K.R. MANGALAM UNIVERSITY

THE COMPLETE WORLD OF EDUCATION

SCHOOL OF BASIC AND APPLIED SCIENCES

(SBAS)

Programme Handbook

(Programme Structure & Evaluation Scheme)

Bachelor of Sciences (Honours) Mathematics

Programme Code: 11

THREE YEAR UNDERGRADUATE PROGRAMME

Approved in the 34th Meeting of Academic Council Held on 29 June 2024

(with effect from 2024-25 session)

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 endeavour; it offers a new vision to all its Under-Graduate courses. It imbibes a Learning Outcome-based Curriculum Framework (LOCF) for all its Undergraduate programmes. The LOCF approach is envisioned to provide a focused, outcome-based syllabus at the undergraduate level with an agenda to structure the teaching-learning experiences in a more student-centric manner. The LOCF approach has been adopted to strengthen students' experiences as they engage themselves in the programme of their choice. The Under-Graduate 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 skills for employability. The school acknowledges all the faculty members for their valuable contributions in preparing the curriculum.

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1. Introduction: About University

K.R. Mangalam University located on Sohna Road, Gurugram, is one of the fastest growing and most promising upcoming universities in India. It is a State Private University established in 2013 by an act of the legislature of the Haryana Government under Haryana Private Universities Act (Amendment) 8 of 2013.It is recognized by the UGC under Section 2f of the UGC Act, 1956. The primary aim of the University is to promote excellence in basic and professional education while upholding moral values. KRMU offers various Undergraduate, Postgraduate and Doctoral Degree programs across different disciplines. The group of educational units in the University promote education in the areas of Engineering& Technology, Legal Studies, Basic and Applied Sciences, Management Sciences, Commerce, Journalism and Mass Communication, Hotel Management and Catering Technology, Medical and Allied Sciences, Architecture and Planning, Agriculture, Fashion Designing, Humanities and Education. All the disciplines follow a well-defined curriculum design keeping in view the guidelines of UGC/AICTE and appropriate regulatory bodies like Council of Architecture (COA), Bar Council of India (BCI), Pharmacy Council of India (PCI), National Council for Teachers Education (NCTE) etc., wherever applicable. All courses are semester and credit based.

2. University Vision and Mission

2.1 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.

2.2 Mission

- Foster employability and entrepreneurship through futuristic curriculum and progressive pedagogy with cutting-edge technology
- Instill the notion of lifelong learning through stimulating research, Outcomes-based education, and innovative thinking
- Integrate global needs and expectations through collaborative programs with premier universities, research centers, industries, and professional bodies.
- Enhance leadership qualities among the youth understanding of ethical values and environmental realities

3. About the School

The School of Basic and Applied Science imparts both teaching and research through its four disciplines of Physics, Chemistry, Mathematics and Forensic science.
SBAS 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 endeavours. 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.

4. School Vision and Mission

4.1 Vision

To be a premier school for advance learning and research in the field of basic and applied sciences.

4.2 Mission

1. Collaborations with national, international academic & research organisations and industries for knowledge creation, advancement, and application of innovative practises in sciences.
2. Create conducive environment for lifelong learning.
3. Empower students to be socially responsible and ethically strong individuals through value-based science education.

5. Programme offered by the school

5.1 B.Sc. (Hons.) Mathematics

School offers undergraduate B.Sc. (Hons) Mathematics, 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. School offers undergraduate B.Sc. (Hons) Mathematics. This course emphasized on hands on practice, innovative thought process and project based learning. The goals and objectives of this program are to widen student's horizon in understanding fundamental concepts and applications of Mathematical concept, supporting their specialization in the field, and helping them expand their skills.

5.2 Duration

The minimum period required for the B.Sc. (Hons.) Mathematics offered by the department of Mathematics shall extend over a period of three Academic Years.
The maximum period for the completion of the B.Sc. (Hons) Mathematics offered by the department of Mathematics shall be five years.

5.3 Career Avenues

Graduates can pursue careers in research and development (R&D) in industries, work as research scientists or assistants in academic and research institutions, or continue with higher education (MSc, PhD) leading to academic or specialized roles in Mathematics. Opportunities also exist in sectors like govt. jobs, defence services, data science, banking, finance, and competitive examinations.

5.5 Class Timings

The classes will be held from Monday to Friday from 09:10 am to 04:00 pm.

6. Definitions

- **Programme Outcomes (POs)**

Programme Outcomes are statements that describe what the students are expected to know and would be able to do upon the graduation. These relate to the skills, knowledge, and behavior that students acquire through the programme.

- **Programme Specific Outcomes (PSOs)**

Programme Specific Outcomes are statements about the various levels of knowledge specific to the given program which the student would be acquiring during the program.

- **Programme Educational Objectives (PEOs)**

Programme Educational Objectives of a degree are the statements that describe the expected achievements of graduates in their career, and what the graduates are expected to perform, achieve and how they will conduct professionally during the first few years after graduation.

- **Credit**

Credit refers to a unit of contact hours/tutorial hours per week or 02 hours of lab/practical work per week.

6.1 Programme Educational Objectives (PEO*)*

These are deferred outcomes measured few years after completion of the programme, where the graduates of this program will:

PEO 1: Graduates will develop a strong foundation in mathematical principles, empowering them to excel in careers across academia, government, industry, and research, and to respond to evolving challenges in mathematics and interdisciplinary fields.

PEO 2: Graduates will commit to continuous learning and self-improvement, adapting their knowledge and skills to keep pace with advancements in mathematics and to make meaningful contributions to society.

PEO 3: Graduates will integrate ethical practices, human values, and a sense of responsibility toward environmental sustainability in their professional and personal lives, fostering a positive societal impact.

PEO 4: Graduates will be equipped with problem-solving and critical thinking skills in mathematical modeling, programming, and data analysis, enhancing their employability in diverse sectors.

PEO 5: Graduates will be prepared to pursue advanced studies and research in mathematics and related fields, contributing to the development of new mathematical knowledge and applications.

6.2 Programme Outcomes (PO)

At the end of the programme the students will be able:

PO1: To understand the impact of mathematical research on the environment and society and show a commitment by using sustainable and ethical practices in work.

PO2: To apply mathematical techniques, modern tools, software and programming languages to identify and solve complex mathematical problems.

PO3: To analyze and evaluate mathematical arguments and solutions with a keen, logical approach.

PO4: To use mathematical knowledge in research that connects with other fields like physics, computer science, engineering, economics, and social sciences

PO5: To clearly present and explain mathematical concepts and research findings to both specialized and general audiences.

PO6: To collaborate effectively with peers and professionals, contributing positively to team settings and academic environments.

PO7: To understand and follow ethical standards in research and practice, ensuring integrity and social responsibility in the use of mathematical knowledge.

PO8: To stay dedicated to ongoing learning and keep up with new developments in mathematics and related fields.

6.3 Programme Specific Outcomes (PSO)

At the end of the program the students will be:

PSO1: Understanding fundamental concepts, theories, principles and their applications in different areas of mathematics.

PSO2: Applying mathematical methods and tools to model, simulate, and solve mathematical problems, enhancing research capabilities and practical applications.

PSO3: Analyzing complex mathematical problems and research data to determine patterns, relationships, and underlying principles.

PSO4: Evaluating mathematical models, algorithms and tools for solving mathematical problems.

PSO5: Operating mathematical software tools like Mathematica, MATLAB, and LaTeX to *organize, demonstrate,* and *present* mathematical solutions with accuracy, preparing them for research and industry applications that require computational expertise.

6 Student's Structured Learning Experience from Entry to Exit in the Programme

- **Education Philosophy and Purpose:**

Learn to Earn a Living:
At KRMU we believe in equipping students with the skills, knowledge, and qualifications necessary to succeed in the job market and achieve financial stability. All the programmes are tailored to meet industry demands, preparing students to enter specific careers and contributing to economic development.

Learn to Live:
The university believes in the holistic development of learners, fostering sensitivity towards society, and promoting a social and emotional understanding of the world. Our aim is to nurture well-rounded individuals who can contribute meaningfully to society, lead fulfilling lives, and engage with the complexities of the human experience.

- **University Education Objective: Focus on Employability and Entrepreneurship through Holistic Education using Bloom's Taxonomy**

By targeting all levels of Bloom's Taxonomy—remembering, understanding, applying, analyzing, evaluating, and creating—students are equipped with the knowledge, skills, and

attitudes necessary for the workforce and entrepreneurial success. At KRMU we emphasize on learners critical thinking, problem-solving, and innovation, ensuring application of theoretical knowledge in practical settings. This approach nurtures adaptability, creativity, and ethical decision-making, enabling graduates to excel in diverse professional environments and to innovate in entrepreneurial endeavours, contributing to economic growth and societal well-being.

- **Importance of Structured Learning Experiences**

A structured learning experience (SLE) is crucial for effective education as it provides a clear and organized framework for acquiring knowledge and skills. By following a well-defined curriculum, teaching-learning methods and assessment strategies, learners can build on prior knowledge systematically, ensuring that foundational concepts are understood before moving on to more complex topics. This approach not only enhances comprehension but also fosters critical thinking by allowing learners to connect ideas and apply them in various contexts. Moreover, a structured learning experience helps in setting clear goals and benchmarks, enabling both educators and students to track progress and make necessary adjustments. Ultimately, it creates a conducive environment for sustained intellectual growth, encouraging learners to achieve their full potential. At K.R. Mangalam University SLE is designed as rigorous activities that are integrated into the curriculum and provide students with opportunities for learning in two parts:

- Inside classroom (mention broad approach – cognitive outcome, student centric learning, methods, approach, tools and techniques)
- Outside classroom (People skills and psychomotor skills comprising of various types of activities in industry, community and labs)

- **Educational Planning and Execution: What, when and how learning will happen**

The School of Basic and Applied Sciences (SBAS) emphasizes a holistic approach to educational planning and execution, ensuring that both academic and personal development are seamlessly integrated into the student experience. The curriculum encompasses core subjects that establish a solid academic foundation, complemented by open electives, discipline-specific electives, Value-Added Courses (VAC), and Ability Enhancement Compulsory Courses (AECC) to expand intellectual perspectives. In addition, students are offered the opportunity to pursue a Minor in fields such as Environmental Science, Data Science, Artificial Intelligence & Machine Learning, and Nanoscience, enhancing their specialization in the four-year bachelor's degree course. The selection of these minors happens in the first semester, continuing throughout the degree program.

The learning is thoughtfully planned across the curriculum. In the early stages, foundational knowledge and skills are built through core courses. As students' progress, learning becomes more specialized, with electives and minors supporting deeper exploration of disciplines. Co-curricular activities, including sports, technical events, and cultural activities, are integrated throughout to ensure all-around growth. Leadership training, teamwork, communication skills, and discipline are emphasized through structured personality development activities. Ethical values such as truthfulness, gender sensitization, and environmental consciousness are instilled from the outset, becoming a continuous part of the student journey.

At SBAS, learning is dynamic and flexible, utilizing a variety of teaching methods including lectures, case-based learning, problem-based learning, and project-based learning, all aimed at fostering critical thinking and problem-solving abilities. Hands-on learning is reinforced through lab sessions, internships, research projects, and practical activities that connect theoretical knowledge to real-world applications. Workshops, seminars, and guest lectures from industry experts further provide practical insights and professional exposure. We have a strong students' support system in terms of differential learning (slow & fast learning), mentor-mentee system and personal counselling thereby ensuring students move up on the learning curve.

