models to practical business and logistics problems.

CO4: Apply game theory concepts to solve competitive decision-making problems.

ILO 4.1: Explain the fundamental concepts of two-person zero-sum games and their formulation.

ILO 4.2: Apply different strategies, including mixed strategies, to solve game theory problems.

ILO 4.3: Use graphical and linear programming methods to determine optimal game strategies.

ILO 4.4: Solve real-world decision-making problems using game theory principles.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1	X	X	X	X
Conceptual Knowledge	X	X	CO1, CO2	X	X	CO3
Procedural Knowledge	X	X	CO3	CO1, CO2	X	X
Metacognitive Knowledge	X	X	CO4	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (18 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 (12 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)**

- **Two Internal Examinations** - **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. 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.

REFERENCES:

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.
4. Karak, P. M., Linear Programming and Game Theory, New Central Book Agency.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Computer Programming (Theory)**
Course Code	**: C-MAT-503B(T)**
Nature of the Course	**: MAJOR**
Total Credits	**: 03 (L=2, T=1, P=0)**
Distribution of Marks	**: 45 (End Sem) + 40 (In-Sem)**

Course Description:

This course introduces fundamental programming concepts using the C programming language. Students will learn essential problem-solving techniques, algorithm development, and program design using flowcharts and pseudocode. The course covers topics such as C tokens, variables, operators, expressions, control structures, arrays, functions, and recursion. Additionally, students will develop hands-on programming skills through practical assignments, reinforcing theoretical concepts with real-world applications.

Pre Requisites:

- Basic knowledge of computers and their operation
- Familiarity with mathematical concepts such as arithmetic operations and algebra
- Logical reasoning and problem-solving skills (no prior programming experience required)

Course Objectives:

1. To Understand the fundamental concepts of programming and problem-solving approaches.
2. To Develop algorithms and flowcharts for problem-solving.
3. To Write C programs using appropriate syntax and semantics.
4. To Utilize different operators, expressions, and mathematical functions effectively.
5. To Implement decision-making and looping constructs to control program execution.
6. To Handle input and output operations proficiently.
7. To Work with arrays, both single and multi-dimensional, for data storage and manipulation.
8. To Define and use user-defined functions, including recursion.
9. To Apply storage classes in C for efficient memory management.
10. To Develop practical programming skills through hands-on exercises and projects.

Course Outcomes (COs):

By the end of this course, the students will be able to

CO1: Understand and apply the fundamental programming concepts, C tokens, operators, and input-output operations.

ILO 1.1: Explain basic programming concepts, flowcharts, and algorithms.

ILO1.2: Identify and use different C tokens, keywords, identifiers, and data types.

ILO1.3: Apply arithmetic, logical, and relational operators in expressions.

ILO1.4: Demonstrate formatted input/output operations using scanf(), printf(), and character I/O functions.

CO2: Implement conditional statements and looping constructs to control program execution.

ILO 2.1: Develop programs using if, if-else, and else-if ladder statements for decision-making.

ILO 2.2: Use while, do-while, and for loops effectively for iterative operations.

ILO 2.3: Implement branching mechanisms using break, continue, and goto statements.

ILO 2.4: Apply exit() function to terminate programs when necessary.

CO3: Utilize arrays to store, process, and manipulate data.

ILO 3.1: Define and initialize one-dimensional and two-dimensional arrays.

ILO 3.2: Perform operations such as matrix addition, subtraction, multiplication, and transpose.

ILO 3.3: Implement array-based algorithms for searching and sorting.

ILO 3.4: Develop programs using multi-dimensional arrays for structured data storage.

CO4: Implement user-defined functions and recursion for modular programming.

ILO 4.1: Explain the elements of user-defined functions, function declaration, and function calls.

ILO 4.2: Implement functions with arguments and return values for better modularity.

ILO 4.3: Utilize recursion to solve problems like factorial and Fibonacci series.

ILO 4.4: Demonstrate the use of storage classes (auto, static, register, extern) in C programs.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	CO1	X	X	X	CO2, CO3
Procedural Knowledge	X	X	CO1, CO2, CO4	X	X	X
Metacognitive Knowledge	CO3, CO4	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 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. Input output operations, Reading and writing a character, formatted input and formatted output, Character input/ Output functions: getchar(), Putchar() etc.	15	-	-	15
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.	10	-	-	10
III (10 Marks)	Arrays, One dimensional array, declaration of one-dimensional array, initialization of two-dimensional arrays, multidimensional array.	10	-	-	10
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.	10	-	-	10
	Total	45	-	-	45

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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. 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.

REFERENCES:

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

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Computer Programming (Practical)**
Course Code	**: C-MAT-503B(P)**
Nature of the Course	**: MAJOR**
Total Credits	**: 01 (L=0, T=0, P=1)**
Distribution of Marks	**: 15 (Practical)**

Course Description:

This course introduces fundamental programming concepts using the C programming language. Students will learn essential problem-solving techniques, algorithm development, and program design using flowcharts and pseudocode. The course covers topics such as C tokens, variables, operators, expressions, control structures, arrays, functions, and recursion. Additionally, students will develop hands-on programming skills through practical assignments, reinforcing theoretical concepts with real-world applications.

