SCHOOL OF BASIC AND APPLIED SCIENCES (SBAS)

PROGRAMME HANDBOOK

Department of Mathematics

Programme Code:

Four Year Undergraduate Programme

B.Sc. (Hons. with Research) Mathematics

(Undergraduate Programme)

(2023-24)


K.R. MANGALAM UNIVERSITY

List of Contents		
S.No.	**Particulars**	**Page No**

PREAMBLE

The objective of any programme at Higher Education Institute is to prepare their students for the society at large. The K. R. Mangalam University visualizes all its programmes in the best interest of their students and in this endeavor; it offers a new vision to all its Under-Graduate courses. The Mathematics division of the school presented four year under graduate programme B.Sc. (H) mathematics with research according to the New Education Policy-2020. We have designed a flexible choice-based credit system, multidisciplinary approach, and multiple entry and exit options for the duration of 2023-2027.

We are following Curriculum and Credit Framework for Undergraduate Programmes (CCFUP)" incorporating a flexible choice-based credit system, multidisciplinary approach, and multiple entry and exit options. This will facilitate students to pursue their career path by choosing the subject/field of their interest.

According NEP Curriculum Framework is

The new curriculum framework will have the following features:

i. Flexibility to move from one discipline of study to another;
ii. Opportunity for learners to choose the courses of their interest in all disciplines;
iii. Facilitating multiple entry and exit options with UG certificate/ UG diploma/ or degree depending upon the number of credits secured;
iv. Flexibility for learners to move from one institution to another to enable them to have multi and/or interdisciplinary learning;
v. Flexibility to switch to alternative modes of learning (offline, ODL, and Online learning, and hybrid modes of learning).

The Undergraduate Programmes will prepare the students for both, academia and employability. The programmes also state the attributes that it offers to inculcate at the graduation level. The graduate attributes encompass values related to emotional stability, well-being, critical thinking and also skills for employability.

The new curriculum of B.Sc. (Hons. with Research) Mathematics offer courses keeping in view of the wide applications of Mathematics in science, engineering, social science, business and a host of other areas. All the courses are having defined objectives and learning outcomes, which will help prospective students in choosing the elective courses to broaden their skills in the field of mathematics and interdisciplinary areas. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry. The courses also offer ample skills to pursue research as career in the field of mathematics and allied areas. The K. R. Mangalam University hopes the NEP-2020 approach of the four year under graduate programme B.Sc. (Hons. with Research) Mathematics will help students in making an informed decision regarding the goals that they wish to pursue in further education and life, at large.

Prepared by:

Dr. Yogendra Kumar Rajoria Assistant Professor	Dr. Pooja Vats Assistant Professor	Dr. Mina Yadav Assistant Professor
Ms. Sonu Mehla Assistant Professor	Dr. Rupali Assistant Professor	

Verified by: Approved by:

1. UNIVERSITY VISION AND MISSION

K.R. Mangalam University is the fastest-growing higher education institute in Gurugram, India. Since its inception in 2013, the University has been striving to fulfil its prime objective of transforming young lives through ground-breaking pedagogy, global collaborations, and world-class infrastructure.

Recognized for its virtues of quality, equality, inclusiveness, sustainability, and professional ethics, KRMU is synonymous with academic excellence and innovation.

1.1. VISION

K.R Mangalam University aspires to become an internationally recognized institution of higher learning through excellence in inter-disciplinary education, research and innovation, preparing socially responsible life-long learners contributing to nation-building.

1.2 MISSION

1. Foster employability and entrepreneurship through futuristic curriculum and progressive pedagogy with cutting-edge technology.

2. Instill notion of lifelong learning through stimulating research, outcomes-based education and innovative thinking.

3. Integrate global needs and expectations through collaborative programs with premier universities, research centers, industries and professional bodies.

4. Enhance leadership qualities among the youth having understanding of ethical values and environmental realities.

2. SCHOOL OF BASIC AND APPLIED SCIENCES (SBAS)

2.1 About the School

The school imparts both teaching and research through its various science disciplines viz Mathematics, Chemistry and Physics. School of Basic and Applied Sciences imparts students disciplinary knowledge, enhances their skills and ability, motivating them to think ingeniously, helping them to act independently and take decisions accordingly in all their scientific pursuits and other endeavors. It strives to empower its students and faculty members to contribute for the development of society and Nation. The faculty is in constant touch with various experts in the relevant fields and is willing to experiment with latest ideas in teaching and research.

3. SCHOOL VISION AND MISSION

3.1 School Vision

To emerge as a Centre of Excellence by disseminating analytical and scientific knowledge in the disciplines of Mathematics, Physics, Chemistry through fostering interdisciplinary research and innovation.

3.2 School Mission

- Enable students to be scientists/entrepreneurs/academicians by accomplishing fundamental and advanced research in diverse areas of Basic and Applied Sciences.
- Create strong associations with academic organizations/industries for knowledge creation, promotion, and application of scientific fervor.
- Develop a conducive environment for lifelong learning.
- Empower students to be socially responsible and ethically strong individuals through value-based science education.

The School comprises of Department of Chemistry, Physics and Mathematics

3.3 Programmes offered by the School

School offers undergraduate B.Sc. (Hons) Programmes, postgraduate M.Sc. Programmes, and Doctoral Programmes. All these programmes are designed to impart scientific knowledge to the students and are aimed to provide theoretical as well as practical training in their respective fields.

4. Department of Mathematics

Department offers undergraduate B.Sc. (Hons) Mathematics. This department established in 2013. This course emphasized on hands on practice, innovative thought process and project based learning.

4.1. Nature of B.Sc. (Hons) Mathematics (with research) and Data Science as Minor

The B.Sc. (Hons) Mathematics with a minor in Data Science is a four-year undergraduate program includes dynamic and interdisciplinary course that blends the fundamental principles of mathematics with the practical applications of data science. The nature of this program is designed to provide students with a comprehensive understanding of advanced mathematical theories and problem-solving techniques, while also equipping them with the essential tools and skills to explore, analyze, and

Sl. No.	Type of Award	Stage of Exit	Mandatory Credits to besecured for the Award
1	Certificate in Mathematics with Specialization in Data analytics	After successful completion of 1stYear	**43 (20+23)**
2	Diploma in Mathematics with Specialization in Data analytics	After successful completion of 1st and 2nd Years	**89(43+23+23)**
3	B.Sc. in Mathematics with Specialization in Data analytics	After successful completion of 1st,2nd and 3rd Years	**126(89+22+15)**
4	**B.Sc. (Honours) Mathematics (withResearch) with Minor in Data Sciences**	**After successful completion of 1st,2nd, 3rd and 4th Years**	**162 (126+20+20)**

interpret complex data sets. The integration of data science as a minor component enriches the curriculum by introducing students to data collection, cleaning, visualization, and statistical analysis, as well as programming

languages commonly used in data science, such as Python and R. This balanced combination of mathematics and data science nurtures students' analytical and critical thinking abilities, enabling them to tackle real-world challenges across various industries. Moreover, the program fosters a collaborative and research-oriented environment, encouraging students to work in interdisciplinary teams and engage in data-driven projects. Graduates of this program emerge as versatile professionals, well-prepared to excel in the ever-evolving landscape of mathematics and data science, with the capability to make valuable contributions in their chosen careers and address complex problems that drive innovation and progress in today's data-driven world.

4.2. Aims of the Programme

The overall aims of B.Sc. (Hons. with Research) Mathematics Programme are:

- To create strong interest in learning mathematics.
- To develop broad and balanced knowledge and understanding of definitions, concepts, principles and theorems.
- To enable the learners to familiarize with suitable tools and skill of mathematics to solve specific problems of both theory and applications.
- To equip students with statistical knowledge and tools necessary to analyze and interpret data effectively.
- To introduce students to the foundational concepts of data science, including data collection, data cleaning, data analysis, and data visualization.
- To provide students with practical programming skill in languages commonly used in data science such as SQL, Python and R.
- To provide sufficient knowledge and skills that enable the learners to undertake further studies in mathematics and the areas on multiple disciplines concerned with mathematics.
- To encourage the students to develop a range of generic skills helpful in employment, internships and social activities.
- To impart research-based knowledge to create interest for further study.

5. LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK IN B.SC. (HONS. WITH RESEARCH) MATHEMATICS PROGRAMME

The Learning Outcomes-based Curriculum Framework (LOCF) for the B.Sc. (Hons. with research) Mathematics with data science as a minor program is designed to provide students with a comprehensive and interdisciplinary education that combines the theoretical depth of mathematics with the practical applications of data science. The framework aims to equip students with a strong foundation in advanced mathematical concepts and problem-solving skills while introducing them to the fundamental principles of data collection, analysis, and visualization. Throughout the program, students will develop proficiency in mathematical modeling and statistical techniques, allowing them to apply their knowledge to real-world data-driven challenges across various domains. By integrating data science as a minor, the curriculum ensures that students gain practical programming abilities in languages such as Python and R, along with exposure to machine learning concepts. Ethical considerations and data privacy are also emphasized to instill responsible data practices. The LOCF emphasizes research and project experiences, empowering students to engage in independent exploration and apply their mathematical expertise to relevant data science projects. By fostering effective communication and presentation skills, the curriculum prepares graduates to effectively convey complex mathematical and data-driven concepts to diverse audiences. Ultimately, the LOCF for B.Sc. (Hons. with Research) Mathematics with a data science minor aims to produce versatile and well-rounded graduates, well-equipped to thrive in the ever-evolving landscape of mathematics and data science, and ready to make valuable contributions in their chosen careers.

6. GRADUATE ATTRIBUTES OF B.SC. (HONS. WITH RESEARCH) MATHEMATICS PROGRAMME

Graduate attributes of a B.Sc. (Hons. with Research) Mathematics program refer to the skills, knowledge, and qualities that students are expected to develop and possess upon completing the program. These attributes are designed to prepare graduates for successful careers in various fields and equip them with the abilities to contribute positively to society. The specific graduate attributes of the program's focus include:

GA 1. Advanced Mathematical Knowledge: Graduates will possess a deep understanding of advanced mathematical concepts, theories, and techniques, enabling them to tackle complex problems in mathematics and related disciplines.

GA 2. Problem-Solving Skills: Graduates will be proficient problem solvers, able to apply mathematical methodologies and critical thinking to address real-world challenges in diverse contexts.

GA 3. Analytical Thinking: Graduates will demonstrate strong analytical skills, allowing them to analyze data, evaluate arguments, and derive meaningful insights from complex information.

GA 4. Mathematical Modeling and Abstraction: Graduates will be adept at constructing mathematical models to represent and solve practical problems, as well as abstracting general principles from specific situations.

GA 5. Effective Communication: Graduates will be skilled communicators, able to convey complex mathematical concepts and results clearly and concisely to both technical and non-technical audiences.

GA 6. Numerical and Computational Proficiency: Graduates will have proficiency in using numerical and computational tools to solve mathematical problems, perform simulations, and analyze data.

GA 7. Collaboration and Teamwork: Graduates will have experience working collaboratively in teams, engaging in interdisciplinary projects, and effectively contributing their mathematical expertise.

GA 8. Research Skills: Graduates will be familiar with research methods in mathematics and related fields, capable of conducting independent research, and presenting their findings.

GA 9. Adaptability and Lifelong Learning: Graduates will demonstrate adaptability in various professional settings and possess a commitment to lifelong learning, keeping up with advancements in mathematics and related areas.

GA 10. Ethical and Professional Integrity: Graduates will exhibit ethical and professional behavior, adhering to academic integrity and ethical standards in their mathematical practice.

GA 11. Data Literacy: Graduates will be equipped with basic data literacy skills, understanding the significance of data and its applications in various domains.

GA 12. Innovation and Creativity: Graduates will be encouraged to think creatively, fostering innovative approaches to problem-solving and contributing to the advancement of mathematics and its applications.

7. QUALIFICATION DESCRIPTORS FOR B.SC. (HONS) MATHEMATICS PROGRAMME

Qualification descriptors for a B.Sc. (Hons) Mathematics program outline the intended learning outcomes and skills that students should achieve upon completing the program. These descriptors may vary depending on the university or educational institution offering the program, but here are some common qualification descriptors you might find:

1. **Mathematical Knowledge**: Graduates will demonstrate a comprehensive understanding of core mathematical concepts, theories, and principles, including calculus, algebra, discrete mathematics, linear algebra, statistics, probability theory, and numerical methods.

2. **Problem-Solving Skills**: Graduates will be proficient in applying mathematical techniques to solve complex problems in various domains, such as physics, engineering, economics, computer science, and social sciences.

3. **Critical Thinking**: Graduates will possess strong analytical and critical thinking skills, enabling them to analyze and evaluate mathematical arguments, proofs, and theorems.

4. **Abstraction and Generalization**: Graduates will be capable of abstract thinking and generalizing mathematical concepts to address real-world challenges and theoretical developments.

5. **Mathematical Modeling**: Graduates will be skilled in constructing mathematical models to represent and analyze practical situations, allowing them to make predictions and decisions based on mathematical reasoning.

6. **Numerical and Computational Proficiency**: Graduates will be proficient in using numerical and computational tools to solve mathematical problems and perform simulations.

7. **Communication:** Graduates will have effective communication skills, both written and oral, allowing them to present mathematical ideas and results clearly to both specialized and non-specialized audiences.

8. **Independent Research:** Graduates will be able to conduct independent research in mathematics, including formulating research questions, conducting literature reviews, and presenting their findings.

9. **Collaboration**: Graduates will be able to work effectively as part of a team, particularly in interdisciplinary settings, to solve complex problems and contribute to broader research efforts.

10. **Mathematical Software**: Graduates will have proficiency in using mathematical software and programming languages commonly used in mathematical analysis and modeling.

11. **Ethical Considerations**: Graduates will understand and adhere to ethical principles in the practice of mathematics, including proper attribution of sources and the responsible use of mathematical models and analysis.

12. **Lifelong Learning**: Graduates will recognize the importance of continuous learning and professional development in the field of mathematics and related disciplines.

8. PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 1: To prepare competent and effective teachers who have a strong foundation in their respective subjects and can use a variety of teaching strategies to engage and motivate students.

PEO 2: To develop in student-teachers an understanding of the principles of pedagogy and educational psychology, and how to apply them in classroom settings.

PEO 3: To equip student-teachers with the knowledge and skills needed to create a positive and inclusive learning environment, and to effectively manage classroom behaviour.

PEO 4: To instil in student-teachers a commitment to professional ethics and values, and to prepare them to be responsible and ethical educators.

PEO 5: To encourage student-teachers to engage in lifelong learning and professional development, and to prepare them to be reflective practitioners who can continuously improve their teaching practice.

PEO 6: To prepare student-teachers to use technology effectively in teaching and learning, and to be able to integrate technology into their classroom practices.

PEO 7: To foster in student-teachers an appreciation for diversity and multiculturalism, and to prepare them to be able to teach students from diverse backgrounds.

PEO 8: To prepare student-teachers to be effective collaborators and communicators who can work with colleagues, parents, and other stakeholders to promote student learning and development.

9. PROGRAMME OUTCOMES (PO)

PO1. Mathematical Knowledge: Demonstrate a thorough understanding of fundamental mathematical concepts, theories, and principles across various branches of mathematics.

PO2. Problem-Solving Skills: Apply mathematical techniques to solve complex problems in pure and applied mathematics, as well as in interdisciplinary contexts.

PO3. Critical Thinking: Analyze and evaluate mathematical arguments, proofs, and theorems to make informed decisions and draw logical conclusions.

PO4. Mathematical Modeling: Develop mathematical models to represent real-world situations and use them to analyze and interpret data.

PO5. Data Science Proficiency: Acquire a solid foundation in data science, including data manipulation, data visualization, statistical analysis, machine learning, and data mining techniques.

PO6. Interdisciplinary Skills: Develop the ability to apply mathematical principles and data science methodologies to solve real-world problems in diverse domains, such as finance, healthcare, engineering, and social sciences.

PO7. Data Analysis and Interpretation: Gain expertise in collecting, cleaning, and interpreting data, and apply appropriate statistical methods and machine learning algorithms to draw meaningful insights from data.

PO8. Computational Skills: Acquire proficiency in using programming languages and computational tools commonly used in data science, mathematical modeling, and statistical analysis.

PO9. Research and Problem-Solving Abilities: Cultivate independent research skills and the ability to tackle complex problems, combining mathematical rigor and data-driven analysis.

PO10. Teamwork and Communication: Enhance teamwork and communication skills through collaborative projects and the effective presentation of mathematical and data science concepts.

PO11. Lifelong Learning: Recognize the importance of continuous learning and engage in professional development to stay abreast of advancements in mathematics and related fields.

10. PROGRAMME SPECIFIC OUTCOMES (PSO)

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

PSO-2: Ability to illustrate mathematical ideas from basic theorems and axioms.
PSO-3: Ability to apply mathematics to solve, analyze theoretical problems of mathematics.

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

PSO-5: Ability to perform as a successful Mathematician analyst for industry, trade and commerce, banking, and non-banking financial institutions.

MAPPING OF SCHOOL VISION, MISSION WITH PROGRAMME OUTCOMES (PO) AND PROGRAMME SPECIFIC OUTCOMES(PSO)

School Vision	School Mission	Programme Outcomes (PO)	Programme Specific Outcomes (PSO)

The School of Basic and Applied Science aspires to emerge as a Centre of Excellence by disseminating analytical and scientific knowledge in the disciplines of Mathematics, Physics, Chemistry through fostering interdisciplinary research and innovation.	**M 1**	**PO 5, PO 6, PO 8, PO 9**	**PSO 5, PSO 2**
	M 2	**PO 1, PO 2, PO 3, PO 4, PO 7**	**PSO 1, PSO 2, PSO 3, PSO 5**
	M 3	**PO 6, PO 9, PO 11**	**PSO 5**
	M 4	**PO 1, PO 2, PO 3, PO 4, PO 5 PO 10, PO 11**	**PSO 1, PSO 2, PSO 3, PSO 4, PSO 5**

11. PROGRAMME DURATION

Name of the Programme	Duration
B.Sc. (Hons. with Research) Mathematics	4 Years (8 Semesters)

12. CAREER AVENUES

Graduates with a B.Sc. (Hons. with Research) Mathematics have a diverse range of career avenues to explore. This combination of mathematics and data science skills equips them to thrive in various industries and professions where data-driven decision-making and analytical expertise are highly sought-after. Some potential career avenues for such graduates include:

1. **Data Analyst**: Data analysts are responsible for collecting, cleaning, and analyzing data to extract valuable insights that inform business decisions and strategies.
2. **Data Scientist**: Data scientists apply mathematical and statistical techniques to large datasets to develop predictive models and make data-driven recommendations.
3. **Business Analyst:** Business analysts use data analysis to identify trends, opportunities, and potential areas for improvement within organizations.
4. **Financial Analyst**: Financial analysts apply mathematical and statistical techniques to analyze financial data, assess investment opportunities, and make informed financial decisions.
5. **Market Research Analyst**: Market research analysts gather and analyze data to help companies understand market trends, consumer preferences, and competitive landscapes.
6. **Operations Research Analyst**: Operations research analysts use mathematical modeling and optimization techniques to improve operational efficiency in various industries.
7. **Actuarial Analyst**: Actuarial analysts assess risk and uncertainty in insurance and finance industries, using mathematical and statistical methods to estimate future events' probabilities.
8. **Quantitative Analyst**: Quantitative analysts, or quants, develop and implement mathematical models for financial and investment strategies.

9. **Data Engineer**: Data engineers design, build, and maintain data infrastructure and systems for efficient data processing and storage.
10. **Research Scientist**: Graduates can pursue research roles in academia, government, or private organizations, contributing to the advancement of mathematical and data science knowledge.
11. **Consultant**: Graduates can work as data science or analytics consultants, helping businesses and organizations optimize their operations and decision-making processes.
12. **Machine Learning Engineer**: Machine learning engineers develop and deploy machine learning models for various applications, such as natural language processing, image recognition, and recommendation systems.
13. **Healthcare Analyst**: In the healthcare sector, graduates can work on analyzing medical data, improving patient outcomes, and conducting research in medical data analysis.
14. **Academic and Teaching Careers**: Graduates can pursue further studies and research in mathematics or data science and build careers as educators and professors in academic institutions.
15. **Government and Public Sector**: Graduates may find opportunities in government agencies and public sectors, where data analysis and policy-making go hand in hand.

13. ELIGIBILITY CRITERIA

1. The student should have passed the 10+2 examination conducted by the Central Board of Secondary Education or equivalent examination from a recognized Board with an aggregate of 50% or more with Mathematics as a main subject.

2. The reservation and relaxation for SC/ST/OBC/PwD and other categories shall be as per the rules of the Central Government/ State Government, whichever is applicable.

14. CLASS TIMINGS

The class will be held from Monday to Friday from 9.10 A.M. to 4.00 P.M.

15. TEACHING- LEARNING PROCESS

The School of Basic and Applied Sciences brings an attitudinal change among prospective teachers for their advancement into accountable agents of change in society. They are actively engaged in undertaking different activities during their course with systematic support and feedback from the faculty. During this program, the student-teachers in organization of different activit human resources, and organization of various activities. Such practices bring experiential learning by emphasizing reciprocal learning and reflection. The faculties foster and maintain a creative environment with a deep commitment to inculcate excellence in academics and contribute to student development through a focus on student-centric methods such as experiential learning, participative learning, problem-solving and ICT integration in the teaching-learning process.

16. ASSESSMENT METHODS

Methods	Weightage
Semester End Examination	50%
Internal Assessment	50%

Internal assessment is based on – Mid-semester Examination, Class test, Assignment, Project, Viva-voce, attendance of the student, seminar, group discussion, fieldwork etc.

17. MINIMUM ACCEPTABLE LEVEL OF ACADEMIC STANDARDS

The minimum acceptable level of achievement that a student must demonstrate to be eligible for the award of academic credit or qualification is the minimum acceptable level of academic standards. The Letter Grades and Grade Points which shall be used to reflect the outcome of the assessment process of the student's performance is indicated in Table 1.

Table 1

Marks Range (%)	Letter Grade	Grade Points	Description of the Grade
>90	O	10.0	Outstanding
80-90	A+	9.0	Excellent
70-80	A	8.0	Very Good
60-70	B+	7.0	Good
55-60	B	6.0	Above Average
50-55	C	5.5	Average
40-50	P	5.0	Pass
<40	F	0	Fail
-	AB	0	Absent
% marks≥ 50	S	-	Satisfactory
% marks <50	US	-	Unsatisfactory
	W	0	Withdrawal

18. PROGRAMME STRUCTURE

Four-YEAR B.SC. (HONS. WITH RESEARCH) MATHEMATICS AT A GLANCE

Total Credits [C]	**128 (upto 3rd Year)** **168 (upto 4th Year)**

19 Scheme of Studies for Programme

SEMESTER-WISE STRUCTURE

SEMESTER I

SN	COURSE CODE	COURSE TITLE	L	T	P	C
1	SCMA101	Calculus	4	0	0	4
2	SCMA151	Calculus Lab	0	0	2	1
3	SCMA103	Classical Algebra	4	0	0	4
4	UDT101	Data analytics using SQL (Minor 1)	2	0	4	4
5	AEC001	New Age Life skills - I	3	0	0	3
6	VAC	Value Added Course (EVS+Disaster)through Moodle	2	0	0	2
7	SEC011	SEC1 (Statistics for Data Science)	1	0	2	2
TOTAL			**20 Credits**			

SEMESTER II						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	SCMA202	Multivariable Calculus	4	0	0	4
2	SCMA251	Multivariable Calculus Lab	0	0	2	1
3	SCMA204	Modern Algebra	4	0	0	4
4	UDT102	Data analytics using R (Minor 2)	2	0	4	4
5	AEC002	New Age Life skills - II	3	0	0	3
6	VACII	Value Added Course (Based on Extension Activity)	2	0	0	2
7		Open Elective/Generic Elective-I	3	0	0	3
8	SEC012	Introduction to data science using basic to advanced level Excel (SEC-II)	1	0	2	2
TOTAL			**23 Credits**			

SEMESTER III						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	SCMA301	Real Analysis	4	0	0	4
2	SCMA303	Ordinary Differential Equation	4	0	0	4
3	SCMA351	Ordinary Differential Equation Lab	0	0	2	1
4	AEC003	New Age Life skills - III	3	0	0	3
5		Open Elective/Generic Elective-II	3	0	0	3

6	VAC3	Vedic Mathematics	2	0	0	2
7	UDT103	Python for Data Science (Minor 3)	2	0	4	4
8		Mandatory 4 weeks Summer internship/Project	2	0	0	2
TOTAL			**23**			

SEMESTER IV						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	SCMA402	Linear Algebra	4	0	0	4
2	SCMA404	Complex analysis	4	0	0	4
3	SCMA451	Complex analysis Lab	0	0	2	1
4	SCMA406	Partial Differential Equation and Calculus of Variation	4	0	0	4
5	SCMA452	Partial Differential Equation and Calculus of Variation Lab	0	0	2	1
6		Open Elective/Generic Elective-III	3	0	0	3
7	VAC4	VAC-IV (**FUNDAMENTAL RIGHTS OF CONSTITUTION WITH GENDER JUSTICE**)	2	0	0	2
8	UDT104	Data Preprocessing and visualization using Python (Minor 4)	2	0	4	4
TOTAL			**23**			

SEMESTER V						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	SCMA501	Numerical Method	4	0	0	4
2	SCMA551	Numerical Method Lab	0	0	4	2

3	SCMA503	Metric Spaces	4	0	0	4
4	SCMA505/507	Discipline Specific Elective - I	4	0	0	4
5	UDT105	Time Series Analysis & Forecasting using Python (Minor 5)	3	0	2	4
6	SEC013	Data Analytics with Tableau (SEC 3)	2	0	0	2
7		Mandatory 4 weeks Summer internship/Project	2	0	0	2
TOTAL			22			

SEMESTER VI						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	SCMA602	Probability and Statistics	4	0	0	4
2	SCMA651	Probability and Statistics Lab	0	0	2	1
3	SCMA604/606	Discipline Specific Elective - II	4	0	0	4
4	UDT106	Fundamental of Machine Learning (Minor 6)	2	0	4	4
5	SEC014	SEC (Documentation using Latex)) (SEC-4)	1	0	2	2
6		Additional Minor Project	2	0	0	2
TOTAL			**15+Minor Project (17 Credit)**			

SEMESTER VII						
SN	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	SCMA701	Research Methodology	4	0	0	4
2	SCMA703-7013	(Guide specific paper)	4	0	0	4
3	SCMA7015	Integral Transform and Spatial Functions	4	0	0	4
4	UDT107	Deep Learning Using Python (Minor 7)	3	0	2	4
5	UDT108	Project and Case study (Minor 8)	2	0	4	4
TOTAL			**20**			

SEMESTER VIII						
SN	COURSE CODE	COURSE TITLE	L	T	P	C
1	SCMA802	Research Ethics and Intellectual Property Rights	4	0	0	4
2	SCMA804	Computer Algebra System and related Software's	2	0	0	2
3	SCMA851	Computer Algebra System and related Software's Lab	0	0	4	2
4	SCMA806	Research Project-II	12	0	0	0
TOTAL			20			

Total Credits [C]	128 (upto 3rd Year) 168 (upto 4th Year)

Discipline Specific Electives

Discipline Specific Elective I and II (Choose any two)						
SN	COURSE CODE	COURSE TITLE	L	T	P	C
1	SCMA505	Advanced Algebra	4	0	0	4
2	SCMA507	Linear Programming	4	0	0	4
3	SCMA604	Applied Mechanics	4	0	0	4
4	SCMA606	Mathematical Modeling	4	0	0	4

SEMESTER-I

SCMA101	CALCULUS (VERSION 1)	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours					
Pre-requisites/Exposure	NIL				
Co-requisites	--				

COURSE OBJECTIVES

The course will enable the student-teacher to:

- To assimilate the notions of limit of a sequence and convergence of a series of real numbers.
- To calculate the limit and examine the continuity of a function at a point.
- To understand the consequences of various mean value theorems for differentiable functions.
- Sketch curves in Cartesian and polar coordinate systems.
- Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

COURSE OUTCOMES (CO)

On completion of this course, the student-teacher will be able to:

C. Applied the methods to test convergence/divergence of some basis series.
CI. Appreciate how functions can be used to model situations such as population growth tides, vibrating springs, and gas emissions.
CII. Recognize the rules of identifying asymptotes and employ the same to different curves.
CIII. Learn the concepts of curvature, circle of curvature and apply the concepts to solve problems
CIV. Determine limits numerically, algebraically, and from a graph.
CV. Apply the derivative to solve a variety of problems (related rates problems, optimization problems, curve sketching).

CATALOG DESCRIPTION

Calculus is a transition course to upper-division mathematics and computer science courses. Students will extend their experience with functions as they study the fundamental concepts of calculus: limiting behaviors, derivatives, optimization, related rates, graphing and other applications of derivatives. Important objectives of the calculus sequence are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

COURSE CONTENT

Unit I: **8 Contact Hours**

Sequences and Integration: Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences; Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals.

Unit II: **12 Contact Hours**

Limit and Continuity: definition of limit of a real valued function, Limit at infinity and infinite limits;Continuity of a real valued function, Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity, Types of discontinuity; Uniform continuity.

Unit III: **14 Contact hours**

Differentiability: Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity, Differentiability and monotonicity, Chain rule of differentiation; Darboux's theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems; Successive differentiation, Leibnitz's theorem.

Expansions of Functions: Maclaurin's and Taylor's theorems for expansion of a function in an infinite series, Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder; Maxima and minima.

Unit IV: **12 Contact hours**

Curvature, Asymptotes and Curve Tracing: Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes; Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points, Position and nature of double points; Tracing of Cartesian, polar and parametric curves.

Suggested Text Books

1. Gorakh Prasad (2016). *Differential Calculus* (19^{th} edition). Pothishala Pvt. Ltd

Advanced Readings

1. Howard Anton, I. Bivens& Stephan Davis (2016). *Calculus* (10^{th} edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. WieslawKrawcewicz&Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. George B. Thomas Jr., Joel Hass, Christopher Heil& Maurice D. Weir (2018). *Thomas*'

Calculus (14th edition). Pearson Education.

Open Educational Resources (OER)

https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.1x+2T2019/about

https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.2x+3T2019/about

https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.3x+1T2020/about

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5
SCMA 101 CALCULUS	CO 1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO 2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO 3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2
	CO 4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO 5																
	CO 6																

Unit I	Sequences and Integration
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research

National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Limit and Continuity
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Differentiability
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Expansions of Functions
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
SDG	Foster Innovation (SDG9), Skills for Decent Work (SDG 4.4), Skills for Decent Work (SDG 4.4), Professional Development of Teachers (SDG 4.c)
NEP 2020	Online and Digital Education: Ensuring Equitable Use of Technology (24.1-24.5), Technology Use & Integration (23.1- 23.13), Technology Use & Integration (23.1- 23.13), Promoting High-quality research (18.1-18.9)
POE/4th IR	-

Teaching Plan:

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]-Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	Real numbers, Sequences of real numbers, Convergence of sequences and series, Bounded and monotonic sequences	TB1	Lecture
Week 2	Definite integral as a limit of sum, Integration of irrational algebraic functions and transcendental functions, Reduction formulae, Definite integrals	TB1	Lecture
Week 3	definition of limit of a real valued function, Limit at infinity and infinite limits;Continuity of a real valued function	TB1, https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.1x+2T2019/about	Lecture
Week 4	Properties of continuous functions, Intermediate value theorem, Geometrical interpretation of continuity	TB1	Presentation
Week 5	Types of discontinuity; Uniform continuity	TB1	Lecture

Week 6	Differentiability of a real valued function, Geometrical interpretation of differentiability, Relation between differentiability and continuity	TB1,https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.2x+3T2019/about	Lecture
Week 7	Differentiability and monotonicity, Chain rule of differentiation; Darboux's theorem, Rolle's theorem	TB1	Quiz
Week 8	Lagrange's mean value theorem, Cauchy's mean value theorem, Geometrical interpretation of mean value theorems; Successive differentiation, Leibnitz's theorem	TB1	Lecture
Week 9	Maclaurin's and Taylor's theorems for expansion of a function in an infinite series	TB1	Lecture
Week 10	Taylor's theorem in finite form with Lagrange, Cauchy and Roche–Schlomilch forms of remainder; Maxima and minima	TB1	Lecture
Week 11	Curvature; Asymptotes of general algebraic curves, Parallel asymptotes, Asymptotes parallel to axes	TB1	Lecture
Week 12	Symmetry, Concavity and convexity, Points of inflection, Tangents at origin, Multiple points	TB1	Lecture
Week 13	Position and nature of double points	TB1	Lecture

Week 14	Tracing of Cartesian, polar and parametric curves.	TB1	Lecture

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1	To assimilate the notions of limit of a sequence and convergence of a series of real numbers.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	To calculate the limit and examine the continuity of a function at a point.		
3	To understand the consequences of various mean value theorems for differentiable functions.		
4	Sketch curves in Cartesian and polar coordinate systems. Apply derivative tests in optimization problems appearing in social sciences, physical sciences, life sciences and a host of other disciplines.		

SCMA151	CALCULUS LAB (VERSION 1)	L	T	P	C
Version 3.0		0	0	4	2
Total Contact Hours					
Pre-requisites/Exposure					
Co-requisites	MATLAB software				

COURSE OBJECTIVES

The course will enable the student-teacher to:

- Understand how to plot the graph of functions, polynomials and evolution of limit.
- Learn how to trace conics in both coordinates system by MATLAB.
- Understand how to plot of ellipsoid, hyperboloid by MATLAB.

COURSE OUTCOMES (CO)

On completion of this course, the student-teacher will be able to:

CO1. Students learn by plotting graph of functions and polynomials of order 4 and 5.
CO2. Understanding of the evaluation limit and derivative by MATLAB
CO3. To skech the graph of parametic curve, and obtained surface of revolution with MATLAB
CO4. Students learn how to trace conics in Cartesian coordinates/polar coordinates by MATLAB
CO5. To plot the graph of ellipsoid, hyperboloid of one and two sheets by MATLAB

CATALOG DESCRIPTION

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs.

COURSE CONTENT

List of practical

- Plotting the graphs of the functions

and to illustrate the effect of a and b on the graph.

- Plotting the graphs of the polynomial of degree 4 and 5.
- Calculate the limit and derivative of above function.
- Sketching parametric curves (eg. Trochoid, cycloid, hypocycloid).
- Obtaining surface of revolution of curves.
- Tracing of conics in Cartesian coordinates/polar coordinates.
- Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates)

Suggested Text Books

1. Lisa Ober broeckling, Programming Mathematics Using MATLAB, Academic Press
2. Ronald L. Lipsman, Jonathan M. Rosenberg, Calculus with MATLAB: With Applications to Geometry and Physics, Springer International Publishing

Open Educational Resources (OER)

https://www.youtube.com/watch?v=xw569QYppfw&list=PLaFkSNXeEhSjzymLLWCJH4BORqXYPKA5E

https://www.youtube.com/watch?v=56WnDNxLuZU&list=PLIBq0Le-hnWtpCWuzGwdi7tYva64B_nYZ

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5

SCMA CALCULUS LAB(VERSION1)	**CO 1**	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO 2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO 3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2
	CO 4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO 5																
	CO 6																

Unit I	Plottting of graphs, surface of revolution of curves
Local	Applicable in Mathematical Modelling
Regional	Applicable in Mathematical Modelling
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Plotting the graphs of the functions and to illustrate the effect of a and b on the graph. Plotting the graphs of the polynomial of degree 4 and 5. Tracing of conics in Cartesian coordinates/polar coordinates. Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates)
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Foster Innovation (SDG9)
NEP 2020	Technology Use & Integration (23.1- 23.13)
POE/4th IR	Technical Skills that match Industry Needs

Teaching Plan:

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]-**	**Teaching-Learning Method**

		Chapter/ Page No./ Open Education Resources [OER]	
Week 1	Plotting the graphs of the functions and to illustrate the effect of a and b on the graph.	TB1	Demonstration
Week 2	Plotting the graphs of the polynomial of degree 4 and 5.	TB1, https://www.youtube.com/watch?v=56WnDNxLuZU&list=PLIBq0Le-hnWtpCWuzGwdi7tYva64B_nYZ	Demonstration
Week 3	Calculate the limit and derivative of above function.	TB1,**https://www.youtube.com/watch?v=xw569QYppfw&list=PLaFkSNXeEhSjzymLLWCJH4BORqXYPKA5E**	Demonstration
Week 4	Sketching parametric curves (eg. Trochoid, cycloid, hypocycloid).	TB1	Demonstration
Week 5	Obtaining surface of revolution of curves.	TB1	Demonstration
Week 6	Tracing of conics in Cartesian coordinates/polar coordinates.	TB1	Demonstration
Week 7	Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates)	TB1	Demonstration

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1	Students learn by plotting graph of functions and polynomials of order 4 and 5.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	Practical and viva-voce examinations.
2	Understanding of the evaluation limit and derivative by MATLAB		
3	To sketch the graph of parametic curve, and obtained surface of revolution with MATLAB		
4	Students learn how to trace conics in Cartesian coordinates/polar coordinates by MATLAB To plot the graph of ellipsoid, hyperboloid of one and two sheets by MATLAB		

UDT101	**Data Analytics using SQL**	**L**	**T**	**P**	**C**
Version 3.0		**2**	**0**	**4**	**4**
Total Contact Hours	**64**				
Pre-requisites/Exposure	**Nil**				

Co-requisites	--

The course objective of "Data Science Using SQL" typically revolves around teaching students or participants the essential skills and knowledge needed to effectively utilize SQL (Structured Query Language) for data analysis and exploration within the context of data science. The course aims to provide a strong foundation in SQL and its application in various data-related tasks, with a focus on supporting data-driven decision-making processes.