In terms of infrastructure, SBAS supports its academic planning with highly qualified faculty, smart classrooms, a well-equipped library, computer labs, and experimental research facilities. The inclusion of Massive Open Online Courses (MOOCs) and experiential learning ensures that students are prepared for both academic success and professional excellence. This carefully executed planning ensures that students are engaged at all levels of Bloom's Taxonomy, progressing from foundational understanding to higher-order thinking, while also fostering emotional, social, and ethical development. Continuous stakeholder feedback, including input from faculty, industry experts, students, and alumni, ensures that the curriculum remains relevant, aligned with academic advancements, and tuned to industry needs.

- **Course Registration and Scheduling**

- ✓ **Major and Minor Selection** – Every student must register at the beginning of each semester for the courses offered in the given semester. Major courses are registered centrally for the students. However, for other multidisciplinary courses (Minor, VAC, OE) the students must register by themselves through ERP.

- ✓ **Internships/ Research Project**– Students need to do summer internship after second and fourth semesters, which carries 2 credits, during the summer breaks. The same will be evaluated in the upcoming odd semester. In the eighth semester students of B.Sc. (Hons. / Hons. with Research) Physics will do Research Project (Dissertation). Projects are also mapped along with the Lab/ Practical Courses and Experiential Learning Activities.

- ✓ **Cocurricular Activities Credit Choices: Participation in Co/ Extracurricular activities is part of outside classroom learning.**

  Students must earn 2 credits from co/ extracurricular activities. One credit from participation in co-curricular activities like Club/Society activities and another credit from Community Service (1 credit each) through participation in NSS/ Redcross activities or NGOs that contribute to their personal development, leadership skills, and community engagement.

- Under the category of **Club/Society**, 1 credit can be earned by registration in one of the Club/Societies of university and active participation in the events organized by the club/society **OR**
- 15 hours of active engagement in any of the recreational/sports activities

Under the category of **Community Service**, 1 credit can be earned by

- 15 hours active engagement in community service through NGO/NSS/Redcross or any other society approved/ empanelled by the university.
- At the end of the semester, students are required to submit a log of hours, a report, and a certificate of participation/ completion summarizing their activities followed by a presentation.

✓ **Academic Support Services:** (Differential learning needs): The School of Basic and Applied Sciences offers a variety of academic support services tailored to meet the diverse learning needs of its students, ensuring success for all. These services include:

- **Personalized Tutoring**: One-on-one sessions with experienced tutors focus on specific areas such as laboratory techniques, experimental design, research projects, data analysis, and theoretical understanding. Tutoring is customized to each student's level, allowing for targeted support in areas like crystal structure analysis, magnetic properties, and dielectric behaviour.
- **Workshops and Seminars**: Regular workshops on topics such as advanced scientific research methods, materials characterization techniques, and the latest advancements in nanotechnology and superconductivity. These workshops, alongside industry connections, help students enhance both practical skills and theoretical knowledge.
- **Peer Mentoring Programs**: Advanced learners' mentor fellow students by leading study groups, assisting with assignments, and guiding practical projects, fostering a collaborative and supportive academic environment.
- **Accessible Learning Resources**: A variety of online platforms provide access to resources such as recorded lectures, research papers, interactive simulations, and experimental procedure guides, catering to different learning styles and enhancing independent study.
- **Outcome-Based Activities**: Students are encouraged to engage in hands-on practical, such as conducting experiments on material properties, to produce meaningful results. These outcomes are then showcased and celebrated, motivating students to further develop their skills.
- **Diversity and Inclusion Initiatives**: Programs promoting diversity and inclusion ensure that all students, regardless of background, feel valued and can contribute to a rich, collaborative learning environment.
- **Feedback and Assessment**: Continuous feedback mechanisms provide students with constructive evaluations of their work, allowing them to refine their techniques, improve their understanding, and achieve academic excellence.

- **Student Career & personal Support Services**

- **Mentor Mentee Relationship**

Every student enrolled in the school is considered a mentee and will be assigned a faculty member as their mentor. The mentor's role is to guide and support the mentee, helping them grow both personally and professionally. Mentors act as coaches by giving feedback, sharing advice, and offering insights from their own experiences. They also challenge the mentee's thinking, help them make important decisions, and connect them to valuable resources and networks. Additionally, mentors provide emotional support, celebrating successes and offering encouragement during tough times. On the other hand, the mentee's role is to actively participate in the learning process by planning meetings, setting goals, and communicating openly with their mentor. Mentees should also apply what they learn, continue growing outside the mentor-mentee relationship, and stay proactive in seeking new opportunities. By staying committed and enthusiastic, mentees can make the most of this relationship and achieve their goals.

- **Counselling and Wellness Services**

Counselling and wellness services typically encompass a range of resources to support students' mental health, emotional well-being, and overall quality of life. The school has various counselling programs such as individual Counselling where one-on-one sessions with licensed counsellors or psychologists are held to address personal issues, stress, and mental health concerns, **Group Counselling** which support groups for shared experiences like anxiety, depression, or adjustment challenges, **Crisis Counselling** for Immediate support for students in urgent situations or experiencing severe emotional distress, **Career Counselling** for guidance on career planning, job search strategies, and professional development and **Academic Counselling** for managing academic stress, time management, and study strategies. School also has various Wellness Services like On-campus clinics which provides medical care, including physical exams, vaccinations, and treatment for minor illnesses. Various mental health workshops on topics like stress management, mindfulness, and coping strategies are organized**.** All the students have access to gyms, fitness classes to promote physical health. These services aim to support students in maintaining a balanced and healthy lifestyle while managing the demands of university life.

- **Career Services and Training**

Career services and training programs are designed to support students in their professional development and job search. School provides personalized advice on career paths, goal setting, and job search strategies to students. They are given proper guidance on creating and refining job application materials. Mock interviews are also held. They are given opportunities to connect with alumni, professionals, and potential employers. Students are given professional training in areas like communication, leadership, and time management. These services and programs aim to prepare students for successful careers by enhancing their skills, providing practical experience, and connecting them with potential employers.

- **Assessment and Evaluation**

a. Evaluation scheme for theory courses

Evaluation Component	Weightage
Internal Marks (Theory): - **I) Continuous Assessment (30 Marks)** **(All the components to be evenly spaced)** Projects/ Quizzes/ Assignments and Essays/ Presentations/ Participation/ Case Studies/ Reflective Journals (minimum of five components to be covered)	30 Marks
Mid Term Exam	20 Marks
External Marks (Theory): – End Term Examination	50 Marks

* (**It is compulsory for a student to secure 40% marks in the Internal and End Term Examination separately to secure minimum passing grade).**

Overview of Internal Evaluation (30 Marks) –

Internal evaluation is designed to assess students' ongoing learning and application of course materials through diverse assessment methods. Instructors have full autonomy within the 30 marks to employ assessment strategies that best align with the course's learning objectives.

Recommended Assessment Types: -

Projects: - Individual or group projects focusing on research, analysis, and practical application of concepts.

Quizzes: - Regular, short assessments to evaluate understanding of the material.

Assignments and Essays: - In-depth tasks to assess critical thinking and problem-solving skills.

Presentations: - Assessing knowledge dissemination and communication skills.

Participation: - Evaluation of engagement and contributions to class activities.

Case Studies: - Application of theoretical knowledge to real-world scenarios.

b. Evaluation scheme for practical courses

Particular	Weightage
Internal Marks (Practical): -	
I) Conduct of Experiment	10 Marks
II) Lab Records	10 Marks

III) Lab Participation IV) Lab Project	10 Marks 20 Marks
External Marks (Practical): - End Term Practical and Viva Voce	 50 Marks

* (**It is compulsory for a student to secure 40% marks in Internal and End Term Practical's and Viva Voce separately to secure minimum passing grade).**

c. Evaluation scheme for internship/research project

Particular	**Weightage**
Internal Marks: - (Punctuality, Performance, Work Ethics, Efforts and Research Output)	 50 Marks
External Marks (Practical): - Presentation Report Writing Viva Voce	50 Marks 20 10 20

*(**It is compulsory for the student to provide an internship certificate issued by the relevant institution or organization where they completed their internship during the evaluation process.)**

7.5.2 GRADING SYSTEM

Based on the performance in all evaluation components of a Course, each student will be awarded a final grade in the Course registered, at the end of the semester. The total marks obtained by a student in the Course will be converted to a corresponding letter grade as described below.

1.
2.
3.
4.
5.
6.
7.
8.

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

Feedback and Continuous Improvement Mechanisms:

Teaching-learning is driven by outcomes. Assessment strategies and andragogy are aligned to course outcomes. Every CO is assessed using multiple components. The attainment of COs is calculated for every course to know the gaps between the desired and actual outcomes. These gaps are analysed to understand where does the student lags in terms of learning levels. Thereafter each student's learning levels are ascertained, if found below desirable level, and intervention strategy is affected in the following semester to make necessary corrections. To cater to the diverse learning needs of its student body, K.R. Mangalam University employs a comprehensive assessment framework to identify both slow and advanced learners. Students' learning levels are continually assessed based on their performance at various stages. If a student's performance in internal assessments falls below or equal to 55%, they are categorized as slow learners. Conversely, if a student's performance score in internal assessments is greater than or equal to 80%, they are identified as advanced learners. Such students are encouraged to participate in advanced learning activities. Through periodic evaluations and the utilization of modern management systems, the institution adeptly tracks

students' performance across various courses, allowing for targeted interventions and support mechanisms.

7.6 Academic Integrity and Ethics

The School of Basic and Applied Sciences (SBAS) is committed to promoting safety and academic integrity by enforcing rigorous behavioural standards. Alcohol consumption and

substance abuses are strictly prohibited, with escalating penalties for repeat offenders, which may include rustication. Ragging is also banned, adhering to UGC regulations and Supreme Court directives, and is managed through a comprehensive anti-ragging policy. The Anti-Ragging Committee, led by student affairs advisors and comprising diverse members, is tasked with handling ragging complaints and making recommendations. The Anti-Ragging Squad plays a proactive role by monitoring the campus, patrolling potential ragging hotspots, and investigating incidents. Penalties for violations can range from suspension and withholding benefits to expulsion and filing an FIR, in line with UGC regulations.

Sexual harassment in any form is taken very seriously and will be addressed by the Internal Committee Against Sexual Harassment in accordance with the Institute's policies.

The school also enforces strict penalties for other forms of misconduct, including possession of weapons, theft, and misuse of Institute property or facilities. These actions are subject to severe disciplinary measures.

Academic integrity is a cornerstone of SBAS's research and educational missions. It encompasses honesty, responsibility, and the proper acknowledgment of others' contributions. Violations such as plagiarism and cheating are treated as serious offenses. Students are required to follow principles of academic integrity, including proper citation, ethical data collection, and respect for others' work. Examples of misconduct include copying, falsifying data, and submitting purchased materials. The Institute provides guidelines for accurate record-keeping, truthful reporting, and proper attribution to uphold high academic standards.

Both individual and collective responsibility are emphasized in maintaining academic integrity. Students must ensure their theses are free from plagiarism and original before submission and are encouraged to report any violations. Faculty members are responsible for guiding students in proper research methods, ensuring accurate data recording, and reviewing student work. Additionally, faculty must educate students on academic integrity and address any breaches.

Reporting academic violations involves several steps. Faculty members should report breaches to the School Dean, and any student-faculty conflicts are managed by the Dean with committee support. The Director may appoint a committee to investigate scientific misconduct. Penalties for academic breaches are severe, with initial offenses resulting in warnings or an "F" grade, and repeat offenses potentially leading to expulsion.