Pre Requisites:

- Basic knowledge of computers and their operation
- Familiarity with mathematical concepts such as arithmetic operations and algebra
- Logical reasoning and problem-solving skills (no prior programming experience required)

Course Objectives:

1. To Understand the fundamental concepts of programming and problem-solving approaches.
2. To Develop algorithms and flowcharts for problem-solving.
3. To Write C programs using appropriate syntax and semantics.
4. To Utilize different operators, expressions, and mathematical functions effectively.
5. To Implement decision-making and looping constructs to control program execution.
6. To Handle input and output operations proficiently.
7. To Work with arrays, both single and multi-dimensional, for data storage and manipulation.
8. To Define and use user-defined functions, including recursion.
9. To Apply storage classes in C for efficient memory management.
10. To Develop practical programming skills through hands-on exercises and projects.

Course Outcomes (COs):

By the end of this course, the students will be able to

CO1: Develop real-world applications using C programming.

ILO 1.1: Apply programming concepts to solve mathematical problems like interest calculation, series sum, and quadratic equations.

ILO 1.2: Implement programs for number-based operations like prime checking, factorial computation, and palindrome detection.

ILO 1.3: Develop programs for matrix manipulations, sorting algorithms, and salary computation.

ILO 1.4: Demonstrate proficiency in writing efficient and optimized C programs.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	CO1	X	X	X	CO1
Procedural Knowledge	X	X	CO1	X	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 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 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)	-	-	30	30

	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	-	-	**30**	**30**

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations - 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. 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.

REFERENCES:

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

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Linear Programming**
Course Code	**: MIN-MAT-501A**
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:

This course provides an in-depth introduction to Linear Programming and its applications in optimization. Students will explore the fundamental concepts of the Simplex Method, duality theory, transportation and assignment problems, and game theory. Practical applications and real-life problem-solving techniques will be emphasized through case studies. The course balances theoretical understanding with hands-on computational techniques to equip students with skills in decision-making and resource optimization.

Pre Requisites:

- Basic knowledge of Linear Algebra

Course Objectives:

1. To Formulate and solve Linear Programming Problems (LPP) using the Simplex Method.
2. To Understand and apply artificial variable techniques, including the Two-Phase and Big-M Methods.
3. To Interpret duality in linear programming and analyze primal-dual relationships.
4. To Solve transportation and assignment problems using various optimization methods.
5. To Apply game theory concepts to decision-making problems, including two-person zero-sum games.
6. To Utilize mathematical programming techniques to solve real-world optimization problems.

Course Outcomes (COs):

By the end of this course, the students will be able to

CO1: Understand and analyze the fundamentals of linear programming and various solution methods.

ILO 1.1: Define and explain the basic concepts of linear programming and formulate linear programming.

ILO 1.2: Apply the simplex method, including its tableau format, to find optimal solutions.

ILO 1.3: Compare the two-phase method and Big-M method in handling artificial variables.

ILO 1.4: Analyze real-life optimization problems and interpret results using case studies.

CO2: Analyze and apply duality principles to solve optimization problems.

ILO 2.1: Formulate the dual problem corresponding to a given primal problem.

ILO 2.2: Analyze the primal-dual relationships and interpret their economic significance.

ILO 2.3: Utilize duality theory to verify the optimality of solutions.

ILO 2.4: Apply duality concepts to solve real-world optimization problems.

CO3: Solve transportation and assignment problems using appropriate mathematical techniques.

ILO 3.1: Formulate and solve transportation and assignment problems mathematically.

ILO3.2: Implement initial feasible solution techniques such as the northwest-corner method, least-cost method, and Vogel's approximation method.

ILO 3.3: Develop an algorithmic approach for solving transportation and assignment problems.

ILO 3.4: Apply transportation and assignment models to practical business and logistics problems.

CO4: Apply game theory concepts to solve competitive decision-making problems.

ILO 4.1: Explain the fundamental concepts of two-person zero-sum games and their formulation.

ILO 4.2: Apply different strategies, including mixed strategies, to solve game theory problems.

ILO 4.3: Use graphical and linear programming methods to determine optimal game strategies.

ILO 4.4: Solve real-world decision-making problems using game theory principles.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1	X	X	X	X
Conceptual Knowledge	X	X	CO1, CO2	X	X	CO3
Procedural Knowledge	X	X	CO3	CO1, CO2	X	X
Metacognitive Knowledge	X	X	CO4	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (18 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 (12 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)**

- **Two Internal Examinations** - **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. 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.

REFERENCES:

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.
4. Karak, P. M., Linear Programming and Game Theory, New Central Book Agency.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Computer Programming (Theory)**
Course Code	**: MIN-MAT-501B(T)**
Nature of the Course	**: MINOR**
Total Credits	**: 03 (L=2, T=1, P=0)**
Distribution of Marks	**: 45 (End Sem) + 40 (In-Sem)**

Course Description:

This course introduces fundamental programming concepts using the C programming language. Students will learn essential problem-solving techniques, algorithm development, and program design using flowcharts and pseudocode. The course covers topics such as C tokens, variables, operators, expressions, control structures, arrays, functions, and recursion. Additionally, students will develop hands-on programming skills through practical assignments, reinforcing theoretical concepts with real-world applications.