CO:

Upon successful completion of the course students should be able to:

1. Write complex SQL queries to retrieve, filter, and aggregate data from relational databases.
2. Apply SQL commands to clean and pre-process data, including handling missing values, duplicates, and data transformations.
3. Utilize SQL queries to explore datasets, identify patterns, and summarize key statistics to gain initial insights into the data.
4. Visualize query results using tools or libraries to create meaningful charts, graphs, and plots that enhance data understanding.
5. Apply SQL skills to real-world data science problems in domains such as business, finance, marketing, and healthcare.

Course Contents:

Unit 1 Contact Hours: 16

- Introduction to Data Science
- Introduction To SQL Server
- Understanding Data & Information
- Database
- DBMS
- RDBMS
- DB Design
- Types of Databases
- SQL Server versions
- Creating DB
- Sub Languages of TSQL
- DDL
- DML
- TCL
- DCL
- DQL
- Creating Tables
- Insert,Delete,Update Data into Tables
- Normalization
- Constraints
- Unique
- Not Null

- Primary key
- Check
- Default
- Foreign Key

Unit 2 Contact Hours: 22

- Working With Single Table Queries
- Writing Queries using SELECT Statement
- Understanding Query Flow
- Operators in SQL Server
- Clauses in SQL Server
- Filtering Data Using WHERE Clause
- Sorting Data using ORDER BY Clause
- Avoid Duplicates using DISTINCT Clause
- Using Top Clause
- DML Commands
- Copying Data From one Table to Another
- Insert command
- Update Command
- Delete Command
- DDL Commands
- Create command
- Alter Command
- Drop Command
- Truncate Command
- Delete vs Truncate

Unit 3 Contact Hours: 10

- Built in Functions
- Scalar Functions
- String
- Date
- DateFromParts
- ISNULL
- Group Functions
- Aggregate Functions
- Cunt(*)
- MAX()
- MIN()
- AVG()
- SUM()

Unit 4 Contact Hours: 16

- Sub Queries
- Importance of Sub Query
- Types of Sub Queries
- Nested Queries

- JOINS
- Importance of Joins
- Types of Joins
- Inner Join or Equi Join
- Outer Join
- Left Outer Join
- Right Outer Join

List of Practical's

- Create a student table with the student id, name, and marks as attributes where the student id is the primary key.
- Insert the details of a new student in the above table
- Delete the details of a student in the above table
- Use the select command to get the details of the students with marks more than 80
- Find the min, max, sum, and average of the marks in a student marks table
- Find the total number of customers from each country in the table (customer ID, customer Name, country) using group by.
- Write a SQL query to order the (student ID, marks) table in descending order of the marks
- Write a SQL query to display the marks without decimal places, display the reminder after diving marks by 3 and display the square of marks
- Write a SQL query to display names into capital letters, small letters, display first 3 letters of name, display last 3 letters of name, display the position the letter A in name
- Remove extra spaces from left, right and both sides from the text - " SQL for Data Science "
- Display today's date in "Date/Month/Year" format
- Display day name, month name, day, day name, day of month, day of year for today's date.

Reference Books

SQL: QuickStart Guide – The Simplified Beginner's Guide To SQL

Open Educational Resources (OER)

Assessment & Evaluation

Components	**Assignment**	**Mid Term Examination**	**Attendance**	**End Term Examination**
Weightage (%)	**20**	**20**	**10**	**50**

Programme and Course Mapping

Programme and Course Mapping																	
CO	**PO**	**PO2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO**	**PSO**	**PSO**

	1														**4**	**5**	**6**
CO 1					**3**		**2**	**2**				**3**	**2**	**2**	**2**	**3**	**3**
CO 2					**3**		**2**	**2**				**3**	**2**	**2**	**2**	**3**	**3**
CO 3				**3**								**3**	**2**	**2**	**2**	**3**	**3**
CO 4							**3**					**3**	**2**	**2**	**2**	**3**	**3**
CO 5							**2**					**3**	**2**	**2**	**2**	**3**	**3**
CO 6	**2**											**3**	**2**	**2**	**2**	**3**	**3**
CO 7			**2**									**3**	**2**	**2**	**2**	**3**	**3**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	**Introduction to SQL and Relational Databases:**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Basic SQL Queries:**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	It equips you with the ability to manage and manipulate data in relational databases, a critical aspect of modern data-driven

	environments.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Data Manipulation with SQL:**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Allows you to retrieve, update, and analyze data efficiently, making you a valuable asset in various industries, including business, data analysis, and software development
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Working with Multiple Tables**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	It's a foundational skill that opens doors to more advanced data management and analytics techniques, empowering you to work with real-world data and make informed decisions.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	-
NEP 2020	Promoting High-quality research (18.1-18.9), Technology Use & Integration (23.1- 23.13)
POE/4th IR	Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	Introduction to Data Science, SQL, Database	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
2	Understanding SQL syntax: SELECT, FROM, WHERE, ORDER BY. Basic data retrieval: filtering, sorting.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
3	Data Manipulation with SQL	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
4	Inserting data: INSERT INTO. Updating data: UPDATE. Deleting data: DELETE.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
5	Modifying tables: ALTER TABLE, adding and dropping columns. Practical exercises combining SELECT, INSERT, UPDATE, and DELETE.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**

6	Data Filtering and Sub Queries	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
7	Complex WHERE clauses: AND, OR, IN, NOT IN, BETWEEN, LIKE, IS NULL. Working with wildcards: % and _. Subqueries: understanding, using, and optimizing.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
8	Complex WHERE clauses: AND, OR, IN, NOT IN, BETWEEN, LIKE, IS NULL. Working with wildcards: % and _. Subqueries: understanding, using, and optimizing.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
9	Data Aggregation and Grouping	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
10	Aggregation functions: COUNT, SUM, AVG, MIN, MAX. GROUP BY clause and its importance.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
11	Aggregation functions: COUNT, SUM, AVG, MIN, MAX. GROUP BY clause and its importance.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**

12	Aggregation functions: COUNT, SUM, AVG, MIN, MAX. GROUP BY clause and its importance.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
13	Data Manipulation and Functions:String functions: CONCAT, LENGTH, UPPER, LOWER, SUBSTRING. Numeric functions: ROUND, ABS, CEIL, FLOOR. Date functions: DATE, EXTRACT, DATE_FORMAT. Case statements for conditional logic.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
14	String functions: CONCAT, LENGTH, UPPER, LOWER, SUBSTRING. Numeric functions: ROUND, ABS, CEIL, FLOOR. Date functions: DATE, EXTRACT, DATE_FORMAT. Case statements for conditional logic.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**
15	Presentations and discussion. Review of key concepts and skills learned throughout the course.	**"SQL For Dummies" by Allen G. Taylor**	**Lectures, Examples, and Problem-Solving**

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Understand Database Fundamentals and SQL Basics	Lectures on database concepts, relational databases, and SQL fundamentals. Interactive discussions on the importance of data organization and querying. Hands-on exercises to write basic SQL queries for data retrieval. In-depth lectures on SELECT statements, WHERE clauses, and ORDER BY. Interactive query writing sessions with real-world scenarios. Group exercises to retrieve specific data using complex filtering criteria. Guided lessons on INSERT, UPDATE, DELETE statements. Practical examples of transforming data within a table. Mini-projects involving data aggregation, such as calculating averages, sums, and counts. Group discussions on the importance of data summarization. Project-based learning where students apply SQL to analyze and draw	**• Presentations and class discussions.** **• Assignments and class tests.** **• Hands on training** **• Student presentations.** **• Mid-term examinations.** **•Practical and viva-voce examinations.** **• End-term examinations.**
2	Proficiently Retrieve Data with SQL		
3	Manipulate and Transform Data Using SQL		
4	Aggregate and Group Data with SQL Utilize Joins Effectively for Data Integration		

		insights from datasets.	

SEC011	SEC1 (Statistics for Data Science)	L	T	P	C
Version		**1**	**0**	**2**	**2**
Total Contact Hours	42				
Pre-requisites/Exposure	NIL				
Co-requisites	NIL				

Course Description

Students learn the basics of business statistical methods. This course introduces the concepts of basic statistics concepts like measure of central tendancy, correlation, regression, with excel.

Course Objective

The course will enable the students to:

1. To understand the fundamentals of Statistics Methods

2. To interpret simple correlation and Regression analysis

3. To gain knowledge on time series and forecasting problems in statistical data

Course Outcome

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

1. Deploy concepts of Statistics method to compute averages for statistics data

2. Understand and explore techniques for creating effective data visualizations using charts, graphs, and

plots to gain insights from data.

3. Analyze casual relation between two variables by using correlation and regression methods.

Prerequisites: NIL

Unit 1: STATISTICAL METHODS

Introduction to statistics and Data collection – Summarizing and presenting statistical Data – Measures of central tendency – Measures of variation – Measures of skewness and kurtosis

Unit 2: CORRELATION AND REGRESSION

Introduction – correlation analysis – simple correlation analysis – Rank correlation –Regression analysis

List of Experiment

1. Graphical Representation of Data.

2. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles.

3. Measures of Dispersion (Ungrouped Data).

4. Measure of Dispersion (Grouped Data).

5. Moment, Measures of Skewness & Kurtosis (Ungrouped Data).

6. Moments, Measures of Skewness & Kurtosis (Grouped Data).

7. Correlation & Regression Analysis.

TEXT BOOKS

1. Richard I. Levin, David S. Rubin, " Statistics for Management ", Seventh Edition, Prentice – Hall of India, 2017.

2. T. Veerarajan," Statistics", Third Edition, McGraw hill, 2008.

3. Dr. B.S.Grewal, "Higher engineering Mathematics", Sixth Edition, Khanna publishers, 2017.

REFERENCE BOOKS

1 Allen B. Downey, "Think Stats: Exploratory Data Analysis 2nd Edition", O'Reilly publications, 2015.

2 Peter Bruce , Andrew Bruce , Peter Gedeck, "Practical Statistics for Data Scientists", O'Reilly publications, 2020.

E BOOKS https://greenteapress.com/thinkstats2/html/thinkstats2015.html#sec150

MOOC Ø https://www.udemy.com/course/statistics-for-data-science-and-business-analysis/

Ø https://www.coursera.org/specializations/data-science-statistics-machine-learning

Assessment & Evaluation

Components	Assignment/Project /Practicals	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Code and Title	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
SEC001	CO1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2

Unit I & 2	STATISTICAL METHODS & CORRELATION AND REGRESSION
Local	Applicable in Mathematical Modelling and research
Regional	Applicable in Mathematical Modelling and research industry
National	Applicable in Mathematical Modelling and research industry
Global	Applicable in fields like finance, marketing, and operations.
Employability	-
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Foster Innovation (SDG9)
NEP 2020	Technology Use & Integration (23.1- 23.13)
POE/4th IR	Technical Skills that match Industry Needs

Teaching Plan:

Weekly Teaching Plan	Topic/Unit No.	Textbook [TB]/ Reference Book [RB]-Chapter/ Page No./ Open Education Resources [OER]	Teaching-Learning Method
Week 1	Introduction to Statistics and Data Science Importance, limitation, functions, and applications.	TB1	Lecture/Presentation
Week 2	Types of Data (Categorical, Numerical) Data presenatation.	TB1, https://www.udemy.com/course/statistics-for-data-science-and-business-analysis/	Lecture/Presentation
Week 3	Measures of Central Tendency (Mean, Median, Mode) Introduction to Excel and Data Entry Basic Data Manipulation in Excel	TB1, https://www.udemy.com/course/statistics-for-data-science-and-business-analysis/	Lecture/Presentation

Week 4	Measures of Variability (Range, Variance, Standard Deviation) Data Visualization with Excel (Bar charts, Histograms)	TB1	Demonstration
Week 5	Creating Bar Charts and Histograms Designing Line and Scatter Plots	TB2	Demonstration
Week 6	quizzes or assignments	TB2	Demonstration
Week 7	Correlation	TB2	Demonstration
Week 8	Calculating Correlation Coefficients in Excel Understanding Covariance in Excel	TB2	Lecture/Presentation / Demonstration
Week 9	Introduction to Linear Regression Simple Linear Regression with Excel	TB2	Lecture/Presentation / Demonstration
Week 10	Linear Regression in Excel Multiple Regression in Excel	TB2	Lecture/Presentation / Demonstration
Week 11	Data Cleaning and Preprocessing in Excel Handling Missing Data in Excel Detecting and Managing Outliers in Excel	TB2	Lecture/Presentation / Demonstration
Week 12	data analysis project and presentation	TB2	Lecture/Presentation / Demonstration
Week 13	data analysis project and presentation	TB2	Lecture/Presentation / Demonstration
Week 14	Revision	TB2	Lecture/Presentation / Demonstration

Facilitating the Achievement of Course Learning Outcomes
For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Calculate and interpret measures of central	Start each topic with a brief lecture to introduce	Practical project and viva-voce examinations.

	tendency (mean, median, mode) and measures of dispersion (variance, standard deviation) to summarize and describe data.	concepts and provide context. Encourage questions and discussions during the lecture to clarify doubts.	
2	Create effective data visualizations using Excel to represent data graphically, including bar charts, histograms, line graphs, and scatter plots.	Conduct practical sessions using Excel to apply statistical concepts. Have students work on Excel exercises, such as calculating mean, median, and creating charts. Divide students into groups and assign them statistical problems to solve. Encourage collaboration and critical thinking to find solutions.	

---SCMA103	Classical Algebra	L	T	P	C

Version 1.0		**4**	**0**	**0**	**4**
Total Contact Hours	**58**				
Pre-requisites/Exposure	**Senior Secondary level knowledge of Algebra and Geometry**				
Co-requisites	**--**				

Course Objectives

The course will enable the student-teacher to:

- To introduce the basic tools of theory of equations, complex numbers, number theory and matrices to understand their linkage to the real-world problems
- To impart the fundamental concepts of classical algebra.
- To make the student understand and apply the results of classical algebra to any other field of mathematics for higher study.
- Perform matrix algebra with applications to Computer Graphics.

Course Outcomes (CO)

On completion of this course, the student-teacher will be able to:

CO1: Recall and identify elementary theorems on the roots of an equation.
CO2: List properties of polynomials, such as the remainder and factor theorem.
CO3: Interpret the significance of eigenvalues and eigenvectors.
CO4: Utilize De Moivre's theorem to find powers of complex numbers.
CO5: Examine the rank of a matrix and its applications in linear systems.
CO6: Assess the properties of invertible matrices and their applications in graphics.
CO7: Generate a step-by-step solution to a challenging matrix transformation problem.

Catalog Description

This course imparts the basic concepts of algebra and Number Theory. It enables them to differentiate between real and imaginary numbers. This course helps students in variety of ways to solve the problem efficiently. The course introduces the basic concepts about number system, matrices and polynomials. Throughout the course, students will engage in critical analysis and reflection on mathematical concepts and theorems.

Top of Form
Bottom of Form

Course Contents:

Unit 1: Theory of Equations and Complex Numbers **20 Contact hours**
Elementary theorems on the roots of an equation, Polynomials, The remainder and factor theorem, Synthetic division, Factored form of a polynomial, Descarte's rule of signs, Strum's theorem (statement

only), Symmetric functions of roots, Solution of cubic equation by Cardon's method, Solution of biquadratic equation by Ferrari's method. The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations, Imaginary roots occur in pairs, Integral and rational roots;

Polar representation of complex numbers, The nth roots of unity, De Moivre's theorem for integer and rational indices and its applications.

Unit 2: Equivalence Relations and Functions **10 Contact hours**

Equivalence relations, Binary relation, Well ordering principle, Equivalence relation, congruence relation in integers, Equivalence class, Relation induced by a partition of a set, Fundamental theorem on Equivalence relation, Partial order relation, Functions, Composition of functions, Invertibility and inverse of functions, One-to-one correspondence and the cardinality of a set.

Unit 3: Basic Number Theory **10 Contact hours**

The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering principle.

Unit 4: Row Echelon Form of Matrices and Applications **18 Contact hours**

Systems of linear equations, Row reduction and echelon forms, Vector equations, The matrix equation Ax = b, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations, The matrix of a linear transformation; Matrix operations, The inverse of a matrix, Characterizations of invertible matrices, Applications to Computer Graphics, Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton theorem.

Suggested Text Books

1. Andreescu, Titu & Andrica Dorin. (2014). Complex Numbers from A to...Z. (2nd ed.). Birkhäuser. Department of Mathematics, University of Delhi 17
2. Dickson, Leonard Eugene (1922). First Course in The Theory of Equations. John Wiley & Sons, Inc. New York. The Project Gutenberg EBook.
3. Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.
4. Kolman, Bernard, & Hill, David R. (2001). Introductory Linear Algebra with Applications (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.
5. Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). Linear Algebra and its Applications (5th ed.). Pearson Education

Advanced Readings

1. Andrilli, Stephen, & Hecker, David (2016). Elementary Linear Algebra (5th ed.). Academic Press, Elsevier India Private Limited.
2. Burton, David M. (2007). Elementary Number Theory (7th ed.). Tata Mc-Graw Hill Edition, Indian Reprint.
3. Schaum's outline series, "Linear Algebra", McGraw Hills.

Open Educational Resources (OER)

1. **https://www.askiitians.com/iit-study-material/iit-jee-mathematics/algebra/**

2. https://www.mathplanet.com/
3. https://ocw.mit.edu/courses/mathematics/18-701-algebra-i-fall-2010/study-materials/
4. https://www.edx.org/learn/algebra
5. https://tutorial.math.lamar.edu/
6. https://www.freebookcentre.net/Mathematics/Basic-Algebra-Books.html
7. https://www.khanacademy.org/math/algebra

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme and Course Mapping

Programme and Course Mapping																	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6
CO 1					3		2	2				3	2	2	2	3	3
CO 2					3		2	2				3	2	2	2	3	3
CO 3				3								3	2	2	2	3	3
CO 4							3					3	2	2	2	3	3
CO 5							2					3	2	2	2	3	3
CO 6	2											3	2	2	2	3	3
CO 7			2									3	2	2	2	3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Theory of Equations and Complex Numbers
Local	Access to resources

Regional	Access to resources
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Equivalence relation and functions
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Basic Number Theory
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Row Echelon Form of Matrices and Applications
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling

Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill, Foster Innovation (SDG9)
NEP 2020	Towards a More Holistic and Multidisciplinary Education (11), Transforming the Regulatory System of Higher Education (18), Online and Digital Education: Ensuring Equitable Use of Technology (24.1- 24.5)
POE/4th IR	Reflective and Constructivist Approach of learning, Team Work, Caring classroom communities that are focused on mathematical goals help develop students' mathematical identities and proficiencies, Entrepreurship Program through Innovation System, Application Based Learning, Reflective and Constructivist Approach of learning

Teaching Plan:

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	Elementary theorems on the roots of an equation, Polynomials, The remainder and factor theorem	Dickson, Leonard Eugene (1922). First Course in The Theory of Equations. John Wiley & Sons, Inc. New York. The Project Gutenberg EBook.	Lectures, Examples, and Problem-Solving
2	Synthetic division, Factored form of a polynomial, Descarte's rule of signs, Strum's theorem (statement	Dickson, Leonard Eugene (1922). First Course in The Theory of Equations. John Wiley & Sons, Inc. New York. The Project Gutenberg	Lectures, Examples, and Problem-Solving

	only)	EBook.	
3	Symmetric functions of roots, Solution of cubic equation by Cardon’s method	Dickson, Leonard Eugene (1922). First Course in The Theory of Equations. John Wiley & Sons, Inc. New York. The Project Gutenberg EBook.	Lectures, Examples, and Problem-Solving
4	Solution of biquadratic equation by Ferrari’s method, The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations	Dickson, Leonard Eugene (1922). First Course in The Theory of Equations. John Wiley & Sons, Inc. New York. The Project Gutenberg EBook.	Lectures, Examples, and Problem-Solving
5	Imaginary roots occur in pairs, Integral and rational roots; Polar representation of complex numbers	Andreescu, Titu & Andrica Dorin. (2014). Complex Numbers from A to...Z. (2nd ed.). Birkhäuser. Department of Mathematics, University of Delhi	Lectures, Examples, and Problem-Solving
6	The nth roots of unity, De Moivre’s theorem for integer and rational indices and its applications	Andreescu, Titu & Andrica Dorin. (2014). Complex Numbers from A to...Z. (2nd ed.). Birkhäuser. Department of Mathematics, University of Delhi	Lectures, Examples, and Problem-Solving

7	Equivalence relations, Binary relation, Well ordering principle	Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.	Lectures, Examples, and Problem-Solving
8	Equivalence relation, congruence relation in integers, Equivalence class, Relation induced by a partition of a set	Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.	Lectures, Examples, and Problem-Solving
9	Fundamental theorem on Equivalence relation, Partial order relation, Functions, Composition of functions	Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.	Lectures, Examples, and Problem-Solving
10	Invertibility and inverse of functions, One-to-one correspondence and the cardinality of a set	Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.	Lectures, Examples, and Problem-Solving
11	The division algorithm, Divisibility and the Euclidean algorithm, The fundamental theorem	Goodaire, Edgar G., & Parmenter, Michael M. (2005). Discrete Mathematics with Graph Theory	Lectures, Examples, and Problem-Solving

	of arithmetic	**(3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2015.**	
12	**Modular arithmetic and basic properties of congruences; Principles of mathematical induction and well ordering principle**	**Burton, David M. (2007). Elementary Number Theory (7th ed.). Tata Mc-Graw Hill Edition, Indian Reprint.**	**Lectures, Examples, and Problem-Solving**
13	**Systems of linear equations, Row reduction and echelon forms, Vector equations**	**Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). Linear Algebra and its Applications (5th ed.). Pearson Education**	**Lectures, Examples, and Problem-Solving**
14	**The matrix equation Ax = b, Solution sets of linear systems, Linear independence, The rank of a matrix and applications; Introduction to linear transformations**	**Lay, David C., Lay, Steven R., & McDonald, Judi J. (2016). Linear Algebra and its Applications (5th ed.). Pearson Education**	**Lectures, Examples, and Problem-Solving**
15	**The matrix of a linear transformation; Matrix operations, The inverse of a matrix, Characterizations of invertible matrices, Applications to Computer Graphics, Eigenvectors and eigenvalues, The characteristic equation and the Cayley-Hamilton**	**Kolman, Bernard, & Hill, David R. (2001). Introductory Linear Algebra with Applications (7th ed.). Pearson Education, Delhi. First Indian Reprint 2003.**	**Lectures, Examples, and Problem-Solving**

	theorem		

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Understand elementary theorems on the roots of an equation, polynomials, the remainder and factor theorem, synthetic division, factored form of a polynomial, Descarte's rule of signs, Strum's theorem (statement only), symmetric functions of roots, and solution of cubic and biquadratic equations. Comprehend the fundamental theorem of algebra, relations between the roots and coefficients of polynomial equations, and the occurrence of imaginary roots in pairs. Apply polar representation of complex numbers, De Moivre's theorem for integer and rational indices, and nth roots of unity to solve problems.	In-depth lectures explaining the concepts, exploring historical context, and showcasing real-world applications. Group discussions to explore connections between theory and practical problems. Engage students in group activities to identify examples of equivalence relations and binary relations. Use scenarios to explain the concept of well-ordering principle and its applications. Problem-solving sessions with modular arithmetic, examples from cryptography, and applications in computing. Encourage students to explore modular arithmetic in different number systems. Step-by-step explanations of matrix inversion, examples of diagonalization using eigenvalues and eigenvectors, and applications in differential equations and data analysis.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. •Practical and viva-voce examinations. • End-term examinations.
2	Demonstrate understanding of equivalence relations, binary relations, and well-ordering principle. Analyze congruence relations in integers, equivalence classes, and relations induced by a partition of a set. Explain fundamental		

	theorems on equivalence relations and partial order relations. Understand functions, composition of functions, invertibility, and one-to-one correspondence in sets.	**Lectures with visual representations, group discussions on linear independence, and practical applications of matrix equations in computer graphics and optimization problems.**	
3	**Apply mathematical induction and well-ordering principle to prove statements and solve problems.** **Understand the division algorithm, divisibility, and the Euclidean algorithm. Apply the fundamental theorem of arithmetic to factorize numbers.** **Utilize modular arithmetic and congruences to solve problems.**		
4	**Demonstrate proficiency in solving systems of linear equations, row reduction, echelon forms, and vector equations.** **ntroduce students to linear transformations, the matrix of a linear transformation, and matrix operations.** **Teach the concept of the inverse of a matrix, invertible matrices, and their characterizations. Explore applications of eigenvalues and eigenvectors, the characteristic equation, and the Cayley-Hamilton theorem.** **Provide access to suggested textbooks and open educational resources to deepen understanding and explore advanced topics.**		

SEMESTER-II

SCMA202	MULTIVARIATE CALCULUS (VERSION 1)	L	T	P	C
Version 3.0		**4**	**0**	**0**	**4**
Total Contact Hours					
Pre-requisites/Exposure					
Co-requisites	--				

COURSE OBJECTIVES

The course will enable the student-teacher to:

- To understand that many quantitates in various scientific fields depend on more than one variable: the strength of the gravitational force between two bodies depends on their masses and their distance apartTo calculate the limit and examine the continuity of a function at a point.
- To understandthat the monthly mortgage payments depend on the amount borrowed, the interest rate, and the number of years to pay off.
- To understand that many different ways of representing functions of several variables including algebraic formulas, graphs, contour diagrams, cross sections, and numerical tables.

COURSE OUTCOMES (CO)

On completion of this course, the student-teacher will be able to:

CO1 Learn conceptual variations while advancing from one variable to several variables in calculus.

CO2 Apply multivariable calculus in optimization problems.

CO3 Inter-relationship amongst the line integral, double and triple integral formulations

CO4 Apply the partial differentiation in Functions of several variables

CO5 Applications of multivariable calculus tools in physics, economics, optimization, and

understanding the architecture of curves and surfaces in plane and space etc.

CO6 Realize importance of Green, Gauss and Stokes' theorems in other branches of mathematics.

CATALOG DESCRIPTION

Calculus is a transition course to upper-division mathematics and computer science courses. Students will extend their experience with functions as they study the fundamental concepts of calculus: limiting behaviors, derivatives, optimization, related rates, graphing and other applications of derivatives. Important objectives of the calculus sequence are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

COURSE CONTENT

Unit I: **8 Contact Hours**

Partial Differentiation: Functions of several variables, Level curves and surfaces, Limits and continuity, Partial differentiation, Tangent planes, Chain rule, Directional derivatives, The gradient, Maximal andnormal properties of the gradient, Tangent planes and normal lines.

Unit II: **12 Contact Hours**

Differentiation: Higher order partial derivatives, Total differential and differentiability, Jacobians, Change of variables, Euler's theorem for homogeneous functions, Taylor's theorem for functions of two variables and more variables, Envelopes and evolutes.

Unit III: **14 Contact hours**

Extrema of Functions and Vector Field: Extrema of functions of two and more variables, Method of Lagrange multipliers, Constrained optimization problems, Definition of vector field, Divergence, curl, gradient and vector identities.

Double and Triple Integrals: Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integral over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates, Change of variables in double and triple integrals, Dirichlet integral.

Unit IV: **12 Contact hours**

Green's, Stokes' and Gauss Divergence Theorem: Line integrals, Applications of line integrals**:** Mass and Work, Fundamental theorem for line integrals, Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.

Suggested Text Books

1. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd

Advanced Readings

1. Jerrold Marsden, Anthony J. Tromba& Alan Weinstein (2009). *Basic MultivariableCalculus*, Springer India Pvt. Limited.
2. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.
3. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

https://online.stanford.edu/courses/math51-linear-algebra-multivariable-calculus-and-modern-applications

https://ocw.mit.edu/courses/18-02-multivariable-calculus-fall-2007/video_galleries/video-lectures/

https://archive.nptel.ac.in/courses/111/107/111107108/

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5
SCMA101 CALCULUS	CO 1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO 2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO 3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2

	CO 4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO 5																
	CO 6																

Unit I	Partial Differentiation
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment &Sustainability	-
Unit II	**Differentiation**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Extrema of Functions and Vector Field, Double and Triple Integrals**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-

Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Green's, Stokes' and Gauss Divergence Theorem
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill, Foster Innovation (SDG9)
NEP 2020	Promoting High-quality research (18.1-18.9), Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Reflective and Constructivist Approach of learning, Application Based Learning, Reflective and Constructivist Approach of learning

Teaching Plan:

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	Functions of several variables, Level curves and surfaces,	TB1	Lecture
Week 2	Limits and continuity, Partial differentiation, Tangent planes	TB1	Lecture

Week 3	Chain rule, Directional derivatives, The gradient,	TB1, https://online.stanford.edu/courses/math51-linear-algebra-multivariable-calculus-and-modern-applications	Lecture
Week 4	Maximal andnormal properties of the gradient, Tangent planes and normal lines.	TB1	Presentation
Week 5	Higher order partial derivatives, Total differential and differentiability	TB1	Lecture
Week 6	Jacobians, Change of variables, Euler's theorem for homogeneous functions	TB1,https://ocw.mit.edu/courses/18-02-multivariable-calculus-fall-2007/video_galleries/video-lectures/	Lecture
Week 7	Taylor's theorem for functions of two variables and more variables, Envelopes and evolutes.	TB1	Quiz
Week 8	Extrema of functions of two and more variables, Method of Lagrange multipliers,Constrained optimization problems	TB1	Lecture
Week 9	Definition of vector field, Divergence, curl, gradient and vector identities.	TB1	Lecture
Week 10	Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates, Triple integral over a parallelepiped and solid regions,	TB1	Lecture
Week 11	Volume by triple integrals, Triple	TB1	Lecture

	integration in cylindrical and spherical coordinates,		
Week 12	Change of variables in double and triple integrals, Dirichletintegral.	TB1	Lecture
Week 13	Line integrals, Applications of line integrals**:** Mass and Work, Fundamental theorem for line integrals,	TB1	Lecture
Week 14	Conservative vector fields, Green's theorem, Area as a line integral, Surface integrals, Stokes' theorem, The Gauss divergence theorem.	TB1, https://archive.nptel.ac.in/courses/111/107/111107108/	Lecture

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	The conceptual variations when advancing in calculus from one variable to multivariable discussions.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Apply multivariable calculus in optimization problems.		
3	Inter-relationship amongst the line integral, double and triple integral formulations,		

SCMA251	**MULTIVARIATE CALCULUS LAB (VERSION 1)**	**L**	**T**	**P**	**C**
Version 3.0		**0**	**0**	**4**	**2**
Total Contact					

Hours	
Pre-requisites/Exposure	
Co-requisites	MATLAB software/Mathematica/Maple software

COURSE OBJECTIVES

The course will enable the student-teacher to:

- Understand the evaluation of multiple integrals, volume of closes curve, arc length,Crical point andsaddle point.
- Learn how to evaluate dot product, cross product, gradient, Divergence and curl by MATLAB.
- Learn how to solve partial differentiation by by MATLAB.

COURSE OUTCOMES (CO)

On completion of this course, the student-teacher will be able to:

CO1. Students learn analysis of multivariable functions, continuity, and differentiability.
CO2. Understanding of the evaluation of multiple integrals by MATLAB
CO3. To calculate volume of closes curve, arc length,Crical point and saddle point with MATLAB
CO4. Students learn analysis of dot product, cross product, gradient, Divergence and curl by by MATLAB
CO5. To calculate partial derivatives and higher order of derivative by MATLAB

CATALOG DESCRIPTION

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs.

COURSE CONTENT

List of practical

- Evaluate the integration of the function
- Evaluate the double/ triple integral integration of the function
- Evaluate the area of closed curve
- Evaluate the arc length of curve
- Evaluate the Volume of closed curve
- Find the critical points and use Mathematica to graph the surface and determine the max/min/saddle nature of these points.

- Calculate the dot and cross product of vectors
- Calculate the Gradient of a vector, Divergence and Curl of vector

Suggested Text Books

1. Lisa Oberbroeckling, Programming Mathematics Using MATLAB, Academic Press
2. Ronald L. Lipsman, Jonathan M. Rosenberg, Multivariable Calculus with MATLAB: With Applications to Geometry and Physics, Springer International Publishing

Open Educational Resources (OER)

https://online.stanford.edu/courses/math51-linear-algebra-multivariable-calculus-and-modern-applications

https://ocw.mit.edu/courses/18-02-multivariable-calculus-fall-2007/video_galleries/video-lectures/

https://archive.nptel.ac.in/courses/111/107/111107108/

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5
SCMA CALCULUS	CO 1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO 2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO 3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2

LAB(VERSION1)	**CO 4**	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO 5																
	CO 6																

Unit I	Evaluate double/triple integration, area and volume of closed curve gradient , divergence, and curl
Local	Applicable in Mathematical Modelling
Regional	Applicable in Mathematical Modelling
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Evaluate the area of closed curve Evaluate the arc length of curve
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Safe and Inclusive Learning Environments
NEP 2020	Online and Digital Education: Ensuring Equitable Use of Technology (24.1-24.5)
POE/4th IR	Simulation

Teaching Plan:

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]-Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	Evaluate the integration of the function	TB1, https://www.youtube.com/watch?v=G9THGoGjNlo	Demonstration

Week 2	Evaluate the double/ triple integral integration of the function	TB1,	Demonstration
Week 3	Evaluate the area of closed curve	TB1,	Demonstration
Week 4	Evaluate the arc length of curve	TB1	Demonstration
Week 5	Evaluate the Volume of closed curve	TB1	Demonstration
Week 6	Find the critical points and use Mathematica to graph the surface and determine the max/min/saddle nature of these points.	TB1 https://www.youtube.com/watch?v=T-ZfIEjfBTA	Demonstration
Week 7	Calculate the dot and cross product of vectors Calculate the Gradient of a vector, Divergence and Curl of vector	TB1	Demonstration

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods

1	Students learn analysis of multivariable functions, continuity, and differentiability	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	Practical and viva-voce examinations.
2	Understanding of the evaluation of multiple integrals by MATLAB		
3	To calculate volume of closes curve, arc length,Crical point and saddle point with MATLAB		
4	Students learn analysis of dot product, cross product, gradient, Divergence and curl by MATLAB		

Modern Algebra

SCMA204	Modern Algebra	L	T	P	C
Version 2.0		4	0	0	4
Pre-requisites/Exposure	Classical Algebra				
Co-requisites	--				

Course Objectives:

The course will enable the students to:

1. Recognize the mathematical objects called groups.
2. Link the fundamental concepts of groups and symmetries of geometrical objects.
3. Explain the significance of the notions of cosets, normal subgroups, and factor groups.
4. Analyze consequences of Lagrange's theorem.
5. Learn about structure preserving maps between groups and their consequences.

Course Outcomes:

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

CO1. Understand the concept of algebraic structure groups
CO2. To connect algebraic structure with geometrical objects
CO3. To apply the notions of cosets, normal subgroups, and factor groups.
CO4. To make inferences about relations between group and its subgroup
CO5. Apply some special type maps like homomorphisms on algebraic structures
CO6. Compare various properties of group

Catalog Description:

This course particularly attempts to give an introduction to group theory, and shall lay a foundation for a more advanced course in algebra. The course begins with the concept of a group with definitions and examples of it. Subgroups and their properties are the key concepts in this learning programme. Moreover, the concept of cosets, normal subgroups, homomorphisms and their applications are also considered in the plan of action.

Course Content

Unit I: **12 lecture hours**

Groups and its Elementary Properties: Symmetries of a square, Definition and examples of groups including dihedral, permutation and quaternion groups, Elementary properties of groups. Subgroups and examples of subgroups, Cyclic groups, Properties of cyclic groups, Lagrange's theorem,

Unit II: **12 lecture hours**

Normal Subgroups: Properties of cosets, Normal subgroups, Simple groups, Factor groups, Cauchy's theorem for finite abelian groups; Centralizer, Normalizer, Center of a group, Product of two subgroups; Classification of subgroups of cyclic groups

Unit III: 8 lecture hours

Permutation Groups: Cycle notation for permutations, Properties of permutations, Even and odd permutations, alternating groups, Cayley's theorem and its applications

Unit IV: 8 lecture hours

Group Homomorphisms, Rings and Fields: Group homomorphisms, Properties of homomorphisms, Group isomorphisms, Properties of isomorphisms; First, second and third isomorphism theorems for groups; Definitions and elementary properties of rings and fields.

Text Books

1. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.

2. I.S. Luthar & I.B.S. Passi (2013). Algebra: Volume 1: Groups. Narosa.

Reference Books/Materials

1. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
2. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Assignment**	**Mid Term Examination**	**Attendance**	**End Term Examination**
Weightage (%)	**20**	**20**	**10**	**50**

CO and PO mapping:-

Course Code and Title	**Course Outcome**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
MODERN ALGEBRA	**CO1**	3	2	2	2	1	-	1	2	2	-	-	2	-	-	2	-
	CO2	2	3	2	2	-	2	2	2	2	2	-	1	-	2	2	-
	CO3	2	2	3		-	2	2	2	2	2	-	-	1	2	2	-
	CO4	2	2	2	3	2	2	2	2	3	2	1	2	-	2	3	2

CO5	2	2	2	2	3	2	2	2	2	2	-	2	-	2	2	2
CO6	2	2	2	2	2	3	2	2	2	2	1	2	1	2	2	2

Unit I	Groups and its Elementary Properties
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Normal Subgroups
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Permutation Groups
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit IV	Group Homomorphisms, Rings and Fields
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment &Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	Introduction to Modern algebra, symmetries of square as a motivating example, Definition and Basic example of groups	TB1	Lecture
Week 2	Dihedral, permutation, and quaternion groups, Elementary properties of groups, Subgroups and examples of subgroups	TB1	Lecture

Week 3	Cyclic groups: Definitions and examples, Properties of cyclic groups	TB1	Lecture
Week 4	Lagrange's theorem and its applications, Review and exercises	TB1	Lecture
Week 5	Properties of cosets, Normal subgroup and factor groups	TB1	Lecture
Week 6	Simple groups and their significance, Cauchy's theorem for finite abelian groups	TB1	Lecture
Week 7	Centralizer and normalizer of a group, center of a group	TB1	Lecture
Week 8	Product of two subgroups, classification of subgroups of cyclic groups	TB1	Lecture
Week 9	Cyclic notation for permutations, Properties of permutations, Even and odd permutations	TB1	Lecture
Week 10	Alternating groups and their properties, Cayley's theorem and its applications	TB1	Lecture
Week 11	Group homomorphism: Definition and Properties, Properties of Isomorphisms	TB1	Lecture
Week 12	First, Second and Third Isomorphism theorems for groups, Introduction to rings and fields, Definitions and elementary properties of rings and fields	TB1	Lecture

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Understand elementary properties of groups, subgroups, and cyclic groups.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Grasp concepts of normal subgroups, factor groups, and classify subgroups of cyclic groups.		
3	Learn about permutation groups, cycle notation and their application.		
4	Understand group homomorphisms, isomorphisms, and basic properties of rings and fields.		