Students must also seek permission before engaging with media on behalf of the Institute or recording classroom activities. Unauthorized sharing of audio/video clippings or posting derogatory comments on social media is prohibited. Misconduct can be reported by students, staff, or faculty, and penalties may include warnings, community service, restrictions, fines, withholding grades, suspension, expulsion, or a ban on reapplying for admission. The disciplinary process involves a hearing, documentation, and recommendations by a committee, with final actions decided by the Dean and enforced by the academic office. Repeat offenders face harsher penalties.

Table 2: Programme Study

SEMESTER-I							
S.No.	**TYPE OF COURSE**	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	Major 1	SCMA101	Calculus	4	0	0	4
2	Major 1 Lab	SCMA151	Calculus Lab	0	0	4	2
3	Major 2	SCMA103	Classical Algebra	4	0	0	4
4	VAC-I		VAC	2	0	0	2
5	Major 3	UDT101	Data analytics using SQL	2	0	4	4
6	SEC-I	SEC011	Statistics for Data Science	2	0	2	3
7	SEC-II	SEC014	Documentation using Latex	1	0	2	2
TOTAL CREDITS							**21**
SEMESTER-II							
S.No	**TYPE OF COURSE**	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	Major 4	SCMA102	Multivariate Calculus	4	0	0	4
2	Major 4 Lab	SCMA152	Multivariate Calculus practical Lab	0	0	4	2
3	Major 5	SCMA104	Modern Algebra	4	0	0	4
4	VAC-II		**VAC**	**2**	**0**	**0**	**2**
5	Major 6		Data analytics using R	2	0	4	4
6	Generic Elective-I		OE-I	3	0	0	3
7	SEC-III	SEC013	Data Analytics with Tableau	1	0	4	3
8			Summer internship/Project				
TOTAL CREDITS							**22**

SEMESTER-III							
S.No	**TYPE OF COURSE**	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	Major 7	SCMA201	Real Analysis	4	0	0	4
2	Major 8	SCMA203	Ordinary Differential Equation	4	0	0	4
3	Major 8 Lab	SCMA251	Ordinary Differential Equation Lab	0	0	4	2
4	GEC-IV/Open Elective II		GE-II	_	_	_	3
5	SEC-III	UDT103	Python for Data Science	2	0	4	4
6	AEC-I	AEC006	Verbal Ability	3	0	0	3
7		SIMA001	Evaluation of Summer Internship	2	0	0	2
8	**VAC-III**		VAC	**1**	**0**	**2**	**2**
TOTAL CREDITS							**24**

SEMESTER-IV							
S.No	**TYPE OF COURSE**	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	Major 9	SCMA202	Linear Algebra	4	0	0	4
2	Major 10	SCMA204	Complex analysis	4	0	0	4
3	Major 11	SCMA206	Partial Differential Equation and Calculus of Variation	4	0	0	4
4	Major 11 Lab	SCMA254	Partial Differential Equation and Calculus of Variation, Lab	0	0	4	2
5	SEC-IV	UDT104	Data Preprocessing and visualization using Python	2	0	4	4
6	Generic Elective-III		GE-III	_	_	_	3
7	SEC-V	SEC075	Basic IT Tools	1	0	2	3

8	AEC-II	AEC007	Communication & Personality Development	3	0	0	3
TOTAL CREDITS							**27**
SEMESTER-V							
S.No	**TYPE OF COURSE**	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	Major 12	SCMA301	Numerical Methods	4	0	0	4
2	Major 12 Lab	SCMA351	Numerical Methods Lab	0	0	4	2
3	Major 13	SCMA303	Metric Spaces	4	0	0	4
4	Major 14 DSE1(Any one)	SCMA305	Advanced Algebra	4	0	0	4
		SCMA307	Linear Programming	4	0	0	4
5	Major 15 DSE2 (Any one)	UDT105	Time Series Analysis and Forecasting using Python	2	0	4	4
		UDT109	Data Structures and Algorithms	3	0	0	3
6	Major 16	SCMA403, 407, 409,4011, 4013, 4015	(Guide specific paper)	5	1	0	6
7	Major 17	SCMA4021	Special Functions	5	1	0	6
8	AEC-III	AEC010	Arithmetic and Reasoning Skills-III	3	0	0	3
TOTAL CREDITS							**33**
SEMESTER-VI							
S.No	**TYPE OF COURSE**	**COURSE CODE**	**COURSE TITLE**	**L**	**T**	**P**	**C**
1	Major 18	SCMA302	Probability and Statistics	4	0	0	4

2	Major 18 Lab	SCMA352	Probability and Statistics Lab	0	0	4	2
3	Major 19 DSE3 (Any one)	SCMA304	Applied Mechanics	4	0	0	4
		SCMA306	Mathematical Modeling	4	0	0	4
4	Major 21	SCMA402	Research Ethics and Intellectual Property Rights	4	0	0	4
5	Major 22	SCMA4010	q- analog and Fractional Calculus	5	1	0	6
6		SCMA308	Dissertation (Research Project)	6	0	0	6
TOTAL CREDITS							**26**

Total Credits [C]	**153**

Major16 (Guide specific paper)		
1	SCMA4015	Advanced Operational Research
2	SCMA409	Mathematical Finance
3	SCMA407	Computational Mathematics
4	SCMA403	Advanced Mechanics
5	SCMA4011	Fuzzy Mathematics
6	SCMA4013	Fractional Calculus

SYLLABUS

SEMESTER I					
SCMA101	**Calculus**	**L**	**T**	**P**	**C**

Version		4	0	0	4
Category of Course	Major-I				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

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 Outcomes

Upon completion of the course, the learner will be able to:

CO1: Understanding the principles and applications of differential and integral calculus.
CO2: Identifying and classifying various types of differential and integral calculus techniques to solve real-world problems.
CO3: Analyzing the behaviour of functions using calculus tools such as derivatives, integrals, and limits.
CO4: Evaluating: Assess the validity of solutions to calculus problems by verifying results and determining the appropriateness of methods used.

Course Content

Unit 1: Sequences and Integration **Contact Hours:** 15

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: Limit and Continuity **Contact Hours:** 15

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: Differentiability **Contact Hours:** 15

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: Curvature, Asymptotes and Curve Tracing **Contact Hours:** 15

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.

Learning Experience

In this calculus course, learning is experiential and participatory, blending lectures with hands-on problem-solving and group discussions. Students will engage with real-world applications of calculus through collaborative group work and peer reviews. Technology, including online platforms and Matlab Labs, will enhance understanding through interactive exercises. Continuous assessment will be done via quizzes, assignments, and reflective journals. The course instructor will provide ongoing support and feedback, encouraging students to seek help as needed. Group activities will foster collaboration and critical thinking, ensuring students actively apply and deepen their understanding of calculus concepts.

Textbooks

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

Suggested Readings

1. Howard Anton, I. Bivens& Stephan Davis (2016). *Calculus* (10th 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* (14thedition). Pearson Education.

Open Educational Resources (OER)

1. https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.1x+2T2019/about
2. https://openlearninglibrary.mit.edu/courses/course-v1:MITx+18.01.2x+3T2019/about

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

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/attendance/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER I					
SCMA151	**Calculus Lab**	**L**	**T**	**P**	**C**
Version		0	0	4	2
Category of Course	Major-I (Practical)				
Total Contact Hours	30 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

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

Upon completion of the course, the learner will be able to:
CO1: Observing and analyzing mathematical models and simulations to understand calculus concepts visually and intuitively.

CO2: Imitating demonstrated methods to perform basic calculus operations using lab tools such as Maple, MATLAB, or Mathematica.

CO3: Practicing and applying calculus techniques in lab settings to solve computational problems efficiently.

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

Learning Experience

In this calculus lab course, students will engage in hands-on learning through practical exercises such as evaluating integrals, areas, volumes, and arc lengths of curves, and exploring vector calculus concepts like divergence and curl. Instruction will blend guided practice with the use of technology, such as Matlab/Mathematica, for graphing and visualizing results. Collaborative group work and peer reviews will promote active participation and critical thinking. Continuous assessment through lab assignments will

ensure mastery of techniques. The instructor will provide support and feedback, encouraging students to seek help and collaborate to enhance their learning experience.

Instruction Methods:

- **Lectures:** Core Matlab/Mathematica concepts will be taught using multimedia presentations and real-world examples.
- **Interactive Sessions:** Q&A, live coding exercises, and group discussions will actively engage students.

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support: The course instructor will offer additional guidance, with peer collaboration encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving course outcomes.

Textbooks

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)

1. https://online.stanford.edu/courses/math51-linear-algebra-multivariable-calculus-and-modern-applications
2. https://ocw.mit.edu/courses/18-02-multivariable-calculus-fall-2007/video_galleries/video-lectures/
3. https://archive.nptel.ac.in/courses/111/107/111107108/

Evaluation Scheme

Evaluation components	Weighage

Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SCMA103	**Classical Algebra**	**L**	**T**	**P**	**C**
Version 1.0		**4**	**0**	**0**	**4**
Category of Course	**Core Course**				
Total Contact Hours	**60**				
Pre-requisites/ Co-requisites	**Senior Secondary level knowledge of Algebra and Geometry**				

Course Perspective

This course provides a comprehensive introduction to advanced topics in algebra, number theory, and linear algebra. Students will explore the theory of equations, polynomial roots, factorization techniques, and complex numbers, with applications such as Cardan's and Ferrari's methods for solving cubic and biquadratic equations. They will study equivalence relations, congruence relations, and set theory, enhancing their understanding of functions and cardinality. The course also covers fundamental number theory concepts, such as the division algorithm and modular arithmetic. Additionally, students will gain hands-on experience with linear algebra, focusing on matrix operations, row echelon forms, and applications to linear systems, culminating in discussions on eigenvalues, eigenvectors, and the Cayley-Hamilton theorem.

Course Outcomes (CO)

CO1: Recalling and defining key theorems and methods related to polynomial equations, equivalence relations, DeMoivre's Theorem and number theory (e.g., Cardano's method, the fundamental theorem of arithmetic).

CO2: Solving mathematical problems using various methods and theorems.

CO3: Examining the structure of systems of linear equations, Modular arithmetic, properties of congruences and bijective function.

CO4: Assessing the invertibility of matrices and evaluate the solution sets of linear systems by applying matrix operations, inverse matrix characterizations, and the Cayley-Hamilton theorem.

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 20 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.

Learning Experience:

The learning experience in this course is designed to foster deep understanding and practical application of advanced mathematical concepts through a blend of theoretical exploration and hands-on problem-solving. Students will engage with the material through a combination of lectures, problem sets, and collaborative discussions that emphasize the connections between abstract theory and real-world applications.

Instruction Methods:

- **Lectures with Visual Aids:** Core concepts and theories will be explained through detailed lectures, supported by visual aids like PowerPoint slides, diagrams, and animations to help students grasp complex ideas such as polynomial factorization, matrix operations, and complex number representations.
- **Interactive Discussions:** Class discussions will be encouraged, particularly when exploring challenging topics like theorems, proofs, and their applications. This method promotes critical thinking and allows students to clarify doubts in a collaborative environment.
- **Assignments and Quizzes:** Regular assignments and quizzes will be used to assess understanding and provide continuous feedback. These will include both theoretical questions and practical problems that require application of learned concepts.
- **Peer Learning:** Group activities and peer-review sessions will encourage collaboration among students, allowing them to learn from each other's approaches and perspectives, particularly in solving intricate mathematical problems.

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support: The course instructor will offer additional guidance, with peer collaboration encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving course outcomes.