Pre Requisites:

- Basic knowledge of computers and their operation
- Familiarity with mathematical concepts such as arithmetic operations and algebra
- Logical reasoning and problem-solving skills (no prior programming experience required)

Course Objectives:

1. To Understand the fundamental concepts of programming and problem-solving approaches.
2. To Develop algorithms and flowcharts for problem-solving.
3. To Write C programs using appropriate syntax and semantics.
4. To Utilize different operators, expressions, and mathematical functions effectively.
5. To Implement decision-making and looping constructs to control program execution.
6. To Handle input and output operations proficiently.
7. To Work with arrays, both single and multi-dimensional, for data storage and manipulation.
8. To Define and use user-defined functions, including recursion.
9. To Apply storage classes in C for efficient memory management.
10. To Develop practical programming skills through hands-on exercises and projects.

Course Outcomes (COs):

By the end of this course, the students will be able to

CO1: Understand and apply the fundamental programming concepts, C tokens, operators, and input-output operations.

ILO 1.1: Explain basic programming concepts, flowcharts, and algorithms.

ILO1.2: Identify and use different C tokens, keywords, identifiers, and data types.

ILO1.3: Apply arithmetic, logical, and relational operators in expressions.

ILO1.4: Demonstrate formatted input/output operations using scanf(), printf(), and character I/O functions.

CO2: Implement conditional statements and looping constructs to control program execution.

ILO 2.1: Develop programs using if, if-else, and else-if ladder statements for decision-making.

ILO 2.2: Use while, do-while, and for loops effectively for iterative operations.

ILO 2.3: Implement branching mechanisms using break, continue, and goto statements.

ILO 2.4: Apply exit() function to terminate programs when necessary.

CO3: Utilize arrays to store, process, and manipulate data.

ILO 3.1: Define and initialize one-dimensional and two-dimensional arrays.

ILO 3.2: Perform operations such as matrix addition, subtraction, multiplication, and transpose.

ILO 3.3: Implement array-based algorithms for searching and sorting.

ILO 3.4: Develop programs using multi-dimensional arrays for structured data storage.

CO4: Implement user-defined functions and recursion for modular programming.

ILO 4.1: Explain the elements of user-defined functions, function declaration, and function calls.

ILO 4.2: Implement functions with arguments and return values for better modularity.

ILO 4.3: Utilize recursion to solve problems like factorial and Fibonacci series.

ILO 4.4: Demonstrate the use of storage classes (auto, static, register, extern) in C programs.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	CO1	X	X	X	CO2, CO3
Procedural Knowledge	X	X	CO1, CO2, CO4	X	X	X
Metacognitive Knowledge	CO3, CO4	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 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. Input output operations, Reading and writing a character, formatted input and formatted output, Character input/ Output functions: getchar(), Putchar() etc.	15	-	-	15
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.	10	-	-	10
III (10 Marks)	Arrays, One dimensional array, declaration of one-dimensional array, initialization of two-dimensional arrays, multidimensional array.	10	-	-	10
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.	10	-	-	10
	Total	45	-	-	45

Where: L: Lectures T: Tutorials P: Practicals

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

- **Two Internal Examinations - 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. 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.

REFERENCES:

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

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 5TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Computer Programming (Practical)**
Course Code	**: MIN-MAT-501B(P)**
Nature of the Course	**: MINOR**
Total Credits	**: 01 (L=0, T=0, P=1)**
Distribution of Marks	**: 15 (Practical)**

Course Description:

This course introduces fundamental programming concepts using the C programming language. Students will learn essential problem-solving techniques, algorithm development, and program design using flowcharts and pseudocode. The course covers topics such as C tokens, variables, operators, expressions, control structures, arrays, functions, and recursion. Additionally, students will develop hands-on programming skills through practical assignments, reinforcing theoretical concepts with real-world applications.

Pre Requisites:

- Basic knowledge of computers and their operation
- Familiarity with mathematical concepts such as arithmetic operations and algebra
- Logical reasoning and problem-solving skills (no prior programming experience required)

Course Objectives:

1. To Understand the fundamental concepts of programming and problem-solving approaches.
2. To Develop algorithms and flowcharts for problem-solving.
3. To Write C programs using appropriate syntax and semantics.
4. To Utilize different operators, expressions, and mathematical functions effectively.
5. To Implement decision-making and looping constructs to control program execution.
6. To Handle input and output operations proficiently.
7. To Work with arrays, both single and multi-dimensional, for data storage and manipulation.
8. To Define and use user-defined functions, including recursion.
9. To Apply storage classes in C for efficient memory management.
10. To Develop practical programming skills through hands-on exercises and projects.

Course Outcomes (COs):

By the end of this course, the students will be able to

CO1: Develop real-world applications using C programming.

ILO 1.1: Apply programming concepts to solve mathematical problems like interest calculation, series sum, and quadratic equations.

ILO 1.2: Implement programs for number-based operations like prime checking, factorial computation, and palindrome detection.

ILO 1.3: Develop programs for matrix manipulations, sorting algorithms, and salary computation.

ILO 1.4: Demonstrate proficiency in writing efficient and optimized C programs.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	CO1	X	X	X	CO1
Procedural Knowledge	X	X	CO1	X	X	X
Metacognitive Knowledge	X	X	X	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 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 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	-	-	30	30

	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	-	-	**30**	**30**

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations - 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. 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.