(UDT102)	Data Analytics using R-Software	L	T	P	C
Version 3.0		2	0	4	4
Total Contact Hours	64				
Pre-requisites/Exposure	Basic concepts of Statistics				
Co-requisites	--				

Data Science is a fast-growing interdisciplinary field, focusing on the analysis of data to extract knowledge and insight. This course will introduce students to the collection. Preparation, analysis, modeling and visualization of data, covering both conceptual and practical issues. Examples and case studies from diverse fields will be presented, and hands-on use of statistical and data manipulation software will be included.

Course Objectives:

The student will have ability to:

1. Describe R syntax, including assigning variables

2. Describe simple operations with one of R's most important data structures – vectors 3

3. Describe lists, matrix, arrays and data frames.

4. Describe conditional statements, functions, classes and debugging.

5. Describe important functions for character strings and dates in R.

6. Develop understanding of interpreting and identifying patterns and trends

7. Describe steps to create customized graphics and charts

Course Outcomes:

Upon completion of the subject, students will be able to:

1. Command over R programming for Data Visualization

2. Understand the processes of data science - identifying the problem to be solved, data collection, preparation, modeling, evaluation and visualization.

3. Able to use basic R data structures in loading, cleaning the data and preprocessing the data.

4. Able to do the exploratory data analysis on real time datasets

5. Able to understand and implement Linear Regression

6. Able to understand and use - lists, vectors, matrices, dataframes, etc.

Syllabus:

UNIT I FUNDAMENTALS OF R

Introduction to R- Features of R - Environment - R Studio. Basics of R-Assignment - Modes - Operators - special numbers - Logical values - Basic Functions - R help functions - R Data Structures - Control Structures. Vectors: Definition- Declaration - Generating - Indexing - Naming - Adding & Removing elements - Operations on Vectors - Recycling - Special Operators - Vectorized if- then else-Vector Equality – Functions for vectors - Missing values - NULL values - Filtering & Subsetting.

UNIT II:

Matrices - Creating Matrices - Adding or Removing rows/columns - Reshaping - Operations - Special functions on Matrices. Lists - Creating List – General List Operations - Special Functions - Recursive Lists. Data Frames - Creating Data Frames - Naming - Accessing -

Adding - Removing - Applying Special functions to Data Frames - Merging Data Frames- Factors and Tables.

UNIT III:

WORKING WITH R

Working with data in R - Reading CSV and Excel Files, reading text files, Writing and saving data objects to file in R, String operations in R - Regular Expressions, Dates in R, Using Visualization tools – Bar Charts, Histograms, Pie Charts, Scatter Plots, Line Plots.

Input / Output – Reading and Writing datasets in various formats - Functions - Creating User-defined functions - Functions on Function Object - Scope of Variables - Accessing Global, Environment - Closures - Recursion. Exploratory Data Analysis - Data Preprocessing - Descriptive Statistics - Central Tendency - Variability - Mean - Median - Range - Variance - Summary - Handling Missing values and Outliers - Normalization

Data Visualization in R : Types of visualizations - packages for visualizations - Basic Visualizations, Advanced Visualizations and Creating 3D plots.

UNIT IV Data Visualization with R:

Basic Visualization Tools-Bar Charts, Histograms, Pie Charts, Basic Visualization Tools ContinuedScatter Plots, Line Plots and Regression, Specialized Visualization Tools-Word Clouds, Radar Charts, Waffle Charts, Box Plots, how to create Maps Creating Maps in R, How to build interactive web pages- Introduction to Shiny, Creating and Customizing Shiny Apps, Additional Shiny Features Hands on with ggplot2: Marginal Plots, Bubble Plots & Count Charts, Diverging Charts, Themes, Multi Panel Plots, Multiple Plots, Background Colors.

Text Books:

1. Cognitive computing with IBM Watson (by Rob High (Author), Tanmay Bakshi (Author),30 April 2019)-1st edition.

Reference Books:

1. Nina Zumel, John Mount, “Practical Data Science with R”, Manning Publications, 2014.

2. Jure Leskovec, Anand Rajaraman, Jeffrey D.Ullman, “Mining of Massive Datasets”,

Cambridge University Press, 2014.

3. Mark Gardener, “Beginning R - The Statistical Programming Language”, John Wiley & Sons, Inc., 2012.

4. W. N. Venables, D. M. Smith and the R Core Team, “An Introduction to R”, 2013.

5. Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, “Practical Data

Science Cookbook”, Packt Publishing Ltd., 2014.

6. Nathan Yau, “Visualize This: The FlowingData Guide to Design, Visualization, and Statistics”, Wiley, 2011.

7. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”,

Wiley, ISBN: 9788126551071, 2015.

8. R in a Nutshell: Second Edition Paperback– (23 Oct 2012) by Joseph Adler-2nd edition.

9. Applied Predictive Modeling Hardcover– (27 Apr 2018) by Max Kuhn, Kjell Johnson- 1st edition.

10. An Introduction to Statistical Learning: with Applications in R (Springer Texts in Statistics) Hardcover– (29 Sep 2017), by Gareth James, Daniela Witten, Trevor Hastie.

Student Activity

Databases need to undergo pre-processing to be useful for data mining. Dirty data can cause confusion for the data mining procedure, resulting in unreliable output. Data cleaning includes smoothing noisy data, filling in missing values, identifying and removing outliers, and resolving inconsistencies.

RECOMMENDED CO-CURRICULAR ACTIVITIES:

(Co-curricular activities shall not promote copying from textbook or from others work and shall encourage self/independent and group learning)

A. Measurable

1. Assignments (in writing and doing forms on the aspects of syllabus content and outside the syllabus content. Shall be individual and challenging)

2. Student seminars (on topics of the syllabus and related aspects (individual activity))

3. Quiz (on topics where the content can be compiled by smaller aspects and data (Individuals or groups as teams))

4. Study projects (by very small groups of students on selected local real-time problems pertaining to syllabus or related areas. The individual participation and contribution of students shall be ensured (team activity

B. General

1. Group Discussion

2. Try to solve MCQ's available online.

3. Others

RECOMMENDED CONTINUOUS ASSESSMENT METHODS:

Some of the following suggested assessment methodologies could be adopted;

1. The oral and written examinations (Scheduled and surprise tests)

2. Closed-book and open-book tests

3. Problem-solving exercises

4. Practical assignments and laboratory reports

5. Observation of practical skills

6. Individual and group project reports like "COVID-19 Analysis", "Estimated Quanrantain Period for Covid-19 Contacts", etc.

7. Efficient delivery using seminar presentations,

8. Viva voce interviews.

9. Computerized adaptive testing, literature surveys and evaluations,

10. Peers and self-assessment, outputs form individual and collaborative work.

E BOOKS

1. https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf

MOOC

1. https://online-learning.harvard.edu/subject/r

2. https://www.udemy.com/course/r-basics/

3. https://www.datacamp.com/courses/free-introduction-to-r

List of Practicals

R Programming LAB

1) Installing R and R studio

2) Create a folder DS_R and make it a working directory. Display the current working directory

3) installing the "ggplot2", "caTools", "CART" packages

4) load the packages "ggplot2", "caTools".

5) Basic operations in r

6) Working with Vectors:

• Create a vector v1 with elements 1 to 20.

• Add 2 to every element of the vector v1.

• Divide every element in v1 by 5

• Create a vector v2 with elements from 21 to 30. Now add v1 to v2.

7) Getting data into R, Basic data manipulation

8) Using the data present in the table given below, create a Matrix "M"

	C1	***C2***	***C3***	***C4***	***C5***
C1	***0***	***12***	***13***	***8***	***20***
C2	***12***	***0***	***15***	***28***	***88***
C3	***13***	***15***	***0***	***6***	***9***
C4	***8***	***28***	***6***	***0***	***33***

C5 20 88 9 33 0

• Find the pairs of cities with shortest distance.

9) Consider the following marks scored by the 6 students

Section	Student no	M1	M2	M3
A	1	45	54	45
A	2	34	55	55
A	3	56	66	64
B	1	43	44	45
B	2	67	76	78
B	3	76	68	37

- create a data structure for the above data and store in proper positions with proper names
- display the marks and totals for all students
- Display the highest total marks in each section.
- Add a new subject and fill it with marks for 2 sections.

- Three people denoted by P1, P2, P3 intend to buy some rolls, buns, cakes and bread. Each of them needs these commodities in differing amounts and can buy them in two shops S1, S2. The individual prices and desired quantities of the commodities are given in the following table "demand.

- Create matrices for above information with row names and col names.
- Display the demand.quantity and price matrices
- Find the total amount to be spent by each person for their requirements in each shop
- Suggest a shop for each person to buy the products which is minimal.

10) Consider the following employee details:

 Create a list for the employee data and fill gross and net salary.

- Add the address to the above list
- display the employee name and address
- remove street from address
- remove address from the List.

11) Loops and functions - Find the factorial of a given number

12) Implementation of Data Frame and its corresponding operators and functions

13) Implementation of Reading data from the files and writing output back to the specified file

14) Treatment of NAs, outliers, Scaling the data, etc

15) Applying summary() to find the mean, median, standard deviation, etc

16) Implementation of Visualizations - Bar, Histogram, Box, Line, scatter plot, etc.

E BOOKS

1. https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf

MOOC

1. https://online-learning.harvard.edu/subject/r
2. https://www.udemy.com/course/r-basics/
3. https://www.datacamp.com/courses/free-introduction-to-r

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme and Course Mapping

Programme and Course Mapping																	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	2		3		3			2				2	2	3	2	3	3
CO2			2		3		2	2				3	2	2	2	3	3
CO3				3								3	2	2	2	3	3
CO4				3			3					3	2	2	2	3	3
CO5		2					2					3	2	2	2	3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Fundamentals of R
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Creating list and matrices
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	A powerful programming language and environment for statistical computing and data analysis can significantly enhance your skill set
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit III	Working with R
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Data manipulation, visualization, and statistical modeling.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Data visualization with R
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Clean and preprocess data efficiently, create informative data visualizations, and conduct advanced statistical analyses.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	-
NEP 2020	Promoting High-quality research (18.1-18.9), Technology Use & Integration (23.1- 23.13)
POE/4th IR	Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topics	Reference Books /	Teaching Learning

		Textbooks	Method
1	Introduction to Data Analytics and R Basics Introduction to the course and syllabus What is data analytics and its importance Setting up R and RStudio	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving,** **Hands on practice**
2	R Basics: Variables, data types, basic operations Introduction to R packages and libraries Working with data frames	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
3	Data Manipulation and Visualization Importing and exporting data in R (CSV, Excel, etc.) Data cleaning and preprocessing Exploratory Data Analysis (EDA)	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
4	Basic data visualization using ggplot2 Creating bar plots, histograms, scatter plots	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
5	Statistical Foundations Descriptive statistics: Mean, median, mode, standard deviation, etc. Probability distributions Hypothesis testing basics	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
6	Introduction to t-tests and p-values	https://web.itu.edu.tr/~tokerem/The_Book	**Lectures, Examples, and Problem-**

	Understanding correlation and causation	_of_R.pdf	**Solving**
7	Data Wrangling and Transformation Working with dplyr package for data manipulation Filtering, arranging, summarizing data	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
8	Grouping and aggregating data Joining and merging datasets Reshaping data using tidyr	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
9	Advanced Visualization Customizing plots in ggplot2 Creating line plots, box plots, density plots	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
10	Advanced Visualization Customizing plots in ggplot2 Creating line plots, box plots, density plots	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
11	Faceting and multiple plots Interactive visualizations with Shiny (basic introduction)	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
12	Faceting and multiple plots Interactive visualizations with Shiny (basic introduction)	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
13	Project Work and Practical Applications Working on a guided data analytics project using real-	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**

	world dataset Developing data analysis pipelines		
14	Project Work and Practical Applications Working on a guided data analytics project using real-world dataset Developing data analysis pipelines	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**
15	Final Project Presentations and Review Students present their individual or group projects Review of key concepts and skills learned throughout the course Discussion on further resources for continued learning	https://web.itu.edu.tr/~tokerem/The_Book_of_R.pdf	**Lectures, Examples, and Problem-Solving**

Facilitating the Achievement of Course Learning Outcomes

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1	Students will be able to import, clean, manipulate, and visualize data using R and relevant packages.	Explain and perform descriptive statistics calculations (mean, median, standard deviation) on a sample dataset. Guide students	**• Presentations, practices and class discussions.** **• Assignments and class tests.** **• Student presentations.** **• Mid-term examinations.** **•Practical and viva-voce examinations.**
2	Students will be able to perform basic statistical analysis and conduct hypothesis tests using R.		
3	Students will develop the skills to work on a complete data		

	analytics project, analyze results, and effectively communicate findings.	through a t-test using R to compare two groups of data.	• **End-term examinations.**
4	Students will develop the skills to work on a complete data analytics project, analyze results, and effectively communicate findings.	Provide a dataset and instruct students to explore relationships between variables using correlation and scatter plots. Assign a hypothesis testing project where students formulate and test a hypothesis using real-world data.	

SEC012	**Introduction to Data Science Using Excel and Advanced Excel**	**L**	**T**	**P**	**C**
Version 3.0		**4**	**0**	**0**	**4**
Total Contact Hours					
Pre-requisites/Exposure					
Co-requisites	--				

COURSE OBJECTIVES

The course will enable the student-teacher to:

- To enhance excel based data modeling skills.
- To understand Data Conversion, data categorization, selection of appropriate data category and Collection and to utilize excel based data modeling skills.
- To compute Logical and Mathematical Averages, measures of dispersion, compute skewness, moments and kutosis and to use graph from graphical tool.
- To represent data on the graph, Cumulative frequency, subgroup of data with Histogram and subgroup of data with Histogram as well as with bar chart.
- To analyze data about the frequency of problems /Cause of problem and to use financial function.
- To compute variance, coefficient of variation, standard deviation two subgroups, correlation and co-variance.
- To implement statistical function on series of data and forecasting techniques.

COURSE OUTCOMES (CO)

On completion of this course, the student-teacher will be able to:

CO1 Use Microsoft Excel for business and data analytics, applying insert function library, make use of "Add-Ins Tool pack" for different statistical and mathematical function,Do Data Entry and manipulation using data context, to transpose the tabular data, convert data in to tabular format and able to use the excel tools for data categorization.

CO2 Discover Measures of central tendency by using analysis tools and formula and able state the conclusion.

CO3 Find Measures of Dispersion, Skewness & Kurtosis by using formula, calculate statistics measures using add-ins analytical tools, Able to use graph/chart from chart tool and deriving the conclusion of the experiment.

CO4 Display Graphical Presentation with Excel by using graph/Chart, templates to improve presentation of data, represent cumulative frequency, data analysis, understand "cause analysis", make use of formula and analytical tools to compute combined variance and Standard Deviation and compute coefficient of variation.

CO5 Find Correlation by applying statistical formula and analytical tool, identifying wrong data entries, make use of financial function using insert and deriving conclusion of the experiment.

CO6 Do Regression analysis by predicting using data analysis tools, make use of forecasting techniques, Able to use multiple regression using time series data and deriving conclusion of the experiment.

COURSE CONTENT

Unit I: **8 Contact Hours**

Understanding Data Tools, Understanding Formula Tools, insert functional library using insert function, Add-Ins Analysis Tool packs, Using Formulae and Charts, Formula writing, Functions, using Cell reference, Understanding Insert Tool: Chart Tools, Different types of charts and their use, Data Entry and manipulation, Tools for data entry and accuracy: Quick Access Toolbar customization, Form tool., Data Transposition to Fit Excel (as An Array), Data Conversion with the Logical IF, VLOOKUP, HLOOKUP, Pivot table, Pivot chart, Data Conversion of Text from Non–Excel Sources, Using Text To Column(From Data tool), Data Queries with Sort, Filter, and Advanced Filter Exact function data entry comparison

Unit II: **12 Contact Hours**

Data Validation, Specifying a valid range of values for a cell, Specifying a list of valid `values for a cell, Specifying custom validations based on formula for a cell, Measures of central tendency, Calculating Mean, Median, Mode, Minimum, Maximum, range with cell reference, Using Summary statistics, Calculate A.M., G.M., H.M.

Unit III: **14 Contact hours**

Measures of Dispersion, Skewness & Kurtosis, Calculate Range, Quartile Deviation, Mean absolute deviation, Standard deviation with cell reference, Using summary statistics Measures of Skewness Coefficient of skewness based on moments, Measure of Kurtosis, Graphical representation of Skewness, Graphical Presentation with Excel -1, Producing a Histogram, Improving the Graph, Producing a Cumulative Frequency Diagram, Producing a Histogram of subgroups of data, Producing a bar chart of subgroups of data

Unit IV: **12 Contact hours**

Correlation, Use of formula for calculating correlation and Co-variance, Use of error checking (Using Exact( ), IF), Use of frequently used financial functions (e.g. NPV) with suitable example of correlation, Regression analysis, Linear Regression and visual analysis(Chart), Multiple Regression equation with coefficient standard error and visual chart.

Suggested Text Books

Mohamed Miled. *Introduction to Data Analysis: Excel/VBA, SQL, Python, R*

Advanced Readings

Robert de Levie (2004) *Advanced Excel for Scientific Data Analysis*

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5
SCMA101 CALCULUS	CO 1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO 2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO 3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2
	CO 4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO 5																
	CO 6																

Unit I	Introduction to Excel data tools, formulas, charts and functions
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment &	-

Sustainability	
Unit II	Calculating Measures of central tendancy, summary statistics
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	organize, analyze, and visualize data efficiently.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Measure of dispersion, skewness, kurtosis
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Excel expertise becomes an essential skill for personal and professional growth.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Regression Analysis
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	enable you to tackle data analysis projects.
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
SDG	-
NEP 2020	Promoting High-quality research (18.1-18.9), Technology Use & Integration (23.1- 23.13)
POE/4th IR	Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	Data Tools, Functions, Types of Charts	TB1	Lecture
Week 2	q		
Week 3			
Week 4			
Week 5			
Week 6			
Week 7			
Week 8	Range, quartile Deviation, Mean absolute deviation,	TB1	Lecture
Week 9	Graphical representation of skewness, histogram, bar graph	TB1	Lecture
Week 10	Correlation	TB1	Lecture
Week 11	Calculation of correlation and covariance	TB1	Lecture
Week 12	Checking error	TB1	Lecture
Week 13	Linear Regression	TB1	Lecture

Week 14	Multiple Regression	TB1,	Lecture

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1	Use Microsoft Excel for business and data analytics, applying insert function library, make use of "Add-Ins Tool pack" for different statistical and mathematical function,	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Do Data Entry and manipulation using data context, to transpose the tabular data, convert data in to tabular format and able to use the excel tools for data categorization.		
3	Do Regression analysis by predicting using data analysis tools, make use of forecasting techniques, Able to use multiple regression using time series data and deriving conclusion of the experiment.		

SEMESTER III

-SCMA301	REAL ANALYSIS	L	T	P	C
		5	1	0	6
Pre-requisites/Exposure	**Limit, Continuity and Differentiability**				
Co-requisites	**--**				

Course Objectives

After successful completion of this course students will be able to :-

1. Learn basic properties and theorems of Real Numbers.
2. Know about higher order derivative and their application.
3. Learn some of the properties of Riemann integrable functions, and the applications of the fundamental theorems of integration
4. Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.

Course Outcomes

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

CO1 Understand many properties of the real line $\mathbb{R}$ and learn to define sequence in terms of functions from $\mathbb{R}$ to a subset of $\mathbb{R}$.

CO2 Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and concept of limit superior, limit inferior, and the limit of a bounded sequence.

CO3 Analyze and correlate difference between theorem, lemma and corollary.

CO4 Formulate and solve problems based upon higher order derivative.

CO5 Formulate and solve problems based upon sequence and Series

CO6 Differentiate between point wise and Uniform Convergence.

Catalog Description

This course imparts the basic concepts of Real numbers, sequence and Series. It enables students to differentiate between point wise and Uniform Convergence. This course helps students in variety of ways to solve the problems based upon improper integral. The course introduces the basic concepts about Riemann Integral and its properties. It also explains concept of Uniform Convergence.

Course Content

Unit I: **8 lecture hours**

Real Number System: Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$,The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$, Definition and types of intervals, Nested intervals property; Neighborhood of a point in $\mathbb{R}$, Open, closed and perfect sets in $\mathbb{R}$, Connected subsets of $\mathbb{R}$, Cantor set and Cantor function

Unit .II: **12 lecture hours**

Sequences of Real Numbers: Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano Weierstrass theorem for sequences, Limit superior and limit inferior of a sequence of real numbers, Cauchy sequence, Cauchy's convergence criterion.

Unit III: **8 lecture hours**

Infinite Series: Convergence and divergence of infinite series of positive real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series**;** Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's n^{th} root test, Integral test; Alternating series, Leibniz test, Absolute and conditional convergence, Rearrangement of series and Riemann's theorem.

Unit IV: **12 lecture hours**

Riemann Integration: Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus, First mean value theorem, Bonnet and Weierstrass forms of second mean value theorems.

Uniform convergence and Improper integral: Pointwise and uniform convergence of sequence and series of functions, Weierstrass's M-test, Dirichlet test and Abel's test for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiability, Improper integrals, Dirichlet test and Abel's test for improper integrals.

Text Books

1. Robert G. Bartle & Donald R. Sherbert (2015). Introduction to Real Analysis (4th edition).Wiley India.
2. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). An Introduction to Analysis (2nd edition), Jones and Bartlett India Pvt. Ltd.
3. K. A. Ross (2013). Elementary Analysis**:** The Theory of Calculus (2nd edition). Springer.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

<u>CO and PO mapping:-</u>

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5
REAL ANALYSIS	CO1	2	2	3	2	3	3	2	1	2	-	-	2	2	1	3	-
	CO2	2	3	2	2	2	3	3	2	3	-	-	-	2	2	2	-
	CO3	-	2	3	2	2	2	2	2	2	1	-	-	2	-	2	-
	CO4	-	2	2	3	3	3	3	3	3	-	-	2	1	2	3	2
	CO5	2	2	2	3	2	3	3	-	3	-	-	2	2	1	3	2
	CO6	1	1	1	3	2	3	2	2	2	1	-	1	2	-	-	1

Unit I	Real Number System
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Sequences of Real Numbers**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research

Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Infinite Series
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Riemann Integration, Uniform convergence and Improper integral
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:-

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	Introduction to the subject and its importance, Algebraic Properties and order propeties of real numbers, Bounded above and bounded below sets	TB1	Lecture
Week 2	Supremum and infimum of sets, Complementary property of real numbers, Archimidean property, Definitions and types of intervals	TB1	Lecture
Week 3	Neighbourhood of a point, Open set, Closed set, Perfect set, Properties of open sets and closed sets, Connected subsets of real numbers	TB1	Lecture
Week 4	Cantor set, cantor function and Exercises	TB1	Lecture
Week 5	Convergent sequence, Limit of a sequence, Bounded sequence and Limit theorems of sequence	TB1	Lecture
Week 6	Monotone sequence, Monotone convergence sequence, Subsequence and Bolzano-Weirstrass theorem for	TB1	Lecture

	sequences		
Week 7	Convergence and divergence of infinite series, Necessary condition for convergence, Cauchy criterion for convergence	TB1	Lecture
Week 8	Test for convergence of positive term series:- Basic comparison test, Limit comparison test, D' Alembert's ratio test, Cauchy nth root test	TB1	Lecture
Week 9	Alternating series, Leibnitz test, Absolute convergence	TB1	Lecture
Week 10	Conditional convergence, rearrangement of series, Riemann's theorem	TB1	Lecture
Week 11	Riemann integral, Integrability of continuous and monotonic functions, Fundamental theorem of integral calculus	TB1	Lecture
Week 12	First mean value theorem, Bonnet and Weirstrass forms of the second mean value theorems, Uniform convergence of sequence and series of functions, Improper integrals and tests for convergence	TB1	Lecture

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Understand properties of real number system,	(i) Each topic to be	• Presentations and class

	intervals, and sets, including completeness and density properties.	explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Recognize and analyze sequences of real numbers, including convergence, limits, monotone sequences, and Cauchy sequences.		
3	Comprehend concepts related to infinite series, convergence tests, and alternating series, including conditional and absolute convergence		
4	Learn Riemann integration, properties of integrable functions, and the fundamental theorem of integral calculus, along with uniform convergence and improper integrals.		

SCMA303	**ORDINARY DIFFERENTIAL EQUATIONS**	**L**	**T**	**P**	**C**
Version		**4**	**0**	**0**	**4**
Pre-requisites/Exposure	**Differentiation, Integration**				
Co-requisites	**--**				

Course Objectives

1	Identify, analyze and subsequently solve physical situations whose behaviour can be described by ordinary differential equations
2	Enhance and develop the ability of using the language of mathematics in analyzing the real-world problems of sciences and engineering.
3	Demonstrate the strength of mathematics in modelling and simulating real world problems of science and engineering.

Course Outcomes

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

CO1	Recognize different types of first-order differential equations, their characteristics, and apply appropriate techniques to find their solutions.
CO2	Apply the general theory of second-order linear differential equations with variable coefficients to solve problems using methods such as variation of parameters and undetermined coefficients.
CO3	Examine higher-order linear differential equations with constant coefficients, distinguish between homogeneous and non-homogeneous cases, and utilize techniques like variation of parameters and undetermined coefficients for solving these equations.
CO4	Utilize power series methods and Frobenius method to solve specific differential equations like Legendre's equation and Bessel's equation with specific properties.
CO5	Develop mathematical models based on differential equations to analyze and solve real-world problems in fields like physics, biology, engineering, and population dynamics.
CO6	Assess the physical implications of solutions derived from differential equations in practical scenarios, such as population growth and decay, mechanical oscillations, and electrical LCR circuits.

Catalog Description

In this introductory course on Ordinary Differential Equations, we first provide basic terminologies on the theory of differential equations and then proceed to methods of solving various types of ordinary differential equations. We handle first and second order differential equations and then higher order linear differential equations. The course demonstrates the usefulness of ordinary differential equations for modelling physical, biological, financial or economic problems. The ability to predict the way in which these systems evolve or behave is determined by modelling these systems and find solutions of the equations explicitly or approximately. The course includes complementary mathematical approaches for their solution, including analytical methods, graphical analysis and numerical techniques. A significant part of the course is emphasis on solving linear systems with computer software as a mathematical tool.

Course Content

UNIT-I **8 Lectures**

First Order Differential Equations: Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, Linear differential equations and equations reducible to linear form, Exact differential equations, Integrating factor, First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Picard's method of successive approximations and the statement of Picard's theorem for the existence and uniqueness of the solutions of the first order differential equations.

UNIT-II **8 Lectures**

Second Order Linear Differential Equations: Statement of existence and uniqueness theorem for linear differential equations, General theory of linear differential equations of second order with variable coefficients, Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, Transformations of the equation by changing the dependent/independent variable, Method of variation of parameters and method of undetermined coefficients, Reduction of order, Coupled linear differential equations with constant coefficients.

UNIT-III **12 Lectures**

Higher Order Linear Differential Equations: Principle of superposition for a homogeneous linear differential equation, Linearly dependent and linearly independent solutions on an interval, Wronskian and its properties, Concept of a general solution of a linear differential equation, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler-Cauchy equation, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

UNIT-IV **12 Lectures**

Series Solutions of Differential Equations: Power series method, Legendre's equation, Legendre polynomials, Rodrigue's formula, Orthogonality of Legendre polynomials, Frobenius method, Bessel's equation, Bessel functions and their properties, Recurrence relations.

Applications: Orthogonal trajectories, Acceleration-velocity model, Minimum velocity of escape from Earth's gravitational field, Growth and decay models, Malthusian and logistic population models, Radioactive decay, Drug assimilation into the blood of a single cold pill; Free and forced mechanical oscillations of a spring suspended vertically carrying a mass at its lowest tip, Phenomena of resonance, LCR circuits, Lotka-Volterra population model.

Reference Books/Materials

1. Belinda Barnes & Glenn Robert Fulford (2015). *Mathematical Modelling with Case Studies*: *A Differential Equation Approach Using* Maple *and* MATLAB (2nd edition).

Chapman & Hall/CRC Press, Taylor & Francis.

2. H. I. Freedman (1980). *Deterministic Mathematical Models in Population Ecology*. Marcel Dekker Inc.

3. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). Wiley.
4. Daniel A. Murray (2003). *Introductory Course in Differential Equations*, Orient.
5. B. Rai, D. P. Choudhury & H. I. Freedman (2013). *A Course in Ordinary Differential Equations* (2nd edition). Narosa.

6. Shepley L. Ross (2007). *Differential Equations* (3rd edition), Wiley India.
7. George F. Simmons (2017). *Differential Equations with Applications and Historical*

Notes (3rd edition). CRC Press. Taylor & Francis.

Open Educational Resources (OER)

1. https://nptel.ac.in/courses/111/106/111106100/
2. https://nptel.ac.in/courses/111/107/111107111
3. https://nptel.ac.in/courses/111/108/111108081/

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme and Course Mapping																	
CO	PO 1	PO 2	PO 3	PO 4	P O5	PO 6	P O7	P O8	P O9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PS O4	PS O5	PS O6
CO 1	3	2	1													2	
CO 2	2			2	3	1						3					
CO 3	3		3	3	2							2					
CO 4	2				2												
CO 5	3											3		2			
CO 6	3											2		3			
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	First Order Differential Equations
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Second Order Linear Differential Equations
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Higher Order Linear Differential Equations
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Series Solutions of Differential Equations, Applications
Local	Ingredient in Interdisciplinary Research

Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	-
NEP 2020	Promoting High-quality research (18.1-18.9), Technology Use & Integration (23.1- 23.13)
POE/4th IR	Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topic/Unit	Teaching-Learning Method	Textbook/Reference (Chapter/Page/OER)
1	UNIT-I: First Order Differential Equations	Lecture-based	TB: Chapter - First Order Differential Equations
	Basic concepts and genesis of ODEs		
	Order and degree of a differential equation		
	Differential equations of first order and first		

	degree		
	Equations with separable variables		
2	Homogeneous equations		
	Linear differential equations and reducible form		
	Exact differential equations		
	Integrating factor		
3	First order higher degree equations		
	Clairaut’s form and singular solutions		
	Picard’s method of successive approximations		
	Picard’s theorem for existence and uniqueness		

4	UNIT-II: Second Order Linear Differential Equations	Lecture-based	TB: Chapter - Second Order Linear Differential Equations
	Existence and uniqueness theorem		
	General theory of linear ODEs with variable coeffs		
	Solutions of homogeneous linear ODEs with const coeffs		
	Transformations of the equation		
5	Method of variation of parameters		
	Method of undetermined coefficients		
	Reduction of order		
	Coupled linear differential equations		

6	UNIT-III: Higher Order Linear Differential Equations	Lecture-based	TB: Chapter - Higher Order Linear Differential Equations
	Principle of superposition		
	Linearly dependent and independent solutions		
	Wronskian and its properties		
	General solution of a linear differential equation		
7	Linear homogeneous and non-homogeneous equations		
	Euler-Cauchy equation		
	Method of variation of parameters		
	Method of undetermined coefficients		

8	Inverse operator method		
	UNIT-IV: Series Solutions of Differential Equations	Lecture-based	TB: Chapter - Series Solutions of Differential Equations
	Power series method		
	Legendre's equation and polynomials		
9	Rodrigue’s formula and orthogonality		
	Frobenius method		
	Bessel's equation and functions		
	Applications: Orthogonal trajectories		
10	Acceleration-velocity model		
	Minimum velocity of escape from Earth’s		

	gravitational		
	Growth and decay models		
	Radioactive decay		
11	Drug assimilation into the blood of a single cold pill		
	Free and forced mechanical oscillations		
	Phenomena of resonance		
12	LCR circuits		
	Lotka-Volterra population model		
13	Review and Revision		
14	Final Exam		

Facilitating the Achievement of Course Learning Outcomes

Unit	Course Learning Outcomes (CLOs)	Teaching-Learning Activities	Assessment Task Methods
Unit-I	Understand basic concepts and genesis of ordinary differential equations. Solve first-order differential equations using appropriate techniques.	Lecture-based sessions, Problem-solving exercises	Written tests, Quizzes, Assignments
Unit-II	Analyze and solve second-order linear differential equations.Apply methods for solving coupled linear differential equations.	Lectures, Interactive discussions, In-class examples	Class tests, Group discussions,
Unit-III	Differentiate between linearly dependent and independent solutions. Apply various methods for solving higher-order linear differential equations.	Workshops, Group activities, Hands-on practice	Problem-solving assessments,
Unit-IV	Use power series and Frobenius method to find series solutions.Apply differential equations to real-world applications.	Numerical simulations, Case studies, Open educational resources (OER)	Project work, Practical examinations

SCMA351	**ORDINARY DIFFERENTIAL EQUATIONS Lab**	**L**	**T**	**P**	**C**
Version 2.0		**0**	**0**	**2**	**1**
Pre-requisites/Exposure					
Co-requisites	**--**				

Course Objectives

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically, to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs.

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

CO1. Evaluate program output accuracy through hand calculations

CO2. Analyze and interpret differential equation graphs

CO3. Apply integration techniques to find double and triple integrals of a function.

CO4. Apply mathematical techniques to find the area of closed curves

CO5. Create accurate two-dimensional graphs

CO6. Develop efficient and well-documented MATLAB code

Catalog Description

The aim of this course is to learn theory of ordinary differential equations and solution methods. Use knowledge of Ordinary Differential Equations (ODEs), modelling, the general structure of solutions, and analytic and numerical methods for solution. Nature of ODEs.. After completion of the course, the students will be able to solve the ODEs independently. They can solve PDEs in higher dimension. Convert ordinary differential equations to canonical form.

Course Content

List of practical

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model)
9. Basic Epidemic model of influenza
10. Basic Battle model

NOTE: Ten experiments are to be performed, out of which at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & setup by the concerned person as per the scope of the syllabus.

Programme and Course Mapping																	
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PS O4	P S O 5	P S O 6
CO 1	3				3												
CO 2	2	3			2												
CO 3	3		3		3												
CO 4	3		3		2				3								
CO 5	3		2		3	3										2	3
CO 6	3		3		3											3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Potting family of differential equations, depict various models
Local	Applicable in Mathematical Modelling
Regional	Applicable in Mathematical Modelling
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Reflective and Constructivist Approach of learning

-(UDT103)	Python for Data Science	L	T	P	C
		2	0	4	4
Pre-requisites/Exposure					
Co-requisites	--				

COURSE OUTCOMES

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

1 Identify the need for data science and solve basic problems using Python built-in data types and their methods.

2 Employ efficient storage and data operations using NumPy arrays.

3 Apply powerful data manipulations using Pandas.

4 Do data pre-processing and visualization using Pandas.

Prerequisites: NIL

Unit 1: INTRODUCTION TO DATA SCIENCE AND PYTHON PROGRAMMING

Introduction to Data Science - Why Python? - Essential Python libraries - Python Introduction- Features, Identifiers, Reserved words, Indentation, Comments, Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set - Type Conversion- Operators. Decision Making- Looping- Loop Control statement- Math and Random number functions. User defined functions - function arguments & its types.

Practical Component:

1. Implement basic Python programs for reading input from console.
2. Perform Creation, indexing, slicing, concatenation and repetition operations on Python built-in data types: Strings, List, Tuples, Dictionary, Set
3. Solve problems using decision and looping statements.
4. Apply Python built-in data types: Strings, List, Tuples, Dictionary, Set and their methods to solve any given problem
5. Handle numerical operations using math and random number functions
6. Create user-defined functions with different types of function arguments.

Unit 2: INTRODUCTION TO NUMPY

NumPy Basics: Arrays and Vectorized Computation- The NumPy ndarray- Creating ndarrays- Data Types for ndarrays- Arithmetic with NumPy Arrays- Basic Indexing and Slicing - Boolean Indexing- Transposing Arrays and Swapping Axes. Universal Functions: Fast Element-Wise Array Functions- Mathematical and Statistical Methods-Sorting Unique and Other Set Logic.

Practical Component:

1. Create NumPy arrays from Python Data Structures, Intrinsic NumPy objects and Random Functions.
2. Manipulation of NumPy arrays- Indexing, Slicing, Reshaping, Joining and Splitting.
3. Computation on NumPy arrays using Universal Functions and Mathematical methods.
4. Import a CSV file and perform various Statistical and Comparison operations on rows/columns.
5. Load an image file and do crop and flip operation using NumPy Indexing.

Unit 3: DATA MANIPULATION WITH PANDAS

Introduction to pandas Data Structures: Series, DataFrame, Essential Functionality: Dropping EntriesIndexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking. Summarizing and Computing Descriptive Statistics- Unique Values, Value Counts, and Membership. Reading and Writing Data in Text Format.