Textbooks

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

Suggested 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**

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals (minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grad

SEMESTER I					
UDT101	**Data Analytics using SQL**	**L**	**T**	**P**	**C**
Version		2	0	4	4
Category of Course	Minor				
Total Contact Hours	64 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

This course is designed to provide students with essential skills in SQL, a fundamental tool in data analysis and data science. Students will learn to effectively retrieve, clean, manipulate, and analyze data stored in relational databases, supporting data-driven decision-making in various domains. The course emphasizes practical application, equipping students with the ability to use SQL to solve real-world problems in business, finance, marketing, healthcare, and more. By mastering SQL, students will gain a strong foundation in data analytics, enabling them to make meaningful contributions in their careers.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Understanding and constructing complex SQL queries to retrieve, filter, and aggregate data from relational databases.

CO2: Applying SQL commands to clean and preprocess data, including handling missing values, duplicates, and performing data transformations.

CO3: Analyzing datasets using SQL queries to identify patterns and summarize key statistics for initial insights.

CO4: Evaluating and interpreting query results by visualizing data with tools or libraries to create meaningful charts, graphs, and plots that enhance understanding.

Course Content

Unit 1: Introduction to SQL and Database Management **Contact Hours:** 16

- Introduction to Data Science
- Introduction to SQL Server
- Understanding Data & Information
- Database Concepts

- DBMS and RDBMS
- Database Design Principles
- Types of Databases
- SQL Server Versions
- Creating Databases
- Sub-languages of T-SQL: DDL, DML, TCL, DCL, DQL
- Creating Tables
- Data Manipulation (Insert, Delete, Update)
- Normalization
- Constraints (Unique, Not Null, Primary Key, Check, Default, Foreign Key)

Unit 2: SQL Queries and Data Manipulation **Contact Hours:** 22

- Working with Single Table Queries
- Writing Queries using SELECT Statement
- Understanding Query Flow
- Operators in SQL Server
- Clauses in SQL Server (WHERE, ORDER BY, DISTINCT, TOP)
- Filtering and Sorting Data
- DML Commands (Insert, Update, Delete)
- DDL Commands (Create, Alter, Drop, Truncate)
- Delete vs Truncate

Unit 3: SQL Functions and Aggregation **Contact Hours:** 10

- Built-in Functions
- Scalar Functions (String, Date, ISNULL, etc.)
- Group Functions (Aggregate Functions: COUNT, MAX, MIN, AVG, SUM)
- Usage of Functions in Data Analysis

Unit 4: Advanced SQL Queries: Subqueries and Joins **Contact Hours:** 16

- Subqueries: Importance and Types
- Nested Queries
- JOINS: Importance and Types (Inner Join, Outer Joins, Left, Right Outer Joins)

List of Practicals

- Create a student table with student ID, name, and marks as attributes where 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 students with marks more than 80.
- Find the min, max, sum, and average of marks in a student marks table.
- Find the total number of customers from each country using GROUP BY.

- Write a SQL query to order the (student ID, marks) table in descending order of marks.
- Write a SQL query to display marks without decimal places, the remainder after dividing marks by 3, and the square of marks.
- Write a SQL query to display names in capital letters, small letters, first 3 letters of the name, last 3 letters of the name, and the position of the letter 'A' in the name.
- Remove extra spaces from left, right, and both sides of the text "SQL for Data Science".
- Display today's date in "Date/Month/Year" format.
- Display the day name, month name, day, day name, day of the month, and day of the year for today's date.

Learning Experience

This course will integrate lectures, interactive sessions, and hands-on projects to deepen understanding of SQL, data manipulation, and data analysis.

Instruction Methods:

- **Lectures:** Core SQL concepts will be taught using multimedia presentations and real-world examples.
- **Interactive Sessions:** Q&A, live coding exercises, and group discussions will actively engage students.
- **Technology Use:**
- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.
- **Assessments:**
- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support: The course instructor will offer additional guidance, with peer collaboration encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving course outcomes.

Textbooks

1. "Learning SQL" by Alan Beaulieu
2. "SQL for Dummies" by Allen G. Taylor

Suggested Readings

1. "SQL in 10 Minutes, Sams Teach Yourself" by Ben Forta
2. "SQL Pocket Guide" by Jonathan Gennick

3. "The Practical SQL Handbook" by Judith S. Bowman, Sandra L. Emerson, and Marcy Darnovsky

Open Educational Resources (OER)

1. https://www.w3schools.com/sql/
2. https://www.khanacademy.org/computer-programming/new/sql
3. https://www.coursera.org/learn/sql-for-data-science

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER I					
SEC011	**Statistics for Data Science**	**L**	**T**	**P**	**C**
Version		2	0	2	3
Category of Course	Minor				
Total Contact Hours	42 Hours				
Pre-Requisites/ Co-Requisites	**Nil**				

Course Perspective

Statistics for Data Science is a fundamental course designed to introduce students to essential statistical methods and their applications in data science. This course is crucial for students pursuing careers in data analysis, business intelligence, and related fields as it builds a solid foundation in statistical techniques used to interpret and analyze data. Students will gain proficiency in statistical methods, data visualization, and predictive analytics, which are critical skills in the data-driven job market. The knowledge and skills acquired in this course are applicable in real-world scenarios such as business decision-making, market analysis, and data-driven research. For instance, understanding regression analysis can help businesses forecast sales trends, while data visualization skills can enhance the presentation of analytical findings to stakeholders.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Identifying and describing fundamental statistical concepts such as measures of central tendency and dispersion to summarize data effectively.

CO2: Applying techniques for visualizing data using charts, graphs, and plots to reveal insights and communicate findings clearly.

CO3: Analyzing relationships between variables through correlation and regression methods to interpret the strength and direction of relationships.

CO4: Evaluating and interpreting results from statistical analyses to make informed decisions based on data insights.

Course Content

Unit 1: Statistical Methods *No. of Hours: 10*

- 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 *No. of Hours: 10*

- Introduction to Correlation Analysis
- Simple Correlation Analysis
- Rank Correlation
- Regression Analysis

Unit 3: Time Series Analysis *No. of Hours: 10*

- Introduction to Time Series
- Components of Time Series
- Forecasting Techniques
- Applications in Statistical Data

Unit 4: Data Visualization *No. of Hours: 12*

- Introduction to Data Visualization
- Creating Effective Charts and Graphs
- Visualizing Statistical Data in Excel
- Practical Applications of Visualization Techniques

Learning Experience

This course will be a blend of lectures, hands-on sessions, and collaborative activities to develop practical skills in statistical methods and data visualization for data science.

Instruction Methods:

- **Lectures:** Core statistical concepts will be introduced through multimedia presentations and real-world applications.
- **Hands-on Sessions:** Practical exercises using Excel will allow students to apply statistical techniques and create data visualizations.
- **Group Activities:** Collaborative projects will involve case studies and real-world problem-solving.

Technology Use:

- **Excel:** Primary tool for statistical analysis and data visualization.
- **Online Platforms:** LMS for accessing resources, recorded lectures, and discussion forums.

Assessments:

- **Formative:** Regular quizzes, practical exercises, and assignments for continuous feedback.
- **Summative:** Case study analyses, project presentations, and a final exam to evaluate students' grasp of statistical methods.

Support: The course instructor will be available for guidance during office hours, and students are encouraged to collaborate through peer reviews and group work. Regular feedback will be provided to help students refine their skills and meet course outcomes effectively.

Textbooks

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.

Suggested Readings

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.
3. Dr. B.S. Grewal, *Higher Engineering Mathematics*, Sixth Edition, Khanna Publishers, 2017.

Open Educational Resources (OER)

1. Think Stats: Exploratory Data Analysis (eBook)
2. Statistics for Data Science and Business Analysis (Udemy Course)
3. Data Science: Statistics and Machine Learning (Coursera Specialization)

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEC014	**Documentation using Latex**	**L**	**T**	**P**	**C**
Version 1.0		**1**	**0**	**2**	**2**

Category of Course	**Skill Enhancement Course**				
Total Contact Hours	**30**				
Pre-requisites/ Co-requisites					

Course Perspective

This course introduces students to LaTeX, a high-quality typesetting system commonly used for technical and scientific documents. Students will explore the advantages of LaTeX over traditional word processors, focusing on its precision in formatting and mathematical typesetting. The course covers essential topics such as formatting text, creating lists, typing complex math formulas, and utilizing various environments (e.g., equations, matrices). Students will learn to insert tables, figures, and graphics, as well as create professional presentations using Beamer. Additionally, the course will guide students through the installation of LaTeX and necessary packages, while leveraging online resources for enhanced productivity.

Course Outcomes (CO)

CO1: Remembering the basic commands and syntax of LaTeX, including formatting lines, paragraphs, and simple documents.

CO2: Applying LaTeX commands to format text, insert tables, figures, and create professional presentations using Beamer.

CO3: Analyzing the structure of LaTeX documents by breaking down environments (e.g., equations, matrices) and correctly integrating mathematical formulas and symbols.

CO4: Critically assessing and troubleshooting LaTeX documents by identifying and correcting errors in formatting, layout, or typesetting.

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

Learning Experience:

The learning experience in this LaTeX course is designed to be highly practical and hands-on, allowing students to build confidence in document preparation through incremental mastery of LaTeX. Starting with foundational concepts, students will engage in guided exercises that introduce essential commands and structures. As they progress, students will tackle increasingly complex tasks, such as typesetting mathematical formulas, creating professional-grade presentations, and integrating graphics.

Interactive sessions, coupled with real-time feedback, will enable students to experiment and refine their skills in a supportive environment. By the end of the course, students will have not only a thorough understanding of LaTeX but also a portfolio of completed projects that showcase their ability to produce polished, publication-ready documents. This experiential learning approach ensures that students are well-equipped to apply LaTeX in their academic and professional endeavors.

Instruction Methods:

- **Lectures with Visual Aids:** Core concepts and LaTeX fundamentals will be introduced through live or recorded lectures, supplemented with visual demonstrations of coding and document preparation. These sessions will focus on explaining the syntax, commands, and structural elements of LaTeX.
- **Assignments and projects:** Students will be given regular assignments and a final project that requires them to apply the skills learned in class. These tasks will range from simple document creation to more complex projects involving advanced formatting, mathematical typesetting, and presentations.

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support: The course instructor will offer additional guidance, with peer collaboration encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving course outcomes.

Textbooks

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

Suggested Readings

1. **The LaTeX Companion** by Frank Mittelbach, Michel Goossens, Johannes Braams, David Carlisle, and Chris Rowley

   This book offers a deeper dive into advanced LaTeX techniques, including formatting, typesetting, and customizing documents, making it perfect for students looking to go beyond the basics.

2. **Guide to LaTeX** by Helmut Kopka and Patrick W. Daly

   A practical guide that walks readers through LaTeX commands and document structuring, with examples ranging from simple to complex document preparation.

3. **More Math into LaTeX** by George Grätzer

   Ideal for students focusing on mathematical typesetting, this book provides detailed guidance on producing equations, formulas, and mathematical symbols in LaTeX.

4. **LaTeX in 24 Hours: A Practical Guide for Scientific Writing** by Dilip Datta

   This book provides a step-by-step approach to learning LaTeX, making it an excellent resource for beginners looking for practical, hands-on learning.

5. **Online Resource: LaTeX Wikibook**

   Available online for free, this resource is an excellent place for students to explore tutorials, examples, and community-driven content on LaTeX.