REFERENCES:

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

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 6TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Metric Spaces and Complex Analysis**
Course Code	**: C-MAT-601**
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:

This course offers a comprehensive introduction to metric spaces and complex analysis. It begins with the foundational aspects of metric spaces, including open and closed sets, convergence, continuity, compactness, and completeness. The complex analysis portion focuses on analytic functions, Cauchy's theorem, contour integration, and residue calculus, with practical applications to evaluating real integrals and performing conformal mappings.

Pre Requisites:

- Real Analysis and Multivariable Calculus.

Course Objectives:

1. Understand and apply the fundamental concepts of metric spaces, including convergence, continuity, compactness, and completeness.
2. To Develop a solid foundation in complex function theory.
3. To Solve problems using Cauchy's integral theorem and residue calculus.
4. To Apply conformal mappings to physical problems.

Course Outcomes (COs):

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

CO1: Understand and Analyze the fundamental concepts of metric spaces and their properties.

ILO 1.1: Define and explain metric spaces, open and closed sets, and their significance.

ILO 1.2: Analyze the behavior of sequences in metric spaces, including Cauchy sequences and completeness.

ILO 1.3: Apply Cantor's theorem and understand the concepts of dense and separable spaces.

ILO 1.4: Demonstrate knowledge of subspaces, diameter, and closure properties in metric spaces.

CO2: Analyze the properties of continuous mappings.

ILO 2.1: Explain different characterizations of continuity, including uniform continuity and homeomorphisms.

ILO 2.2:

CO3: Develop an understanding of complex function theory, limits, and differentiability.

ILO 3.1: Define and compute limits and continuity of functions in the complex plane.

ILO 3.2: Analyze the properties of complex numbers and their geometric interpretations.

ILO 3.3: Apply Cauchy-Riemann equations to determine differentiability.

ILO 3.4: Develop mathematical proofs and applications of fundamental differentiation formulas.

CO4: Explore analytic functions, contour integration, and fundamental theorems in complex analysis.

ILO 4.1: Identify and analyze examples of analytic functions, including exponential and trigonometric functions.

ILO 4.2: Compute contour integrals and apply upper bound estimates.

ILO 4.3: Apply Cauchy-Goursat theorem and Cauchy integral formula to solve problems.

ILO 4.4: Evaluate definite integrals and use analytic techniques to study contour integration.

CO5: Understand and analyze advanced topics in complex analysis, including power series and convergence.

ILO 5.1: Apply Liouville's theorem and the Fundamental Theorem of Algebra to complex functions.

ILO 5.2: Analyze the convergence of sequences and series, including power series.

ILO 5.3: Apply Taylor and Laurent series expansions.

ILO 5.4: Differentiate between absolute and uniform convergence and apply them to problem-solving.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1	X	X	X	X
Conceptual Knowledge	X	CO5	CO1	CO2, CO4	X	CO3
Procedural Knowledge	X	X	CO4	CO1, CO3 CO5	CO2, CO4	X
Metacognitive Knowledge	X	X	CO2; CO3; CO5	X	X	X

UNITS	CONTENTS	L	T	P	Total Hours
I (16 Marks)	Metric spaces: definition and examples. Open and closed sphere, neighborhood, open set, interior, closure of a set. Limit point of a set, closed set, subspaces, diameter of a set, sequences in metric spaces, Cauchy sequences. Complete Metric Spaces.	15	05	-	20
II (11 Marks)	Continuous mappings, sequential criterion and other characterizations of continuity. Uniform continuity. Homeomorphism, Contraction mappings.	09	03	-	12
III (11 Marks)	Limits, Limits involving the point at infinity, continuity. Functions of complex variable, mappings, harmonic function, 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, 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)

- **Two Internal Examinations - 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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 6TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Ring Theory and Linear Algebra II**
Course Code	**: C-MAT-602**
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:

This course introduces the concept of polynomial rings, factorization and divisibility in integral domains, along with key concepts in linear algebra such as dual spaces, eigen values, and the Cayley-Hamilton theorem. Students will also study inner product spaces, orthogonality and spectral theory, gaining essential problem-solving skills in algebra and linear algebra.

Pre Requisites:

- Linear Algebra
- Abstract Algebra
- Vector Space

Course Objectives:

1. To Understand polynomial rings, factorization and unique factorization domains.
2. To Analyze properties of integral domains, irreducibility and Eisenstein's criterion.
3. To Develope expertise in dual spaces, eigen values, and invariant subspaces.
4. To Apply inner product space techniques, including Gram-Schmidt and least squares approximation.
5. To explore spectral theory, orthogonal projections, and self-adjoint operators.

Course Outcomes (COs):

After completion of the course students will be able to

CO1: Understand the structure of polynomial rings over commutative rings and apply the division algorithm.

ILO 1.1: Define polynomial rings over commutative rings and explain their algebraic properties.

ILO 1.2: Apply the division algorithm to polynomials and analyze its consequences.

CO2: Explore factorization of polynomials, reducibility, and irreducibility tests.

ILO 2.1: Identify principal ideal domains and their role in polynomial factorization.

ILO 2.2: Use Eisenstein's criterion and other tests to determine the irreducibility of polynomials.

CO3: Analyze divisibility properties in integral domains and distinguish between irreducibles and primes.

ILO 3.1: Define and differentiate between irreducible and prime elements in an integral domain.

ILO 3.2: Explain divisibility rules and their applications in algebraic structures.

CO4: Understand the classification of factorization domains and their relationships.