Practical Component:

1. Create Pandas Series and DataFrame from various inputs.
2. Import any CSV file to Pandas DataFrame and perform the following:

(a) Visualize the first and last 10 records
(b) Get the shape, index and column details
(c) Select/Delete the records(rows)/columns based on conditions.
(d) Perform ranking and sorting operations.
(e) Do required statistical operations on the given columns.
(f) Find the count and uniqueness of the given categorical values.
(g) Rename single/multiple columns.

Unit 4: DATA CLEANING, PREPARATION AND VISUALIZATION

Data Cleaning and Preparation: Handling Missing Data - Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers- String Manipulation: Vectorized String Functions in pandas. Plotting with pandas: Line Plots, Bar Plots, Histograms and Density Plots, Scatter or Point Plots.

Practical Component:

1.Import any CSV file to Pandas DataFrame and perform the following:

(a) Handle missing data by detecting and dropping/ filling missing values.
(b) Transform data using apply() and map() method.
(c) Detect and filter outliers.
(d) Perform Vectorized String operations on Pandas Series.
(e) Visualize data using Line Plots, Bar Plots, Histograms, Density Plots and Scatter Plots.

TEXT BOOKS

1. Y. Daniel Liang, “Introduction to Programming using Python”, Pearson,2012.
2. Wes McKinney, “Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython”, O’Reilly, 2nd Edition,2018.
3. Jake VanderPlas, “Python Data Science Handbook: Essential Tools for Working with Data”, O’Reilly, 2017.

REFERENCE BOOKS

1. Wesley J. Chun, “Core Python Programming”, Prentice Hall,2006.
2. Mark Lutz, “Learning Python”, O’Reilly, 4th Edition, 2009.

E BOOKS

1. https://www.programmer-books.com/introducing-data-science-pdf/
2. https://www.cs.uky.edu/~keen/115/Haltermanpythonbook.pdf
3. http://math.ecnu.edu.cn/~lfzhou/seminar/[Joel_Grus]_Data_Science_from_Scratch_First_Princ.pdf

MOOC

1. https://www.edx.org/course/python-basics-for-data-science
2. https://www.edx.org/course/analyzing-data-with-python
3. https://www.coursera.org/learn/python-plotting?specialization=data-science-python

Assessment & Evaluation

Components	**Assignment**	**Mid Term Examination**	**Attendance**	**End Term Examination**
Weightage (%)	**20**	**20**	**10**	**50**

Programme and Course Mapping

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1					**3**		**2**	**2**				**3**	**2**	**2**	**2**	**3**	**3**
CO2					**3**		**2**	**2**				**3**	**2**	**2**	**2**	**3**	**3**
CO3				**3**								**3**	**2**	**2**	**2**	**3**	**3**
CO4							**3**					**3**	**2**	**2**	**2**	**3**	**3**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Introduction to data science and python Programming
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Introduction to Programming: Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Introduction to numpy
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	The basic elements of python
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Data Manipulation with Pandas
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Abstract Data Types and Classes, table construction
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Data cleaning, preparation, and visualization
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	Handles data and works on real projects
Entrepreneurship	-
Skill Development	Simple Algorithms for data manipulations

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	-
NEP 2020	Promoting High-quality research (18.1-18.9), Technology Use & Integration (23.1- 23.13)
POE/4th IR	Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	Weeks 1-2: Introduction to Python Basics Introduction to Python and its applications in Data Science Setting up Python environment (Anaconda, Jupyter Notebook) Variables, data types, and basic operations Control structures: if statements, loops Functions and their usage		**Lectures, Examples, and Problem-Solving, Hands on practice**
2	Weeks 1-2: Introduction to Python Basics Introduction to Python and its applications in Data Science Setting up Python environment (Anaconda, Jupyter Notebook) Variables, data types, and basic operations Control structures: if statements, loops Functions and their		**Lectures, Examples, and Problem-Solving**

	usage		
3	Python Libraries for Data Science Introduction to NumPy: arrays, basic operations Introduction to Pandas: Series, DataFrames, data manipulation Data cleaning and preprocessing		**Lectures, Examples, and Problem-Solving**
4	Python Libraries for Data Science Introduction to NumPy: arrays, basic operations Introduction to Pandas: Series, DataFrames, data manipulation Data cleaning and preprocessing		**Lectures, Examples, and Problem-Solving**
5	Data Visualization with Matplotlib and Seaborn Introduction to Matplotlib: basic plots, customization Introduction to Seaborn: statistical data visualization Creating visualizations from sample datasets		**Lectures, Examples, and Problem-Solving**
6	Data Visualization with Matplotlib and Seaborn Introduction to Matplotlib: basic plots, customization Introduction to Seaborn: statistical data		**Lectures, Examples, and Problem-Solving**

	visualization Creating visualizations from sample datasets		
7	Data Analysis with Pandas Data aggregation and grouping Merging and joining data Introduction to descriptive statistics Exploratory Data Analysis (EDA) techniques		**Lectures, Examples, and Problem-Solving**
8	Data Analysis with Pandas Data aggregation and grouping Merging and joining data Introduction to descriptive statistics Exploratory Data Analysis (EDA) techniques		**Lectures, Examples, and Problem-Solving**
9	Introduction to Statistics for Data Science Basic concepts of probability Descriptive vs. inferential statistics Common probability distributions Hypothesis testing and p-values		**Lectures, Examples, and Problem-Solving**
10	Introduction to Statistics for Data Science Basic concepts of		**Lectures, Examples, and Problem-Solving**

	probability Descriptive vs. inferential statistics Common probability distributions Hypothesis testing and p-values		
11	Introduction to Machine Learning Overview of supervised, unsupervised, and reinforcement learning Introduction to scikit-learn Linear regression: concept and implementation Classification algorithms: logistic regression, decision trees		**Lectures, Examples, and Problem-Solving**
12	Final Projects and Review Students work on small data science projects Applying concepts learned throughout the course Final project presentations Course review and next steps in the learning journey		**Lectures, Examples, and Problem-Solving**
13	inal Projects and Review Students work on small data science projects Applying concepts learned throughout the		**Lectures, Examples, and Problem-Solving**

	course Final project presentations Course review and next steps in the learning journey		
14	final Projects and Review Students work on small data science projects Applying concepts learned throughout the course Final project presentations Course review and next steps in the learning journey		**Lectures, Examples, and Problem-Solving**
15	Practice and revision		**Lectures, Examples, and Problem-Solving**

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Demonstrate a solid understanding of Python syntax, variables, data types, and basic operations.	Interactive coding sessions to practice Python syntax. Small coding exercises to reinforce variable and data type concepts. Guided exercises involving NumPy arrays and Pandas DataFrames. Analyzing and cleaning real-world datasets using Pandas.	**• Presentations, practices and class discussions.** **• Assignments and class tests.** **• Student presentations.** **• Mid-term examinations.** **•Practical and viva-voce examinations.** **• End-term examinations.**
2	Proficiently use libraries like NumPy and Pandas for data manipulation and analysis.		
3	Create informative and visually appealing data visualizations using Matplotlib and Seaborn.		
4	Evaluate and compare machine learning models for various tasks.		

SEMESTER-IV

--SCMA402	LINEAR ALGEBRA	L	T	P	C
Version		5	1	0	6
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

To introduce the theoretical concepts linear transfor mations, Range, Null space, Eigen values and Eigen vectors, Invertibility and Iso morphis ms.

Course Outcomes

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

CO1: To understand the concepts or methods to solve vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity, for analysis of matrices and systems of linear equations.

CO2: Appreciate and identify linear transformations of finite dimensional vector spaces and compose their matrices in specific bases.

CO3: Recognize the characteristic polynomial to compute the eigenvalues and eigenvectors of a square matrix and use them to diagonalise matrices when this is possible; discriminate between diagonalizable and non-diagonalizable matrices.

CO4: To learn the concepts of orthogonally diagonalise symmetric matrices and quadratic forms.

CO5: Determine the concepts of Hilbert space and inner product space.

CO6: Apply the mathematical modelling and reasoning to solve basic problems.

Catalog Description

This course covers matrix theory and linear algebra, emphasizing topics useful in other disciplines. Linear algebra is a branch of mathematics that studies systems of linear equations and the properties of matrices. The concepts of linear algebra are extremely useful in physics, economics and social sciences, natural sciences, and engineering. Due to its broad range of applications, linear algebra is one of the most widely taught subjects in college-level mathematics. Important objectives of the linear algebra are to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: **08 lecture hours**

Vector Space: Definition and examples, Subspace, Linear span, Quotient space and direct sum of subspaces, Linearly independent and dependent sets, Bases and dimension.

Unit II: **08 lecture hours**

Linear transformations: Definition and examples, Linear Transformation, Null space, Range space, Rank nullity theorem, Algebra of linear transformations, Matrix of a linear transformation, Change of coordinates.

Unit III: **16 lecture hours**

Further Properties of Linear Transformations: Representation of linear transformations by matrices, changeange of basis, Singular and nonsingular transformation ,Isomorphism of vector space, Canonical forms, Jordan forms, Triangular forms ,Dual space.

Eigen value & Eigen vectors of linear transfor mation ,Ch aracteristic polyno mial, Ch arac teristic equation of a m atrix, Cayley-Ha milton theore m and its use in finding the inverse of a matrix, Mini mal polyno mial, Diagonalization, Linear transfor mations

Unit IV:

10 lecture hours

Inner Product Spaces: Inner product spaces and orthogonality, Cauchy-Schwarz inequality, Gram-Schmidt orthogonalisation, Diagonalization of symmetric matrices.

Text Books

1. R. Vasishtha, J.N. Sharma, A. K. Vasishtha; *Linear Algebra*; Krishna Prakashan, Meerut.
2. Kenneth Hoffman, Ray Alden Kunz; *Linear Algebra*; Prentice-Hall of India Pvt.

Reference Books/Materials

1. Joseph A. Gallian; *Contemporary Abstract Algebra*; Narosa Publishing House.
2. S. Lang; *Introduction to Linear Algebra*; Springer.
3. S. Kumaresan; *Linear Algebra- A Geometric Approach*; Prentice Hall of India.

MOOC

https://archive.nptel.ac.in/courses/111/106/111106135/

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme and Course Mapping

Programme and Course Mapping																	
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	P O 10	PO 11	PS O 1	PS O 2	PS O3	PS O4	PS O5	PS O6
CO 1					3		2	2				3	2	2	2	3	3
CO 2					3		2	2				3	2	2	2	3	3
CO 3				3								3	2	2	2	3	3
CO 4							3					3	2	2	2	3	3
CO 5							2					3	2	2	2	3	3
CO 6	2											3	2	2	2	3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	**Vector Space**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research

National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Linear transformations**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Further Properties of Linear Transformations**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Inner Product Spaces**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-

Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	• Definition and importance of linear algebra • Scalars, vectors, and vector spaces • Vector addition and scalar multiplication	TB1	Lectures, Examples, and Problem-Solving
2	• ector properties and vector spaces • Dot product and cross product	TB1	Lectures, Geometrical Visualization

3	• Matrix notation and operations • Matrix multiplication and inverses • Special types of matrices (identity, diagonal, etc.)	**TB1**	**Lectures, Examples, and Problem-Solving**
4	• Solving linear systems using matrices • Row echelon form and reduced row echelon form • Existence and uniqueness of solutions	**TB1**	**Lectures, PPT**
5	• Subspaces and span • Basis and dimension • Linear independence and dependence	**TB1**	**Lectures, Demonstrations** **Examples, and Problem-Solving**
6	• Definition and properties of linear transformations • Kernel and image of a linear transformation • Matrix representations of linear transformations	**TB1**	**Lectures, Examples, and Problem-Solving**

7	• Definition of determinants • Properties of determinants • Cramer's rule and applications	**TB1**	
8	• Eigenvalues and eigenvectors of matrices • Diagonalization of matrices • Applications in physics and engineering	**TB1**	**Lectures, Examples, and Problem-Solving**
9	• Inner product spaces • Orthogonal vectors and orthogonality • Gram-Schmidt process	**TB1**	**Lectures, Examples, and Problem-Solving**
10	• Diagonalization using orthogonal matrices • Orthogonal diagonalization of symmetric matrices • Applications in optimization and principal component analysis	**TB1**	**Lectures, Examples, and Problem-Solving**

11	• Complex numbers and complex vector spaces • Hermitian matrices and unitary matrices	**TB1**	**Lectures, Examples, and Problem-Solving**
12	• Applications of linear algebra in engineering disciplines • Eigenvalues and eigenvectors in structural analysis • Solving differential equations with matrices	**TB1**	**Lectures, Examples, and Problem-Solving**
13	• Review of key concepts and techniques • Real-world applications of linear algebra • Student presentations on applications of linear algebra	**TB1**	**Lectures, Examples, and Problem-Solving**
14	Comprehensive review of the entire course	**TB1**	**Lectures, Examples, and Problem-Solving**
15	Comprehensive review of the entire course	**TB1**	**Lectures, Examples, and Problem-Solving**

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	To understand the concepts or methods to solve vector and matrix algebra, including linear dependence / independence, basis and dimension of a subspace, rank and nullity, for analysis of matrices and systems of linear equations.	(i) Each topic to be explained with examples. (ii) Students to be involved in discussions and encouraged to ask questions. (iii) Students to be given homework/assignment (iv) Students to be encouraged to give short presentations.	**• Presentations and class discussions.** **• Assignments and class tests.** **• Student presentations.** **• Mid-term examinations.** **•Practical and viva-voce examinations.** **• End-term examinations.**
2	Appreciate and identify linear transformations of finite dimensional vector spaces and compose their matrices in specific bases.		
3	Recognize the characteristic polynomial to compute the eigenvalues and eigenvectors of a square matrix and use them to diagonalise matrices when this is possible; discriminate between diagonalizable and non-diagonalizable matrices.		
4	To learn the concepts of orthogonally diagonalise symmetric matrices and quadratic forms. Determine the concepts of Hilbert space and inner product space. Apply mathematical modelling and reasoning to solve basic problems.		

---SCMA404	Complex Analysis	L	T	P	C
Version		4	0	0	4
Total Contact Hours	58				
Pre-requisites/Exposure	Senior Secondary level knowledge of Complex Numbers				
Co-requisites	--				

Course Objectives

The course will enable the student-teacher to:

1. Provide the brief knowledge of Complex number.
2. To understand and find the limit and continuity of the Complex variable function.
3. Solve the Analytic function and its properties.
4. Identify the applications of Cauchy Integral formula and Residues.
5. Apply Taylor and Laurent series expansions appearing in social sciences, physical sciences, life sciences and a host of other disciplines.

Course Outcomes

On completion of this course, the students will be able to
CO1: Identify the imaginary unit and its role in defining complex numbers.
CO2: Explain the geometric representation of complex numbers in the complex plane.
CO3: Understand the polar form of complex numbers and its connection with trigonometric functions.
CO4: Apply algebraic operations on complex numbers, such as addition, subtraction, multiplication, and division.
CO5: Investigate the properties of complex analytic functions and their relationship with harmonic functions.
CO6: Evaluate complex integrals using various techniques, such as line integrals and residue theorem.
CO7: Develop solutions to challenging problems involving complex analysis, including applications in physics, engineering, and other fields.
.

Catalog Description

Complex analysis is indeed a beautiful and useful branch of mathematics. It is one of the classical subjects with most of the main results extending back into the nineteenth century and earlier. Yet, the subject is far from dormant. It is a launching point for many areas of research and it continues to find new areas of applicability, from pure mathematics to applied physics. Many of the giants of mathematics have contributed to the development of complex analysis. Important objectives of the Complex analysis is to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

Unit I: 15 Contact hours Complex Plane and functions: Complex numbers and their representation, algebra of complex numbers; Complex plane, Open set, Domain and region in complex plane; Stereographic projection and Riemann sphere; Complex functions and their limits including limit at infinity; Continuity, Linear fractional transformations and their geometrical properties.

Unit II: 15 Contact hours

Analytic Functions and Cauchy-Riemann Equations: Differentiability of a complex valued function, Cauchy-Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability, Analytic functions; Analyticity and zeros of exponential, trigonometric and logarithmic functions; Branch cut and branch of multi-valued functions.

Unit III: 10 Contact hours

Cauchy's Theorems and Fundamental Theorem of Algebra: Line integral, Path independence, Complex integration, Green's theorem, Anti-derivative theorem, Cauchy-Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem and its consequences.

Unit IV: 18 Contact hours

Power Series: Sequences, series and their convergence, Taylor series and Laurent series of analytic functions, Power series, Radius of convergence, Integration and differentiation of power series, Absolute and uniform convergence of power series.

Singularities and Contour Integration: Meromorphic functions, Zeros and poles of meromorphic functions, Nature of singularities, Picard's theorem, Residues, Cauchy's residue theorem, Argument principle, Rouche's theorem, Jordan's lemma, Evaluation of proper and improper integrals.

Text Books

1. (AR) A.R. Vashisth, Complex Analysis, krishana prakashan Media, Meerut, 1942.i.

Reference Books/Materials

1. J.B. Conway, Functions of One Complex Variable, 2nd ed., Narosa, New Delhi, 1978.

2. T.W. Gamelin, Complex Analysis, Springer International Edition, 2001.
3. R. Remmert, Theory of Complex Functions, Springer Verlag, 1991.
4. A.R. Shastri, An Introduction to Complex Analysis, Macmilan India, New Delhi, 1999.

Open Educational Resources (OER)

https://www.edx.org/course/complex-analysis
https://www.youtube.com/playlist?list=PLyqSpQzTE6M9gCgajvQbc68Hk_JKGBAYT
https://nptel.ac.in/courses/111/105/111105129/
https://open.umn.edu/opentextbooks/textbooks/complex-analysis-with-applications

Programme and Course Mapping

Programme and Course Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6
CO 1					3		2	2				3	2	2	2	3	3
CO 2					3		2	2				3	2	2	2	3	3
CO 3				3								3	2	2	2	3	3
CO 4							3					3	2	2	2	3	3
CO 5							2					3	2	2	2	3	3
CO 6	2											3	2	2	2	3	3
CO 7			2									3	2	2	2	3	3

1=lightly mapped 2= moderately mapped 3=strongly mapped

Unit I	Complex Plane and functions

Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Analytic Functions and Cauchy-Riemann Equations
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Cauchy’s Theorems and Fundamental Theorem of Algebra
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Power Series, Singularities and Contour Integration
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-

Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	**Introduction to Complex Numbers and their representation**	**AR Vashisth, Complex Analysis**	**Lectures, Examples, and Visual Aids**
2	**Algebra of Complex Numbers; Complex Plane; Open Sets**	**AR Vashisth, Complex Analysis**	**Lectures, Geometrical Visualization**
3	**Domain and Region in Complex Plane; Stereographic Projection**	**AR Vashisth, Complex Analysis**	**Lectures, Riemann Sphere Visualization**

4	**Complex Functions and their Limits**	**AR Vashisth, Complex Analysis**	**Lectures, Limit Calculations**
5	**Continuity of Complex Functions; Linear Fractional Transformations**	**AR Vashisth, Complex Analysis**	**Lectures, Transformations Demonstrations**
6	**Analytic Functions and Cauchy-Riemann Equations**	**J.B. Conway, Functions of One Complex Variable**	**Lectures, Derivation of Cauchy-Riemann Equations**
7	**Differentiability of Complex Functions; Harmonic Functions**	**J.B. Conway, Functions of One Complex Variable**	**Lectures, Proof of Analyticity and Harmonic Functions**
8	**Necessary and Sufficient Conditions for Differentiability**	**J.B. Conway, Functions of One Complex Variable**	**Lectures, Examples and Counterexamples**
9	**Analyticity and Zeros of Exponential, Trigonometric and Logarithmic Functions**	**J.B. Conway, Functions of One Complex Variable**	**Lectures, Analyzing Zeros of Special Functions**
10	**Branch Cut and Branch of Multi-valued Functions**	**J.B. Conway, Functions of One Complex Variable**	**Lectures, Illustrating Branch Cuts**
11	**Cauchy's Theorems: Line Integral, Path**	**J.B. Conway, Functions of One**	**Lectures, Examples of Path Independence**

	Independence	Complex Variable	
12	Complex Integration; Green's Theorem	J.B. Conway, Functions of One Complex Variable	Lectures, Applications of Green's Theorem
13	Cauchy-Goursat Theorem; Cauchy Integral Formula	T.W. Gamelin, Complex Analysis	Lectures, Proof and Applications of Cauchy-Goursat Theorem
14	Cauchy's Inequality; Derivative of Analytic Function	T.W. Gamelin, Complex Analysis	Lectures, Analyzing Bounds and Derivatives of Analytic Functions
15	Liouville's Theorem; Fundamental Theorem of Algebra	T.W. Gamelin, Complex Analysis	Lectures, Proof and Consequences of Liouville's Theorem and F.T. of Algebra

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Understand the concept of complex numbers, their representation, and the algebra of complex numbers. Interpret the complex plane and differentiate between open sets, domains, and regions in the complex plane. Comprehend stereographic	Active Learning: Incorporate active learning techniques like group discussions, problem-solving, and hands-on activities to engage students and deepen their understanding. Visual Aids: Use visual aids such as diagrams, graphs, and	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. •Practical and viva-voce examinations. • End-term examinations.

	projection and the Riemann sphere representation of the complex plane. Analyze complex functions and their limits, including the limit at infinity. Identify the properties of continuity in complex functions and explore linear fractional transformations and their geometrical properties.	animations to illustrate complex concepts and improve comprehension. Technology Integration: Leverage technology like graphing software, complex calculators, and simulation tools to enhance learning experiences.	
2	Determine the differentiability of complex-valued functions and apply the Cauchy-Riemann equations. Investigate the concept of harmonic functions and understand necessary and sufficient conditions for differentiability. Analyze and work with analytic functions, including the behavior of exponential, trigonometric, and logarithmic functions. Examine the concept of branch cuts and branches in multi-valued functions.	Real-world Applications: Highlight the relevance of complex analysis in various fields to motivate students and demonstrate its practical importance. Encourage Questions: Create a supportive environment where students feel comfortable asking questions and seeking clarifications. Formative Assessment: Use formative assessments like quizzes, in-class exercises, and homework to provide feedback and monitor students' progress.	
3	Demonstrate understanding of line integrals, path independence, and complex integration. Apply Green's theorem and the anti-derivative theorem to solve complex integration problems. Utilize Cauchy-Goursat theorem and Cauchy integral formula to evaluate complex integrals. Apply Cauchy's inequality and Liouville's theorem in the study of analytic		

	functions. **Recognize the significance of the Fundamental Theorem of Algebra and the Maximum Modulus theorem in complex analysis.**		
4	**Explore sequences, series, and their convergence in the context of power series and Taylor series of analytic functions.** **Determine the radius of convergence of power series and analyze the properties of absolute and uniform convergence.** **Demonstrate the ability to integrate and differentiate power series.**		

SCMA451	**COMPLEX ANALYSIS LAB**	**L**	**T**	**P**	**C**
Total Contact Hours	**28**	**0**	**0**	**4**	**2**
Pre-requisites/Exposure					
Co-requisites	**MATLAB SOFTWARE**				

Course Objectives

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically, to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs.

Course Outcomes

On completion of this course, the students will be able to:

CO1: Identify the properties of complex functions and mappings.

CO2: Recall and understand the basic theorems of complex analysis, such as Cauchy-Riemann equations and contour integration.

CO3: Describe the concept of analyticity and its implications for complex functions.

CO4: Utilize Cauchy's integral theorem and formula to evaluate contour integrals.

CO5: Solve problems involving power series representations and Laurent series expansions.

CO6: Investigate the behavior of complex functions along various paths in the complex plane.

CO7: Compare and contrast different techniques for solving complex analysis problems.

Catalog Description

It is one of the classical lab of the complex analysis with most of the main results extending back into the nineteenth century and earlier. Yet, the subject is far from dormant. It is a launching point for many areas of research and it continues to find new areas of applicability, from pure mathematics to applied physics. Many of the giants of mathematics have contributed to the development of complex analysis. Important objectives of the Complex analysis lab is to develop and strengthen the students' problem-solving skills and to teach them to read, write, speak, and think in the language of mathematics. In particular, students learn how to apply the tools of calculus to a variety of problem situations.

Course Content

List of practical

1. Declaring a complex number and graphical representation. e.g.

2. Program to discuss the algebra of complex numbers.

e.g., if Z1 =3 + 4i, Z2 = 4 – 7i, then find Z1 + Z2, Z1 - Z2, Z1 * Z2, and Z1 / Z2

3. To find conjugate, modulus and phase angle of an array of complex numbers.

   e.g., Z = [2+ 3i, 4-2i, 6+11i, 2-5i]

4. To compute the integral over a straight-line path between the two specified end points.

   e. g., where C is the straight-line path from -1+ i to 2 - i.

5. To perform contour integration.

   e.g., (i), where C is the Contour given by x = y2 +1;

   (ii), where C is the contour given by, which can be

   parameterized by x = cos (t), y = sin (t) for.

6. To plot the complex functions and analyse the graph.

e.g., (i) f(z) = Z (ii) f(z)=Z3 (iii) f(z) = (Z^4-1)1/4

7. To perform the Taylor series expansion of a given function f(z) around a given point z.

The number of terms that should be used in the Taylor series expansion is given for each function. Hence plot the magnitude of the function and magnitude of its Taylors series expansion. e.g., (i) f(z) = exp(z) around z = 0, n =40.

(ii) f(z)=exp(z2) around z = 0, n = 160.

8. To determines how many terms should be used in the Taylor series expansion of a given function f(z) around z = 0 for a specific value of z to get a percentage error of less than 5 %.

e.g., For f(z) = exp(z) around z =0, execute and determine the number of necessary terms to get a percentage error of less than 5 % for the following values of z: (i) z = 30 + 30 i

9. To perform Laurent's series expansion of a given function f(z) around a given point z.

e.g., (i) f(z)= (sin z -1)/z4 around z = 0

(ii) f(z) = cot (z)/z4 around z = 0

10. To compute the poles and corresponding residues of complex functions.

11. To perform Conformal Mapping and Bilinear Transformations.

NOTE: Ten experiments are to be performed, out of which at least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & setup by the concerned person as per the scope of the syllabus.

Reference Books/Materials

1. J.B. Conway, Functions of One Complex Variable, 2nd ed., Narosa, New Delhi, 1978.
2. T.W. Gamelin, Complex Analysis, Springer International Edition, 2001.
   Rudra Pratap; Getting Started with MATLAB 7, Oxford Press.

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO 1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	**2**		**2**		**2**			**3**				**3**	**2**	**2**	**2**	**3**	**3**
CO2	**2**	**2**			**3**							**3**	**2**	**2**	**2**	**3**	**3**
CO3	**3**	**2**	**2**		**3**							**3**	**2**	**2**	**2**	**3**	**3**
CO4	**2**	**2**			**2**				**2**	**3**		**3**	**2**	**2**	**2**	**3**	**3**
CO5	**2**		**2**		**2**			**2**	**2**			**3**	**2**	**2**	**2**	**3**	**3**
CO6	**3**		**2**		**2**							**3**	**2**	**2**	**2**	**3**	**3**
CO7	**2**				**2**		**3**					**3**	**2**	**2**	**2**	**3**	**3**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Practicals for series solutions, types of complex graphs, draw transformations
Local	Ingredient in Research and Analysis
Regional	Ingredient in Research and Analysis
National	Ingredient in Research and Analysis
Global	Ingredient in Research and Analysis
Employability	-
Entrepreneurship	-
Skill Development	To perform Laurent’s series expansion of a given function f(z) around a given point z; To compute the poles and corresponding residues of complex functions; To perform Conformal Mapping and Bilinear Transformations.
Professional Ethics	-
Gender	-
Human Values	-

Environment &Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9)
POE/4th IR	Learning by doing

Teaching Plan

Week	Topic	Experiment	Reference Material
1	**Introduction to Complex Numbers**	**Declaring a complex number and graphical representation**	**N/A**
2	**Algebra of Complex Numbers**	**Program 2 - Z1 + Z2, Z1 - Z2, Z1 * Z2, Z1 / Z2**	**J.B. Conway, Functions of One Complex Variable**
3	**Conjugate, Modulus, and Phase Angle**	**Program 3 - Z = [2+3i, 4-2i, 6+11i, 2-5i]**	**J.B. Conway, Functions of One Complex Variable**
4	**Contour Integration**	**Program 5 - (i) C: x = y^2 + 1**	**J.B. Conway, Functions of One Complex Variable**
5	**Contour Integration**	**Program 5 - (ii) C: parameterized by x = cos(t), y = sin(t)**	**J.B. Conway, Functions of One Complex Variable**

6	**Plotting Complex Functions**	**Program 6 - (i) f(z) = Z, (ii) f(z) = Z^3, (iii) f(z) = (Z^4-1)^(1/4)**	**T.W. Gamelin, Complex Analysis**
7	**Taylor Series Expansion**	**Program 7 - (i) f(z) = exp(z) around z = 0, n = 40**	**T.W. Gamelin, Complex Analysis**
8	**Taylor Series Expansion**	**Program 7 - (ii) f(z) = exp(z^2) around z = 0, n = 160**	**T.W. Gamelin, Complex Analysis**
9	**Estimating Taylor Series Terms**	**Program 8 - f(z) = exp(z) around z = 0, percentage error**	**T.W. Gamelin, Complex Analysis**
10	**Laurent's Series Expansion**	**Program 9 - (i) f(z) = (sin z -1)/z^4, around z = 0**	**T.W. Gamelin, Complex Analysis**
11	**Laurent's Series Expansion**	**Program 9 - (ii) f(z) = cot(z)/z^4, around z = 0**	**T.W. Gamelin, Complex Analysis**
12	**Computing Poles and Residues**	**Program 10 - To compute poles and residues**	**T.W. Gamelin, Complex Analysis**
13	**Conformal Mapping and Bilinear Transformations**	**Program 11 - Conformal Mapping and Bilinear Transformations**	**T.W. Gamelin, Complex Analysis**

14	**Additional Experiment**	**Design and setup an experiment from the list or as per scope**	**N/A**
15	**Revision and Project Work**	**N/A**	**N/A**

SCMA406	**PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS**	**L**	**T**	**P**	**C**
Version		**4**	**0**	**0**	**4**
Pre-requisites/Exposure	**Differentiation, Integration**				
Co-requisites	**--**				

Course Objectives

This course enables the students to understand

1. Origin of partial differential equations and their types, Lagrange's method, Cauchy's problem
2. Charpit's and Jacobi's methods, Cauchy's method of characteristics, Higher order linear partial differential equations with constant coefficients.
3. Classification and canonical transformation of second order linear partial differential equations. Method of separation of variables for solving hyperbolic, parabolic
4. Dirichlet, Neumann, Cauchy boundary conditions. Dirichlet and Neumann problems for a rectangle, theory of Green's function for Laplace equation.

Course Outcomes

This course will enable the students to:

CO1: Identify and classify first-order partial differential equations (PDEs) based on their order, degree, and linearity.

CO2: Analyze and classify linear second-order partial differential equations with constant coefficients, including homogeneous and non-homogeneous cases.

CO3: Formulate and solve second-order partial differential equations with variable coefficients, reducing them to equations with constant coefficients.

CO4: Analyze and solve heat and wave equations in one and two dimensions using the method of separation of variables and reduction to canonical or normal form

CO5: Apply Euler's equation to variational problems with fixed boundaries, considering functionals containing first-order partial derivatives.

CO6: Analyze and solve variational problems with moving boundaries and functionals dependent on one and two variables, applying one-sided variations and understanding sufficient conditions for an extremum

Catalog Description

The aim of this course is to learn theory of partial differential equations and solution methods. Use knowledge of Partial Differential Equations (PDEs), modelling, the general structure of solutions, and analytic and numerical methods for solution. Nature of PDEs like parabolic, elliptic, hyperbolic. After completion of the course, the students will be able to solve the PDEs independently. They can solve PDEs in higher dimension. Convert partial differential equations to canonical form.

Course Content

Unit I: **8 lecture hours**

First Order Partial Differential Equations Order and degree of Partial differential equations (PDE), Concept of linear and non-linear partial differential equations, Partial differential equations of the first order, Lagrange's method, Some special type of equation which can be solved easily by methods other than the general method, Charpit's general method.

Unit II: **12 lecture hours**

Second Order Partial Differential Equations with Constant Coefficients Classification of linear partial differential equations of second order, Homogeneous and non-homogeneous equations with constant coefficients.

Unit III: **8 lecture hours**

Second Order Partial Differential Equations with Variable Coefficients Partial differential equations reducible to equations with constant coefficient, Second order PDE with variable coefficients, Classification of second order PDE, Reduction to canonical or normal form; Monge's method; Solution of heat and wave equations in one and two dimensions by method of separation of variables.

Unit IV: **12 lecture hours**

Calculus of Variations-Variational Problems with Fixed Boundaries Euler's equation for functional containing first order and higher order total derivatives, Functionals containing first order partial derivatives, Variational problems in parametric form, Invariance of Euler's equation under coordinates transformation. Calculus of Variations-Variational Problems with Moving Boundaries Variational problems with moving boundaries, Functionals dependent on one and two variables, One sided variations. Sufficient conditions for an extremum-Jacobi and Legendre conditions, Second variation.

Text Books

1. A. S. Gupta (2004). Calculus of Variations with Applications. PHI Learning.
2. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
3. TynMyint-U & Lokenath Debnath (2013). Linear Partial Differential Equation for Scientists and Engineers (4th edition). Springer India.
4. H. T. H. Piaggio (2004). An Elementary Treatise on Differential Equations and Their Applications. CBS Publishers.
5. S. B. Rao & H. R. Anuradha (1996). Differential Equations with Applications. University Press.
6. Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.

Reference Books/Materials

1. M.D. Raisinghania: Advanced Differential Equations, S. Chand & Co.

2. Walter A. Strauss: An Introduction to Partial Differential Equation, Wiley

Open Educational Resources (OER)

1. https://tutorial.math.lamar.edu/Classes/DE/HeatEqnNonZero.aspx
2. https://web.math.ucsb.edu/~grigoryan/124A.pdf

Unit I	First order Partial Differential Equation
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Second order Partial Differential Equation with constant coefficient
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Second order Partial Differential Equation with variable coefficient
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment &	-

Sustainability	
Unit IV	Calculus of Variation
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9), Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching plan:

Week	Topic/Unit	Textbook/Reference Book (Chapter/Page/OER)	Teaching-Learning Method
1	Unit I: First Order Partial Differential Equations	- TynMyint-U & Lokenath Debnath (Chapter:1)	Lecture-based instruction
		- S. B. Rao & H. R. Anuradha (Chapter:1)	
		- OER:	

		https://tutorial.math.lamar.edu/Classes/DE/HeatEqnNonZero.aspx	
2	Unit I: First Order Partial Differential Equations (Continued)	- TynMyint-U & Lokenath Debnath (Chapter:1)	Lecture-based instruction
		- S. B. Rao & H. R. Anuradha (Chapter:1)	
3	Unit II: Second Order Partial Differential Equations with Constant Coefficients	- Erwin Kreyszig (Chapter: 3)	Lecture-based instruction
4	Unit II: Second Order Partial Differential Equations with Constant Coefficients (Continued)	- Erwin Kreyszig (Chapter:3)	Lecture-based instruction
5	Unit III: Second Order Partial Differential Equations with Variable Coefficients	- TynMyint-U & Lokenath Debnath (Chapter:4)	Lecture-based instruction
		- OER: https://web.math.ucsb.edu/~grigoryan/124A.pdf	
6	Unit III: Second Order Partial Differential Equations with	- TynMyint-U & Lokenath Debnath	Lecture-based instruction

	Variable Coefficients (Continued)	(Chapter:4)	
		- OER: https://web.math.ucsb.edu/~grigoryan/124A.pdf	
7	Unit IV: Calculus of Variations-Variational Problems with Fixed Boundaries	- A. S. Gupta (Chapter:6)	Lecture-based instruction
		- H. T. H. Piaggio (Chapter:6)	
		- OER: https://tutorial.math.lamar.edu/Classes/DE/HeatEqnNonZero.aspx	
8	Unit IV: Calculus of Variations-Variational Problems with Fixed Boundaries (Continued)	- A. S. Gupta (Chapter:8)	Lecture-based instruction
		- H. T. H. Piaggio (Chapter:8)	
		- OER: https://tutorial.math.lamar.edu/Classes/DE/HeatEqnNonZero.aspx	

9	Unit IV: Calculus of Variations-Variational Problems with Moving Boundaries	- A. S. Gupta (Chapter:9)	Lecture-based instruction
10	Unit IV: Calculus of Variations-Variational Problems with Moving Boundaries (Continued)	- H. T. H. Piaggio (Chapter:9)	Lecture-based instruction
11	Unit IV: Calculus of Variations-Variational Problems with Moving Boundaries (Continued)	- H. T. H. Piaggio (Chapter:10)	Lecture-based instruction
12	Review and Revision	- All Textbooks and References	Lecture-based instruction
13	Assessment and Practice	- All Textbooks and References	Lecture-based instruction
14	Assessment and Practice	- All Textbooks and References	Lecture-based instruction

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	**20**	**20**	**10**	**50**

Facilitating the Achievement of Course Learning Outcomes

Unit	Course Learning Outcomes (CLO)	Teaching-Learning Activities	Assessment Tasks
I	1. Understand the concept of linear and non-linear PDEs.	- Lectures on first-order PDEs, linear and non-linear concepts.	- Written test on concepts and definitions.
	2. Apply Lagrange's and Charpit's methods to solve PDEs.	- Problem-solving exercises on Lagrange's and Charpit's methods.	- Problem-based assignments and solutions.
II	3. Classify second-order PDEs with constant coefficients.	- Lectures on classification and properties of second-order PDEs.	- In-class quizzes on classification.