Open Educational Resources (OER)

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

Evaluation Scheme

Evaluation components	Weighage

Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals (minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER-II

SEMESTER II					
SCMA102	**Multivariate Calculus**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Major-III				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

Multivariate Calculus is a gateway to advanced studies in mathematics, physics, and engineering, extending foundational calculus into higher dimensions. Students explore functions of multiple variables, learning how to describe changes and rates in multidimensional spaces. The course emphasizes key concepts like partial derivatives, optimization, and integration over complex regions, fostering a deeper understanding of mathematical modelling. Students are introduced to techniques for solving real-world problems involving rates of change, optimization with constraints, and spatial calculations. The course also emphasizes the application of key theorems that connect abstract mathematical principles with practical scenarios. Through this course, students strengthen their problem-solving skills while learning to think critically and communicate effectively in the language of higher mathematics.

Course Outcomes

Upon completion of the course, the learner will be able to:
CO1: Identifying the behaviour of functions in multiple dimensions and demonstrate an **understanding** of key theorems, including Green's, Stokes', and Gauss' divergence theorems.
CO2: Applying multivariate calculus techniques to solve real-world problems involving optimization, rates of change, and integration in different coordinate systems.
CO3: Analysing complex problems by breaking them into manageable components and utilize the tools of multivariate calculus to explore relationships between variables and their applications in various fields.
CO4: Evaluating the accuracy and appropriateness of calculus methods used in various physical and geometrical applications, verifying results through theorems and integrals.

Course Content

Unit 1: Partial Differentiation: **Contact Hours:** 15

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 1I: Differentiation: **Contact Hours:** 15

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: Extrema of Functions and Vector Field: **Contact Hours:** 15

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: Green's, Stokes' and Gauss Divergence Theorem: **Contact Hours:** 15

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.

Learning Experience

The "Multivariate Calculus" course offers an engaging and participatory learning experience. Lectures will be supplemented with interactive discussions, case studies, and real-world applications to help students grasp complex concepts. Hands-on learning will be promoted through regular assignments and problem-solving activities, using technology such as graphing software and online platforms for simulations and visualizations. Group work will foster collaboration, with peer reviews allowing for deeper understanding and shared feedback. Assessments will include quizzes, exams, and project-based tasks to evaluate progress. The course instructor will provide ongoing support and feedback, encouraging students to seek help and collaborate with peers for a successful learning experience.

Textbooks

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

Suggested 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.

Open Educational Resources (OER)

1. https://online.stanford.edu/courses/math51-linear-algebra-multivariable-calculus-and-modern-applications
2. https://ocw.mit.edu/courses/18-02-multivariable-calculus-fall-2007/video_galleries/video-lectures/
3. https://archive.nptel.ac.in/courses/111/107/111107108/

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/attendance/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER II					
SCMA152	**Multivariate Calculus Practical Lab**	**L**	**T**	**P**	**C**
Version		0	0	4	2
Category of Course	Major-III (Practical)				
Total Contact Hours	30 Hours				
Pre-Requisites/ Co-Requisites	MATLAB software/Mathematica/Maple software				

Course Perspective

The "Multivariate Calculus Practical Labs" course focuses on applying calculus concepts to solve real-world problems involving functions of multiple variables. Students will work with integrals to compute areas, volumes, and arc lengths, and explore techniques for analysing the behaviour of functions, including identifying critical points and using software for graphing. Vector operations and concepts such as gradients, divergence, and curl will also be introduced. Through practical exercises, students will develop a deeper understanding of multivariable calculus, enhance their analytical skills, and gain proficiency in mathematical tools for complex problem-solving.

Course Outcomes

Upon completion of the course, the learner will be able to:
CO1: Observing and analyzing multivariate functions, interpreting their geometric and analytic behaviors in practical applications.

CO2: Imitating standard computational techniques for solving multivariate calculus problems, including partial derivatives, gradients, and optimization in lab settings.

CO3: Practicing problem-solving methods by applying multivariate calculus principles to real-world situations and computational simulations.

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

Learning Experience

In the "Multivariate Calculus Practical Labs" course, students will engage in a dynamic, hands-on learning experience designed to deepen their understanding of complex calculus concepts. Instruction will blend lectures with interactive technology, including software for computational simulations and graphical analysis. Activities will encompass case studies, group projects, and individual assignments, fostering both collaborative and independent problem-solving skills. Students will tackle real-world problems through practical exercises and lab work, supported by regular feedback from the course instructor, who will be available for additional guidance. Peer reviews and group discussions will enhance collaborative learning. Assessments will include practical tasks, written reports, and presentations to evaluate both theoretical and applied knowledge.

Instruction Methods:

- **Lectures:** Core Matlab/Mathematica concepts will be taught using multimedia presentations and real-world examples.
- **Interactive Sessions:** Q&A, live coding exercises, and group discussions will actively engage students.

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support: The course instructor will offer additional guidance, with peer collaboration encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving course outcomes.

Textbooks

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)

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

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

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

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SCMA104	**Modern Algebra**	**L**	**T**	**P**	**C**
Version 1.0		**4**	**0**	**0**	**4**
Category of Course	**Core Course**				
Total Contact Hours	**60**				
Pre-requisites/ Co-requisites	**Classical Algebra**				

Course Perspective

This course provides a fundamental understanding of the structure of algebraic systems, focusing primarily on groups, rings, and fields. It is designed for students who have a basic background in algebra and are looking to explore the deeper theoretical aspects of the subject.

Course Outcomes (CO)

CO1: Recalling the definitions and key properties of groups, subgroups, cyclic groups, rings, and fields, including specific groups such as dihedral, permutation, and quaternion groups.

CO2: Applying Lagrange's theorem to determine the possible orders of subgroups within a group and using Cauchy's theorem to identify elements of specific orders in finite abelian groups.

CO4: Analyzing the structure of groups by examining their normal subgroups and cosets, and classifying subgroups of cyclic groups.

CO5: Evaluating the properties of group, group homomorphisms and isomorphisms.

Course Content

Unit I: **14 lecture hours**

Groups and their 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: **16 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: **14 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: **16 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.

Learning Experience:

The learning experience in this Abstract Algebra course is designed to be dynamic and immersive, combining interactive lectures, hands-on problem-solving, and collaborative group work to deepen students' understanding of algebraic structures. Students will engage with real-world applications of abstract concepts, such as group theory's role in cryptography, while regular assessments and feedback will ensure they are continuously progressing. The

course leverages technology, including mathematical software and online resources like MIT Open Course Ware, to enhance learning and provide additional support.

Instruction Methods:

1. Interactive Lectures

- **Approach**: Lectures will be conducted interactively, incorporating questions, discussions, and real-time problem-solving. Concepts will be explained with visual aids such as diagrams, animations, and geometric interpretations to help students visualize abstract ideas.
- **Tools**: Use of slides and smart board.

2. Problem-Based Learning (PBL)

- **Approach**: Students will regularly engage in problem-based learning, where they tackle algebraic problems and case studies that require the application of theoretical concepts. This method encourages active learning and critical thinking.
- **Tools**: Problem sets distributed through a learning management system (LMS), with in-class problem-solving sessions.

3. Flipped Classroom

- **Approach**: Some portions of the course will use a flipped classroom model, where students are assigned pre-class readings or video lectures. Class time will then be devoted to discussing the material, solving problems, and addressing any misconceptions.
- **Tools**: Pre-recorded lectures, online readings, and interactive quizzes to assess pre-class learning.

4. Continuous Assessment and Feedback

- **Approach**: The course will include frequent assessments such as quizzes, short assignments, and in-class activities to gauge understanding and provide timely feedback. This will help students stay engaged and identify areas for improvement.
- **Tools**: Online quizzes via the LMS, peer assessments during group work, and in-class formative assessments.

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support:

Support for students in this Abstract Algebra course is comprehensive and multifaceted, ensuring a conducive learning environment for all. Regular office hours and peer tutoring sessions will be available, offering personalized assistance to help students grasp challenging concepts and work through problem sets. The course will also provide timely and constructive feedback through continuous assessments, quizzes, and in-class activities, allowing students to monitor their progress and address any difficulties promptly. Additionally, online resources, including pre-recorded lectures, tutorials, and discussion forums, will be accessible to support learning outside the classroom. For collaborative projects, students will have access to digital tools and platforms to facilitate group work and communication, ensuring that they can effectively collaborate and succeed in their assignments. Overall, these support mechanisms are designed to help every student thrive academically and fully engage with the course material.

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.

Suggested Readings

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.

Open Educational Resources (OER)

1. Abstract Algebra: Theory and Applications
2. Algebra: Abstract and Concrete
3. MIT Open CourseWare - Abstract Algebra
4. NPTEL Abstract Algebra

Evaluation Scheme

Evaluation components	Weighage

Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals (minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER II					
UDT102	**Data Analytics using R**	**L**	**T**	**P**	**C**
Version		2	0	4	4
Category of Course	Minor				
Total Contact Hours	64 Hours				
Pre-Requisites/ Co-Requisites	**Basic concepts of Statistics**				

Course Perspective

The course "Data Analytics using R" is designed to equip students with the foundational skills in R programming necessary for data analysis in various domains. By engaging with this course, students will gain hands-on experience in data manipulation, visualization, and statistical analysis using R, making them proficient in handling real-world data challenges. The knowledge acquired in this course is applicable across industries where data-driven decision-making is key. The skills developed will enhance students' academic prowess and prepare them for careers in data science, analytics, and research. For example, students will be able to create insightful visualizations to present data-driven solutions, identify trends, and model data effectively, which are essential skills in today's data-centric job market.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Understanding and applying R programming concepts to perform basic data manipulation and visualization tasks.

CO2: Analyzing data sets by employing appropriate R data structures, such as vectors, matrices, and data frames.

CO3: Creating custom R functions and utilizing control structures to automate data analysis processes.

CO4: Evaluating and interpreting data trends through various graphical representations in R.

Course Content

Unit I: Fundamentals of R: (No. of Hours: 16)

- Introduction to R: Features of R, Environment, R Studio
- Basics of R: Assignment, Modes, Operators, Logical values, Basic Functions
- R Data Structures: Vectors, Lists, Matrices, Data Frames, Factors
- Control Structures: if-else, loops, and functions

Unit II: Data Structures in R: (No. of Hours: 16)

- Vectors: Definition, Declaration, Operations
- Matrices: Creating, Reshaping, Operations
- Lists: Creating, General Operations
- Data Frames: Creating, Accessing, Merging, Special Functions

Unit III: Working with Data in R: (No. of Hours: 16)

- Reading and Writing Data: CSV, Excel, Text Files
- String Operations: Regular Expressions, Dates in R
- Data Preprocessing: Descriptive Statistics, Handling Missing Values, Normalization
- Exploratory Data Analysis: Summarizing Data, Identifying Patterns

Unit IV: Data Visualization with R: (No. of Hours: 16)

- Basic Visualization Tools: Bar Charts, Histograms, Pie Charts, Scatter Plots, Line Plots
- Introduction to ggplot2: Creating Simple Plots, Customization Techniques
- Project on R and related discussion

Learning Experience

This course will be conducted through a blend of lectures, practical sessions, and interactive activities. Students will engage in hands-on learning using R software, working on real-world data sets to apply concepts learned in class. Methods of instruction will include case studies, group work, and individual assignments.

Instruction Methods:

- **Lectures:** Core R programming concepts will be taught through multimedia presentations and coding examples.

- **Hands-on Sessions:** Students will work on real-world data sets using R, applying concepts through practical exercises.
- **Group Work and Case Studies:** Collaborative projects and case studies will reinforce learning and promote teamwork.
- **Technology Use:**
- **R and RStudio:** Students will use R and RStudio for data manipulation, visualization, and analysis.
- **Shiny:** For creating interactive web applications and visualizations.
- **Online Platforms:** LMS for accessing resources, recorded lectures, and submitting assignments.
- **Assessments:**
- **Formative:** Regular quizzes, coding exercises, and assignments for continuous feedback.
- **Summative:** Project presentations, case study analyses, and a final assessment to evaluate students' mastery of R programming and data analysis.