ILO 4.1: Compare and contrast unique factorization domains (UFDs), principal ideal domains (PIDs), and Euclidean domains.

ILO 4.2: Provide examples of Euclidean domains and explain how they ensure unique factorization.

CO5: Develop an understanding of dual spaces, dual basis,and the transpose of linear transformations.

ILO 5.1: Define dual spaces and construct dual bases for given vector spaces.

ILO 5.2: Compute the transpose of a linear transformation and represent it in a dual basis.

CO6: Apply eigen value concepts, diagonalizability and the Cayley-Hamilton theorem in linear algebra.

ILO 6.1: Determine eigen values, eigen vectors and analyze conditions for diagonalizability.

ILO 6.2: Apply the Cayley-Hamilton theorem to compute minimal polynomials and analyze their significance.

CO7: Understand the properties of inner product spaces, orthogonality and least squares approximation.

ILO 7.1: Apply the Gram-Schmidt orthogonalization process to construct orthonormal bases.

ILO 7.2: Solve least squares approximation problems and find minimal solutions for linear equations.

CO8: Analyze self-adjoint operators, orthogonal projections and the Spectral theorem.

ILO 8.1: Differentiate between normal and self-adjoint operators and compute their spectral properties.

ILO 8.2: Apply the Spectral theorem to study eigen values and eigen vectors of symmetric matrices.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	CO1, CO7	X	X	CO3	CO5	X
Conceptual Knowledge	X	CO2	CO2, CO6	CO8	X	CO5
Procedural Knowledge	X	CO3	CO1, CO2	X	CO6	X
Metacognitive Knowledge	X	CO4	CO8	X	X	CO4

UNITS	CONTENTS	L	T	P	Total Hours
I (9 Marks)	Polynomial rings over commutative rings, division algorithm and consequences.	06	02	-	08
II (15 Marks)	Divisibility in integral domains, irreducibles, primes, Euclidean domains, Principal ideal domains, unique factorization domains, factorization of polynomials in $\mathbb{Z}[n]$, reducibility tests and irreducibility tests, Eisenstein criterion, mod p test.	09	03	-	12
III (18 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 (18 Marks)	Inner product spaces and norms, Gram-Schmidt orthogonalization process, orthogonal linear transformation, 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)

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

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 6TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Number Theory**
Course Code	**: C-MAT-603A**
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:

This course covers fundamental topics such as divisibility, prime numbers, modular arithmetic, Diophantine equations, congruences, number-theoretic functions, and cryptographic applications. Students will develop problem-solving skills and logical reasoning through rigorous proofs and computational techniques.

Pre Requisites:

- Basic knowledge of algebra and mathematical proofs

Course Objectives:

1. To understand and apply divisibility rules, prime factorization, and modular arithmetic.
2. To Solve congruences and Diophantine equations.
3. To Explore number-theoretic functions and their properties.
4. To Analyze applications in cryptography.

Course Outcomes (COs):

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

CO1: Understand and apply fundamental results in modular arithmetic and classical congruence theorems.

ILO 1.1: Define linear congruences and complete residue systems.

ILO 1.2: Solve linear congruences and apply the Chinese Remainder Theorem.

ILO 1.3: Explain and use Euler's Phi function, Fermat's Little Theorem, and Wilson's Theorem.

ILO 1.4: State and interpret results related to the Prime Number Theorem and Goldbach's Conjecture.

CO2: Analyze arithmetic functions and operations in multiplicative number theory.

ILO 2.1: Define arithmetic functions including number of divisors and sum-of-divisors functions.

ILO 2.2: Analyze multiplicativity and compute values of Euler's phi-function.

ILO 2.3: Apply the Dirichlet product and use the Mobius inversion formula in arithmetic calculations.

ILO 2.4: Evaluate properties of Euler's phi-function and its relation with reduced residue systems.

CO3: Study quadratic residues, non-residues, and advanced modular structures.

ILO 3.1: Define order of an integer modulo n and identify primitive roots.

ILO 3.2: Use Euler's criterion and Legendre symbol to test quadratic residues.

ILO 3.3: Analyze and apply the Law of Quadratic Reciprocity to solve congruences.

ILO 3.4: Solve quadratic congruences involving composite moduli using symbolic methods.

CO4: Understand classical Diophantine problems and introductory cryptographic algorithms.

ILO 4.1: Solve Diophantine equations of the form x^2+y^2=z^2 and discuss their number-theoretic significance.

ILO 4.2: State Fermat's Last Theorem and explain its significance in number theory.

ILO 4.3: Describe the principles of public-key cryptography, especially RSA encryption and decryption.

ILO 4.4: Apply Euler's theorem in modular exponentiation in RSA encryption contexts.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	CO1, CO2, CO3, CO4	CO1, CO4	CO1, CO4	X	X	X
Conceptual Knowledge	CO3, CO4	CO1, CO2, CO4	CO2, CO3, CO4	CO2, CO3	CO1, CO2, CO3, CO4	X
Procedural Knowledge	X	X	CO1, CO2, CO3, CO4	CO2, CO3	CO2, CO3, CO4	X
Metacognitive Knowledge	X	X	X	X	CO4	X

UNITS	CONTENTS	L	T	P	Total Hours
I (15 Marks)	Congruence Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Euler's Phi Function, Fermat's Little theorem, Wilson's theorem.	09	03	-	12
II (18 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 (18 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 (09 Marks)	Solution of the equation $x^2 + y^2 = z^2$, Fermat's Last theorem (Statement only without proof). Introduction to Cryptography: Public key encryption, RSA encryption and decryption.	06	02	-	08
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- **Two Internal Examinations** - **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. 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.