	4. Solve homogeneous and non-homogeneous PDEs with constant coefficients.	- Worked examples and practice problems on constant coefficients PDEs.	- Homework submissions and evaluation.
III	5. Reduce second-order PDEs to canonical form using various methods.	- Interactive sessions on reduction techniques like Monge's method.	- Individual or group projects on reduction techniques.
	6. Solve heat and wave equations using separation of variables.	- In-class demonstrations and numerical simulations.	- Practical exam on solving PDEs by separation of variables.
IV	7. Apply Euler's equation to variational problems.	- Lectures on calculus of variations and Euler's equation.	- Written test on variational problems and Euler's equation.
	8. Analyze variational problems with moving boundaries.	- Discussion and analysis of variational problems with moving boundaries.	- Presentation and report on moving boundary problems.
	9. Apply sufficient conditions for extremum in variational problems.	- Practice exercises and worked examples on Jacobi and Legendre conditions.	- Assessment based on analyzing variational problems.

SCMA452	**Partial Differential Equation AND CALCULUS OF VARIATION, Lab**	**L**	**T**	**P**	**C**
Version 1.0		**0**	**0**	**2**	**1**
Pre-requisites/Exposure					
Co-requisites	**MATLAB SOFTWARE**				

Course Objectives

The purpose of these labs is to help students talk and write in meaningful ways about mathematics. Specifically, to describe quantities and changes in quantities clearly in terms of context, to make rigorous arguments about how such quantities are related, and to make connections between these features in the contexts and on graphs.

Course Outcomes

On completion of this course, the students will be able to
CO1. Test program output for accuracy using hand calculations and debugging techniques
CO2. Analyses the accuracy of numerical approximations to derivatives and integrals and their dependence on grid resolution
CO3. Analyses the applicability and accuracy of matrix numerical solutions to linear systems of equations
CO4. Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
CO5. Write efficient, well-documented MATLAB code and present numerical results in an informative way of different real life problems.

Catalog Description

The aim of this lab course is to learn the experimental work of partial differential equations and solution methods. Use knowledge of Partial Differential Equations (PDEs) lab, modelling, the general structure of solutions, and analytic and numerical methods for solution. Nature of PDEs like parabolic, elliptic,hyperbolic. After completion of the course, the students will be able to solve the PDEs independently. They can solve PDEs in higher dimension. Convert partial differential equations to canonical form.

Course Content

List of practical

Modeling of the following problems using Mathematica /MATLAB/ Maple/ Maxima/ Scilab etc.
1. Solution of Cauchy problem for first order PDE.
2. Plotting the characteristics for the first order PDE.
3. Plot the integral surfaces of a given first order PDE with initial data.
4. Solving systems of ordinary differential equations.
5. Solution of wave equation.
6. To solve linear equation
7. Solution of Linear equations.

8. Determination of Eigen values and Eigen vectors of a Square matrix.

Reference Books/Materials

1. M.D. Raisinghania: Advanced Differential Equations, S. Chand & Co.
2. Walter A. Strauss: An Introduction to Partial Differential Equation, Wiley
3. Rudra Pratap; Getting Started with MATLAB 7, Oxford Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Programme and Course Mapping																	
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**P O5**	**PO 6**	**P O7**	**P O8**	**P O9**	**PO 10**	**PO 11**	**PS O 1**	**PS O 2**	**PS O3**	**PS O4**	**P S O 5**	**P S O 6**
CO 1	**3**				**3**												
CO 2	**2**	**3**			**2**												
CO 3	**3**		**3**		**3**												
CO 4	**3**		**3**		**2**				**3**								
CO 5	**3**		**2**		**3**	**3**										**2**	**3**
CO 6	**3**		**3**		**3**											**3**	**3**

1=lightly mapped	2= moderately mapped	3=strongly mapped

Unit I	Fitting of distributions, regression and correlation
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	Fitting of polynomials, exponential curves, Fitting of Poisson distributions after computing mean, Application problems based on Poisson distribution
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill
NEP 2020	Promoting High-quality research (18.1-18.9)
POE/4th IR	Technical Skills that match Industry Needs; Focus on Employability Skills (Local/Regional and Global) Team Work

-(UDT104)	Data Pre-processing and Visualization using Python	L2	T0	P4	C4
Pre-requisites/Exposure					
Co-requisites	--				

Course Description

Data Handling and Visualization course deals with Data visualization, implementation, and principles of proportions

Course Objective

1. To explain the basics of Data Visualization
2. To enable students to Implement visualization of distributions
3. To make students to write programs on visualization of time series, proportions & associations
4. To make students to apply visualization on Trends and uncertainty
5. To enable students, understand the principles of proportions

Course Outcome

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

CO1. Understand the significance of data preprocessing in data analysis and machine learning, and be able to articulate its impact on the quality of results.

CO2. Identify and handle missing data, duplicates, and outliers to ensure the data is clean and ready for analysis.

CO3. Perform data transformation: normalizing, scaling, and encoding data to bring it to a consistent format and enable better comparisons.

CO 4. able to use various statistical and visual methods to summarize and explore the data, gaining insights into its distribution, correlations, and patterns.

CO 5. Visualize data effectively: Students should be proficient in using Python libraries like Matplotlib, Seaborn, and Plotly to create various types of visualizations, including histograms, box plots, scatter plots, heatmaps, and more.

CO 6. able to communicate their results effectively through presentations or reports, explaining the data preprocessing steps taken and the insights gained from the visualizations (i.e., able to present finding and insights of real data).

Prerequisites: Nil

1. Introduction to Data Preprocessing

Understanding the importance of data preprocessing

Steps involved in data preprocessing

Handling missing data

Dealing with outliers

2. Data Cleaning and Transformation

Removing duplicates

Data normalization and scaling

Data encoding (e.g., one-hot encoding, label encoding)

Handling categorical variables

3 Exploratory Data Analysis (EDA)

Data summarization and descriptive statistics

Data visualization techniques (e.g., histograms, box plots, scatter plots)

Correlation analysis

Heatmaps and pair plots

4. Data Visualization Libraries

Introduction to popular Python libraries (e.g., Matplotlib, Seaborn, Plotly)

Creating basic plots and customizing visuals

Interactive visualizations

4. Data Preprocessing for Machine Learning

Feature engineering and selection

Handling imbalanced data

Data splitting (train-test split, cross-validation)

5. Integrating Data Preprocessing and Visualization in Python

Applying data preprocessing techniques to real-world datasets

Visualizing data after preprocessing

6. Project Work

Applying data preprocessing and visualization techniques to a specific dataset

Presenting findings and insights

E BOOKS

1. https://www.netquest.com/hubfs/docs/ebook-data-visualization-EN.pdf

MOOC

1. https://www.coursera.org/learn/data-visualization
2. https://www.coursera.org/learn/python-for-data-visualization

Practical Content

Prerequisite: Python Basics

LIST OF EXPERIMENTS:

1. Importing data from various sources (CSV, Excel, SQL).
2. Handling missing data: identifying and imputing missing values.
3. Data cleaning: removing duplicates and handling outliers.
4. Data normalization and scaling techniques.
5. Handling categorical data: encoding categorical variables (Label Encoding, One-Hot Encoding).
6. Feature engineering: creating new features, feature selection.
7. Descriptive statistics and summary metrics.
8. Data visualization with Matplotlib and Seaborn.
9. Customizing plots using Matplotlib and Seaborn.
10. Creating interactive visualizations with Plotly.
11. Aggregating data using Pandas.
12. Grouping data based on categories.
13. Pivot tables and cross-tabulation.

Project (Data Visualization Case Study)

- Visualizing real-world datasets.
- Applying data pre-processing and visualization techniques to a new dataset.
- Creating meaningful and insightful visualizations using Matplotlib, Seaborn, and Plotly.
- Presenting findings and insights.

REFERENCE BOOKS

1. Claus Wilke, "Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures", 1st edition, O'Reilly Media Inc, 2019.
2. Data Wrangling with Python by Jacqueline Kazil and Katharine Jarmul.

https://www.datacamp.com/

https://towardsdatascience.com/

https://seaborn.pydata.org/

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	**20**	**20**	**10**	**50**

Programme and Course Mapping

Programme and Course Mapping																	
CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1					3		2	2				3	2	2	2	3	3
CO2					3		2	2				3	2	2	2	3	3
CO3				3								3	2	2	2	3	3
CO4							3					3	2	2	2	3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	**Introduction to Data Preprocessing**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Use of NumPy and Pandas
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Data Cleaning and transformation

Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Data Handling and preprocessing
Entrepreneurship	-
Skill Development	Use of Pandas
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Visualization with Matplotlib and seaborn
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Visualization with Matplotlib
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Project work
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Handling complex data, work on case study and statistically analyse data
Entrepreneurship	-
Skill Development	Plotting with pandas and Scaborn
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)

POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	Weeks 1-2: Introduction to Python Basics Introduction to Python and its applications in Data Science Setting up Python environment (Anaconda, Jupyter Notebook) Variables, data types, and basic operations Control structures: if statements, loops Functions and their usage		**Lectures, Examples, and Problem-Solving, Hands on practice**
2	Weeks 1-2: Introduction to Python Basics Introduction to Python and its applications in Data Science Setting up Python environment (Anaconda, Jupyter Notebook) Variables, data types, and basic operations Control structures: if statements, loops Functions and their usage		**Lectures, Examples, and Problem-Solving**
3	Python Libraries for Data Science Introduction to NumPy: arrays, basic operations		**Lectures, Examples, and Problem-Solving**

	Introduction to Pandas: Series, DataFrames, data manipulation Data cleaning and preprocessing		
4	Python Libraries for Data Science Introduction to NumPy: arrays, basic operations Introduction to Pandas: Series, DataFrames, data manipulation Data cleaning and preprocessing		**Lectures, Examples, and Problem-Solving**
5	Data Visualization with Matplotlib and Seaborn Introduction to Matplotlib: basic plots, customization Introduction to Seaborn: statistical data visualization Creating visualizations from sample datasets		**Lectures, Examples, and Problem-Solving**
6	Data Visualization with Matplotlib and Seaborn Introduction to Matplotlib: basic plots, customization Introduction to Seaborn: statistical data visualization Creating visualizations from sample datasets		**Lectures, Examples, and Problem-Solving**
7	Data Analysis with Pandas		**Lectures, Examples, and Problem-Solving**

	Data aggregation and grouping Merging and joining data Introduction to descriptive statistics Exploratory Data Analysis (EDA) techniques		
8	Data Analysis with Pandas Data aggregation and grouping Merging and joining data Introduction to descriptive statistics Exploratory Data Analysis (EDA) techniques		**Lectures, Examples, and Problem-Solving**
9	Introduction to Statistics for Data Science Basic concepts of probability Descriptive vs. inferential statistics Common probability distributions Hypothesis testing and p-values		**Lectures, Examples, and Problem-Solving**
10	Introduction to Statistics for Data Science Basic concepts of probability Descriptive vs. inferential statistics Common probability distributions Hypothesis testing and p-values		**Lectures, Examples, and Problem-Solving**

11	Introduction to Machine Learning Overview of supervised, unsupervised, and reinforcement learning Introduction to scikit-learn Linear regression: concept and implementation Classification algorithms: logistic regression, decision trees		**Lectures, Examples, and Problem-Solving**
12	Final Projects and Review Students work on small data science projects Applying concepts learned throughout the course Final project presentations Course review and next steps in the learning journey		**Lectures, Examples, and Problem-Solving**
13	inal Projects and Review Students work on small data science projects Applying concepts learned throughout the course Final project presentations Course review and next steps in the learning journey		**Lectures, Examples, and Problem-Solving**

14	final Projects and Review Students work on small data science projects Applying concepts learned throughout the course Final project presentations Course review and next steps in the learning journey		**Lectures, Examples, and Problem-Solving**
15	Practice and revision		**Lectures, Examples, and Problem-Solving**

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Demonstrate a solid understanding of Python syntax, variables, data types, and basic operations.	Interactive coding sessions to practice Python syntax. Small coding exercises to reinforce variable and data type concepts. Guided exercises involving NumPy arrays and Pandas DataFrames. Analyzing and cleaning real-world datasets using Pandas.	**• Presentations, practices and class discussions.** **• Assignments and class tests.** **• Student presentations.** **• Mid-term examinations.** **•Practical and viva-voce examinations.** **• End-term examinations.**
2	Proficiently use libraries like NumPy and Pandas for data manipulation and analysis.		
3	Create informative and visually appealing data visualizations using Matplotlib and Seaborn.		
4	Evaluate and compare machine learning models for various tasks.		

VAC3	**Vedic Mathematics**	**L**	**T**	**P**	**C**
Version		**2**	**0**	**0**	**2**
Total Contact Hours	**29**				

Pre-requisites/Exposure	Basic Mathematics
Co-requisites	--

Vedic Mathematic

Course Objective

The course will enable the student-teacher to:

- Provide knowledge of our ancient Indian mathematics and how it was invented /originated.
- Help students to relate our ancient Hindu mathematics with modern mathematics.
- Help in developing a deep understanding of the mathematics that we have studied by seeing the various changes that were developed over the time.
- Helps students in further research and development.

Course Outcomes (CO)

On completion of this course, the student will be able to:

CO1: Recall and list the basic Vedic Mathematics sutras (formulae) and their meanings.

CO2: Explain the rationale behind Vedic Mathematics techniques and how they simplify complex calculations.

CO3: Apply Vedic Mathematics methods to mentally calculate large multiplications and divisions quickly and accurately.

CO4: Analyze different types of mathematical problems and determine the most suitable Vedic Mathematics technique for each.

CO5: Evaluate the efficiency and accuracy of Vedic Mathematics compared to conventional methods for solving mathematical problems.

CO6: Develop new and creative Vedic Mathematics techniques to solve advanced mathematical challenges and puzzles.

Catalog description

Vedic mathematics is an ancient technique consisting of sixteen sutras and sixteen sub-sutras. It simplifies not only the fundamental arithmetic operations, such as multiplication and division, but also more advanced concepts such as simultaneous equations, quadratic equations, the factorization of cubic equations, and so on. Vedic mathematical technique is rapidly emerging as a tool for students appearing in various competitive examinations, where speed and accuracy play a vital role.

This course is designed to introduce with the concepts of Vedic Mathematics which will help them to do complex calculations within the time of few seconds.

Course Content

Unit I **6 Hours**

Introduction of Vedic Mathematics

- Base and complement
- Mental Instant Subtraction/ General Subtraction
- Magic with 11
- Multiplication by 11 to 19

Unit II **7 Hours**

- General/random multiplication
- Instant Multiplication with 99999
- Multiplication of any number with 111
- Multiplication of numbers near bases (Type- 1,2 & 3)

Unit III **8 Hours**

- Finding square of number in one line
- Interesting mental squares
- Faster addition and mental addition
- Table upto 100

Unit IV **8 Hours**

- Square root at a glance
- Cube root
- Digital root
- Magic divisions
- Cubing below and above the base
- General Cube of a number

Suggested Text Books

20 Datta, B., & Singh, A. N. (1935). History of Hindu mathematics I, II. *Delhi: Bharatiya Kala Prakashan.(Reprinted (2001))*.

21 Flood, G. (Ed.). (2008). *The blackwell companion to hinduism*. John Wiley & Sons.

22 Hayashi, T. (1994). Indian mathematics. *Companion Encyclopedia of the History and Philosophy of the Mathematical Sciences*, *1*, 118-130.

23 Sridharan, R. (2005). Mathematics in ancient and medieval India. In *Contributions to the History of Indian Mathematics* (pp. 1-29). Hindustan Book Agency, Gurgaon.

Advanced Readings

24 Kaye, G. R. (1915). *Indian mathematics*. Thacker, Spink & Co.

25 Whitehead, A. N. (2017). *An introduction to mathematics*. Courier Dover Publications.

26 Plofker, K. (2008). Mathematics in india. In *Mathematics in India*. Princeton University Press.

27 Tularam, G. A. (2012). Investigating the Development of Arithmetic and Algebra in Vedic India: Tribute to Swami Dayananda Saraswati. *International Journal of Mathematics, Game Theory and Algebra*, *20*, 163-187.

28 Dauben, J. W., & Parikh, R. (2010). Beginnings of modern mathematics in India. *Current Science*, *99*(3), 15-37.

Open Educational Resources (OER)

1. https://byjus.com/maths/vedic-maths/
2. https://www.youtube.com/watch?v=BpSYaLkoLbI
3. https://www.youtube.com/watch?v=VcAMbVNrPHc
4. https://www.youtube.com/watch?app=desktop&v=grkWGeqW99c&t=5s
5. https://www.youtube.com/watch?v=G7jpketWjLg

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Outcome (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	2	2	2	3	1	1	3	2	1	3	2	2	1	3	2
CO2	2	1	2	2	2	1	1	3	2	1	2	1	1	1	2	1
CO3	2	1	2	2	2	1	1	3	3	1	3	2	1	1	2	1
CO4	2	1	2	3	3	1	1	3	3	1	3	2	2	1	2	1
CO5	2	1	2	2	3	1	1	2	2	1	3	1	2	1	2	1
CO6	2	1	2	3	3	1	1	2	2	1	3	1	2	1	2	2

Unit I	Introduction to Vedic Mathematics
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research

Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment &Sustainability	-
Unit II	Basic Mathematical Operations
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Speed Mathematics Techniques
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Spacial Vedic Sutras and Techniques
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-

Entrepreneurship	-
Skill Development	Foster Mental Calculations to crack any competitive exam
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	-
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning, Presentations

Teaching Plan:

Weekly Teaching Plan	Topic/Unit No.	Textbook [TB]/ Reference Book [RB]-Chapter/ Page No./ Open Education Resources [OER]	Teaching-Learning Method
Week 1	Introduction	TB: Introduction to the History of Hindu Mathematics - Datta & Singh, Ch. 1	Lecture, Discussion
Week 2	Unit 1	TB: Mathematics in Ancient and Medieval India - Sridharan, pp. 1-10	Lecture, Group Work
Week 3	Unit 1	RB: The Blackwell Companion to Hinduism - Flood (relevant chapters)	Lecture, Practical
Week 4	Unit 2	TB: Indian Mathematics - Hayashi, pp. 118-130	Lecture, Discussion

Week 5	**Unit 2**	**OER: Byju's Vedic Mathematics - https://byjus.com/maths/vedic-maths/**	**Lecture, Group Work**
Week 6	**Unit 3**	**RB: Mathematics in India - Plofker, (relevant chapters)**	**Lecture, Practical**
Week 7	**Unit 3**	**OER: YouTube Video - Introduction to Vedic Mathematics - https://www.youtube.com/watch?v=BpSYaLkoLbI**	**Lecture, Discussion**
Week 8	**Revision**	**TB/RB: Review of Units 1-3**	**Lecture, Group Work**
Week 9	**Unit 4**	**RB: Beginnings of Modern Mathematics in India - Dauben & Parikh, pp. 15-37**	**Lecture, Practical**
Week 10	**Unit 4**	**OER: YouTube Video - Ancient Indian Mathematics - https://www.youtube.com/watch?v=VcAMbVNrPHc**	**Lecture, Discussion**
Week 11	**Unit 4**	**Advanced Reading - Choose relevant chapter from suggested advanced readings**	**Lecture, Group Work**
Week 12	**Unit 4**	**OER: YouTube Video - Vedic Mathematics Techniques - https://www.youtube.com/watch?app=desktop&v=g**	**Lecture, Practical**

		rkWGeqW99c&t=5s	
Week 13	Review	TB/RB: Review of Units 4-5	Lecture, Discussion
Week 14	Revision	TB/RB/OER: Comprehensive Review	Lecture, Group Work
Week 15	Assessment	TB/RB: Assessment and Evaluation	Exam, Discussion

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes (CLO)	Teaching-Learning Activities	Assessment Task Methods
Unit I	Introduction of Vedic Mathematics	- Lectures on the basics of Vedic Mathematics	- Quizzes on Vedic Mathematics topics
		- Demonstrations of mental subtraction and magic with 11	- In-class written tests
		- Hands-on practice of mental multiplication by 11	- Homework assignments

		to 19	
Unit II	**Advanced Multiplication Techniques in Vedic Mathematics**	**- Problem-solving sessions on general/random multiplication**	**- Individual and group presentations**
		- Practical exercises on instant multiplication with 99999 and 111	**- Problem-solving assessments**
		- Application of Vedic techniques for multiplication of numbers near bases	**- Case study evaluations**
Unit III	**Efficient Techniques for Finding Squares and Mental Addition**	**- Interactive sessions on finding squares of numbers in one line**	**- Oral presentations**
		- Engaging activities for mental squares and faster addition	**- Group projects**
		- Memorization and practice of multiplication tables up to 100	**- Conceptual problem-solving exercises**

Unit IV	**Advanced Techniques for Square Roots, Cube Roots, and Magic Divisions**	**- Demonstrations and practice of finding square roots at a glance**	**- Timed assessments for mental math**
		- Hands-on exercises for cube roots and digital roots	**- Group quizzes**
		- Exploration of magic divisions and cubing below/above the base	**- Individual and group presentations**
		- Application of Vedic methods for general cube of a number	**- Problem-solving assessments**

SEC014	**Documentation using Latex**	**L**	**T**	**P**	**C**

Total Contact Hours	**29**	**2**	**0**	**0**	**2**
Pre-requisites/Exposure					
Co-requisites					

Course Objectives

The objective of the course is

1. To learn about a document preparation system for high-quality typesetting
2. To learn typesetting of complex mathematical formulas

Course Outcomes

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

CO1. Identify the components of a LaTeX document (e.g., preamble, body, document classes).
CO2. Summarize the purpose and usage of common LaTeX packages.
CO3. Create a simple LaTeX document with proper formatting, including sections, subsections, and lists.
CO4. Compare and contrast different LaTeX document classes and their intended uses.
CO5. Construct a complex document, such as a research paper or thesis, utilizing advanced LaTeX features.
CO6. Judge the appropriateness of using LaTeX for specific document types compared to other tools.

Catalog Description

The course aims to introduce students to LaTeX - a high quality open-source typesetting software. LaTeX is most commonly used for medium to large technical or scientific documents but can be used for almost any type of publication. The course will, therefore, enable students to type a report, article, or mathematical document.

Course Content

Introduction to LaTeX, Benefits and comparison with word processor, Installing LaTeX, Formatting lines and paragraph, Typesetting a simple document, Text alignment, Installing packages

Creating Lists, Typing Math Formulas, Environments – equations, arrays, matrices, Footnotes, Fonts, Title and headers, Sectioning, Listing references, Math styles – cases, braces, math symbols

Graphics in LaTeX, Inserting Tables and Figures, Beamer presentation, Sample presentation, Using online resources

Text Books

1. David F. Griffiths, Desmond J. Higham, Learning LaTeX, Society for Industrial and Applied Mathematics(SIAM), 2016.
2. Stefan Kottwitz , LaTeX Beginner's Guide. Packt Publishing, Birmingham, UK, 2011.
3. Lamport, Leslie, LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.). Addison-Wesley, 1994.

Open Educational Resources (OER)

1. https://www.overleaf.com
2. https://www.w3schools.com/html/

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Programme And Course Mapping

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO 1	1	1	2	2	1	3	1	2	2	2	3	2	2	2	1	2
CO 2	1	1	2	1	1	1	3	2	3	1	2	2	2	1	1	1
CO 3	1	1	1	2	1	1	2	2	3	1	2	2	2	1	1	1
CO 4	1	1	1	2	1	1	1	1	2	1	2	1	1	1	1	1

CO 5	2	1	2	2	1	2	1	2	2	1	2	2	2	1	1	1
CO 6	1	2	1	2	1	2	3	1	1	1	1	1	3	2	1	1

Unit I	Installing LaTeX, Graphics, Text alignment, Styles
Local	Tool for Academic Writing
Regional	Tool for Academic Writing
National	Tool for Academic Writing
Global	Tool for Academic Writing
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9)
POE/4th IR	Presentation, Online Tutorials

Teaching Plan:

Week	Weekly Teaching Plan	Topic/Unit No.	Resources	Teaching-Learning Method
1	Introduction to LaTeX		TB: Ch. 1, RB: -	Lecture, Discussion, OER Exploration

2	**Benefits and Comparison with Word Processor**		**TB: Ch. 2, RB: -**	**Lecture, Discussion**
3	**Installing LaTeX**		**TB: Ch. 3, RB: -**	**Demonstration, Hands-on Practice**
4	**Formatting Lines and Paragraphs**		**TB: Ch. 4, RB: -**	**Lecture, Hands-on Practice**
5	**Typesetting a Simple Document**		**TB: Ch. 5, RB: -**	**Lecture, Hands-on Practice**
6	**Text Alignment**		**TB: Ch. 6, RB: -**	**Lecture, Hands-on Practice**
7	**Installing Packages**		**TB: Ch. 7, RB: -**	**Demonstration, Hands-on Practice**
8	**Creating Lists**		**TB: Ch. 8, RB: -**	**Lecture, Hands-on Practice**
9	**Typing Math Formulas**		**TB: Ch. 9, RB: -**	**Lecture, Hands-on Practice**

10	**Environments – Equations, Arrays, Matrices**		**TB: Ch. 10, RB: -**	**Lecture, Hands-on Practice**
11	**Footnotes, Fonts**		**TB: Ch. 11, RB: -**	**Lecture, Hands-on Practice**
12	**Title and Headers**		**TB: Ch. 12, RB: -**	**Lecture, Hands-on Practice**
13	**Sectioning, Listing References**		**TB: Ch. 13, RB: -**	**Lecture, Hands-on Practice**
14	**Math Styles – Cases, Braces, Math Symbols**		**TB: Ch. 14, RB: -**	**Lecture, Hands-on Practice**
15	**Graphics in LaTeX, Inserting Tables & Figures**		**TB: Ch. 15, RB: -, OER: https://www.overleaf.com**	**Lecture, Hands-on Practice**

SEMESTER-V

SCMA503	**Metric Spaces**	**L**	**T**	**P**	**C**
Total Contact Hours	**58**	**4**	**0**	**0**	**4**
Pre-requisites/Exposure	**Set Theory**				
Co-requisites					

Course Objectives

1. Learn basic facts about the cardinality of a set.
2. Understand several standard concepts of metric spaces and their properties like openness, closeness, completeness, Bolzano Weierstrass property, compactness, and connectedness.
3. Identify the continuity of a function defined on metric spaces and homeomorphisms.

Course Outcomes

On completion of this course, the students will be able to
CO1: Recognize examples of metric spaces, including Euclidean space and discrete metric spaces.
CO2: Explain the fundamental concepts of metric space, such as convergence of sequences and continuity of functions.
CO3: Apply metric properties to prove various results, such as continuity and convergence of sequences in specific metric spaces.

CO4: Use the metric space framework to solve problems related to continuity and compactness.
CO5: Compare and contrast different metric spaces and their suitability for specific applications.
CO6: Develop new metric spaces by defining appropriate distance functions for specific sets.
CO7: Evaluate the validity of proofs and arguments related to metric space properties and theorems.

Catalog Description

This course imparts the basic concepts of set theory and metric spaces. It enables students to differentiate between open and closed metric spaces. This course helps students in variety of ways to solve the problems based upon supremum, infimum, maximum and minimum efficiently. The course introduces the basic concepts about Set theory, countability, bounded set and all properties of Metric Spaces. It also explains concept of connectedness.

Course Content

Unit I: **lecture hours 14**
Theory of Sets: Finite and infinite sets, Countable and uncountable sets, Cardinality of sets, S chröder Bernstein theorem, Cantor's theorem, Order relation in cardinal

numbers, Arithmetic of cardinal numbers, Partially ordered set, Zorn's lemma and Axiom of choice, Various set theoretic paradoxes

Unit II: **lecture hours 14**

Concepts in Metric Spaces: Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space

Unit III: **lecture hours 18**

Complete Metric Spaces and Continuous Functions: Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem, Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

Unit IV: **lecture hours 12**

Compactness: Compact spaces, Sequential compactness, Bolzano Weierstrass property, Compactness and finite intersection property, Heine Borel theorem, Totally bounded sets, Equivalence of compactness and sequential compactness, Continuous functions on compact spaces.Connectedness: Separated sets, Disconnected and connected sets,Components, Connected subsets of $\mathbb{R}$, Continuous functions on connected sets.

Text Books

1. E. T. Copson (1988). Metric Spaces. Cambridge University Press.
2. P. R. Halmos (1974). Naive Set Theory. Springer.
3. P. K. Jain & Khalil Ahmad (2019). Metric Spaces. Narosa.
4. S. Kumaresan (2011). Topology of Metric Spaces (2nd edition). Narosa.
5. Satish Shirali & Harikishan L. Vasudeva (2006). Metric Spaces. Springer-Verlag.
6. Micheál O'Searcoid (2009). Metric Spaces. Springer-Verlag.

Open Educational Resources (OER)

1. https://www.youtube.com/watch?v=0ktJWbr84zA
2. https://www.youtube.com/watch?v=yvaFeNLZ9s8
3. https://www.geneseo.edu/~aguilar/public/notes/Real-Analysis-HTML/ch9-metric-spaces.html
4. https://math.libretexts.org/Bookshelves/Analysis/Introduction_to_Real_Analysis_(Lebl)/08%3A_Metric_Spaces/8.01%3A_Metric_Spaces
5. https://testbook.com/maths/metric-space

Programme and Course Mapping

Programme and Course Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6
CO 1	2		2		2			3				3	2	2	2	3	3
CO 2	2	2			3							3	2	2	2	3	3
CO 3	3	2	2		3							3	2	2	2	3	3
CO 4	2	2			2				2	3		3	2	2	2	3	3
CO 5	2		2		2			2	2			3	2	2	2	3	3
CO 6	3		2		2							3	2	2	2	3	3
CO 7	2				2		3					3	2	2	2	3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Theory of Sets
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Concepts in Metric Spaces
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-

Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Complete Metric Spaces and Continuous Functions
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Compactness
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan:

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	Introduction to Sets	P. R. Halmos (1974). Naive Set Theory.	Lecture and discussion
2	Cardinality of Sets	P. R. Halmos (1974). Naive Set Theory.	Lecture and discussion
3	Order Relation in Cardinal Numbers	P. R. Halmos (1974). Naive Set Theory.	Lecture and discussion
4	Partially Ordered Sets and Axiom of Choice	P. R. Halmos (1974). Naive Set Theory.	Lecture and discussion
5	Concepts in Metric Spaces	E. T. Copson (1988). Metric Spaces.	Lecture and examples
6	Open and Closed Sets in Metric Spaces	E. T. Copson (1988). Metric Spaces.	Lecture and examples
7	Completeness of Metric Spaces and Baire's Category Theorem	P. K. Jain & Khalil Ahmad (2019). Metric Spaces.	Lecture and proofs
8	Continuous Functions in Metric Spaces	P. K. Jain & Khalil Ahmad (2019). Metric	Lecture and examples

		Spaces.	
9	Compactness and Sequential Compactness	S. Kumaresan (2011). Topology of Metric Spaces.	Lecture and examples
10	Heine-Borel Theorem and Totally Bounded Sets	S. Kumaresan (2011). Topology of Metric Spaces.	Lecture and examples
11	Connected Sets and Components	S. Kumaresan (2011). Topology of Metric Spaces.	Lecture and examples
12	Review and Revision	N/A	Discussion and problem-solving
13	Exam Preparation and Practice	N/A	Practice problems and review
14	Exam Preparation and Practice	N/A	Practice problems and review
15	Final Exam	N/A	Written exam

Facilitating the Achievement of Course Learning Outcomes:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
I	Understand the concepts of sets, cardinality, and order	Lecture and discussion on Theory of Sets	Class participation, quizzes, and in-class exercises
II	Define and analyze metric spaces and their properties	Examples and proofs on Concepts in Metric Spaces	Homework assignments and in-class problem-solving sessions
III	Explore completeness of metric spaces and continuity of functions	Proofs and discussions on Complete Metric Spaces	Mid-term exam
IV	Examine compactness and connectedness in metric spaces	Examples and discussions on Compactness and Connectedness	Group projects and final exam

SCMA505	ADVANCED ALGEBRA	L	T	P	C
Version		4	0	0	4
Total Contact Hours	58 Hours				
Pre-requisites/Exposure	Group Theory				

Co-requisites	--

Course Objectives:

The course will enable the students to:

1. Understand the basic concepts of group actions and their applications.
2. Recognize and use the Sylow theorems to characterize certain finite groups.
3. Know the fundamental concepts in ring theory such as the concepts of ideals, quotient rings, integral domains, and fields.
4. Learn in detail about polynomial rings, fundamental properties of finite field extensions, and classification of finite fields

Course Outcomes:

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

CO1. Recall the fundamental definitions of group actions, orbits, stabilizers, and automorphisms in abstract algebra.
CO2. Utilize polynomial properties and Euclidean division to factor polynomials over various fields, including rational fields and finite fields.
CO3. Analyze the decomposition of a group into its conjugacy classes and using the class equation to extract information about its structure.
CO4. Evaluate the significance of the orbit-stabilizer theorem in understanding the sizes of orbits and stabilizers in group actions.
CO5. Design and construct examples of non-trivial group actions with specific properties, showcasing their creativity in applying abstract algebra concepts.
CO6. Create hypothetical scenarios where field extensions with desired properties are constructed, showcasing the ability to synthesize algebraic structures for specific purposes.

Catalog Description:

This course particularly deals with some more advanced algebra concepts, and it is laid on a preliminary course in algebra. The course begins with the concept of orbits and stabilizers with definitions and examples of it. Subgroups and their properties are the key concepts in this learning programme. Moreover, the concept of Rings, ED, PID and some concepts from fields are also considered in the plan of action.

Course Content

Unit I: **15 Contact Hours**

Group Actions: Group actions, Orbits and stabilizers, Conjugacy classes, Orbit-stabilizer theorem, Normalizer of an element of a group, Center of a group, Class equation of a group, Inner and outer automorphisms of a group

Sylow's Theorems: Cauchy's theorem for finite abelian groups, Finite simple groups, Sylow theorems and applications including non-simplicity tests.

Unit II: 16 Contact Hours

Rings and Fields: Definition, examples and elementary properties of rings, Commutative rings, Integral domain, Division rings and fields, Characteristic of a ring, Ring homomorphisms and isomorphisms, Ideals and quotient rings. Prime, principal and maximal ideals, Relation between Polynomial Rings: Polynomial rings over commutative ring and their basic properties, The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion, Euclidean domain, principal ideal domain, and unique factorization domain. domain and field, Euclidean rings and their properties, Wilson and Fermat's theorems.

Unit III: 15 Contact Hours

Polynomial Rings: Polynomial rings over commutative ring and their basic properties,The division algorithm; Polynomial rings over rational field, Gauss lemma and Eisenstein's criterion, Euclidean domain, principal ideal domain, and unique factorization domain

Unit IV: 12 Contact Hours

Field Extensions and Finite Fields: Extension of a field, Algebraic element of a field, Algebraic and transcendental numbers, Perfect field, Classification of finite fields.

Suggested Text Books

1. Joseph A. Gallian (2017). Contemporary Abstract Algebra (9th edition). Cengage.
2. I.S. Luthar & I.B.S. Passi (2013). Algebra: Volume 1: Groups. Narosa.
3. Michael Artin (2014). Algebra (2nd edition). Pearson.
4. P. B. Bhattacharya, S. K. Jain & S. R. Nagpaul (2003). Basic Abstract Algebra (2nd edition). Cambridge University Press.

Advanced Readings

1. John B. Fraleigh (2007). A First Course in Abstract Algebra (7th edition). Pearson.
5. I. N. Herstein (2006). Topics in Algebra (2nd edition). Wiley India.
6. David S. Dummit & Richard M. Foote (2008). Abstract Algebra (2nd edition). Wiley.