Support: The course instructor will provide continuous guidance, with opportunities for students to collaborate through group work and peer reviews. Regular feedback will be given on assignments and projects, and students are encouraged to seek help as needed to enhance their learning experience.

Textbooks

1. Cognitive Computing with IBM Watson by Rob High, Tanmay Bakshi (1st edition)
2. Nina Zumel, John Mount, Practical Data Science with R, Manning Publications, 2014

Suggested Readings

1. Mark Gardener, Beginning R: The Statistical Programming Language, John Wiley & Sons, 2012
2. Nathan Yau, Visualize This: The FlowingData Guide to Design, Visualization, and Statistics, Wiley, 2011

Open Educational Resources (OER)

1. "Introduction to Data Science with R" (HarvardX Data Science Series on edX)
2. "R Programming" (Coursera by Johns Hopkins University)
3. "Advanced R" by Hadley Wickham (available online at Advanced R)

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

Student Activity

Students will participate in activities such as data cleaning, summarization, and visualization tasks. They will engage in assignments, quizzes, and group discussions, focusing on applying the concepts learned to real-time data. These activities will reinforce the theoretical knowledge acquired and provide practical experience in data analytics.

SEMESTER II					
SEC013	**Data Analytics with Tableau**	**L**	**T**	**P**	**C**
Version		1	0	4	3
Category of Course	Minor				
Total Contact Hours	40 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

This course is designed to equip students with essential skills in Data Warehousing and Tableau, key tools in modern data management and visualization. Students will explore the architecture and characteristics of data warehouses, learning how to efficiently store and retrieve data in support of business intelligence and decision-making processes. The course emphasizes hands-on experience with Tableau, where students will connect to various data sources, create and format visualizations, and develop interactive dashboards. Additionally, the course covers Tableau Server, enabling students to manage, share, and embed visualizations across platforms. By mastering these concepts and tools, students will be prepared to handle complex data analytics tasks, making them valuable assets in fields such as business, finance, healthcare, and beyond.

Course Outcomes

Upon completion of the course, the learner will be able to:
CO1: Explaining the fundamental concepts of data visualization and Tableau's interface, including different types of charts and graphs.
CO2: Applying basic visualizations like bar charts, line charts, and pie charts using Tableau, applying data visualization techniques to represent data effectively.
CO3: Analyzing datasets by using filters, sorting, and grouping features in Tableau to derive meaningful insights from data.
CO4: Evaluating different visualization options in Tableau to choose the most appropriate one based on the type of data and the objective of the analysis.

Course Content

Unit 1: Introduction to Tableau and Data Visualization **Contact Hours:** 10

- Overview of Data Visualization
- Introduction to Tableau Interface and Workflow
- Connecting to Data Sources (Excel, CSV, etc.)
- Basic Charts and Graphs (Bar, Line, Pie Charts)
- Hands-on Practice: Creating First Visualizations

Unit 2: Working with Data in Tableau **Contact Hours:** 10

- Data Import and Data Preparation
- Sorting and Filtering Data
- Grouping and Aggregating Data
- Creating Hierarchies and Drill-downs
- Hands-on Practice: Exploring Data Using Tableau

Unit 3: Advanced Visualization Techniques **Contact Hours:** 10

- Using Calculated Fields and Table Calculations
- Advanced Charts (Heat Maps, Tree Maps, Scatter Plots, etc.)
- Creating Dual-axis and Combined Charts
- Applying Parameters and Filters
- Hands-on Practice: Creating Advanced Visualizations

Unit 4: Dashboards and Storytelling with Data **Contact Hours:** 10

- Introduction to Dashboards in Tableau
- Designing Interactive Dashboards
- Creating Storylines for Presenting Data Insights
- Publishing and Sharing Dashboards
- Hands-on Practice: Building a Complete Dashboard

Learning Experience

This course will integrate lectures, interactive sessions, and hands-on projects to deepen understanding of data warehousing concepts and Tableau. Students will engage in practical exercises to design data warehouses, create complex visualizations, and manage Tableau Server environments, ensuring a comprehensive grasp of both theoretical knowledge and real-world application. Through collaborative projects, learners will apply these skills to solve industry-relevant problems, enhancing their ability to transform data into actionable insights.

Instruction Methods:

- **Lectures:** Core concepts of data warehousing and Tableau will be taught using multimedia presentations, case studies, and real-world examples to illustrate the practical applications of these tools.
- **Interactive Sessions:** Students will participate in Q&A sessions, live demonstrations of Tableau features, and group discussions to actively engage with the material and reinforce their understanding.

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support: The course instructor will offer additional guidance, with peer collaboration encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving course outcomes.

Textbooks

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.

Suggested Readings

1. *Data Warehousing: Concepts, Techniques, Products and Applications" by A. M. Sarma.*
2. *Learning Tableau 2020: Create effective data visualizations, build interactive visual analytics, and transform your organization" by Joshua N. Milligan.*
3. *Data Visualization: A Practical Introduction" by Kieran Healy*

Open Educational Resources (OER)

1. Data Warehousing Concepts - Coursera - A course offering a comprehensive introduction to data warehousing concepts.
2. Khan Academy's Data Management - Free tutorials on SQL and data management concepts.
3. Data Warehouse Concepts - Data Warehouse Concepts - Resources and articles on various data warehousing concepts.

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**

II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER III					
SCMA201	**Real Analysis**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Major-V				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	Limit, Continuity and Differentiability				

Course Perspective

In the undergraduate course "Real Analysis," students delve into the rigorous study of the real number system, focusing on its properties such as completeness, the behavior of sequences, and the nature of infinite series. The course starts by exploring foundational concepts like the algebraic and order properties of real numbers, supremum and infimum, and various types of intervals. Students learn about sequences, emphasizing convergence, limit theorems, and Cauchy sequences. The study of infinite series includes convergence tests and concepts of absolute and conditional convergence. The course also focuses on Riemann integration, addressing the integrability of functions, uniform convergence, and improper integrals, providing a comprehensive foundation in real analysis.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Identifying and recalling key definitions, theorems, and properties of real numbers, sequences, series, and integrals.

CO2: Applying various techniques and theorems to solve problems related to sequences, series, and integrals, including applying convergence tests and integration methods to practical mathematical problems.

CO3: Analyzing complex real analysis problems by breaking them down into simpler parts, such as examining the convergence behavior of sequences and series using different criteria.

CO4: Evaluating the validity and effectiveness of different mathematical proofs, methods, and solutions in real analysis.

Course Content

Unit 1: Real Number System: **Contact Hours:** 15

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 1I: Sequences of Real Numbers: **Contact Hours:** 15

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: Infinite Series: **Contact Hours:** 15

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: Riemann Integration: **Contact Hours:** 15

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.

Learning Experience

The Real Analysis course will be conducted through a blend of interactive methods to ensure a participatory learning experience. Instruction will combine lectures, multimedia presentations, online simulation tools, etc. Students will engage in hands-on learning through problem-solving sessions, case studies, and group work, fostering collaborative skills. Assignments will include both individual and group tasks, encouraging peer review and feedback. Classroom activities will be complemented by outside assignments and research projects. The course in charge will provide additional support and feedback during office hours, and students are encouraged to seek help as needed. Opportunities for collaboration and mutual support will be embedded throughout the course, enhancing learning outcomes and promoting a supportive academic community.

Textbooks

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.

Suggested Readings

1. K. A. Ross (2013). Elementary Analysis**:** The Theory of Calculus (2nd edition). Springer.

Open Educational Resources (OER)

1. https://nptel.ac.in/courses/111106142

Evaluation Scheme

Evaluation components	Weightage

Internal marks (Theory) **I. Continuous assessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/attendance/case studies/reflective journals (minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER III					
SCMA203	ORDINARY DIFFERENTIAL EQUATION	**L**	**T**	**P**	**C**
Version 1.0		**4**	**0**	**0**	**4**
Category of Course					
Total Contact Hours	60				
Pre-Requisites/ Co Requisites	Differentiation, Integration				

Course Perspective

The course on Ordinary Differential Equations (ODEs) provides a thorough exploration of methods for analysing and solving differential equations that involve functions and their derivatives. Students will learn key techniques such as separation of variables, integrating factors, and characteristic equations, and apply them to solve first-order and higher-order ODEs. The course emphasizes real-world applications in physics, engineering, and other fields, demonstrating how ODEs model dynamic systems. With a focus on both theoretical foundations and practical problem-solving, this course equips students with essential skills to tackle complex differential equations encountered in various scientific and engineering contexts.

Course Outcomes

Upon completion of the ordinary differential equation course, the learner will be able to:

CO1: Understanding the genesis of ordinary differential equations and their significance in mathematical modeling.

CO2: Applying various techniques to obtain exact solutions of solvable first-order differential equations and linear differential equations of higher order.

CO3: Analyzing the solutions of first-order differential equations that pass through a given point in the plane, and employing power series methods for higher-order linear equations, particularly when traditional methods are insufficient.

CO4: Evaluating the concept of a general solution of linear differential equations of arbitrary order and applying various methods to derive such solutions.

Course Content

UNIT-I First Order Differential Equations: **14 Lectures**

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.

UNIT-II Second Order Linear Differential Equations: 14 Lectures

Statement of existence and uniqueness theorem for linear differential equations, 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 Higher Order Linear Differential Equations: 17 Lectures

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, Method of variation of parameters and method of undetermined coefficients, Inverse operator method.

UNIT-IV Series Solutions of Differential Equations: 15 Lectures

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.

Learning Experience

This course will integrate lectures, interactive sessions, and hands-on projects to deepen understanding of Ordinary Differential Equations (ODEs) and their applications in various fields.

Instruction Methods:

- **Lectures:** Core concepts of ODEs, including first-order and higher-order differential equations, methods of solutions, and applications, will be taught using multimedia presentations and real-world examples.
- **Interactive Sessions:** Q&A sessions, problem-solving exercises, and group discussions will engage students in active learning and reinforce theoretical knowledge.

Technology Use:

- **Online Platforms:** A Learning Management System (LMS) will host course resources, recorded lectures, assignments, and discussion forums, facilitating extended learning and peer interaction.

Assessments:

- **Formative:** Regular quizzes, problem sets, and online discussions will provide continuous feedback and help students track their progress.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material, with a focus on both theoretical understanding and practical application.

Support: The course instructor will offer additional guidance through office hours, and peer collaboration will be encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving the course outcomes.

Textbooks

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.

Suggested Readings

1. B. Rai, D. P. Choudhury & H. I. Freedman (2013). A Course in Ordinary Differential Equations (2nd edition). Narosa.

2. Shepley L. Ross (2007). Differential Equations (3rd edition), Wiley India.

3. George F. Simmons (2017). Differential Equations with Applications and Historical Notes (3rd edition). CRC Press. Taylor & Francis.

Open Educational Resources (OER)

http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/
https://www.saylor.org/courses/mth302/
https://www.khanacademy.org/math/differential-equations
https://openstax.org/books/calculus-volume-2/pages/9-differential-equations

Evaluation Scheme

Evaluation components	**Weightage**
Internal marks (Theory) **I. Continuous assessments (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER III

SCMA251	ORDINARY DIFFERENTIAL EQUATION LAB	L	T	P	C
Version		0	0	4	2
Category of Course	Minor				
Total Contact Hours	30 Hours				
Pre-Requisites/ Co-Requisites	MATLAB SOFTWARE				

Course Perspective

The Ordinary Differential Equations Lab equips students with practical skills to solve and analyze differential equations using computational tools. The course focuses on applying numerical methods to find solutions to first and second-order differential equations, systems of differential equations, and boundary value problems. Students will gain hands-on experience with software such as MATLAB enhancing their understanding of theoretical concepts.