REFERENCES:

1. Robbins N., Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2005.
2. Douglas R. Stinson & Maura B. Paterson, Cryptography: Theory and Practice, CRC Press, Taylor & Francis Group, Fourth Edition, 2018.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 6TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Hydro-Mechanics**
Course Code	**: C-MAT-603B**
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:

This course provides an in-depth study of fluid dynamics, covering both theoretical and practical aspects of fluid motion. Students will explore fundamental concepts such as kinematics of fluids, equations of motion, and pressure distribution in static and dynamic fluids. The course also delves into advanced topics like irrotational motion, circulation, and stability of floating bodies. Through theoretical analysis and real-world examples, students will develop a solid understanding of fluid behavior, essential for applications in engineering and physical sciences.

Pre Requisites:

- Basic calculus (differentiation and integration).
- Vector analysis
- Basic Physics

Course Objectives:

1. To Apply the Eulerian and Lagrangian methods to analyze fluid motion.
2. To Derive and utilize key fluid motion equations such as Euler's equation, Bernoulli's equation, and the equation of continuity.
3. To Analyze irrotational motion and apply Green's theorem, uniqueness theorems, and Kelvin's minimum energy theorem.
4. To Comprehend fluid pressure principles, equilibrium conditions, and related mathematical formulations.
5. To Calculate the resultant pressure and center of pressure for various geometrical shapes under different conditions.
6. To Evaluate the stability of floating bodies and determine the metacentric height for stability analysis.
7. To Apply theoretical concepts to solve real-world fluid dynamics problems in engineering and physical sciences.

Course Outcomes (COs):

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

CO1: Analyze the fundamental concepts of fluid motion and kinematics.

ILO 1.1: Differentiate between real and ideal fluid and describe various flow patterns.

ILO 1.2: Apply Eulerian and Lagrangian approaches to fluid motion analysis.

ILO 1.3: Derive and interpret the equation of continuity for fluid flow.

ILO 1.4: Analyze the acceleration of a fluid particle using kinematic principles.

CO2: Apply governing equations of motion to solve fluid dynamics problems.

ILO 2.1: Derive and apply Euler's equation of motion for fluid flow.

ILO 2.2: Explain Bernoulli's equation and its applications in steady motion.

ILO 2.3: Describe the concept of circulation and Kelvin's circulation theorem.

ILO2.4: Solve problems related to impulsive motion in fluid dynamics.

CO3: Evaluate irrotational fluid motion using potential flow theory and related theorems.

ILO 3.1: Explain the concept of potential flow and its applications.

ILO 3.2: Apply Green's theorem to derive fluid motion properties.

ILO 3.3: Evaluate kinetic energy distribution in a fluid system.

ILO 3.4: Utilize uniqueness and Kelvin's minimum energy theorem in flow analysis.

CO4: Examine fluid pressure distribution and its impact on equilibrium conditions.

ILO 4.1: Define and apply fundamental theorems of fluid pressure.

ILO 4.2: Explain the relationship between pressure variation and equilibrium conditions.

ILO 4.3: Solve problems related to equi-pressure surfaces and lines of force.

ILO 4.4: Analyze the pressure distribution in static fluids using differential equations.

CO5: Determine resultant pressure and center of pressure for various surfaces.

ILO 5.1: Calculate the resultant pressure on submerged surfaces.

ILO 5.2: Determine the center of pressure for various geometrical shapes.

ILO 5.3: Analyze the effect of fluid thrust on curved surfaces.

ILO 5.4: Solve practical problems involving hydrostatic pressure distribution.

CO6: Assess equilibrium and stability of floating bodies through metacentric analysis.

ILO 6.1: Explain the conditions of equilibrium for floating bodies.

ILO 6.2: Differentiate between stable, unstable, and neutral equilibrium.

ILO 6.3: Determine the metacentric height and its role in stability analysis.

ILO 6.4: Solve real-world problems related to floating bodies and ship stability.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	COGNITIVE PROCESS DIMENSION					
	Remember	Understand	Apply	Analyse	Evaluate	Create
Factual Knowledge	X	X	X	X	X	X
Conceptual Knowledge	X	CO2	X	X	X	X
Procedural Knowledge	X	X	CO2	CO1, CO4	X	X
Metacognitive Knowledge	CO5	CO3, CO6	X	X	X	X

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 (09 Marks)	**Equation of Motion:** Euler's equation of motion, Bernoulli's equation, steady motion under conservative forces, impulsive motion, circulation, Kelvin's circulation theorem.	06	02	-	08
III (09 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 (09 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 (09 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)**

- **Two Internal Examinations** - **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. 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.

REFERENCES:

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

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 6TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Mathematical Methods**
Course Code	**: C-MAT-604A**
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:

Mathematical Methods is a unique course to initiate the students to some fundamental topics of Mathematics. This course equips students with scientific and mathematical techniques used to analyze complex systems and solve practical problems. Topics include Fourier Series, Laplace Transform and its applications. This course prepares students for advanced studies in various applications by developing skills, strategies and reasoning needed to succeed in mathematics.