Open Educational Resources (OER)

1. **https://www.academia.edu/7141249/Abstract_Algebra_Manual_Problems_and_solution_only_the_section_on_GROUPS_**
2. **https://www.researchgate.net/publication/280733004_Abstract_Algebra_Solutions**
3. **https://users.metu.edu.tr/matmah/Graduate-Algebra-Solutions/Undergraduate-Algebra-Problems%20and%20Solutions.pdf**
4. **http://staffnew.uny.ac.id/upload/132319832/pendidikan/REFERENSI+ABSTRACT+ALGEBRA+SCHAUM.pdf**

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination/

Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	10	10	20	10	50

Programme And Course Mapping

Course Outcomes (CO)	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO 1	2	2	3	1	2	2	2	3	2	2	3	2	3	2	2	2
CO 2	3	1	1	2	2	1	3	3	3	3	2	2	2	1	2	2
CO 3	1	1	2	1	2	1	1	2	1	2	2	2	2	1	1	1
CO 4	3	2	2	3	2	2	2	2	2	2	2	2	2	2	2	2
CO 5	2	2	2	2	3	2	3	3	2	2	2	2	2	3	2	2
CO	3	2	3	2	3	2	2	2	2	2	2	2	2	3	2	3

6																

Unit I	Group Actions, Sylow’s Theorems
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment &Sustainability	-
Unit II	Rings and Fields
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Polynomial Rings
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-

Unit IV	Field Extensions and Finite Fields
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	-
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topic/Unit No.	Textbook/Reference	Teaching-Learning Method
1	**Unit I**		
	Group Actions: Group actions, Orbits and stabilizers	**TB: Gallian 1.1-1.2**	**Lecture, Discussion, Examples**
		Luthar & Passi 1.1-1.3	

2	**Unit I**		
	Conjugacy classes, Orbit-stabilizer theorem	**TB: Gallian 1.3-1.4**	**Lecture, Discussion, Examples**
		Luthar & Passi 1.4-1.5	
3	**Unit I**		
	Normalizer of an element of a group, Center of a group	**TB: Gallian 1.5-1.6**	**Lecture, Discussion, Examples**
		Luthar & Passi 1.6-1.7	
4	**Unit I**		
	Class equation of a group, Inner and outer automorphisms of a group	**TB: Gallian 1.7-1.8**	**Lecture, Discussion, Examples**
		Luthar & Passi 1.8-1.9	

5	**Unit I**		
	Sylow’s Theorems: Cauchy’s theorem for finite abelian groups	**TB: Gallian 2.1-2.2**	**Lecture, Discussion, Examples**
6	**Unit I**		
	Finite simple groups, Sylow theorems and applications including non-simplicity tests	**TB: Gallian 2.3-2.4**	**Lecture, Discussion, Examples**
7	**Unit II**		
	Definition, examples, and elementary properties of rings	**TB: Gallian 3.1-3.2**	**Lecture, Discussion, Examples**
8	**Unit II**		
	Commutative rings, Integral domain, Division rings and fields	**TB: Gallian 3.3-3.4**	**Lecture, Discussion, Examples**

9	**Unit II**		
	Characteristic of a ring, Ring homomorphisms and isomorphisms	**TB: Gallian 3.5-3.6**	**Lecture, Discussion, Examples**
10	**Unit II**		
	Ideals and quotient rings, Prime, principal, and maximal ideals	**TB: Gallian 4.1-4.2**	**Lecture, Discussion, Examples**
11	**Unit II**		
	Relation between Polynomial Rings, The division algorithm	**TB: Gallian 4.3-4.4**	**Lecture, Discussion, Examples**
12	**Unit III**		
	Polynomial rings over commutative ring and their basic properties	**TB: Gallian 5.1-5.2**	**Lecture, Discussion, Examples**

13	Unit III		
	The division algorithm; Polynomial rings over rational field, Gauss lemma	TB: Gallian 5.3-5.4	Lecture, Discussion, Examples
14	Unit III		
	Euclidean domain, principal ideal domain, and unique factorization domain	TB: Gallian 5.5-5.6	Lecture, Discussion, Examples
15	Unit IV		
	Field Extensions and Finite Fields: Extension of a field	TB: Gallian 14.1-14.2	Lecture, Discussion, Examples
16	Revision and Assessment		Review, Practice Problems, Assessments

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes (CO)	Teaching-Learning Activities	Assessment Task Methods
Unit I	Recall fundamental definitions of group actions, orbits, stabilizers, etc.	Lectures, Discussions, Examples	Quizzes, Homework, Class Participation
	Utilize polynomial properties and Euclidean division to factor polynomials	Problem-solving Sessions, Group Activities	Problem Sets, In-class Activities, Group Work
	Analyze decomposition of a group into conjugacy classes, use class equation	Group Discussions, Case Studies, Concept Mapping	Group Projects, Presentations, Concept Maps
	Evaluate the significance of orbit-stabilizer theorem	Interactive Sessions, Real-world Examples	Class Participation, Conceptual Assessments
	Design and construct examples of non-trivial group actions	Creative Assignments, Brainstorming	Creative Projects, Portfolio Assessment
	Create hypothetical scenarios for field extensions with desired properties	Scenario-based Exercises, Thought Experiments	Thought Papers, Scenario Analysis

Unit II		Lectures, Group Activities, Problem-solving	Quizzes, Assignments, Group Projects
	Develop protocols as per laboratory standards for field extensions	Lab Sessions, Practical Work	Lab Reports, Practical Assessments
Unit III		Lectures, Workshop-style Sessions, Problem-solving	Problem Sets, Worksheets, Case Studies
	Analyze local and global impacts of understanding algebraic values	Case Studies, Real-world Scenarios	Case Analysis, Discussions
Unit IV		Lectures, Interactive Sessions, Problem-solving	Quizzes, Assignments, Problem Sets
	Apply mathematical modeling and reasoning to solve problems	Modeling Activities, Simulations	Modeling Projects, Problem-solving Tasks

---SCMA507	LINEAR PROGRAMMING	L	T	P	C
Version		4	0	0	4
Total Contact Hours	50 Hours				

Pre-requisites/Exposure	
Co-requisites	--

Course Objectives

1. Analyze and solve linear programming models of real-life situations.
2. Provide graphical solutions of linear programming problems with two variables, and

illustrate the concept of convex set and extreme points.

3. Understand the theory of the simplex method.
4. Know about the relationships between the primal and dual problems, and to

understand sensitivity analysis.

5. Learn about the applications to transportation, assignment and two-person zero-sum

game problems.

Course Outcomes

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

CO1- Understand the origin and development of operation research, linear programming.
CO2- Analyze the real-life systems with limited constraints, Identify and formulate the problem.
CO3- Used the theory of the simplex method, and their cases.
CO4- Check and find a solution by Duality of simplex method, two phase method.
CO5- Investigate the Maximize the profit, minimize the cost, minimize the time in transportation
. problem
CO6 Analyze the application of liner programming : Assignment problem

Catalog Description

This course covers some core areas of Operational Research, namely Linear programming, Transportation problem, Assignment problem and Game Theory. Emphasis will be placed both on the mathematical techniques and on problem formulation through examples from applications.

Course Content

UNIT – I **12 lecture hours**

Linear Programming Problem, Convexity and Basic Feasible Solutions,Formulation, Canonical and standard forms, Graphical method; Convex and polyhedral sets,Hyperplanes, Extreme points; Basic solutions, Basic Feasible Solutions, Reduction of feasible solution to basic feasible solution, Correspondence between basic feasible solutions and extreme points.

Unit II **12 lecture hours**

Simplex Method

Optimality criterion, improving a basic feasible solution, Unboundedness, Unique and alternate optimal solutions; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-M method**.**

Unit III **12 lecture hours**

Formulation of the dual problem, Duality theorems, Complimentary slackness theorem, Economic interpretation of the dual, Dual-simplex method.

Unit IV: **14 lecture hours**

Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions: Northwest-corner rule, Least- cost method, Vogel approximation method; Algorithm for obtaining optimal solution. Assignment Problem: Mathematical formulation and Hungarian method.
Game Theory: Formulation and solution of two-person zero-sum games, Games with mixed strategies, Linear programming method for solving a game.

Text Books

Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sonsv

Reference Books/Materials

1. H.A. Taha, Operation Research-An introducton, Printice Hall of India.
2. P.K. Gupta and D.S. Hira, Operations Research, S. Chand & Co.
3. S.D. Sharma, Operation Research, Kedar Nath Ram Nath Publications

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Understand the origin and development of operation research, linear programming.	**PO2**
CO2	Analyze the real life systems with limited constraints, Identify and formulate the problem.	**PO1**
CO3	Used the theory of the simplex method, and their cases	**PO8**
CO4	Check and find a solution by Duality of simplex method, two phase method	**PO5**
CO5	Investigate the Maximize the profit, minimize the cost, minimize the time in transportation problem	**PO6**
CO6	Analyze the application of liner programming : Assignment problem	**PO5**

		Apply information on scientific facts to face day to day requirements	Apply moral principles and responsibilities of a science graduate to serve the society	Create innovative ideas by using scientific knowledge for analysis and interpretation of data	Ability to work independently as well as in collaboration with other individuals /institutions	Knowledge regarding advancement in various branches of mathematics	Inculcate moral/ethical values and environmental consciousness	Enhance employability/ entrepreneurship skills	Ability to communicate various concepts of mathematics effectively	Capable to use appropriate software's to solve mathematical equations	Capable to use appropriate software's to solve mathematical equations	To gain a strong foundation in various branches of mathematics to investigate and solve the real life problem	To gain a strong foundation in various branches of mathematics to investigate and solve the real life problem	Analyze the local and global impacts of understanding of values, ideas, and outcomes in a specific subject area.	To develop entrepreneurial skills to become empowered and self-reliant	Understand the basic concepts of statistics, algebra, and differential equations	Apply the mathematical modeling and reasoning to solve basic problems.
	LINEAR PROGRAMMING																
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
BSMA 304A		2	2			3	3		2			2	3		3	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**P**	**PO**	**PS**	**PS**	**PS**	**PS**	**PS**	**PS**

	1	2	3	4	5	6	7	8	9	O10	11	O1	O2	O3	O4	O5	O6
CO1		2										3	2	1	1	2	2
CO2	3											3	2	1	1	2	2
CO3								2				3	2	1	1	2	2
CO4					3							3	2	1	1	2	2
CO5						2						3	2	1	1	2	2
CO6					2												
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Basics of Linear Programming Problem
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Linear Programming Problems
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Simplex Method
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Optimality Criterion
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit III	Dual Problem
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Dual Problems
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Transportation Problems
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Transportation Problems
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

SCMA501	**Numerical Methods**	**L**	**T**	**P**	**C**
Version		**4**	**0**	**0**	**4**

Pre-requisites/Exposure	nil
Co-requisites	--

Course Objectives

1. To develop the mathematical skills of the students in the areas of numerical methods

2. The explaining and understanding of the several available methods to Solve the simultaneous equations.

3. Obtaining numerical solutions to problems of mathematics

4. Familiar with numerical integration and differentiation, numerical solution of ordinarydifferential equations.

Course Outcomes

This course will enable the students to:

CO1. Apply numerical methods to solve algebraic and transcendental equations

CO2. Apply numerical methods to solve systems of linear equations

CO3. Analyze and apply interpolating and extrapolating methods

CO4. Apply numerical methods to solve initial and boundary value problems in differential equations

CO5. Analyze and apply numerical methods to solve real-life problems

CO6. Utilize appropriate numerical techniques based on problem requirements

Catalog Description

This course Understand the basic concepts of statistics, algebra, and differential equations. Analyze the relationship of basic mathematics in real life. Acquire the ability to calculate and reason to design complex and critical financial models for any organization and after completing this course students apply the mathematical modeling and reasoning to solve basic problems.

Course Content

Unit I: **8 lecture hours**

Numerical Methods for Solving Algebraic and Transcendental Equations Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence; Bisection method, False position method, Fixed point iteration method, Newton's method and secant method for solving equations.

Unit II: **12 lecture hours**

Numerical Methods for Solving Linear Systems Partial and scaled partial pivoting, Lower and upper triangular (LU) decomposition of a matrix and its applications, Thomas method for tridiagonal systems; Gauss−Jacobi, Gauss−Seidel and successive over-relaxation (SOR) methods.

Unit III: **8 lecture hours**

Interpolation Lagrange and Newton interpolations, Piecewise linear interpolation, Cubic spline interpolation, Finite difference operators, Gregory−Newton forward and backward difference interpolations.

Unit IV: **12 lecture hours**

Numerical Differentiation and Integration First order and higher order approximation for first derivative, Approximation for second derivative; Numerical integration: Trapezoidal rule, Simpson's rules and error analysis, Bulirsch−Stoer extrapolation methods, Richardson extrapolation. Initial and Boundary Value Problems of Differential Equations Euler’s method, Runge−Kutta methods, Higher order one step method, Multi-step methods; Finite difference method, Shooting method, Real life examples: Google search engine, 1D and 2D simulations, Weather forecasting.

Text Books

1. Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson

2. C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education,

India.

3. F. B. Hildebrand (2013). Introduction to Numerical Analysis: (2nd edition). Dover Publications.

4. M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). Numerical Methods for Scientific and Engineering

Computation (6th edition). New Age International Publishers.

5.Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using

MATLAB and C. Thomson-Brooks/Cole.

Reference Books/Materials

1.B. S. Grewal, *Numerical Methods in Engineering and Science*, Khanna Publishers.

Open Educational Resources (OER)

1. Numerical methods - Course (nptel.ac.in)
2. Numerical Methods for Engineers | Coursera
3. Introduction to Numerical Methods | Mathematics | MIT OpenCourseWare
4. **Assessment & Evaluation**

Components	**Assignment**	**Mid Term Examination**	**Attendance**	**End Term Examination**
Weightage (%)	**20**	**20**	**10**	**50**

5.

Programme and Course Mapping

CO	PO 1	PO 2	PO 3	PO 4	P O5	PO 6	P O7	P O8	P O9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PS O4	PS O5	PS O6
CO 1	3	2	1													2	
CO 2	2			2	3	1						3					
CO 3	3		3	3	2							2					
CO 4	2				2												
CO 5	3											3		2			
CO 6	3											2		3			

1=lightly mapped 2= moderately mapped 3=strongly mapped

Unit I	Solution of Equations
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Numerical and Iterative Methods
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Interpolation and Approximation
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment &	-

Sustainability	
Unit IV	Numerical Integration and Differentiation
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topics/Units	Textbook/Reference Book	OER	Teaching-Learning Method
1	Unit I: Numerical Methods for Solving Equations	Bradie (Ch. 1)	Numerical methods - Course (nptel.ac.in)	Lecture, Discussion
2	Unit I: Numerical Methods for Solving	Gerald & Wheatley (Ch. 2)	Numerical Methods for Engineers	Lecture, Practical Sessions

	Equations			
3	Unit II: Numerical Methods for Solving Linear Systems	Jain et al. (Ch. 3)	Introduction to Numerical Methods	Lecture, Practical Sessions
4	Unit II: Numerical Methods for Solving Linear Systems	Grewal (Ch. 4)		Lecture, Practical Sessions
5	Unit III: Interpolation	Hildebrand (Ch. 7)		Lecture, Discussion, Exercises
6	Unit III: Interpolation	Bradie (Ch. 6)		Lecture, Practical Sessions
7	Unit IV: Numerical Differentiation and Integration	Jain et al. (Ch. 8)		Lecture, Discussion, Exercises
8	Unit IV: Numerical Differentiation and Integration	Bradie (Ch. 5)		Lecture, Practical Sessions
9	Review and Midterm Exam			Assessment
10	Unit IV: Initial and Boundary Value Problems	Gerald & Wheatley (Ch. 10)		Lecture, Discussion, Exercises
11	Unit IV: Initial and Boundary Value Problems	Hildebrand (Ch. 12)		Lecture, Practical Sessions

12	Applications of Numerical Methods	Bradie (Ch. 9)		Lecture, Discussion, Exercises
13	Applications of Numerical Methods	Schilling & Harris		Lecture, Practical Sessions
14	Review and Final Exam			Assessment

Top of Form

Facilitating the Achievement of Course Learning Outcomes

Unit	Course Learning Outcomes (CLOs)	Teaching-Learning Activities (TLAs)	Assessment Task Methods
Unit I	1. Recall and apply numerical methods for equations.	- Lectures on numerical methods and algorithms.	- In-class quizzes on methods.
	2. Explain the concepts of round-off and truncation errors.	- Numerical problem-solving exercises.	- Homework assignments.

		- Examples and demonstrations using a computational tool.	**- Mid-term exam on Unit I content.**
Unit II	3. Utilize LU decomposition and iterative methods for linear systems.	- Interactive discussions on LU decomposition and iterative methods.	- In-class group problem-solving activities.
	4. Analyze the convergence properties of iterative methods.	- Workshops and group activities for solving linear systems.	- Submission of a report analyzing iterative methods.
		- Computer-based simulations and exercises on LU decomposition.	**- Assessment of simulation results.**
Unit III	5. Apply interpolation techniques and finite difference operators.	- Demonstrations of interpolation methods and finite difference operators.	- Practical session on interpolation and finite differences.
	6. Evaluate the accuracy and suitability of interpolation methods.	- Practical lab work on implementing interpolation algorithms.	- Submission of a project comparing different interpolation methods.

		- Group discussions on interpolation applications.	**- Peer assessment of practical work.**
Unit IV	7. Use numerical differentiation and integration methods.	- Lectures and problem-solving sessions on numerical differentiation and integration.	- Quizzes on numerical differentiation and integration.
	8. Analyze stability and errors in numerical differential equations.	- Real-world applications and case studies involving numerical methods.	- Final exam covering numerical differentiation and integration concepts.
		- Coding and programming assignments for solving differential equations.	- Assessment of coding assignments and accuracy of results.

SCMA551	**NUMERICAL ANALYSIS LAB**	**L**	**T**	**P**	**C**
Version		**0**	**0**	**2**	**1**
Pre-requisites/Exposure					
Co-requisites	**MATLAB SOFTWARE**				

Course Objectives

The purpose of these labs is to develop the mathematical skills of the students in the areas of numerical methods, The explaining and understanding of the several available methods to Solve the simultaneous equations, Perform statistical data analysis, data interpolation by MATLAB and to calculate the numerical integration and differentiation, numerical solution of differentiation equation with MATLAB

Course Outcomes

On completion of this course, the students will be able to
CO1. To develop the mathematical skills of the students in the areas of numerical methods

CO2. The explaining and understanding of the several available methods to Solve the simultaneous equations.
CO3. Perform statistical data analysis, data interpolation by MATLAB.
CO4. To calculate the numerical integration and differentiation, numerical solution of differentiation equation with MATLAB

Catalog Description

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

- Understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.
- Learn how to obtain numerical solution of nonlinear equations using bisection, secant, newton, and fixed-point iteration methods.
- Solve system of linear equations numerically using direct and iterative methods.
- Understand how to approximate the functions using interpolating polynomials.
- Learn how to solve definite integrals and initial value problems numerically.

Course Content

List of practical

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. To find the absolute value of an integer.
3. Enter 100 integers into an array and sort them in an ascending order.
4. Bisection Method.
5. Newton Raphson Method.
6. Secant Method.
7. Regula-Falsi Method.
8. LU decomposition Method.
9. Gauss-Jacobi Method.
10. SOR Method or Gauss-Siedal Method.
11. Lagrange Interpolation or Newton Interpolation.
12. Simpson's rule
13. Solution of Ordinary Differential Equation

Note: For any of the CAS (Computer aided software) Data types-simple data types, floating datatypes, 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

Text Books

1.B. S. Grewal, *Numerical Methods in Engineering and Science*, Khanna Publishers.

2. Brian Bradie (2006), A Friendly Introduction to Numerical Analysis. Pearson

3. C. F. Gerald & P. O. Wheatley (2008). Applied Numerical Analysis (7th edition), Pearson Education, India.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Programme and Course Mapping

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**	**PSO 5**	**PSO 6**
CO 1	**3**				**3**							1					
CO 2	**2**	**3**			**2**									2	**3**		
CO 3	**3**		**3**		**3**								3				
CO 4	**3**		**3**		**2**				**3**		2				**1**		
CO 5	**3**		**2**		**3**	**3**										**2**	**3**
CO 6	**3**		**3**		**3**									1		**3**	**3**

1=lightly mapped 2= moderately mapped 3=strongly mapped

Unit I	Practicals for different iteration methods
Local	Ingredient in Research and Analysis
Regional	Ingredient in Research and Analysis
National	Ingredient in Research and Analysis
Global	Ingredient in Research and Analysis
Employability	-

Entrepreneurship	-
Skill Development	Use of Technology in Bisection Method, Newton Raphson Method, Secant Method, Regula-Falsi Method
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Universal quality education and lifelong learning (SDG 4- 4.4)
NEP 2020	Online and Digital Education: Ensuring Equitable Use of Technology (24), Towards a More Holistic and Multidisciplinary Education11), Transforming the Regulatory System of Higher Education (18)
POE/4th IR	Hands on experience, Programming Software

-UDT105	Time series analysis and forecasting using Python	L3	T0	P2	C4
Pre-requisites/Exposure					
Co-requisites	--				

Course Description: This course provides a comprehensive introduction to time series analysis and forecasting techniques using the Python programming language. Students will learn how to analyze time-dependent data, extract meaningful patterns, and create accurate forecasts for various applications such as finance, economics, and business. Through hands-on exercises and practical examples, students will develop the skills needed to make informed predictions from historical data.

Course Objectives:

1. Gain a solid grasp of time series concepts, including trend, seasonality, and noise, and understand the challenges associated with analyzing such data.
2. Learn techniques to visualize and explore time series data, identifying underlying patterns and anomalies.
3. Understand and implement fundamental time series models like ARIMA (Auto Regressive Integrated Moving Average) and its variations, which form the foundation for forecasting.
4. Discover how to engineer relevant features from time series data that enhance the forecasting models.
5. Address real-world challenges such as missing data, outliers, and irregularly spaced time intervals in time series datasets.

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

1. Analyze and visualize time series data to identify trends, seasonality, and anomalies.
2. Implement basic and advanced time series forecasting models using Python libraries like

pandas, **statsmodels**, and **scikit-learn**.

3. Evaluate the performance of forecasting models using appropriate metrics.
4. Apply feature engineering techniques to improve the accuracy of time series forecasts.
5. Understand the basics of machine learning approaches for time series analysis, including LSTM networks.
6. Handle challenges commonly encountered in real-world time series datasets.

Unit 1: INTRODUCTION OF TIMESERIES ANALYSIS:

Introduction to Time Series and Forecasting, Different types of data, Internal structures of time series. Models for time series analysis, Autocorrelation and Partial autocorrelation. Examples of Time series Nature and uses of forecasting, Forecasting Process, Data for forecasting, Resources for forecasting.

Unit 2: STATISTICS BACKGROUND FOR FORECASTING:

Graphical Displays, Time Series Plots, Plotting Smoothed Data, Numerical Description of Time Series Data, Use of Data Transformations and Adjustments, General Approach to Time Series Modeling and Forecasting, Evaluating and Monitoring Forecasting Model Performance.

Unit 3: TIME SERIES REGRESSION MODEL:

Introduction Least Squares Estimation in Linear Regression Models, Statistical Inference in Linear Regression, Prediction of New Observations, Model Adequacy Checking, Variable Selection Methods in Regression, Generalized and Weighted Least Squares, Regression Models for General Time Series Data, Exponential Smoothing, First order and Second order.

Unit 4 AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODELS:

Autoregressive Moving Average (ARMA) Models - Stationarity and Invertibility of ARMA Models - Checking for Stationarity using Variogram- Detecting Nonstationarity - Autoregressive Integrated Moving Average (ARIMA) Models - Forecasting using ARIMA - Seasonal Data - Seasonal ARIMA Models Forecasting using Seasonal ARIMA Models Introduction - Finding the “BEST” Model - Example: Internet Users DataModel Selection Criteria - Impulse Response Function to Study the Differences in Models Comparing Impulse Response Functions for Competing Models .

TEXTBOOKS:

1. **Introduction To Time Series Analysis And Forecasting**, 2nd Edition, Wiley Series In Probability And Statistics, By Douglas C. Montgomery, Cheryl L. Jen(2015)
2. **Master Time Series Data Processing, Visualization, And Modeling Using Python** Dr. Avishek Pal Dr. Pks Prakash (2017)

LAB

1 Task to perform on Time Series data
- Time Series Data Cleaning
- Loading and Handling Times series data
- Preprocessing Techniques

2 How to Check Stationarity of a Time Series. How to make a Time Series Stationary? Estimating & Eliminating Trend.
- Aggregation
- Smoothing
- Polynomial Fitting Eliminating Trend and Seasonality
- Differencing
- Decomposition

3 a) Moving Average time analysis data.
b) Smoothing the Time analysis Data.
c) Check out the Time series Linear and non-linear trends.
d) Create a modelling.

4 Modelling time series
- Moving average
- Exponential smoothing
- ARIMA Seasonal autoregressive integrated moving average model (SARIMA)

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	**20**	**20**	**10**	**50**

Programme and Course Mapping

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	2				**3**		**2**	**2**				**2**	**2**	**2**	**2**	**2**	**3**
CO2					**2**		**2**	**2**				**3**	**2**	**2**	**2**	2	**2**
CO3		**3**		**3**								**3**	**2**	**2**	**2**	**2**	**3**
CO4	3						**2**					**2**	**2**	**2**	**2**	**2**	**2**

C O5							2					3	2	2	2	2	3
C O6	2				3					3	3	3	2	2	2	3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	**Introduction to Time series analysis**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Ubiquitous in various industries, including finance, marketing, healthcare, and manufacturing
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Statistical background for forecasting
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Data Handling and preprocessing
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Time series Regression model
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Forecasting to manage inventory, predict customer demand, and optimize resource allocation.
Entrepreneurship	-
Skill Development	

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA) MODELS
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Time series forecasting skills are in high demand to help organizations make accurate predictions and save costs.
Entrepreneurship	-
Skill Development	Predicting stock prices, asset price movements, and economic indicators.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	Introduction to Time Series Analysis Lecture 1: Course overview and objectives Lecture 2: What is a time series? Lecture 3: Components of a time series Lab: Setting up Python environment for time series analysis	TB1	**Lectures, Examples, and Problem-Solving, Hands on practice**

2	Time Series Data Visualization Lecture 4: Time series data visualization techniques Lecture 5: Time series decomposition Lab: Visualizing time series data in Python		**Lectures, Examples, and Problem-Solving**
3	Time Series Decomposition Lecture 6: Trend, seasonality, and residual Lecture 7: Additive vs. Multiplicative decomposition Lab: Decomposing time series data in Python	TB1	**Lectures, Examples, and Problem-Solving**
4	Time Series Smoothing Techniques Lecture 8: Moving averages Lecture 9: Exponential smoothing Lab: Implementing smoothing techniques in Python	TB1	**Lectures, Examples, and Problem-Solving**
5	Stationarity and Differencing Lecture 10: Stationarity in time series data Lecture 11: Differencing and its importance Lab: Making time series data stationary in Python	TB1	**Lectures, Examples, and Problem-Solving**

6	Stationarity and Differencing Lecture 10: Stationarity in time series data Lecture 11: Differencing and its importance Lab: Making time series data stationary in Python	TB1	**Lectures, Examples, and Problem-Solving**
7	Time Series Forecasting Models - ARIMA Lecture 14: Introduction to ARIMA models Lecture 15: Parameter selection for ARIMA Lab: Implementing ARIMA modeling in Python		**Lectures, Examples, and Problem-Solving**
8	Time Series Forecasting Models - Seasonal Decomposition of Time Series (STL) Lecture 16: Introduction to STL Lecture 17: Implementing STL in Python Lab: Seasonal decomposition with STL		**Lectures, Examples, and Problem-Solving**
9	Exponential Smoothing Methods Lecture 18: Holt-Winters exponential smoothing Lecture 19: Exponential smoothing in Python Lab: Forecasting with Holt-Winters method	TB1	**Lectures, Examples, and Problem-Solving**

10	Time Series Cross-Validation Lecture 20: Cross-validation for time series data Lecture 21: Walk-forward validation Lab: Cross-validation in time series forecasting	TB1	**Lectures, Examples, and Problem-Solving**
11	Advanced Topics in Time Series Analysis Lecture 22: Seasonal decomposition of time series using decomposition Lecture 23: SARIMA models Lab: Advanced time series modeling in Python	TB1	**Lectures, Examples, and Problem-Solving**
12	Time Series Forecast Evaluation Lecture 24: Forecast evaluation metrics Lecture 25: Choosing the right evaluation metric Lab: Evaluating time series forecasts in Python	TB1	**Lectures, Examples, and Problem-Solving**
13	Time Series Forecasting with Machine Learning Lecture 26: Introduction to machine learning for time series forecasting Lecture 27: Time series forecasting with	TB1	**Lectures, Examples, and Problem-Solving**

	regression models Lab: Machine learning for time series forecasting		
14	Project Presentation and Conclusion Final project presentations by students Recap of the course and future directions in time series analysis	TB1	**Lectures, Examples, and Problem-Solving**
15	Project Presentation and Conclusion Final project presentations by students Recap of the course and future directions in time series analysis	TB1	**Lectures, Examples, and Problem-Solving**

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Describe the fundamental characteristics of time series data, including trend, seasonality, and noise.	Lectures and discussions on the nature of time series data, supported by real-world examples. Hands-on exercises where students analyze and visualize time series datasets. Practical sessions on data cleaning, handling missing values, and dealing with outliers in time series datasets. Assignments where students preprocess real-world time series data	**• Presentations, practices and class discussions.** **• Assignments and class tests.** **• Student presentations.** **• Mid-term examinations.** **•Practical and viva-voce examinations.** **• End-term examinations.**

		using Python libraries like Pandas. Practical sessions on data visualization libraries like Matplotlib and Seaborn. Group presentations where students communicate their findings and interpretations.	

Data analytics with Tableau

-SEC013	DATA ANALYTICS WITH TABLEAU	L	T	P	C
		2	0	0	2
Pre-requisites/Exposure	**Basic knowledge of data analysis.**				
Co-requisites	**--**				

Course Objectives:-

1. Understand data warehousing concepts, characteristics, and differences from OLTP.

2. Explore BI tools, DWH architecture, and types of dimensional data modelling.

3. Master Tableau Desktop for data analysis, visualization, and dashboard development.

4. Learn calculations, formatting and techniques for interactive dashboards.

5. Gain insights into Tableau Server installation, configuration, and JavaScript API usage.

6. Acquire advanced Tableau skills, including data blending, mapping, and statistical analysis.

Course Outcomes: -

1. Differentiate between OLTP and DWH, explain DWH characteristics, and identify BI tools.

2. Apply dimensional data modelling and understand surrogate keys and dimension types.

3. Analyze data, create visualizations, and develop interactive Tableau dashboards.

4. Share dashboards effectively and demonstrate proficiency in Tableau Server usage.

5. Implement JavaScript API for embedding and enhancing interactivity.

6. Utilize advanced Tableau features for data blending, mapping, and forecasting.

Catalog Description:

This course provides a comprehensive introduction to data analytics using Tableau. Students will learn data warehousing concepts, Tableau Desktop fundamentals (data connection, analysis, calculations, and visualization), Tableau Server administration, and advanced Tableau techniques. Practical skills in data analysis and visualization will be developed to prepare students for real-world applications.

Course Content: -

Unit 1:- Data Warehousing Concepts

Datawarehouse, Characteristics of Datawarehouse, Difference between OLTP and DWH, Architecture of DWH, Various BI tools, Types of DWH, Types of Dimensional Data Modelling, Surrogate key, Types of Dimension

Unit 2:- Introduction to Tableau Desktop

Connecting to Excel, CSV Text Files, Connecting to Databases, Working with Data, Analysing, Formatting, Introduction to Calculations, Dashboard Development, Sharing, Data Calculations, Aggregate Calculations, User Calculations, Table Calculations, Logical Calculations, String Calculations, Number Calculations, Type Conversion, Parameters Filtering, Conditions Filtering, Measures, Histograms, Sorting, Grouping, Sets, Tree maps, word clouds and bubble charts, Pareto Charts, Waterfall Charts, Bump Charts, Funnel Charts, Bollinger Bands.

Unit 3:- Tableau Server

Install Configuration, Tab admin, Tab cmd, Data Server, End User Training, JavaScript API Intro and Embed, JavaScript API Switching Views, JavaScript API Filtering and Selecting, JavaScript API Asynchronous Programming, JavaScript API Event Listeners, JavaScript API Advanced Filtering, JavaScript API Utility Function

Text Books:

1. Getting Started with Tableau 2019.2: Effective data visualization and business intelligence with the new features of Tableau 2019.2, Tristan Guillevin, Packt Publishing Ltd

2. Mastering Tableau 2019.1: An expert guide to implementing advanced business intelligence and analytics with Tableau 2019.1, Marleen Meier and David Baldwin, Packt Publishing Ltd.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Assignment**	**Mid Term Examination**	**Attendance**	**End Term Examination**
Weightage (%)	**20**	**20**	**10**	**50**

CO and PO mappings: -

Course Code	**Course**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**

and Title	Outcome																
SCMA101 DATA ANALYTICS WITH TABLEAU	CO1	-	2	2	1	-	-	2	-	-	2	-	2	3	-	1	-
	CO2	-	2	2	1	-	-	2	-	-	2	-	3	3	-	1	-
	CO3	-	2	2	1	-	-	2	-	-	2	-	2	2	-	-	-
	CO4	-	2	2	-	-	-	2	-	-	2	-	2	3	-	-	-
	CO5	-	2	2	-	-	-	2	-	-	2	-	3	2	-	-	-
	CO6	-	2	2	-	-	-	2	-	-	2	-	2	3	-	-	-

Unit I	Data Warehousing Concepts
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Data Presentation
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Introduction to Tableau Desktop
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Use of Tableau
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Tableau Server
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research

National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Data handling and presentation
Entrepreneurship	-
Skill Development	Dashboard Design
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan: -

Weekly Teaching Plan	Topic/Unit No.	Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]	Teaching-Learning Method
Week 1	Introduction to Data Warehousing	TB1	Lecture
Week 2	Data Warehousing Architecture and BI tools	TB1	Lecture
Week 3	Tableau Desktop Basics	OER	Hands-on session and Presentation
Week 4	Tableau Desktop Intermediate features: formatting and visualization, introduction to calculations and Dashboard development	OER	Presentation and Hands-on sessions
Week 5	Data calculations,	TB1	Presentation and

	Aggregate calculations, user calculations, table calculations, logical calculations, string calculations		Hands-on session
Week 6	Number calculations, type conversion, parameters and filtering, conditions filtering	TB1	Presentation and Hands-on session
Week 7	Measures, histograms and sorting, Grouping and sets, Tree maps, word clouds, and bubble charts	TB1	Presentation and Hands-on session
Week 8	Pareto charts, Waterfall charts, Bump charts, Funnel charts, Bollinger Bands	TB1	Presentation and Hands-on session
Week 9	Installing and configuring Tableau server, Tab admin and Tab cmd, Data server and end-user training	OER	Presentation and Hands-on session
Week 10	Introduction to Java script API, Embedding Tableau views, Filtering and selecting using JavaScript API	TB1	Lecture and Hands-on sessions
Week 11	Advanced Tableau Features, Statistics calculations, Trend lines and forecasting	TB1	Presentation and Hands-on sessions
Week 12	Benford's law and Box Plots, Tableau online security and administration, Online updating data to the cloud	TB1	Presentation and Hands-on sessions

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1	Understand DWH principles, OLTP vs. DWH, and Dimensional Data Modelling	(i) Each topic to be explained with illustrations. (ii) Students will connect to various	• Presentations and class discussions. • Hands on sessions • Projects in groups • Assignments

2	Connect data sources, create visualizations, and perform analysis.	data sources, analyse data, and create visualizations using Tableau Desktop (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Some advance sessions will cover data blending, mapping, analysis, and real-world data scenarios with Tableau.	and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
3	Install/configure Tableau Server, learn about Data Server and JavaScript API.		
4	Create interactive visualizations, work with advanced mappings, and analyze data.		

SEMESTER-VI

SCMA602	**PROBABILITY AND STATISTICS**	**L**	**T**	**P**	**C**
Version		**4**	**0**	**0**	**4**
Total Contact Hours	**50 hours**				
Pre-requisites/Exposure	**Basic algebra**				
Co-requisites	**--**				

Course Objectives

1	To understand distributions in the study of the joint behavior of two random variables.
2	To establish a formulation helping to predict one variable in terms of the other that is, correlation and linear regression.
3	To understand central limit theorem, which establish the remarkable fact that the empirical frequencies of so many natural populations, exhibit a bell-shaped curve.

Course Outcomes

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

CO1	Apply key concepts of probability, including discrete and continuous random variables, probability distributions, conditioning, independence, expectations, and variances.
CO2	Define and explain the different statistical distributions and the typical phenomena that each distribution often describes.
CO3	Calculate probabilities and derive the marginal and conditional distributions of bivariate random variables.
CO4	Compute the covariance and correlation between jointly distributed variables.
CO5	Apply the method of least squares to estimate the parameters in a regression model.
CO6	Understand the law of large numbers and the central limit theorem.

Catalog Description

This course aims to provide an understanding of the basic concepts in probability, conditional probability and independent events. It will also focus on the random variable, mathematical expectation, and different types of univariate and bivariate distributions. In this course, student will learn how to describe relationships between two numerical quantities and characterized these relationships graphically, in the form of summary statistics, and through simple linear regression models.

Course Content

UNIT-I **12 Lectures**

Probability Functions and Moment Generating Function

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

UNIT-II **12 Lectures**

Univariate Discrete and Continuous Distributions

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

UNIT-III **14 Lectures**

Bivariate Distribution

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

UNIT-IV **12 Lectures**

Correlation, Regression and Central Limit Theorem

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Modeling Uncertainty

Uncertainty, Information and entropy, Uniform Priors, Polya's urn model and random graphs.

Reference Books/Materials

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
2. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Apply key concepts of probability, including discrete and continuous random variables, probability distributions, conditioning, independence, expectations, and variances.	**PO8**
CO2	Define and explain the different statistical distributions and the typical phenomena that each distribution often describes.	**PO3**
CO3	Calculate probabilities and derive the marginal and conditional distributions of bivariate random variables.	**PO1**
CO4	Compute the covariance and correlation between jointly distributed variables.	**PO5**
CO5	Apply the method of least squares to estimate the parameters in a	**PO4**

	regression model.	
CO6	Understand the law of large numbers and the central limit theorem.	**PO7**

	PROBABILITY AND STATISTICS	Apply information on scientific facts to face day to day requirements	Apply moral principles and responsibilities of a science graduate to serve the society	Create innovative ideas by using scientific knowledge for analysis and interpretation of data.	Ability to work independently as well as in collaboration with other individuals/institutions.	Knowledge regarding advancement in various branches of mathematics	Inculcate moral/ethical values and environmental consciousness	Enhance employability/ entrepreneurship skills	Ability to communicate various concepts of mathematics effectively.	Capable to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives	To gain a strong foundation in various branches of mathematics to investigate and solve the real-life problem	Acquire jobs in government and public sector or undertakings, banks, central government institutes and pursuing higher studies at country wid	Analyze the local and global impacts of understanding of values, ideas, and outcomes in a specific subject area.	To develop entrepreneurial skills to become empowered and self-reliant	Understand the basic concepts of statistics, algebra, and differential equations	Apply the mathematical modeling and reasoning to solve basic problems.

													e.				
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PS O1	PS O2	PS O3	PS O4	PS O5	PS O6
BS MA 215 A		3		3	2	2		2	2			3			2		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping

CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO7	PO8	PO9	PO 10	PO11	PSO 1	PSO 2	PSO3	PSO 4	PSO 5	PSO 6
CO 1								3				3	2	1	1	2	2
CO 2			3									3	2	1	1	2	2
CO 3	3											3	2	1	1	2	2
CO 4					2							3	2	1	1	2	2
CO 5				3								3	2	1	1	2	2
CO 6							3										
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Probability Functions and Moment Generating Function
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Univariate Discrete and Continuous Distributions
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling

Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Bivariate Distribution
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Correlation, Regression and Central Limit Theorem, Modeling Uncertainty
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Applicable in Mathematical Modelling
Global	Applicable in Mathematical Modelling
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use &

	Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

SCMA651	PROBABILITY AND STATISTICS LAB	L	T	P	C
Version 1.0		**0**	**0**	**2**	**1**
Total Contact Hours	**22 Hours**				
Pre-requisites/Exposure	**--**				
Co-requisites	**MS Excel**				

Course Objectives

1	To understand the concept of random variables, probability distributions and expectation.
2	The fundamental concept of expectation for univariate and bivariate random variables with their distributions and properties.
3	To acquire knowledge of correlation, regression analysis, regression diagnostics, partial and multiple correlations.
4	To understand Central Limit Theorem and its applications.