Course Outcomes

Upon completion of the ordinary differential equations lab course, the learner will be able to:

CO1: Observing and evaluating the accuracy of program output by performing hand calculations and plotting graphs for various types of differential equations.

CO2: Imitating techniques to solve second-order differential equations, including the computation of double and triple integrals of functions, by following established methods.

CO3: Practicing the determination and assessment of the area of closed curves and arc lengths, demonstrating proficiency in integration techniques through repetitive application.

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.

Learning Experience
This lab course offers an immersive experience through practical exercises, interactive discussions, and collaborative projects focused on the application of Ordinary Differential Equations (ODEs).

Methods of Instruction:
Lab Experiments:
Students will engage in hands-on lab activities, solving various ODEs using numerical and analytical methods. Each session includes demonstrations, followed by supervised practice to ensure accurate problem-solving and analysis.

Interactive Lab Sessions:
Students will actively participate in discussions, pose questions, and collaborate with peers and instructors to explore different approaches to solving ODE problems.

Use of Technology:
Lab Software and Tools:
Students will utilize computational tools, such as MATLAB, to solve ODEs, visualize solutions, and analyze results. The focus is on using numerical methods for real-world applications.

Online Resources:
An LMS will provide access to lab manuals, instructional videos, and interactive tutorials. Discussion boards will facilitate collaboration and knowledge-sharing outside lab hours.

Textbooks

1. "Differential Equations with Boundary-Value Problems," 9th Edition by Dennis G. Zill and Michael R. Cullen (2018), Vol. 9, ISBN: 9781337569151
2. "Ordinary Differential Equations" by Morris Tenenbaum and Harry Pollard (1985), Vol. 1, ISBN: 9780486649405

3. "Ordinary Differential Equations: An Elementary Textbook for Students of Mathematics, Engineering, and the Sciences," 2nd Edition by Edward L. Ince (1956), Vol. 2, ISBN: 9780486603490

Suggested Readings

1. "Applied Numerical Methods with MATLAB for Engineers and Scientists," 4th Edition by Steven C. Chapra (2017), Vol. 4, ISBN: 9780073397962
2. "Introduction to Ordinary Differential Equations," 4th Edition by Shepley L. Ross (1989), Vol. 4, ISBN: 9780471098812
3. "Schaum's Outline of Differential Equations," 4th Edition by Richard Bronson and Gabriel Costa (2014), Vol. 4, ISBN: 9780071824859

Open Educational Resources (OER)

http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/
http://tutorial.math.lamar.edu/Classes/DE/DE.aspx
http://learn.saylor.org/course/MA221
http://www.khanacademy.org/math/differential-equations
http://www.ck12.org/c/algebra/differential-equations/

Assessment & Evaluation

Evaluation components	**Weightage**
Internal marks (Practical) **I. Conduct of experiment** **II. Lab Record** **III. Lab Participation** **IV. Lab Project**	 **10 Marks** **10 Marks** **10 Marks** **20 Marks**
II. External Marks (Practical): End Term Examination	**50 Marks**

SEMESTER III					
VAC	**Introduction to Statistics using SPSS**	**L**	**T**	**P**	**C**
Version		1	0	2	2
Category of Course	VAC				
Total Contact	30 Hours				

Hours	
Pre-Requisites/ Co-Requisites	NIL

Course Perspective

The "Introduction to Statistics using SPSS" course offers a foundational understanding of statistical analysis through SPSS software, catering to students from diverse disciplines. The curriculum emphasizes both theoretical and practical aspects of data management, descriptive and inferential statistics, and effective communication of statistical findings. Through hands-on experience, students will learn to import, clean, and analyse datasets, generate visualizations, and perform hypothesis testing and regression analysis. By the course's conclusion, students will be equipped with the skills to manage real-world data, interpret statistical results, and present findings through reports and presentations using SPSS.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Observing key features and functions of SPSS by examining its interface and understanding various data types and formats.

CO2: Imitating and applying basic data management techniques, such as data entry, cleaning, and preparation, by replicating demonstrated methods.

CO3: Practicing descriptive and inferential statistical methods (e.g., mean, variance, t-tests) to analyze and visualize data in SPSS effectively.

Course Content:

Unit 1:

Module 1: Introduction to SPSS **5 hours**

- Overview of SPSS
- Navigating the SPSS interface
- Understanding data types and formats

Module 2: Data Management **5 hours**

- Importing and exporting data
- Data entry and coding
- Data cleaning and preparation

Unit 2:

Module 3: Descriptive Statistics **5 hours**

- Measures of central tendency (mean, median, mode)
- Measures of variability (range, variance, standard deviation)
- Data visualization (charts, graphs, histograms)

Module 4: Inferential Statistics **5 hours**

- Probability and distributions
- Hypothesis testing (t-tests, chi-square tests)
- Analysis of variance (ANOVA)
- Correlation and regression analysis

Unit 3:

Module 5: Reporting and Interpretation **5 hours**

- Writing up statistical results
- Creating tables and figures for reports

Module 6: Practical Applications **5 hours**

- Case studies and real-world examples
- Hands-on practice with datasets
- Group projects and presentations

Learning Experience

In the "Introduction to Statistics using SPSS" course, students will engage in a dynamic and participatory learning experience. The course will blend lectures, hands-on practice, and interactive activities to foster understanding. Instruction will incorporate SPSS software to explore data management, descriptive, and inferential statistics. Students will work on real-world case studies, participate in group projects, and create reports and visualizations, applying their skills to practical problems. Technology will be utilized for demonstrations and assignments, enhancing learning outcomes. The course includes regular feedback sessions, with the instructor available for additional support. Collaborative activities and peer reviews will encourage student interaction and mutual assistance.

Instruction Methods:

- **Lectures:** Core SPSS concepts will be taught using multimedia presentations and real-world examples.
- **Interactive Sessions:** Q&A, live coding exercises, and group discussions will actively engage students.

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support: The course instructor will offer additional guidance, with peer collaboration encouraged through group work and review sessions. Continuous feedback will ensure students' progress and improvement in achieving course outcomes.

Textbooks

"Using SPSS for Windows and Macintosh: Analyzing and Understanding Data" by Samuel B. Green and Neil J. Salkind

Open Educational Resources (OER)

1. https://nptel.ac.in/courses/109107190
2. https://www.youtube.com/watch?v=PN-H8GikRQ0&list=PLVI_iGT5ZuRmXlbuwMKi04R6Oe1G3De8G

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER III					
UDT103	**Python for Data Science**	**L**	**T**	**P**	**C**

Version		2	0	4	4
Category of Course	Minor				
Total Contact Hours	64 Hours				
Pre-Requisites/ Co-Requisites	**Nil**				

Course Perspective

"Python for Data Science" is designed to equip students with the foundational skills necessary for data analysis and manipulation using Python, a leading programming language in the data science field. The course contributes to students' academic and professional development by providing them with essential tools and techniques to solve real-world data problems. Students will gain knowledge in Python programming, data manipulation using NumPy and Pandas, and data cleaning and visualization techniques, making them well-prepared for careers in data science, analytics, and related fields. The skills learned in this course are directly applicable to analyzing large datasets, performing complex data operations, and generating meaningful insights, which are crucial in various industries such as finance, healthcare, marketing, and technology.

Course Outcomes

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

CO1: Understanding and remembering Python's built-in data types and methods to solve basic data-related problems.

CO2: Applying efficient data storage and operations using NumPy arrays for numerical data processing.

CO3: Analyzing data using Pandas for advanced data manipulation tasks, identifying trends and patterns in datasets.

CO4: Evaluating data pre-processing techniques and creating visualizations using Pandas to communicate insights effectively.

Course Content

Unit 1: Introduction to Data Science and Python Programming (No. of Hours: 16)

- 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 the console.
2. Perform operations on Python built-in data types: Strings, List, Tuples, Dictionary, Set.
3. Solve problems using decision and looping statements.
4. Handle numerical operations using math and random number functions.
5. Create user-defined functions with different types of function arguments.

Unit 2: Introduction to NumPy (No. of Hours: 16)

- 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 and Random Functions.
2. Manipulate NumPy arrays: Indexing, Slicing, Reshaping, Joining, and Splitting.
3. Perform computations using Universal Functions and Mathematical methods.
4. Import and analyze data from CSV files using NumPy.
5. Manipulate images using NumPy.

Unit 3: Data Manipulation with Pandas (No. of Hours: 16)

- Introduction to Pandas Data Structures: Series, DataFrame
- Essential Functionality: Dropping Entries, Indexing, 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 DataFrames from various inputs.
2. Perform data operations on CSV files using Pandas.
3. Conduct statistical analysis and operations on DataFrames.
4. Handle categorical data using Pandas.
5. Rename columns and restructure data using Pandas.

Unit 4: Data Cleaning, Preparation, and Visualization (No. of Hours: 16)

- 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, Density Plots, Scatter Plots

Practical Component:

1. Handle missing data and perform data transformations using Pandas.
2. Detect and filter outliers in datasets.
3. Execute vectorized string operations in Pandas.
4. Visualize data using various plotting techniques.

Learning Experience

This course will combine lectures, hands-on sessions, and interactive activities to equip students with Python programming skills for data science.

Instruction Methods:

- **Lectures:** Core Python programming concepts and data science principles will be introduced through multimedia presentations and live coding demonstrations.
- **Hands-on Sessions:** Students will work on real-world data sets using Python, applying concepts learned in class through practical exercises.
- **Group Work and Case Studies:** Collaborative projects will reinforce learning, with case studies to address real-world data science challenges.
- **Technology Use:**
- **Python, NumPy, Pandas:** These tools will be used for data analysis, manipulation, and visualization.
- **Jupyter Notebooks:** For executing and documenting Python code.
- **Online Platforms:** LMS for accessing resources, recorded lectures, and submitting assignments.
- **Assessments:**

- **Formative:** Regular quizzes, coding exercises, and assignments will provide continuous feedback on students' progress.
- **Summative:** Project presentations, case study analyses, and a final assessment will evaluate students' understanding and application of Python for data science.

Support: The course instructor will offer continuous guidance and feedback. Peer collaboration will be encouraged through group work and review sessions. Students will have access to online resources and office hours to seek additional help when needed. Regular feedback will ensure that students meet the course outcomes effectively.

Textbooks

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.
4.

Suggested Readings

1. Wesley J. Chun, "Core Python Programming," Prentice Hall, 2006.
2. Mark Lutz, "Learning Python," O'Reilly, 4th Edition, 2009.
3. Joel Grus, "Data Science from Scratch: First Principles with Python," O'Reilly, 2015.

Open Educational Resources (OER)

1. NPTEL Python for Data Science
2. Kaggle's Python for Data Science
3. Awesome Python for Data Science (GitHub)

Evaluation Scheme

Evaluation components	Weighage

Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER-IV

SEMESTER IV					
SCMA202	**Linear Algebra**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Major-VII				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	--				

Course Perspective

In the undergraduate course "Linear Algebra," students explore foundational concepts and applications of vector spaces and linear transformations. The course begins with an introduction to vector spaces, including subspaces, bases, and dimensions. It focuses on linear transformations, covering their properties, matrices, and coordinate changes, and the Rank-Nullity Theorem. Students gets deep understanding of properties such as isomorphisms, canonical forms, and eigenvalues, including the Cayley-Hamilton theorem and diagonalization. The final unit focuses on inner product spaces, emphasizing orthogonality, the Cauchy-Schwarz inequality, and the Gram-Schmidt process. Overall, the course equips students with essential tools for understanding and applying linear algebra in various mathematical and practical contexts.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: **Understanding** the fundamental definitions and properties related to vector spaces, subspaces, bases, dimensions, linear transformations, and inner product spaces, principles of linear transformations, the Rank-Nullity Theorem, matrix representation, and the significance of canonical and Jordan forms.