Pre Requisites:

- Basic concepts of calculus.
- Boundary Value Problems.

Course Objectives:

The course on Mathematical Methods 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. It includes Fourier Series, Laplace Transform, its inverse and applications.

Course Outcomes (COs):

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

CO1: Discuss the importance of Fourier series in applied mathematics and analyze periodic functions.

ILO 1.1: Learn the required conditions for deriving Fourier series representing common physical phenomena.

ILO 1.2: Understand the convergence of Fourier series of continuous periodic functions.

ILO 1.3: Understand the convergence of Fourier series at discontinuities.

CO2: Enable the students to study the Laplace Transform, properties of Laplace Transform, and some applications to solve the differential equations and integral equations.

ILO 2.1: Learn the application of Laplace transform in engineering analysis.

ILO 2.2: Learn the Laplace transform for ordinary derivatives and partial derivatives of different orders.

ILO 2.3: Learn the required conditions for transforming variable or variables in functions by the Laplace transform.

CO3: Understanding for solving linear differential equations and analyzing system behavior in the frequency domain.

ILO 3.1: Changes a function of a complex variable into a function of a real variable, usually time.

ILO 3.2: Learn to use partial fractions and convolution methods in inverse Laplace transforms.

ILO 3.3: Used in many fields, including engineering and physics, for solving differential equations, analyzing linear systems and optimization.

CO4: Describe a periodic signal in terms of cosine and sine waves.

ILO 4.1: Used to analyze periodic functions into their fundamental and harmonic components.

ILO 4.2: Model any periodic signal using a combination of sines and cosines.

ILO 4.3: Represent both periodic real functions as well as solutions admitted by linear partial differential equations with assigned initial and boundary conditions.

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

ILO 5.1: Recognize Laplace and Fourier transform and use the appropriate method to solve them.

ILO 5.2: Use an initial condition to find a solution of boundary value problem.

ILO 5.3: Solve problems involving Laplace and Poisson equations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1, CO2	X	X	X	X
Conceptual Knowledge	X	CO1, CO2	CO3	CO5	X	CO4
Procedural Knowledge	X	X	CO1, CO2	CO3	CO4	CO5
Metacognitive Knowledge	X	X		X	CO5	X

UNITS	CONTENTS	L	T	P	Total Hours
I (07 Marks)	**Fourier Series:** Fourier Series, Euler's Formulae, Dirichlet conditions, Fourier series for even and odd functions, Half range Fourier series and related problems.	06	02	-	08
II (15 Marks)	**Laplace Transform:** Definition of Laplace transform, Existence theorem for Laplace transform. Laplace transform of some elementary functions and its properties. First and Second shifting theorem, Change of scale property, Laplace transform of derivatives, Laplace transform of Integrals. Laplace transform of multiplication and division by t.	12	04	-	16
III (08 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:** Definition of Fourier transform, Dirichlet conditions, 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, Fourier transform of multiplication by x^n and derivative, convolution theorem, Rayleigh's theorem and related problems.	15	05	-	20
V (11 Marks)	**Applications of Fourier and Laplace transform:** Application of Laplace transforms to the solutions of ODE with constant and variable coefficients, Simultaneous ODE, PDE. Application of Laplace and Fourier transforms to initial and boundary value problems.	09	03	-	12
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

- Two Internal Examinations - 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. 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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 6TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Probability and Statistics**
Course Code	**: C-MAT-604B**
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:

This course provides an elementary introduction to probability and statistics with applications. Probability is the study of chance and is a very fundamental subject that we apply in everyday living, while statistics is more concerned with how we handle data using different analysis techniques and collection methods. Topics include mathematical expectation, moment generating function, Joint cumulative distribution function, Central Limit theorem, covariance, linear regression, Chebyshev's inequality.

Pre Requisites:

- Understanding of probability theory.
- Basic concepts of calculus.
- Random experiment, Outcomes, Sample space, and Event.

Course Objectives:

The main objectives of this course is to provide students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science. This sets the stage for more advanced mathematical concepts and real-world applications. Its goals are to identify distributions, analyze data, and understand probability concepts.

Course Outcomes (COs):

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

CO1: Define the principal concepts about probability.

ILO 1.1: Achieve a solid understanding of concept of random event.

ILO 1.2: Express the features of discrete and continuous random variables.

ILO 1.3: Formulate the distribution functions.

CO2: Understanding the fundamental concepts of a joint PMF, PDF and CDF of two random variables.

ILO 2.1: Finding the frequency of occurrence of values for the given phenomena using cumulative frequency analysis.

ILO 2.2: Able to compute probabilities and marginal from a joint PMF or PDF.

ILO 2.3: Able to test whether two random variables are independent.

CO3: Understanding the difference between covariance and correlation.

ILO 3.1: Used to determine if two variables are dependent on each other.

ILO 3.2: Learn about the differences and similarities between covariance and correlation, and explore their applications.

ILO 3.3: Analyze and widely used in various fields, including finance, economics, and science.

CO4: Investigate and illustrate the central limit theorem.

ILO 4.1: Describe sampling distributions of the sample mean using the theorem.

ILO 4.2: Calculate the standard deviation of sampling distributions using the theorem.

ILO 4.3: Provides a solid foundation for performing hypothesis tests, making statistical estimates more reliable and accurate.