Course Outcomes

On completion of this course, the students will be able to work on

CO1	Tabular and graphical representation of data based on variables.
CO2	Concept of joint, marginal and conditional probability distribution for two dimensional random variables and their independence.
CO3	Univariate transformation and expectation of random variables.
CO4	Knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments.
CO5	Acumen to apply standard discrete and continuous probability distributions to different situations.
CO6	Laws of convergence, their inter relations and applications.

Catalog Description

We generally do not pay attention to the significance of statistics but its significance can be seen from business to politics or from agriculture to sports. This course shall begin with elementary statistical concepts such measures of central tendency and measures of dispersion. Furthermore, some more advanced concepts like correlation and regression are planned to be uncovered. Also students shall learn to determine the probability of an event, and to apply both discrete and continuous probability distributions to practical human problems.

Course Content

List of Practical

1. Graphical representation of data.
2. Problems based on measures of central tendency.
3. Problems based on measures of dispersion.
4. Problems based on combined mean and variance and coefficient of variation.
5. Problems based on moments, skewness and kurtosis.
6. Fitting of polynomials, exponential curves.
7. Karl Pearson correlation coefficient.
8. Correlation coefficient for a bivariate frequency distribution.
9. Lines of regression, angle between lines and estimated values of variables.
10. Spearman rank correlation with and without ties.
11. Partial and multiple correlations.
12. Planes of regression and variances of residuals for given simple correlations.
13. Planes of regression and variances of residuals for raw data.
14. Fitting of binomial distributions for n and p = q = ½.
15. Fitting of binomial distributions for given n and p.
16. Fitting of binomial distributions after computing mean and variance.
17. Fitting of Poisson distributions for given value of lambda.
18. Fitting of Poisson distributions after computing mean.
19. Fitting of negative binomial.
20. Application problems based on binomial distribution.
21. Application problems based on Poisson distribution.
22. Application problems based on negative binomial distribution.
23. Problems based on area property of normal distribution.
24. To find the ordinate for a given area for normal distribution.
25. Application based problems using normal distribution.
26. Fitting of normal distribution when parameters are given.
27. Fitting of normal distribution when parameters are not given.
28. Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit.

Reference Books/Materials

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
2. Irwin Miller & Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.

3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11th edition). Elsevier.
5. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	**Quiz**	**Attendance**	**Mid Term Exam**	**Presentation/ Assignment/ etc.**	**End Term Exam**
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Tabular and graphical representation of data based on variables.	**PO10**
CO2	Concept of joint, marginal and conditional probability distribution for two dimensional random variables and their independence.	**PO8**
CO3	Univariate transformation and expectation of random variables.	**PO5**
CO4	Knowledge related to concept of discrete and continuous random variables and their probability distributions including expectation and moments	**PO9**
CO5	Acumen to apply standard discrete and continuous probability distributions to different situations.	**PO2**
CO6	Laws of convergence, their inter relations and applications.	**PO4**

	PROBABILITY AND STATISTICS LAB	Apply information on scientific facts to face day to day requirements	Apply moral principles and responsibilities of a science graduate to serve the society	Create innovative ideas by using scientific knowledge for analysis and interpretation of data.	Ability to work independently as well as in collaboration with other individuals/institutions.	Knowledge regarding advancement in various branches of mathematics	Inculcate moral/ethical values and environmental consciousness	Enhance employability/ entrepreneurship skills	Ability to communicate various concepts of mathematics effectively.	Capable to use appropriate software's to solve mathematical equations.	Develop the protocols as per laboratory standards to accomplish the objectives	To gain a strong foundation in various branches of mathematics to investigate and solve the real-life problem	Acquire jobs in government and public sector or undertakings, banks, central government institutes and pursuing higher studies at countrywide.	Analyze the local and global impacts of understanding of values, ideas, and outcomes in a specific subject area.	To develop entrepreneurial skills to become empowered and self-reliant	Understand the basic concepts of statistics, algebra, and differential equations	Apply the mathematical modeling and reasoning to solve basic problems.
Course Code	Course Title	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6

BS MA 273 A			3		2	2			2	3	3	3	3		2		

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping

CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO 6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PSO 1**	**PSO 2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO 1										**3**		**3**	**2**	**1**	**1**	**2**	**2**
CO 2								**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO 3					**2**							**3**	**2**	**1**	**1**	**2**	**2**
CO 4									**3**			**3**	**2**	**1**	**1**	**2**	**2**
CO 5		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO 6				**2**													

1=lightly mapped 2= moderately mapped 3=strongly mapped

Unit I	Fitting of distributions, regression and correlation analysis
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-

Skill Development	Graphical representation of data, Fitting of Poisson distributions after computing mean, Fitting of normal distribution when parameters are given, Fitting of normal distribution when parameters are not given, Fitting of Binomial, Poisson distribution and apply Chi-square test for goodness of fit.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill
NEP 2020	Promoting High-quality research (18.1-18.9)
POE/4th IR	Group Discussion

SCMA604	**Applied Mechanics**	**L**		**T**	**P**	**C**
Version		**4**		**0**	**0**	**4**
Pre-requisites/Exposure						
Co-requisites	**--**					

Course Objectives:

The course aims at understanding the various concepts of physical quantities and the related effects on different bodies using mathematical techniques. It emphasizes knowledge building for applying mathematics in physical world.

Course Outcomes:

The course will enable the students to understand:

1. The significance of mathematics involved in physical quantities and their uses;
2. To study and to learn the cause-effect related to these; and
3. The applications in observing and relating real situations/structures.
4. Demonstrate the motion of multiple particles in constrained motion
5. Use the equations of motion to compute the position, velocity, and acceleration of multiple points on rigid bodies in constrained motion.

6. Apply the basic concepts of force, mass and acceleration; of work and energy; and of impulse and momentum for particles and rigid bodies

Course Contents:

Unit 1: Forces in Equilibrium (Lectures: 20)

Coplanar force systems; Three-dimensional force systems; Moment of a force about a point and an axis, Principle of moments, Couple and couple moment, Moment of a couple about a line, Resultant of a force system, Distributed force system, Rigid-body equilibrium, Equilibrium of forces in two and three dimensions, Free-body diagrams, General equations of equilibrium, Constraints and statical determinacy.

Unit 2: Friction, Center of Gravity and Moments of Inertia (Lectures: 20)

Equations of equilibrium and friction, Frictional forces on screws and flat belts; Center of gravity, Center of mass and Centroid of a body and composite bodies; Theorems of Pappus and Guldinus; Moments and products of inertia for areas, composite areas and rigid body, Parallelaxis theorem, Moment of inertia of a rigid body about an arbitrary axis, Principal moments and principal axes of inertia.

Unit 3: Conservation of Energy and Applications (Lectures: 15)

Conservative force fields, Conservation of mechanical energy, Work-energy equations, Kinetic energy and work-kinetic energy expressions based on center of mass, Moment of momentum equation for a single particle and a system of particles.

Unit 4: Rigid Body Motion (Lectures: 15)

Translation and rotation of rigid bodies, Chasles' Theorem, General relationship between time derivatives of a vector for different references, Relationship between velocities of a particle for different references, Acceleration of particle for different references.

References:

1. Hibbeler, R. C. (2016). Engineering Mechanics: Statics & Dynamics (14th ed.). Pearson Prentice Hall (Pearson Education), New Jersey.

2. Shames, Irving H., & Rao, G. Krishna Mohan (2009). Engineering Mechanics: Statics and Dynamics (4th ed.). Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). Delhi.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Quiz	Attendance	Mid Term Exam	Presentation/ Assignment/ etc.	End Term Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	The significance of mathematics involved in physical quantities and their uses;	**PO1**
CO2	To study and to learn the cause-effect related to these; and	**PO3**
CO3	The applications in observing and relating real situations/structures.	**PO5**
CO4	Demonstrate the motion of multiple particles in constrained motion	**PO2**
CO5	Use the equations of motion to compute the position, velocity, and acceleration of multiple points on rigid bodies in constrained motion.	**PO8**
CO6	Apply the basic concepts of force, mass and acceleration; of work and energy; and of impulse and momentum for particles and rigid bodies	

1=weakly mapped
2= moderately mapped
3=strongly mapped

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO1**	**PO11**	**PSO**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**

										0		**1**					
CO1	**2**											**3**	**2**	**1**	**1**	**2**	**2**
CO2			**3**									**3**	**2**	**1**	**1**	**2**	**2**
CO3					**2**							**3**	**2**	**1**	**1**	**2**	**2**
CO4		**3**										**3**	**2**	**1**	**1**	**2**	**2**
CO5								**3**				**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Forces in Equilibrium
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Friction, Center of Gravity and Moments of Inertia
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research

National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Conservation of Energy and Applications
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Rigid Body Motion
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan:

Week	Topic/Unit	Textbook/Reference/OER	Teaching-Learning Method
1	Coplanar force systems; Three-dimensional force systems. Moment of a force about a point and an axis, Principle of moments	[1] Chapter 3, and Chapter 4	
2	Couple and couple moment, Moment of a couple about a line, Resultant of a force system, Distributed force system.	[1] Chapter 3, and Chapter 4	
3	Rigid-body equilibrium, Equilibrium of forces in two and three dimensions, Free-body diagrams,	[1] Chapter 5	
4	, General equations of equilibrium, Constraints and statical determinacy	[1] Chapter 5	
5	Equations of equilibrium and friction, Frictional forces on screws and flat belts; Center of gravity	[1] Chapter 8, and Chapter 9	
6	Center of mass and Centroid of a body and composite bodies; Theorems of Pappus and Guldinus.	[1] Chapter 8, and Chapter 9	

7	Moments and products of inertia for areas, composite areas and rigid body, Parallelaxis theorem,	[1] Chapter 10 (Sections 10.1 to 10.5), and Chapter 21 (Section 21.1)	
8	Moment of inertia of a rigid body about an arbitrary axis, Principal moments and principal axes of inertia.	[1] Chapter 10 (Sections 10.1 to 10.5), and Chapter 21 (Section 21.1)	
9	Conservative force fields, Conservation of mechanical energy, Work-energy equations, Kinetic energy	[2] Chapter 11, and Chapter 12 (Sections 12.5, and 12.6)	
10	work-kinetic energy expressions based on center of mass, Moment of momentum equation for a single particle and a system of particles.	[2] Chapter 11, and Chapter 12 (Sections 12.5, and 12.6)	
11	Translation and rotation of rigid bodies, Chasles' Theorem, General relationship between time derivatives of a vector for different references,	[2] Chapter 13 (Sections 13.1 to 13.3, and 13.6 to 13.8)	
12	Relationship between velocities of a particle for different references, Acceleration of particle for different references.	[2] Chapter 13 (Sections 13.1 to 13.3, and 13.6 to 13.8)	

13	Acceleration of particle for different references.	[2] Chapter 13 (Sections 13.1 to 13.3, and 13.6 to 13.8)	
14	Revision		

Facilitating the Achievement of Course Learning Outcomes

Unit	Course Learning Outcome (CLO)	Teaching-Learning Activity	Assessment Task Method
I	The significance of mathematics involved in physical quantities and their uses;	As a teacher, guide them through the problem-solving process, emphasizing the importance of identifying relevant principles and applying them correctly.	Quiz on mathematical modeling
II	To study and to learn the cause-effect related to these; and	• Utilize simulation software to create virtual experiments and scenarios. Software like	Problem-solving assignment

		MATLAB, Simulink, or specialized mechanics simulation tools can help students visualize and analyze complex mechanical systems.	
III	The applications in observing and relating real situations/structures.	• Have students work on virtual experiments and analyze the results to gain a deeper understanding of mechanics concepts.	Project on modeling scenarios
IV	Demonstrate the motion of multiple particles in constrained motion	Encourage students to critically analyze these case studies and propose alternative solutions.	In-class exam on ODEs
V	Use the equations of motion to compute the position, velocity, and acceleration of multiple points on rigid bodies in constrained motion.		

VI	Apply the basic concepts of force, mass and acceleration; of work and energy; and of impulse and momentum for particles and rigid bodies		

SCMA606	**Mathematical Modeling**	**L**	**T**	**P**	**C**
Version		**4**	**0**	**0**	**4**
Pre-requisites/Exposure					
Co-requisites	**--**				

Course Prerequisites: Basic vector manipulation. Ideas of position vector, velocity, acceleration. Scalar and vector products. Parametrization of a curve; tangent vector, arc length. Parametrization of a surface; normal to a surface. Knowledge of differential equations and their solutions also.

Course Outcomes: After studying this course the student will be able to:

1. Demonstrate a comprehensive understanding of mathematical modeling principles and its historical development.
2. Apply mathematical modeling techniques to solve a wide range of problems, including growth and decay, economic growth, pollution, and epidemic spreading.
3. Assess the suitability of different modeling approaches for specific scenarios.
4. Construct complex mathematical models for various systems, such as combat scenarios, rowing dynamics, and drug distribution.
5. Present numerical solutions and graphical representations of models using EXCEL to convey meaningful insights.

6. Demonstrate an understanding of how mathematical models can be used to analyze and solve real-world problems in diverse domains.

Course Contents:

Unit 1: What is Mathematical Modeling? History of Mathematical Modeling, latest development in Mathematical Modeling, Merits and Demerits of Mathematical Modeling. Introduction to difference equations, Non-linear Difference equations, Steady state solution and linear stability analysis.

Introduction to Discrete Models, Linear Models, Growth models, Decay models, Newton's Law of Cooling, Bank Account Problem and mortgage problem. Compartment model, Drug Delivery Problem, Harrod Model of Economic growth, War Model, Lake pollution model, Alcohol in the bloodstream model, Arm Race models, Linear Prey-Predator models, Density dependent growth models with harvesting, Numerical solution of the models and its graphical representation using EXCEL.

Unit 2: Introduction to Continuous Models, Carbon Dating, Drug Distribution in the Body, Growth and decay of current in a L-R Circuit, Horizontal Oscillations, Vertical Oscillations, Damped Force Oscillation, Dynamics of Rowing, Combat Models, Mathematical Model of Influenza Infection (within host), Epidemic Models (SI, SIR, SIRS, SIC), Spreading of rumor model, Steady State solutions, Linearization and Local Stability Analysis, logistic and gomperzian growth, preypredator model, Competition models, Numerical solution of the models and its graphical representation using EXCEL.

Unit 3: Mathematical Modelling through Ordinary Differential Equations of Second Order:

Planetary Motions- Circular Motion and Motion of Satellites- Mathematical Modelling through Linear Differential Equations of Second Order- Miscellaneous Mathematical Models. Mathematical.

Unit 4: Modelling through Difference Equations:

Simple Models- Basic Theory of linear difference equations with constant coefficients- Economics and Finance-Population Dynamics and GeneticsProbability Theory.

Books Recommended:

1. Albright, B., Mathematical Modeling with Excel, Jones and Bartlett Publishers 2010

2. Marotto, F. R., Introduction to Mathematical Modeling using Discrete

3. Dynamical Systems, Thomson Brooks/Cole. 2006

4. Kapur, J. N., Mathematical Modeling, New Age International 2005

5. Barnes, B. and Fulford, G. R., Mathematical Modelling with Case Studies, CRC Press, Taylor and Francis Group. 2009

6. Edsberg, L., Introduction to Computation and Modeling for Differential Equations, John Wiley and Sons. 2008.

Open Educational Resources (OER)

1. Mathematical Modelling: Analysis and Applications - Course (nptel.ac.in)
2. Precalculus: Mathematical Modeling | Coursera
3. Free Online Mathematic Modeling Courses from Top Universities (learningpath.org)
4. 6 Best + Free Mathematical Modeling Courses [2023 JULY][UPDATED] (digitaldefynd.com)

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme and Course Mapping																	
CO	PO 1	PO 2	PO 3	PO 4	P O5	PO 6	P O7	P O8	P O9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PS O4	PS O5	PS O6
CO 1	3	2	1	2	2	1	3	2	1	2	1	2	1	2	3	2	2
CO 2	2	2	3	2	3	1	2	1	1	1	2	3	2	3	3	3	2
CO 3	3	1	3	3	2	3	2	1	3	3	1	2	3	3	2	3	1
CO 4	2	3	2	1	2	2	1	2	2	1	3	2	2	2	3	2	1
CO 5	3	2	1	3	1	2	1	3	3	2	3	3	1	2	3	1	3

CO 6	**3**	**1**	**3**	**2**	**1**	**3**	**2**	**3**	**1**	**1**	3	2	2	3	**2**	**1**	**3**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Classifications of Mathematical Models
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Need, Techniques, Classifications, Characteristic and Limitations of Mathematical Models
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Ordinary Differential Equation of first order
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Mathematical Modelling through systems of Ordinary Differential Equation of First Order
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Ordinary Differential Equation of second order
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Mathematical Modelling through Graphs
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-

Unit IV	Mathematical Modelling through Graphs
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Mathematical Modelling through Graphs
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4^{th} IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan:

Week	Topic/Unit	Textbook/Reference/OER	Teaching-Learning Method
1	What is Mathematical Modeling?	Recommended Book: - "Mathematical Modeling" by Kapur, J. N.	Lecture on the definition and importance of mathematical modeling
2	Introduction to Difference Equations	Recommended Book: - "Introduction to Computation and Modeling for Differential Equations" by Edsberg, L.	Practical session on solving difference equations using EXCEL

3	Discrete Models and Newton's Law of Cooling	OER: - "Free Online Mathematic Modeling Courses from Top Universities" (learningpath.org)	Group discussion on discrete models and application of Newton's Law of Cooling
4	Growth and Decay Models	Recommended Book: - "Mathematical Modeling with Excel" by Albright, B.	Problem-solving exercises on growth and decay models
5	Drug Delivery Problem and Harrod Model	Recommended Book: - "Mathematical Modeling with Case Studies" by Barnes, B. and Fulford, G. R.	Practical session on drug delivery problem and analysis of the Harrod Model of Economic Growth
6	Lake Pollution Model and Alcohol in the Bloodstream Model	OER: - "6 Best + Free Mathematical Modeling Courses [2023 JULY][UPDATED]" (digitaldefynd.com)	Hands-on practice with numerical solution and graphical representation using EXCEL
7	Arm Race Models and Linear Prey-Predator Models	OER: - "Mathematical Modelling: Analysis and Applications" - Course (nptel.ac.in)	Group project on modeling Arm Race scenarios and analyzing linear prey-predator models
8	Density Dependent Growth Models with Harvesting	Recommended Book: - "Introduction to Mathematical Modeling using Discrete Dynamical Systems" by Marotto, F. R.	Lecture on density-dependent growth models with harvesting
9	Introduction to Continuous Models and Carbon Dating	Recommended Book: - "Mathematical Modeling" by Kapur, J. N.	Practical session on carbon dating and continuous models

10	Drug Distribution in the Body and Growth of Current	OER: - "Precalculus: Mathematical Modeling" - Coursera Course (Coursera)	Problem-solving exercises on drug distribution in the body and growth of current in L-R Circuit
11	Horizontal and Vertical Oscillations	Recommended Book: - "Introduction to Computation and Modeling for Differential Equations" by Edsberg, L.	Lecture on horizontal and vertical oscillations
12	Dynamics of Rowing and Mathematical Influenza Infection	Recommended Book: - "Mathematical Modeling with Excel" by Albright, B.	Practical session on rowing dynamics and within-host infection models
13	Epidemic Models and Spreading of Rumor Model	Recommended Book: - "Introduction to Mathematical Modeling using Discrete Dynamical Systems" by Marotto, F. R.	Group discussion on epidemic models and spreading of rumor model
14	Steady State Solutions and Miscellaneous Models	Recommended Book: - "Mathematical Modeling with Case Studies" by Barnes, B. and Fulford, G. R.	Review session on steady-state solutions and miscellaneous mathematical models

Facilitating the Achievement of Course Learning Outcomes

Unit	Course Learning Outcome (CLO)	Teaching-Learning Activity	Assessment Task Method
I	Understand the concept and history of mathematical modeling	Lecture on the basics of mathematical modeling	Quiz on mathematical modeling
II	Analyze discrete and linear models	Problem-solving exercise on discrete and linear models	Problem-solving assignment
III	Apply continuous models to real-world scenarios	Practical session on carbon dating and continuous models	Project on modeling scenarios
IV	Construct and solve ordinary differential equations	Hands-on practice with solving ordinary differential equations	In-class exam on ODEs

-UDT106	Fundamentals of Machine Learning	L2	T0	P4	C4
Pre-requisites/Exposure					
Co-requisites	--				

Course Objective:

1. To introduce students to the basic concepts and techniques of Machine Learning.

2: To develop skills of using recent machine learning software for solving practical problems.

3: To gain experience of doing independent study and research.

4: Ability to identify the characteristics of datasets and compare the trivial data and big data for various applications.

Learning Outcome:

Upon successful completion of the course the student will be able to:

1. Ability to select and implement machine learning techniques and computing environment that are suitable for the applications under consideration.

2. Ability to solve problems associated with batch learning and online learning, and the big data characteristics such as high dimensionality, dynamically growing data and in particular scalability issues.

3. Ability to understand and apply scaling up machine learning techniques and associated computing techniques and technologies.

4. Ability to recognize and implement various ways of selecting suitable model parameters for different machine learning techniques

Course Contents:

Unit I INTRODUCTION TO MACHINE LEARNING:

Application of Machine Learning, Supervised vs Unsupervised Learning, Python libraries suitable for Machine Learning

II DATA PRE-PROCESSINGAND DATA

- Identifying and handling the missing values
- Encoding the categorical data
- Normalization
- Standardization
- PCA

III SUPERVISED LEARNING REGRESSION AND CLASSIFICATION:

Linear Regression,Non-Linear Regression, Model evaluation methods, KNearest Neighbour, Decision Tree, Logistic Regression, Support Vector Machines, Model Evaluation

IV Unsupervised Learning:

K-means Clustering, Hierarchical Clustering, Density-Based Clustering

Suggested Readings:

1. Machine Learning - Tom M. Mitchell

2. Python Machine Learning – Sebastian, Raschka and Vahid Mirjalili

3. Hands-On Machine Learning with Scikit-Learn and TensorFlow: Concepts, Tools, and Technique to Build Intelligent Systems - AurélienGéron

4. Understanding Machine Learning - Shai Shalev-Shwartz and Shai Ben-David La

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	**20**	**20**	**10**	**50**

Programme and Course Mapping

Programme and Course Mapping																	
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	2				3		2	2				2	2	2	2	2	3
CO2					2		2	2				3	2	2	2	2	2
CO3		3		3								3	2	2	2	2	3
CO4	3						2					2	2	2	2	2	2
CO5							2					3	2	2	2	2	3
CO6	2				3					3	3	3	2	2	2	3	3
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	**Introduction to Machine Learning**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research

National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Opportunities to works in various industries, including finance, marketing, healthcare, and manufacturing
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Data Preprocessing
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Data Handling and preprocessing
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Supervised learning Regression and classification
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	Manage inventory, optimize resource allocation.
Entrepreneurship	-
Skill Development	
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Unsupervised Learning
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research

Employability	Data Driven decision making, Healthcare sector etc.
Entrepreneurship	-
Skill Development	Predicting customer behavior, stock prices, equipment failures, or disease outbreaks, professionals skilled in machine learning can provide valuable forecasts.
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	4.3 technical & Vocational Skill
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Group Discussion, Reflective and Constructivist Approach of learning, Application Based Learning

Teaching Plan:

Week	Topics	Reference Books / Textbooks	Teaching Learning Method
1	Overview of machine learning and its applications.	TB1	**Lectures, Examples, and Problem-Solving, Hands on practice**
2	Types of machine learning (supervised, unsupervised, reinforcement learning), the machine learning workflow, and the importance of data.		**Lectures, Examples, and Problem-Solving**
3	Data cleaning, handling missing values, and dealing with outliers.	TB1	**Lectures, Examples, and Problem-Solving**
4	Data normalization, encoding categorical variables, and feature scaling.	TB1	**Lectures, Examples, and Problem-Solving**
5	Introduction to regression, linear regression, and	TB1	**Lectures, Examples, and Problem-Solving**

	evaluation metrics.		
6	Polynomial regression, regularization techniques (L1, L2), and model selection.	TB1	**Lectures, Examples, and Problem-Solving**
7	Introduction to classification, logistic regression, and decision trees.		**Lectures, Examples, and Problem-Solving**
8	Random forests, k-nearest neighbors, and model evaluation for classification.		**Lectures, Examples, and Problem-Solving**
9	Random forests, k-nearest neighbors, and model evaluation for classification.	TB1	**Lectures, Examples, and Problem-Solving**
10	Clustering algorithms (k-means, hierarchical clustering), and evaluation of clustering results.	TB1	**Lectures, Examples, and Problem-Solving**
11	Dimensionality reduction techniques (PCA, t-SNE).	TB1	**Lectures, Examples, and Problem-Solving**
12	Cross-validation, bias-variance trade-off, and model selection techniques.	TB1	**Lectures, Examples, and Problem-Solving**
13	Project work	TB1	**Lectures, Examples, and Problem-Solving**
14	Project work	TB1	**Lectures, Examples, and Problem-Solving**
15	Project work practicals	TB1	**Lectures, Examples, and Problem-Solving**

Facilitating the Achievement of Course Learning Outcomes

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods

1	• Define and explain fundamental machine learning concepts, including supervised learning, unsupervised learning, and reinforcement learning. • Describe the difference between classification and regression tasks. • Evaluate machine learning models using appropriate metrics for regression and classification tasks. • Understand concepts like bias-variance trade-off and cross-validation for model selection.	• Start with introductory lectures to provide a conceptual understanding of machine learning, its types, and its applications. • Use visual aids, real-world examples, and case studies to illustrate key concepts. • Assign coding exercises using popular machine learning libraries like scikit-learn or TensorFlow. • Develop a series of progressively complex projects, starting with basic linear regression and moving on to more advanced topics like neural networks. • Encourage students to work on real-world datasets and practical problems.	**• Presentations, practices and class discussions.** **• Assignments and class tests.** **• Student presentations.** **• Mid-term examinations.** **•Practical and viva-voce examinations.** **• End-term examinations.**

SEMESTER-VII

Research Methodology

-SCMA701	Research Methodology	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objective:-

1. Understand the fundamental principles, objectives, and significance of research in various academic disciplines.

2. Comprehend the concepts and components of research design, including exploratory and experimental approach.

3. Master the techniques of sampling, data collection, and data preparation for effective research.

4. Develop skills in writing research papers, selecting suitable journals, and navigating the publication process.

5. Acquire knowledge and proficiency in using various research resources and software tools.

6. Promote ethical research practices, including avoiding plagiarism and addressing reviewer feedback professionally.

Course Outcomes:

At the end of the course, students should be able to:

CO1	Understand the fundamental concepts of research methodology, including its meaning, objective, and utility.
CO2	Differentiate between empirical and theoretical research, and grasp the concepts of deductive and inductive reasoning.
CO3	Identify and define key research terminology such as concept, construct, definition and variable.
CO4	Comprehend the importance of research design and distinguish between exploratory, descriptive, and experimental research designs.
CO5	Analyze the concept of qualitative and quantitative research, measurement, casuality, generalization, and replication.
CO6	Apply various sampling techniques and comprehend the process of data preparation, including univariate and bivariate analysis.
CO7	Demonstrate the ability to write a research paper, understand the journal publication process, and address ethical issues in publishing.

CO8	Utilize academic resources, databases, and software tools effectively for research purposes, including reference management and plagiarism detection.

Catalog Description:

This course provides a comprehensive introduction to data analytics using Tableau. Students will learn data warehousing concepts, Tableau Desktop fundamentals (data connection, analysis, calculations, and visualization), Tableau Server administration, and advanced Tableau techniques. Practical skills in data analysis and visualization will be developed to prepare students for real-world applications.

Course Content: -

Unit I: Introduction

Basic Fundamentals:- Meaning, objective, motivation and utility of research. Concept of theory, empiricism, deductive and inductive reasoning. Characteristics of scientific methods – Understanding the language of research-Concept, Construct, Definition, Variable.

Unit II: Research Design:

Concept and Importance of research design. Features of a good research design - Exploratory Research Design - concept, types and uses, Descriptive Research Designs - concept, types and uses. Experimental Research Design: Concept of Independent & Dependent variables. Qualitative research - Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches.

Unit III: Sampling and Data Preparation

Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample- Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis- Cross tabulations and Chisquare test including testing hypothesis of association. Interpretation of Data.

Unit IV: Paper Writing and Publishing Process

Paper Writing- Layout of a Research Paper, Journals, Impact factor of Journals, Choosing Journals and Conferences to publish the work. Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Preparing response to reviewers and editors. Reviewing the manuscript.

Unit V: Use of various resources and software

Use of encyclopaedia, handbooks, research guides and academic databases. Use of tools and techniques for Research, methods to search required information effectively. Reference Management Software like Zotero/ Mendeley. Software for paper formatting like LaTeX, LyX, MS Office. Software for detection of Plagiarism.

References:

1. Panneerselvam, R., Research Methodology, Prentice Hall of India, New Delhi, 2004.
2. Kothari CR, Research Methodology-Methods and Techniques, New Wiley Eastern Ltd., Delhi, 2009.
3. Brymam Alan and Bell, Emma, Business Research Methods

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination
Examination Scheme:

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

<u>CO and PO mappings: -</u>

Course Code and Title	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
RESEARCH METHODOLOGY	CO1	-	2	2	-	-	-	-	-	-	1	-	-	-	-	-	-
	CO2	1	-	2	-	1	-	1	-	1	-	-	-	-	-	-	-
	CO3	-	-	2	-	-	-	-	-	-	1	-	1	-	*-	-	-
	CO4	-	-	-	3	-	1	2	-	2	-	-	-	-	-	-	1
	CO5	-	-	1	-	3	2	2	2	2	-	2	-	-	-	1	-
	CO6	-	1	-	-	-	2	-	-	2	-	-	1	2	-	-	-
	CO7	-	-	-	-	-	2	3	-	2	-	-	1	2	2	-	-
	CO8	-	-	-	-	-	2	2	3	2	3	-	-	-	2	-	-

Unit I	Introduction
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-

Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Research Design
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Sampling and data Preparation
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Research Writing
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan: -

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	Meaning and objective of research, Motivation and utility of research, Concept of theory, empiricism, deductive and inductive reasoning	TB1	Lecture
Week 2	Types of research :- Basic, applied, quantitative and qualitative, Ethics in research, Research Process :- Problem Formulation, research questions and Objectives	TB2	Lecture
Week 3	Concept ad importance of research design, Features of good research design, Experimental research design and Descriptive research design.	TB2	Lecture
Week 4	Independent and Dependent variables, Qualitative and Quantitative research, Concept of measurement,	TB2	Lecture

	causality, generalization and replication, Merging qualitative and quantitative approaches		
Week 5	Concepts of Statistical Population, Sample, Sampling frame, Sampling Error, Sample size distribution, Characteristics of a good sample	TB2	Lecture
Week 6	Simple random sampling, systematic sampling, stratified sampling, multi-stage sampling	TB2	Lecture
Week 7	Data collection methods, Data coding and cleaning, Univariate analysis:- Frequency tables, Bar Charts, pie charts, percentages	TB2	Lecture
Week 8	Bivariate analysis: Cross tabulations and Chi-square tests, Testing hypotheses of association, Interpretation of data	TB2	Lecture
Week 9	Qualitative data analysis methods, Quantitative data analysis methods, Softwares for data analysis (e.g. SPSS, R)	TB2	Lecture and Hands-on Sessions
Week 10	Layout of research paper, Choosing Journals and conferences for publication, Ethical issues related to publishing, Plagiarism and self-plagiarism	OER	Lecture and Hands-on sessions
Week 11	Preparing response to reviewer and editors, Reviewing the manuscripts, Impact factor of Journals	OER	Lecture and Hands-on sessions

Week 12	Use of encyclopedias, handbooks, research guides and academic databases, Effective information search methods, Reference management software (Zotero/Mendley)	OER	Presentation and Hands-on sessions
Week 13	Software for paper formatting, software for plagiarism detection, Preparing research presentation.	OER	Presentation and Hand-on Session
Week 14	Presentations of research projects to class, Peer evaluation and Feedback, Course wrap-up and final review	OER	Hands-on sessions

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Understand the basics of research, scientific methods and research language.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to design research experiments and apply the principles discussed in research design. (iii) Providing sample datasets and encourage students to practise various sampling techniques and data analysis methods. (iv) Conduct Hands-on session to familiarize students with research tools like Zotero/Mendley, LaTex, and plagiarism detection software. (v) Guide students in simulating the process of writing a research paper, including peer review and response to reviewers.	• Presentations and class discussions. • Assignments and class tests. •Hands-on sessions • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Grasp the concept of research design and its importance in various research types.		
3	Learn about sampling methods and data analysis techniques		
4	Develop skills in research paper writing, ethical publishing, and manuscript review.		
5.	Utilize research resources and software tools effectively for information search and management.		

UDT107	**Data driven Applications**	**L2**	**T 0**	**P 4**	**C4**
Version		**2**	**0**	**4**	**4**
Total Contact Hours	**64**				
Pre-requisites/Exposure					
Co-requisites	**--**				

Course Description

This course is designed to provide students with the knowledge and skills needed to create data-driven applications using Tableau, a powerful data visualization and business intelligence tool. Students will learn how to transform raw data into meaningful insights and interactive dashboards to support data-driven decision-making in various industries. Through hands-on exercises and real-world projects, students will gain practical experience in designing, building, and deploying Tableau applications.

Course Outcomes:

Upon successful completion of this course, students will be able to:

1. Prepare and clean raw data for analysis and visualization in Tableau.
2. Create effective and interactive data visualizations, charts, and dashboards using Tableau.
3. Analyze data to uncover trends, patterns, and insights that drive informed decision-making.
4. Design and develop visually appealing and user-friendly dashboards for data presentation.
5. Implement interactive features and filters to enable users to explore and interact with data visualizations.

Course Objectives:

Throughout the course, students will work towards achieving the following specific objectives:

1. Learn how to import and connect to data sources, including databases and spreadsheets, in Tableau.
2. Explore techniques for cleaning, reshaping, and aggregating data to prepare it for visualization.
3. Master the creation of various chart types, maps, and graphs to represent data effectively.
4. Design and build interactive dashboards that facilitate data exploration and decision-making.
5. Understand how to publish and share Tableau dashboards online and embed them in web applications.

Unit 1 : INTRODUCTION TO POWER BI

• Introduction to Power BI - Need, Imprtance • Power BI - Advantages and Scalable Options • History - Power View, Power Query, Power Pivot • Power BI Data Source Library and DW Files • Cloud Colloboration and Usage Scope • Business Analyst Tools, MS Cloud Tools • Power BI Installation and Cloud Account • Power BI Cloud and Power BI Service • Power BI Architecture and Data Access • OnPremise Data Acces and Microsoft On Drive • Power BI Desktop - Instalation, Usage • Sample Reports and Visualization Controls • Power BI Cloud Account Configuration • Understanding Desktop & Mobile Editions • Report Rendering Options and End User Access • Power View and Power Map. Power BI Licenses • Course Plan - Power BI Online Training

Unit 2 : CREATING POWER BI REPORTS, AUTO FILTERS

• Report Design with Legacy & .DAT Files • Report Design with Databse Tables • Understanding Power BI Report Designer • Report Canvas, Report Pages: Creation, Renames • Report Visuals, Fields and UI Options • Experimenting Visual Interactions, Advantages • Reports with Multiple Pages and Advantages • Pages with Multiple Visualizations. Data Access • PUBLISH Options and Report Verification in Cloud• "GET DATA" Options and Report Fields, Filters • Report View Options: Full, Fit Page, Width Scale • Report Design using Databases & Queries • Query Settings and Data Preloads • Navigation Options and Report Refresh • Stacked bar chart, Stacked column chart • Clustered bar chart, Clustered column chart • Adding Report Titles. Report Format Options • Focus Mode, Explore and Export Settings

Unit 3 : REPORT VISUALIZATIONS and PROPERTIES

• Power BI Design: Canvas, Visualizations and Fileds • Import Data Options with Power BI Model, Advantages • Direct Query Options and Real-time (LIVE) Data Access • Data Fields and Filters with Visualizations • Visualization Filters, Page Filters, Report Filters • Conditional Filters and Clearing. Testing Sets • Creating Customised Tables with Power BI Editor • General Properties, Sizing, Dimensions, and Positions • Alternate Text and Tiles. Header (Column, Row) Properties • Grid Properties (Vertical, Horizontal) and Styles • Table Styles & Alternate Row Colors - Static, Dynamic • Sparse, Flashy Rows, Condensed Table Reports. Focus Mode • Totals Computations, Background. Boders Properties • Column Headers, Column Formatting, Value Properties • Conditional Formatting Options - Color Scale • Page Level Filters and Report Level Filters • Visual-Level Filters and Format Options • Report Fields, Formats and Analytics • Page-Level Filters and Column Formatting, Filters • Background Properties, Borders and Lock Aspect

Unit 4: CHART AND MAP REPORT PROPERTIES

• Chart report types and properties • stacked bar chart, stacked column chartclustered bar chart, clustered column chart • 100% stacked bar chart, 100% stacked column chart • line charts, area charts, stacked area charts • line and stacked row charts • line and stacked column charts • waterfall chart, scatter chart, pie chart • Field Properties: Axis, Legend, Value, Tooltip • Field Properties: Color Saturation, Filters Types • Formats: Legend, Axis, Data Labels, Plot Area • Data Labels: Visibility, Color and Display Units • Data Labels: Precision, Position, Text Options • Analytics: Constant Line, Position, Labels • Working with Waterfall Charts and Default Values • Modifying Legends and Visual Filters - Options • Map Reports: Working with Map Reports.

Text Books

1. "Beginning Power BI: A Practical Guide to Self-Service Data Analytics with Excel 2016 and Power BI Desktop" by Dan Clark
2. "Power BI Step-by-Step Part 1: Up and Running: Power BI Mastery through hands-on Tutorials (Power BI Step by Step)" by Grant Gamble
3. "Mastering Microsoft Power BI" by Brett Powell

Links

https://learn.microsoft.com/en-us/power-bi/

https://docs.microsoft.com/en-us/power-bi/guided-learning/

https://docs.microsoft.com/en-us/learn/paths/analyze-visualize-data-power-bi/

UDT108	Project and Case Study	L	T	P	C
Version 3.0		4	0	0	4
Total Contact Hours	64				
Pre-requisites/Exposure					
Co-requisites	--				

---SCMA7015	INTEGRAL TRANSFORMS AND SPACIAL FUNCTIONS	L	T	P	C
Version		4	0	0	4
Total Contact Hours	64 Hours				
Pre-requisites/Exposure	Basic knowledge of Trigonometry, Integration and Differentiation				
Co-requisites	--				

Course Objectives

This course will enable the students to:

1. Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties.
2. Solve ordinary differential equations using Laplace transforms.
3. Familiarise with Fourier transforms of functions, relation between Laplace and Fourier

transforms.

4. Explain Parseval's identity, Plancherel's theorem and applications of Fourier transforms to boundary value problems.
5. Learn Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier series.
6. Apply the concepts of the course in real life problems.

Course Outcomes

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

CO1. Remember and understand important concepts of Laplace and Fourier Transform.

CO2. Apply these concepts in other courses such as Electronics and Signal Processing.

CO3. Analyze and correlate difference between Fourier series and Transform.

CO4. Formulate and solve problems based upon various Integral Transforms.

CO5. Write research article on the application of Fourier transform

CO6. Compare various Integral transforms

Catalog Description

This course imparts the basic concepts of Know about piecewise continuous functions, Dirac delta function, Laplace transforms and its properties. It enables students to solve ordinary differential equations using Laplace transforms. Familiarise with Fourier transforms of functions, relation between Laplace and Fourier transforms. This course explain Parseval's identity, Plancherel's theorem and applications of Fourier transforms to boundary value problems.Students will learn Fourier series, Bessel's inequality, term by term differentiation and integration of Fourier series.

Course Content

Unit I: 16 lecture hours

Laplace Transforms: Laplace transform, Linearity, Existence theorem, Laplace transforms of derivatives and integrals, Shifting theorems, Change of scale property, Laplace transforms of periodic functions, Dirac's delta function.

Unit II: 16 lecture hours

Further Properties of Laplace Transforms and Applications: Differentiation and integration of transforms, Convolution theorem, Integral equations, Inverse Laplace transform, Lerch's theorem, Linearity property of inverse Laplace transform, Translations theorems of inverse Laplace transform, Inverse transform of derivatives, Applications of Laplace transform in obtaining solutions of ordinary differential equations and integral equations.

Unit III: 16 lecture hours

Fourier Transforms: Fourier and inverse Fourier transforms, Fourier sine and cosine transforms, Inverse Fourier sine and cosine transforms, Linearity property, Change of scale property, Shifting property, Modulation theorem, Relation between Fourier and Laplace transforms.

Solution of Equations by Fourier Transforms: Solution of integral equation by Fourier sine and cosine transforms, Convolution theorem for Fourier transform, Parseval's identity for Fourier transform, Plancherel's theorem, Fourier transform of derivatives, Applications of infinite Fourier transforms to boundary value problems, Finite Fourier transform, Inversion formula for finite Fourier transforms.

Unit IV: 16 lecture hours

Fourier Series: Fourier cosine and sine series, Fourier series, Differentiation and integration of Fourier series, Absolute and uniform convergence of Fourier series, Bessel's inequality, The complex form of Fourier series.

Text Books

1. James Ward Brown & Ruel V. Churchill (2011). Fourier Series and Boundary Value Problems. McGraw-Hill Education.
2. Charles K. Chui (1992). An Introduction to Wavelets. Academic Press.
3. Erwin Kreyszig (2011). Advanced Engineering Mathematics (10th edition). Wiley.
4. Walter Rudin (2017). Fourier analysis on Groups. Dover Publications.
5. A. Zygmund (2002).Trigonometric Series (3rd edition). Cambridge University Press.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	Quiz	Attendan	Mid Term	Presentation/	End Term

		ce	Exam	Assignment/ etc.	Exam
Weightage (%)	**10**	**10**	**20**	**10**	**50**

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Remember and understand important concepts of Laplace and Fourier Transform	**PO1,PO7**
CO2	Apply these concepts in other courses such as Electronics and Signal Processing.	**PO5,PO7**
CO3	Analyze and correlate difference between Fourier series and Transform.	**PO8,PO7**
CO4	Formulate and solve problems based upon various Integral Transforms.	**PO4,PO7**
CO5	Write research article on the application of Fourier transform	**PO7**
CO6	Compare various Integral transforms	**PO4**

Programme and Course Mapping																	
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO1 1**	**PS O 1**	**PS O 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**
CO 1	**3**						**2**					**3**	**2**	**1**	**1**	**2**	**2**
CO 2					**2**		**2**					**3**	**2**	**1**	**1**	**2**	**2**
CO 3							**2**	**2**				**3**	**2**	**1**	**1**	**2**	**2**
CO				**3**			**2**					**3**	**2**	**1**	**1**	**2**	**2**

4																	
CO 5							**2**					**3**	**2**	**1**	**1**	**2**	**2**
CO 6				**3**								**3**	**2**	**1**	**1**	**2**	**2**
1=lightly mapped 2= moderately mapped 3=strongly mapped																	

Unit I	Laplace Transforms
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Properties of Laplace Transforms and Applications
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Fourier Transforms, Solution of Equations by Fourier Transforms
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research

Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Fourier Series
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

SEMESTER-VIII

Research Ethics and Intellectual Property Rights.

-SCMA802	RESEARCH ETHICS AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		4	0	0	4
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives:

1. Develop problem-solving skills by understanding research problem sources and criteria for selection.

2. Apply scientific methodology for accurate recording and interpretation of research results.

3. Enhance technical writing proficiency for effective communication of research findings.

4. Grasp the nature of intellectual property rights, including patents, trademarks, and copyright.

5. Recognize the scope of patent rights and stay updated on new developments in Intellectual Property Rights (IPR).

Course Outcomes:

1. Ability to identify and define research problems effectively by considering various sources and criteria.

2. Proficiency in analysing research results using scientific methodology and interpreting their significance.

3. Skill in producing clear and organized technical content for research articles and reports.

4. Understanding of different forms of intellectual property rights, their nature, and implications.

5. Awareness of the scope of patent rights and the capacity to stay updated on emerging trends in Intellectual Property Rights (IPR).

Catalog Description

This course introduces students to the fundamentals of research methodology, emphasizing problem selection, data collection, analysis, and ethical considerations. It also covers technical writing, research proposal preparation, and intellectual property rights, including patents, trademarks, copyrights, and new developments in IPR. Practical skills for recording and analysing results are emphasized.

Course Content

UNIT I: RESEARCH METHODOLOGY

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, Plagiarism, Research ethics.

UNIT II: RESULTS AND ANALYSIS

Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc.

UNIT III: TECHNICAL WRITING

Effective technical writing, how to write a manuscript/ responses to reviewers comments, preparation of research article/ research report, Writing a Research Proposal - presentation and assessment by a review committee

UNIT IV: INTELLECTUAL PROPERTY RIGHTS

Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.

UNIT V: PATENT RIGTS AND NEW DEVELOPMENTS IN IPR

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.

TEXT BOOKS:

1. Ranjit Kumar, Research Methodology- A step by step guide for beginners, Pearson

Education, Australia, 2005.

2. Ann M. Korner, Guide to Publishing a Scientific paper, Bioscript Press 2004.

3. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008.

<u>REFERENCES:</u>

1. Kothari, C. R. Research Methodology - Methods and Techniques, New Age International

publishers, New Delhi, 2004.

2. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science

& engineering students’, Juta & Company, 1996.

<u>WEB RESOURCES:</u>

1. https://nptel.ac.in/courses/106/105/106105077/

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	**Assignment**	**Mid Term Examination**	**Attendance**	**End Term Examination**
Weightage (%)	**20**	**20**	**10**	**50**

CO and PO mapping: -

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5
RESEARCH ETHICS AND INTELLECTUAL PROPETY RIGHTS	CO1	1	-	1	-	1	-	-	-	2	-	1	2	2	-	2	-
	CO2	-	1	-	-	-	1	-	-	2	-	1	2	2	-	2	-
	CO3	-	-	1	-	-	1	-	-	2	-	-	2	2	-	2	-
	CO4	-	-	-	1	-	-	-	1	2	1	-	2	2	-	2	-
	CO5	-	-	-	-	1	-	1	-	2	-	1	2	2	-	2	-

Unit I	Reasearch Methodology
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Result and Analysis
Local	Ingredient in Interdisciplinary Research

Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Technical Writting and intellectual property right
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	Technical Paper writing
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	PATENT RIGTS AND NEW DEVELOPMENTS IN IPR
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical

	Approach of learning

TEACHING PLAN: -

Weekly Teaching Plan	Topic/Unit No.	Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]	Teaching-Learning Method
Week 1	Introduction to research ethics and research problem	TB1	Lecture
Week 2	Research problem scope and objectives	TB1	Lecture
Week 3	Recording results and types	TB1	Lecture and Hands-on session
Week 4	Outcome and Technical Writing	OER	Lecture and Hands-on session
Week 5	Research article and research proposal	OER	Lecture
Week 6	Intellectual property rights overview	TB3	Lecture
Week 7	Patenting process and Development	TB3	Lecture
Week 8	Scope of patent rights and Licensing	TB3	Lecture
Week 9	Patent rights in details	TB3	Lecture
Week 10	Case studies on patent-related issues	TB3, OER	Lecture
Week 11	New Developments in IPR	OER	Lecture
Week 12	Review of the course and presentation	OER	Hands-on session

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Understand research problem selection, sources, criteria, and ethical considerations in data collection and analysis.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to analyze real-world research problems and cases to understand the applications. (iii) Students be given homework/assignments. (iv) Students will engage in group discussions to explore various aspects of intellectual property rights, patenting, and new developments in IPR (v) Practical sessions will involve technical writing exercises, manuscript preparation, and using patent databases. real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Recognize the importance of recording and analysing results, including negative outcomes and their significance in various contexts.		
3	Develop effective teaching writing skills for research manuscripts, responses to reviewers, and research proposal presentations.		
4	Comprehend the nature of intellectual property, including patents, trademarks, copyrights and their processes.		
5.	Explore the scope of patent rights, technology licensing, patent information, databases, and emerging developments in intellectual property rights administrator.		

SCMA804	COMPUTER ALGEBRA SYSTEM AND RELATED SOFTWARE	L	T	P	C
Version		2	0	4	4
Total Contact Hours					
Pre-	nil				

requisites/Exposure	
Co-requisites	--

COURSE OBJECTIVES

The course will enable the student-teacher to:

This course aims at familiarizing students with the usage of computer algebra systems (/Mathematica/MATLAB/Maxima/Maple) and the statistical software R.

The basic emphasis is on plotting and working with matrices using CAS.

Data entry and summary commands will be studied in R.

Graphical representation of data shall also be explored.

COURSE OUTCOMES (CO)

On completion of this course, the student-teacher will be able to:

CO1 Use of computer algebra systems (Mathematica/MATLAB/Maxima/Maple etc.) as a calculator, for plotting functions and animations

CO2 Use of CAS for various applications of matrices such as solving system of equations and finding eigenvalues and eigenvectors.

CO3 Understand the use of the statistical software R as calculator and learn to read and get data into R.

CO4 Learn the use of R in summary calculation, pictorial representation of data and exploring relationship between data.

CO5 Analyze, test, and interpret technical arguments on the basis of geometry.

CATALOG DESCRIPTION

This course aims at familiarizing students with the usage of computer algebra systems (Mathematica and Maxima) and the statistical software R. The basic emphasis is on plotting and working with matrices using CAS. Data entry and summary commands will be studied in R. Graphical representation of data shall also be explored.

COURSE CONTENT

Unit I: **8 Contact Hours**

Introduction to CAS and Applications Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Plotting functions of two variables using Plot3D and Contour Plot, Plotting parametric curves surfaces, Customizing plots, Animating plots, Producing tables of values, working with piecewise defined functions, Combining graphics.

Unit II: **12 Contact Hours**

Working with Matrices Simple programming in a CAS, Working with matrices, Performing Gauss elimination, operations (transpose, determinant, inverse), Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, eigenvector and diagonalization.

Unit III: **14 Contact hours**

R - The Statistical Programming Language R as a calculator, Explore data and relationships in R. Reading and getting data into R: Combine and scan commands, Types and structure of data items with their properties, Manipulating vectors, Data frames, Matrices and lists, Viewing objects within objects, Constructing data objects and conversions.

Unit IV: **12 Contact hours**

Summary commands: Summary statistics for vectors, Data frames, Matrices and lists, Summary tables, Stem and leaf plot, Histograms, Plotting in R: Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, Cleveland dot charts and bar charts, Copy and save graphics to other applications.

PRACTICALS (SCMA851)

- Basic operations: arithmetic, algebraic manipulation, and equation solving
- Manipulating inequalities and solving systems of equations
- Symbolic differentiation and integration
- Definite and indefinite integrals
- Applications in calculus and physics problems
- Representing vectors and matrices symbolically
- Matrix operations: addition, multiplication, and inversion
- Solving systems of linear equations using matrices
- Plotting functions and data
- Customizing plots and graphs
- 2D and 3D visualizations of mathematical functions
- Solving ordinary differential equations (ODEs)
- Initial value problems and boundary value problems
- Applications in science and engineering
- Importing and analyzing data sets
- Descriptive statistics
- **Project Work**
- Apply CAS tools to solve a real-world problem.
- Prepare a report and presentation on the project.

Suggested Text Books

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

- Torrence, Bruce F., & Torrence, Eve A. (2009). The Student's Introduction to Mathematica: A Handbook for Precalculus, Calculus, and Linear Algebra (2nd ed.). Cambridge University Press.
- Gardener, M. (2012). Beginning R: The Statistical Programming Language, Wiley

Advanced Readings

- Verzani, John (2014). Using R for Introductory Statistics (2nd ed.). CRC Press, Taylor & Francis Group.

Assessment & Evaluation

Components	Assignment	Mid Term Examination	Attendance	End Term Examination
Weightage (%)	20	20	10	50

Programme And Course Mapping

Course Code and Title	Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3	PSO4	PSO5
SCMA101 CALCULUS	CO 1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO 2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO 3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2

	CO 4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO 5																
	CO 6																

Unit I	Introduction
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Working with Matrices
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Statistics with R-Software
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-

Skill Development	Technical Paper writing
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Plotting and analysis through R-software
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan:

Weekly Teaching Plan	Topic/Unit No.	Textbook [TB]/ Reference Book [RB]-Chapter/ Page No./ Open Education Resources [OER]	Teaching-Learning Method
Week 1	Computer Algebra System (CAS), Use of a CAS as a calculator, Computing and plotting functions in 2D, Producing tables of	TB1	Lecture

	values,		
Week 2	Working with piecewise defined functions, Combining graphics. Simple programming in a CAS.	TB1	Lecture
Week 3	Functions of two variables using Plot3D and contour plot,	TB1,	Lecture
Week 4	Parametric curves surfaces, Customizing plots, Animating plots.	TB1	Presentation
Week 5	Working with matrices, Performing Gauss elimination, Operations (Transpose, Determinant, Inverse),	TB1	Lecture
Week 6	Minors and cofactors, Working with large matrices, Solving system of linear equations, Rank and nullity of a matrix, Eigenvalue, Eigenvector and diagonalization.	TB1,	Lecture
Week 7	R as a calculator, Explore data and relationships in R. Reading and getting data into R: Combine and scan commands,	TB1	Quiz
Week 8	Types and structure of data items with their properties.	TB1	Lecture
Week 9	Manipulating vectors	TB1	Lecture
Week 10	Data frames, Matrices and lists. Viewing objects within objects.	TB1	Lecture
Week 11	Constructing data objects and conversions.	TB1	Lecture
Week 12	Summary commands: Summary statistics for vectors, Data frames, Matrices and lists.	TB1	Lecture
Week 13	Summary tables. Stem and leaf plot, histograms. Plotting in R	TB1	Lecture
Week 14	Box-whisker plots, Scatter plots, Pairs plots, Line charts, Pie charts, C level and dot charts and	TB1,	Lecture

	Bar charts.		

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1		(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2			
3			

--- SCMA709	ADVANCED MECHANICS	L	T	P	C
Version		4	0	0	4
Pre-requisites/Exposure					
Co-requisites	--				

Course Objectives

1. The students will introduce about the forces, angular momentum and knowledge about the Constraint.
2. The course will give knowledge about the general parameter like velocity, acceleration.
3. The course provide the students about the knowledge of M.I.
4. The course provide the students about the knowledge of hollow cylinder and solid cylinder.

Course Outcomes

This course will enable the students to:

CO1 Understand the reduction of force system in three dimensions to a resultant force acting at a base point and a resultant couple, which is independent of the choice of base of reduction.

CO2 Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.

CO3 Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia and to derive Euler's equations of motion of a rigid body, moving about a point which is kept fixed

CO4 Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.

CO5 Deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

CO6 Compare theories of mechanics and advanced mechanics.

Catalog Description

After completing this course the student able to: inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and deal with two-dimensional fluid motion using the complex potential and also to understand the concepts of sources, sinks, doublets and the image systems of these with regard to a line and a circle.

Course Content

Unit I: **8 contact hours**

Statics in Space: Forces in three dimensions, Reduction to a force and a couple, Equilibrium of a system of particles, Central axis and Wrench, Equation of the central axis, Resultant wrench of two wrenches; Nul points, lines and planes with respect to a system of forces, Conjugate forces and conjugate lines.

Unit II: **12 contact hours**

Motion of a Rigid Body: Moments and products of inertia of some standard bodies, Momental ellipsoid, Principal axes and moments of inertia; Motion of a rigid body with a fixed point, Kinetic energy of a rigid body with a fixed point and angular momentum of a rigid body, Euler's equations of motion for a rigid body with a fixed point, Velocity and acceleration of a moving particle in cylindrical and spherical polar coordinates, Motion about a fixed axis, Compound pendulum.

Unit III: **8 contact hours**

Kinematics of Fluid Motion :Lagrangian and Eulerian approaches, Material and convective derivatives, Velocity of a fluid at a point, Equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates, Cylindrical and spherical symmetry, Boundary surface, Streamlines and pathlines, Steady and unsteady flows, Velocity potential, Rotational and irrotational motion, Vorticity vector and vortex lines.

Unit IV: **12 contact hours**

Kinetics of Fluid Motion: Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates; Bernoulli's equation, Impulsive motion.

Motion in Two-Dimensions Stream function, Complex potential, Basic singularities: Sources, sinks, doublets, complex potential due to these basic singularities; Image system of a simple source and a simple doublet with regard to a line and a circle, Milne−Thomson circle theorem.

Suggested Text Books

1. A. S. Ramsay (1960). A Treatise on Hydromechanics, Part-II Hydrodynamics. G. Bell & Sons.
2. F. Chorlton (1967). A Textbook of Fluid Dynamics. CBS Publishers.
3. Michel Rieutord (2015). Fluid Dynamics An Introduction. Springer.
4. E. A. Milne (1965). Vectorial Mechanics, Methuen & Co.Limited. London.

Advanced Readings

1. G. E. Dieter, "Mechanical metallurgy",third edition; Mc-Graw Hill, 1988.
2. E. P. Popov,"Engineering mechanics of Solids",Second edition, Prentice Hall, 1998.
3. M. H. Sadd,"Elasticity: theory, applications and numerics",Third edition, Elsevier Butterworth Heinemann publications, 2014.

Assessment & Evaluation

Components	Assignment	Mid term Examination	Attendance	End Term Examination
Weightage (%)	10	10	20	10

Program and Course Mapping

Course Code and Title	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
	CO1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2
	CO4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO5																
	CO6																

Unit I	**Statics in Space**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Motion of a Rigid body
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-

Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	**Kinematics of Fluid Motion**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Kinetics of Fluid Motion**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan:

Weekly Teaching Plan	Topic/Unit No.	Textbook [TB]/ Reference Book [RB]-	Teaching-Learning Method

		Chapter/ Page No./ Open Education Resources [OER]	
Week 1	Forces in three dimension, Reduction to force and couple, Equilibrium of a system of particles, Central axis and Wrench	TB1	Lecture
Week 2	Equation of the Central Axis, Resultant wrench of two wrenches, Nul Points, lines and planes with respect to a system of forces, Conjugate forces and conjugate lines.	TB1	Lecture
Week 3	Moments and products of inertia of some standard bodies, Momental ellipsoid, Principal axes and moments of inertia; Motion of a rigid body with a fixed point, Kinetic energy of a rigid body with a fixed point and angular momentum of a rigid body	TB1,	Lecture
Week 4	Euler's equations of motion for a rigid body with a fixed point, Velocity and acceleration of a moving particle in cylindrical and spherical polar coordinates,	TB1	Presentation
Week 5	Motion about a fixed axis, Compound pendulum.	TB1	Lecture
Week 6	Lagrangian and Eulerian approaches, Material and convective derivatives,	TB1,	Lecture
Week 7	Velocity of a fluid at a point, Equation of continuity in Cartesian,	TB1	Quiz

	cylindrical polar and spherical polar coordinates,		
Week 8	Cylindrical and spherical symmetry, Boundary surface, Streamlines and pathlines,	TB1	Lecture
Week 9	Steady and unsteady flows, Velocity potential	TB1	Lecture
Week 10	Rotational and irrotational motion, Vorticity vector and vortex lines. theorems;	TB1	Lecture
Week 11	Euler's equations of motion in Cartesian, cylindrical polar and spherical polar coordinates; Bernoulli's equation, Impulsive motion.	TB1	Lecture
Week 12	Motion in Two-Dimensions Stream function, Complex potential,	TB1	Lecture
Week 13	Basic singularities: Sources, sinks, doublets, complex potential due to these basic singularities;	TB1	Lecture
Week 14	Image system of a simple source and a simple doublet with regard to a line and a circle, Milne–Thomson circle theorem.	TB1	Lecture

Facilitating the Achievement of Course Learning Outcomes

For Example:

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1	Understand the reduction of force system in three dimensions to a	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to	• Presentations and class discussions. • Assignments and class tests. • Student

	resultant force acting at a base point and a resultant couple, which is independent of the choice of base of reduction.	discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Learn about a nul point, a nul line, and a nul plane with respect to a system of forces acting on a rigid body together with the idea of central axis.		
3	Know the inertia constants for a rigid body and the equation of momental ellipsoid together with the idea of principal axes and principal moments of inertia and to derive Euler's equations of motion of a rigid body, moving about a point which is kept fixed		
4	Study the kinematics and kinetics of fluid motions to understand the equation of continuity in Cartesian, cylindrical polar and spherical polar coordinates which are used to derive Euler's equations and Bernoulli's equation.		

---SCMA705	MATHEMATICAL FINANCE	L	T	P	C
Version		5	1	0	6
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives

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

1. Provide the students with knowledge of a range of mathematical and computational techniques that are required for a wide range of quantitative positions in the financial sector.
2. To develop student appreciation of the major issues involved in rigorous advances in the area of financial mathematics
3. Introduction to the application of mathematics in financial world, that enables the student to understand some computational and quantitative techniques required for working in the financial markets and actuarial mathematics

Course Outcomes

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

CO1	Understand the standard and advanced quantitative methodologies and techniques of importance to a range of careers in investment banks and other financial institutions.
CO2	Appreciation of emerging theory and techniques in the area of financial mathematics.
CO3	Apply scientific models and tools effectively.
CO4	Design, build, investigate and evaluate forward contract using arbitrage-free pricing methods.
CO5	Construct, evaluate and analyze models for investments and securities.
CO6	Create and evaluate potential models for the price of shares.

Catalog Description

This course establishes the basics of the one-period model, shows how securities can be represented by vectors and matrices, and introduces the concept of hedging. Further, the course introduces important financial notions such as returns, arbitrage and state prices, and gives examples of asset pricing both in complete and incomplete markets. Then, we introduce the multi-period binomial model for stock prices and compute a dynamic hedging strategy that replicates a given option. Finally, we take the binomial modeling from the discrete-time numerical explorations to the continuous-time complete market trail in Black-Scholes option pricing formula.

Course Content

Unit-I: Basic Theory of Interest and Fixed-Income Securities **8 hours**

Principal and interest: simple, compound and continuous; Present and future value of cashflow streams; Net present value, Internal rates of return and their comparison; Inflation,Annuities; Bonds, Bond prices and yields, Macaulay duration and modified duration.

Unit-II: Term Structure of Interest Rates, Bonds and Derivatives **8 hours**

Spot rates, forward rates and explanations of term structure; Running present value, Floatingratebonds, Immunization, Convexity; Putable and callable bonds; Exchange-traded marketsand over-the-counter markets; Derivatives: Forward contracts, Future contracts, Options,Types of traders, Hedging, Speculation, Arbitrage.

Unit-III: Mechanics of Options Markets **10 hours**

No-arbitrage principle, Short selling, Forward price for an investment asset; Types of options:Call and put options, Option positions, Underlying assets, Factors affecting option prices,Upper and lower bounds for option prices, Put-call parity, Effect of dividends.

Unit-IV: Stochastic Analysis of Stock Prices and Black-Scholes Model **16 hours**

Binomial option pricing model, Risk neutral valuation: European and American options onassets following binomial tree model; Lognormal property of stock prices, Distribution ofrate of return, Expected return, Volatility, Estimating volatility from historical data,Extension of risk-neutral valuation to assets following geometric Brownian motion,Black-Scholes formula for European options.

Hedging Parameters, Trading Strategies and Swaps

Hedging parameters: Delta, gamma, theta, rho and vega; Trading strategies involving options,Swaps, Mechanics of interest rate swaps, Comparative advantage argument, Valuation ofinterest rate swaps, Currency swaps, Valuation of currency swaps.

References:

1. John C. Hull & Sankarshan Basu (2018). *Options, Futures and Other Derivatives* (10th edition). Pearson Education.
2. David G. Luenberger (2013). *Investment Science* (2nd edition). Oxford UniversityPress.
3. Sheldon M. Ross (2011). *An Elementary Introduction to Mathematical Finance*(3rd edition). Cambridge University Press.

Assessment and Evaluation

Components	Assignment	Mid Term Examination	Attendence	End Term Exam
Weightage (%)	**10**	**20**	**10**	**10**

Course Code and Title	Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5
	CO1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2
	CO4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO5	3				3		2			1	3	3		3		3
	CO6		2	3			1			3		3		3			3

Unit I	**Basic Theory of Interest and Fixed-Income Securities**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	**Term Structure of Interest Rates, Bonds and Derivatives**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-

Environment & Sustainability	-
Unit III	**Mechanics of Options Markets**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	**Stochastic Analysis of Stock Prices and Black-Scholes Model**
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan:

Weekly Teaching Plan	Topic/Unit No.	Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]	Teaching-Learning Method

Week 1	Principal and interest: simple, compound and continuous; Present and future value of cashflow streams; Net present value,	TB1	Lecture
Week 2	, Internal rates of return and their comparison; Inflation,Annuities; Bonds, Bond prices and yields, Macaulay duration and modified duration.	TB1	Lecture
Week 3	Spot rates, forward rates and explanations of term structure; Running present value, Floatingratebonds, Immunization, Convexity;	TB1, https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.1x+2T2019/about	Lecture
Week 4	Putable and callable bonds; Exchange-traded marketsand over-the-counter markets;	TB1	Presentation
Week 5	Derivatives: Forward contracts, Future contracts, Options,Types of traders, Hedging, Speculation, Arbitrage.	TB1	Lecture
Week 6	No-arbitrage principle, Short selling, Forward price for an investment asset; Types of options:Call and put options,	TB1,https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.2x+3T2019/about	Lecture
Week 7	Option positions, Underlying assets, Factors affecting option prices,Upper and lower bounds for option prices, Put-call parity, Effect of dividends.	TB1	Quiz

Week 8	Binomial option pricing model, Risk neutral valuation: European and American options onassets following binomial tree model;	TB1	Lecture
Week 9	Lognormal property of stock prices,	TB1	Lecture
Week 10	Distribution ofrate of return, Expected return, Volatility, Estimating volatility from historical data,	TB1	Lecture
Week 11	Extension of risk-neutral valuation to assets following geometric Brownian motion,Black-Scholes formula for European options.	TB1	Lecture
Week 12	Hedging parameters: Delta, gamma, theta, rho and vega; Trading strategies involving options,Swaps,	TB1	Lecture
Week 13	Mechanics of interest rate swaps, Comparative advantage argument,	TB1	Lecture
Week 14	Valuation of interest rate swaps, Currency swaps, Valuation of currency swaps.	TB1	Lecture

Facilitating the Achievement of Course Learning Outcomes
For Example:

Unit No.	**Course Learning Outcomes**	**Teaching Learning Activity**	**Assessment Task Methods**
1	Understand the standard and advanced quantitative methodologies and techniques of importance to a range of careers in	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce

	investment banks and other financial institutions.	homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	examinations. • End-term examinations.
2	Appreciation of emerging theory and techniques in the area of financial mathematics		
3	Apply scientific models and tools effectively		
4	Design, build, investigate and evaluate forward contract using arbitrage-free pricing methods.		

---SCMA707	**Computational Mathematics**	**L**	**T**	**P**	**C**
Version		**4**	**0**	**0**	**4**
Pre-requisites/Exposure	**--**				
Co-requisites	**--**				

Course Objective

To equip students with the essential mathematical tools and techniques needed to solve real-world problems using computers. It focuses on developing proficiency in numerical analysis, optimization, and simulation methods to model and solve complex mathematical problems in various fields such as science, engineering, finance, and data analysis. Students learn to implement algorithms, analyze their efficiency, and apply them to practical situations, enhancing their computational and problem-solving skills.

Course outcome

1. Students should gain a deep understanding of various numerical methods used to approximate solutions to mathematical problems, such as numerical integration, root-finding algorithms, and linear algebra techniques.
2. They should be able to write code to solve mathematical problems efficiently and accurately.
3. Students should learn how to analyze and quantify errors that can occur when using numerical methods.
4. Students should be able to model real-world problems mathematically and use computational methods to simulate and analyze these models.
5. They should be able to apply these techniques to solve optimization problems in different

domains.

6. Students should be proficient in data analysis techniques and be able to create meaningful visualizations to interpret and communicate their findings effectively.

Unit-1 Existence & uniqueness theorem;

General theory of homogenous and non-homogenous differential equations with constant and variable coefficients; Method of variation of parameters, method of undetermined coefficients and the formula for particular integral in terms of wronskian; Solution of simultaneous differential equations.

Unit-2 Series solution for second order linear differential equations near an ordinary point;

Singularity and the solution of differential equation in the neighborhood of regular singular point using method of Frobenious; Solution of Legendre, Bessel, Hypergeometric, Hermite and Lagurre differential equation.

Unit-3 Solution of partial differential equations using Lagrange's method of undetermined multipliers, Charpit's method; Complete solution of homogeneous and non-homogeneous L.P.D.E. of higher order with constant and variable coefficients. Formulation of Heat conduction equation and its solution by variable separation method, Steady state condition and the solution of heat conduction problem with non-zero end conditions. Formation of wave equation and their solution.

Unit-4 Linear homogeneous Boundary Value Problems, Eigen values and Eigen functions, SturmLiouville Boundary Value Problems, Non-homogeneous Boundary Value Problems, Nonhomogeneous heat conduction problems.

Unit-5 Green's functions and the solution of Boundary Value Problems in terms of Green's functions, Concept of stability, asymptotic stability and instability of a solution of the autonomous system $dx/dt = F(x, y)$, $dy/dt = G(x, y)$.

Books Recommended

1. Earl A. Coddington, An Introduction to Ordinary Differential Equation, Dover Publications, INC., 2012.

2. Boyce and Diprime, Elementary Differential Equations and Boundary Value Problems, Wiley, 2008.

3. H. F. Weinberger, A First Course in Partial Differential Equations: with Complex Variables and Transform Methods (Dover Books on Mathematics), Dover Publications, 1995.

4. M. D. Raisinghania, Advanced Differential Equations, S. Chand Publications, 2008.

Assessment and Evaluation

Components	Assignment	Mid Term Examination	Attendence	End Term Exam
Weightage (%)	10	20	10	10

Course Code and Title	Course Outco	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	PSO4	PSO5

	me																
	CO1	3	3	-	2	-	-	-	-	-	2	-	3	3	-	-	2
	CO2	3	3	2	3	-	3	2	-	-	-	1	3	3	2	-	3
	CO3	3	3	3	2	-	3	3	2	2	1	2	3	3	3	-	2
	CO4	3	3	3	1	1	2	3	1	1	2	3	3	3	3	1	2
	CO5																
	CO6																

Unit I	Existence & uniqueness theorem;
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit II	Series solution
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit III	Solution of partial differential equations
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-

Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
Unit IV	Linear homogeneous Boundary Value Problems and Greens Function
Local	Ingredient in Interdisciplinary Research
Regional	Ingredient in Interdisciplinary Research
National	Ingredient in Interdisciplinary Research
Global	Ingredient in Interdisciplinary Research
Employability	-
Entrepreneurship	-
Skill Development	-
Professional Ethics	-
Gender	-
Human Values	-
Environment & Sustainability	-
SDG	Youth and Adult Literacy (SDG 4.6)
NEP 2020	Promoting High-quality research (18.1-18.9) , Technology Use & Integration (23.1- 23.13), More Holistic and Multidisciplinary Education (11.1- 11.13)
POE/4th IR	Presentation /Group Discussion/Doubt Session, Reflective and Constructivist Approach of learning, Application Based Learning, Analytical Approach of learning

Teaching Plan:

Weekly Teaching Plan	**Topic/Unit No.**	**Textbook [TB]/ Reference Book [RB]- Chapter/ Page No./ Open Education Resources [OER]**	**Teaching-Learning Method**
Week 1	General theory of homogenous and non-homogenous differential equations with constant and variable coefficients	TB1	Lecture, Board presentation
Week 2	Variation of parameter	TB1	Lecture
Week 3	Underterminant coeffiecient	TB1	Lecture
Week 4	the formula for	TB1	Presentation

	particular integral in terms of wronskian; Solution of simultaneous differential equations		
Week 5	the formula for particular integral in terms of wronskian; Solution of simultaneous differential equations	TB1	Lecture
Week 6	Series solution for second order linear differential equations near an ordinary point	TB1	Lecture
Week 7	Singularity and the solution of differential equation in the neighborhood of regular singular point using method of Frobenious;	TB2	Ppt, Quiz
Week 8	Solution of Legendre, Bessel, Hypergeometric, Hermite and Lagurre differential equation.	TB1	Lecture
Week 9	Solution of Legendre, Bessel, Hypergeometric, Hermite and Lagurre differential equation.	TB2	Lecture
Week 10	Solution of partial differential equations using Lagrange's method of undetermined multipliers, Charpit's method	TB4	Lecture
Week 11	Complete solution of homogeneous and non-homogeneous L.P.D.E. of higher order with constant and variable coefficients	TB3	Lecture
Week 12	Formulation of Heat conduction equation and its solution by variable separation method, Steady state condition and the solution of heat conduction problem with	TB3	Lecture

	non-zero end conditions		
Week 13	Linear homogeneous Boundary Value Problems, Eigen values and Eigen functions, SturmLiouville Boundary Value Problems, Non-homogeneous Boundary Value Problems, Nonhomogeneous heat conduction problems	TB4	Lecture
Week 14	Green's functions and the solution of Boundary Value Problems in terms of Green's functions, Concept of stability.	TB4	Lecture

Facilitating the Achievement of Course Learning Outcomes
For Example:

Unit No.	Course Learning Outcomes	Teaching Learning Activity	Assessment Task Methods
1	Develop proficiency in solving mathematical problems using computational techniques and algorithms.	(i) Each topic to be explained with illustrations. (ii) Students to be encouraged to discover the relevant concepts. (iii) Students be given homework/assignments. (iv) Discuss and solve the theoretical and practical problems in the class. (v) Students to be encouraged to apply concepts to real world problems.	• Presentations and class discussions. • Assignments and class tests. • Student presentations. • Mid-term examinations. • Practical and viva-voce examinations. • End-term examinations.
2	Learn how to solve ordinary and partial differential equations numerically and analyze the solutions.		
3	Acquire programming skills in languages like Python, MATLAB, or R to implement mathematical algorithms and models.		
4	Understand the process of mathematical		

	modeling and apply it to real-world scenarios, including physics, engineering, finance, and other fields.		