CO5: Joint cumulative distribution function helps to understand how to characterize the probability distribution of a random vector.

ILO 5.1: Recognize the probability that two conditions are true simultaneously.

ILO 5.2: Essential for various applications in statistics, such as hypothesis testing, confidence interval estimation, and data analysis.

ILO 5.3: Fundamental concept in the field of statistics and probability theory.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1, CO2	X	X	X	X
Conceptual Knowledge	X	CO1, CO2	CO3	CO4	X	CO5
Procedural Knowledge	X	X	CO1, CO2	CO3	CO4	CO5
Metacognitive Knowledge	X	X	X	X	CO5	CO4

UNITS	CONTENTS	L	T	P	Total Hours
I (18 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 (18 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 (09 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)

- **Two Internal Examinations** - 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. 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.

REFERENCES:

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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

FOUR-YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN MATHEMATICS

DETAILED SYLLABUS OF 6TH SEMESTER

(AS PER NEP-2020 GUIDELINES)

Title of the Course	**: Mathematical Methods**
Course Code	**: MIN-MAT-601**
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:

Mathematical Methods is a unique course to initiate the students to some fundamental topics of Mathematics. This course equips students with scientific and mathematical techniques used to analyze complex systems and solve practical problems. Topics include Fourier Series, Laplace Transform and its applications. This course prepares students for advanced studies in various applications by developing skills, strategies and reasoning needed to succeed in mathematics.

Pre Requisites:

- Basic concepts of calculus.
- Boundary Value Problems.

Course Objectives:

The course on Mathematical Methods 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. It includes Fourier Series, Laplace Transform, its inverse and applications.

Course Outcomes (COs):

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

CO1: Discuss the importance of Fourier series in applied mathematics and analyze periodic functions.

ILO 1.1: Learn the required conditions for deriving Fourier series representing common physical phenomena.

ILO 1.2: Understand the convergence of Fourier series of continuous periodic functions.

ILO 1.3: Understand the convergence of Fourier series at discontinuities.

CO2: Enable the students to study the Laplace Transform, properties of Laplace Transform, and some applications to solve the differential equations and integral equations.

ILO 2.1: Learn the application of Laplace transform in engineering analysis.

ILO 2.2: Learn the Laplace transform for ordinary derivatives and partial derivatives of different orders.

ILO 2.3: Learn the required conditions for transforming variable or variables in functions by the Laplace transform.

CO3: Understanding for solving linear differential equations and analyzing system behavior in the frequency domain.

ILO 3.1: Changes a function of a complex variable into a function of a real variable, usually time.

ILO 3.2: Learn to use partial fractions and convolution methods in inverse Laplace transforms.

ILO 3.3: Used in many fields, including engineering and physics, for solving differential equations, analyzing linear systems and optimization.

CO4: Describe a periodic signal in terms of cosine and sine waves.

ILO 4.1: Used to analyze periodic functions into their fundamental and harmonic components.

ILO 4.2: Model any periodic signal using a combination of sines and cosines.

ILO 4.3: Represent both periodic real functions as well as solutions admitted by linear partial differential equations with assigned initial and boundary conditions.

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

ILO 5.1: Recognize Laplace and Fourier transform and use the appropriate method to solve them.

ILO 5.2: Use an initial condition to find a solution of boundary value problem.

ILO 5.3: Solve problems involving Laplace and Poisson equations.

Mapping of Course Outcomes with Bloom's Taxonomy:

Cognitive Knowledge Dimension	**COGNITIVE PROCESS DIMENSION**					
	Remember	**Understand**	**Apply**	**Analyse**	**Evaluate**	**Create**
Factual Knowledge	X	CO1, CO2	X	X	X	X
Conceptual Knowledge	X	CO1, CO2	CO3	CO5	X	CO4
Procedural Knowledge	X	X	CO1, CO2	CO3	CO4	CO5
Metacognitive Knowledge	X	X	X	X	CO5	X

UNITS	CONTENTS	L	T	P	Total Hours
I (07 Marks)	**Fourier Series:** Fourier Series, Euler's Formulae, Dirichlet conditions, Fourier series for even and odd functions, Half range Fourier series and related problems.	06	02	-	08
II (15 Marks)	**Laplace Transform:** Definition of Laplace transform, Existence theorem for Laplace transform. Laplace transform of some elementary functions and its properties. First and Second shifting theorem, Change of scale property, Laplace transform of derivatives, Laplace transform of Integrals. Laplace transform of multiplication and division by t.	12	04	-	16
III (08 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:** Definition of Fourier transform, Dirichlet conditions, 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, Fourier transform of multiplication by x^n and derivative, convolution theorem, Rayleigh's theorem and related problems.	15	05	-	20
V (11 Marks)	**Applications of Fourier and Laplace transform:** Application of Laplace transforms to the solutions of ODE with constant and variable coefficients, Simultaneous ODE, PDE. Application of Laplace and Fourier transforms to initial and boundary value problems.	09	03	-	12
	Total	45	15	-	60

Where: L: Lectures T: Tutorials P: Practicals

MODES OF IN-SEMESTER ASSESSMENT: (40 marks)

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

- Assignment
- Group Discussion
- Quiz
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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.

Mapping of Course Outcome to Programme Outcome:

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

S= Strong, M= Medium, L= Low

**********The End**********