CO2: Applying methods for solving problems such as computing eigenvalues and eigenvectors, diagonalizing matrices, and performing change of basis transformations

CO3: Analyzing the relationships within vector spaces and linear transformations, change of bases, the matrix representations, canonical form

CO4: Evaluating the correctness and efficiency of various methods used in linear algebra, such as diagonalization and orthogonalization techniques

Course Content

Unit I: **15 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: **15 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, change of basis, Singular and nonsingular transformation, Isomorphism of vector space, Canonical forms, Jordan forms, Triangular forms, Dual space.

Eigen value & Eigen vectors of linear transformation, Characteristic polynomial, Characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding the inverse of a matrix, Mini mal polynomial, Diagonalization, Linear transformations

Unit IV:

14 lecture hours

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

Learning Experience

Course Integration Approach:

This course blends theoretical instruction with practical problem-solving exercises to provide students with a deep understanding of linear algebra concepts. Through a combination of lectures, interactive sessions, and collaborative projects, students will master essential topics such as matrices, vector spaces, and linear transformations. Practical applications will be explored through hands-on exercises, allowing students to apply linear algebra techniques to real-world problems and enhance their analytical skills.

Instruction Methods:

Lectures:

Core concepts of linear algebra, such as matrix operations, eigenvalues, eigenvectors, and vector spaces, will be presented through multimedia presentations. Real-world examples and applications, such as solving systems of equations and transformations, will be used to highlight the importance of linear algebra in various fields.

Interactive Sessions:

Interactive Q&A sessions, problem-solving workshops, and group discussions will provide students with opportunities to engage actively with the material. Live demonstrations of solving linear algebra problems will help reinforce understanding and encourage collaboration among students.

Hands-on Projects:

Students will participate in hands-on exercises, such as matrix manipulations and eigenvalue computations, and work on projects that apply linear algebra to practical problems in areas like computer graphics, machine learning, and optimization. These projects will help students see the relevance of linear algebra in real-world scenarios and develop their problem-solving skills.

Technology Use:

Online Platforms:

A Learning Management System (LMS) will host course materials, including recorded lectures, assignments, and quizzes. Discussion forums will facilitate extended learning, allowing students to interact with peers and instructors, ask questions, and engage in collaborative problem-solving.

Assessments:

Formative Assessments:

Quizzes and Assignments: Regular quizzes and problem sets will assess students' understanding of core concepts and provide continuous feedback to guide their learning.

Online Discussions: Students will participate in online discussions to reflect on course material and collaborate on problem-solving strategies.

Summative Assessments:

Exams: Written exams will assess students' mastery of linear algebra concepts, including matrix operations, vector spaces, and linear transformations.

Project Presentations: Students will present projects that demonstrate their ability to apply linear algebra to practical problems.

Peer Reviews: Peer assessments of projects will encourage critical thinking and allow students to provide and receive feedback on their work.

Support:

- **Instructor Guidance**: The course instructor will offer additional support through office hours and review sessions, providing personalized feedback to help students overcome challenges and master the material.
- **Peer Collaboration**: Group work and peer-review sessions will encourage collaboration and foster a supportive learning environment where students can learn from each other and enhance their understanding of linear algebra concepts.

Textbooks

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.

Suggested Readings

1. S. Lang; *Introduction to Linear Algebra*; Springer.
2. S. Kumaresan; *Linear Algebra- A Geometric* Approach; Prentice Hall of India.

Open Educational Resources (OER)

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

Evaluation Scheme

Evaluation components	Weightage
Internal marks (Theory) **I. Continuous assessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/attendance/case studies/reflective journals (minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER IV					
SCMA204	**Complex Analysis**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Major-VIII				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	--				

Course Perspective

The undergraduate course "Complex Analysis" provides an in-depth exploration of complex numbers and functions, focusing on their properties and applications. The course begins with an introduction to the complex plane, including the representation of complex numbers, complex functions, and linear fractional transformations. It then covers analytic functions, emphasizing the Cauchy-Riemann equations, differentiability, and the behavior of functions like exponentials and logarithms. Key theorems such as Cauchy's Theorem and the Fundamental Theorem of Algebra are studied, along with their applications in complex integration. The course also explores power series, singularities, and contour integration, equipping students with the tools to analyze and solve complex-valued problems.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Understanding and explaining the principles behind analytic functions and the Cauchy-Riemann equations, as well as the significance of concepts like branch cuts, residues, and singularities.

CO2: Using methods of complex integration and series expansion to solve problems involving complex functions, including Cauchy's Residue Theorem and determining the radius of convergence for power series.

CO3: Analyzing complex functions and their properties by applying theorems such as the Maximum Modulus Theorem and Picard's Theorem to identify singularities, poles, and zeros, assessing their impact on function behavior.

CO4: Evaluating the effectiveness and accuracy of different techniques, including contour integration and series expansion.

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: **12 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.

Learning Experience

This course focuses on developing a deep understanding of complex analysis through theoretical instruction and interactive learning. The content will cover fundamental concepts such as complex functions, analyticity, contour integration, and series expansions. Students will engage with the material through lectures, interactive discussions, and conceptual exercises to ensure a thorough grasp of both the foundational theories and their applications in various fields of mathematics and science.

Instruction Methods:

Lectures:

Core concepts of complex analysis will be presented through detailed lectures, using multimedia presentations and mathematical proofs. Topics will include complex numbers, analytic functions, Cauchy's theorems, residue calculus, and more. Emphasis will be placed on the theoretical foundations, supported by examples from physics and engineering.

Interactive Sessions:

Interactive sessions will involve group discussions, problem-solving activities, and Q&A sessions. These will allow students to engage actively with the content, clarify doubts, and deepen their understanding through collaborative exploration of key ideas. Conceptual exercises will be used to reinforce learning.

Theoretical Exercises:

Students will be tasked with solving theoretical problems and engaging in discussions on the proofs and implications of major theorems in complex analysis. This will help them build the analytical skills necessary for tackling more advanced topics in mathematics.

Technology Use:

Online Platforms:

An LMS will be utilized to host lecture notes, recorded sessions, and assignment submissions. Online discussion forums will be available for students to discuss theoretical problems and collaborate on understanding complex concepts outside of class.

Assessments:

Formative Assessments:

- **Quizzes and Assignments**: Regular quizzes and assignments will be provided to assess students' understanding of the theoretical concepts. These will focus on the application of theorems, problem-solving, and proof-writing.
- **Discussion Participation**: Active participation in discussions, both in-class and online, will be encouraged to facilitate continuous engagement with the material.

Summative Assessments:

- **Exams**: Written exams will test students on their comprehension of complex analysis concepts, focusing on problem-solving, proofs, and theoretical applications.
- **Essay Assignments**: Students may be required to write essays on specific topics within complex analysis, demonstrating a deeper understanding of advanced concepts and their broader implications.

Support:

- **Instructor Guidance**: The instructor will provide additional support through office hours, where students can seek help with difficult concepts and receive personalized feedback on their progress. Regular review sessions will also be conducted to reinforce key topics before exams.
- **Peer Collaboration**: Group discussions and peer-review sessions will be integral to the course, encouraging students to collaborate and refine their understanding through shared insights and collective problem-solving.

Textbooks

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

Suggested Readings

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)

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

Evaluation Scheme

Evaluation components	Weightage
Internal marks (Theory) **I. Continuous assessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/attendance/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER IV					
SCMA206	**PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS**	**L**	**T**	**P**	**C**

	OF VARIATIONS				
Version 1.0		**4**	**0**	**0**	**4**
Category of Course					
Total Contact Hours	60				
Pre-Requisites/ Co Requisites	-				

Course Perspective

This course covers key techniques in Partial Differential Equations (PDEs) and Calculus of Variations, essential for solving complex problems in science and engineering. Students will learn to classify and solve PDEs using methods like Fourier series and Green's functions, with applications such as the heat and wave equations. The course also introduces the Calculus of Variations, focusing on optimizing functionals and solving related problems like geodesics and minimal surfaces. Designed for advanced students and professionals, it requires a solid background in Calculus, Linear Algebra, and Ordinary Differential Equations.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Identifying and understanding physical situations whose behavior can be described by ordinary differential equations.

CO2: Applying competence in solving applied problems in both linear and nonlinear forms.

CO3: Analyzing problems to choose the most suitable method for finding solutions.

CO4: Evaluating the solutions of differential equations with initial and boundary conditions.

Course Content

Unit No I: First Order Partial Differential Equations **No. of Hours 15**

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 No II: Second Order Partial Differential Equations No. of Hours 15

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 No III: Classification of Partial Differential Equations No. of Hours 15

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 No IV: Calculus of Variations No. of Hours 15

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.

Learning Experience

This course will combine lectures, interactive discussions, and practical projects to enhance students' understanding of Partial Differential Equations (PDEs) and the Calculus of Variations, focusing on both theoretical insights and practical applications.

Instruction Methods:

- **Lectures:** Key topics in PDEs, such as equation classification, solution techniques, and real-world applications, along with fundamental concepts of the Calculus of Variations, will be delivered through multimedia presentations and contextual examples.
- **Interactive Sessions:** Students will engage in Q&A sessions, collaborative problem-solving activities, and group discussions to deepen their comprehension and apply what they've learned to complex problems.

Technology Use:

- **Online Platforms:** Course materials, recorded lectures, assignments, and discussion boards will be available on a Learning Management System (LMS), fostering extended learning opportunities and student interaction.

Assessments:

- **Formative:** Students will receive ongoing feedback through regular quizzes, assignments, and participation in online discussions, ensuring they can monitor their progress and understanding.
- **Summative:** Comprehensive exams, project-based presentations, and peer evaluations will be used to assess students' proficiency in both Partial Differential Equations and the Calculus of Variations, emphasizing their ability to apply concepts in practical scenarios.

Support: The course instructor will provide additional support during office hours, and students will be encouraged to collaborate through group projects and study sessions. Continuous feedback will help students achieve their learning objectives and improve their understanding of the course material.

Textbooks

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.

Suggested Readings

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

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

3. S. B. Rao & H. R. Anuradha (1996). Differential Equations with Applications. University Press.

4. Ian N. Sneddon (2006). Elements of Partial Differential Equations. Dover Publications.

Open Educational Resources (OER)

https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/
https://ocw.mit.edu/courses/mathematics/18-100c-real-analysis-fall-2003/
https://openstax.org/books/calculus-volume-2/pages/1-introduction
https://www.saylor.org/courses/mth302/
https://www.khanacademy.org/math/differential-equations

Evaluation Scheme (Please refer to Notice Ref No: KRMU/CoE/Even/2023-24/018 dated 10 May 2025)

Evaluation components	Weightage
Internal marks (Theory) **I. Continuous assessments (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

SEMESTER IV					
SCMA254	PARTIAL DIFFERENTIAL EQUATIONS AND CALCULUS OF VARIATIONS LAB	**L**	**T**	**P**	**C**
Version		0	0	4	2
Category of Course	Minor				
Total Contact Hours	30Hours				
Pre-Requisites/ Co-Requisites	MATLAB SOFTWARE				

Course Perspective

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

Upon completion of the partial differential equations and calculus of variations lab course, the learner will be able to:

CO1: Observing and documenting the output of numerical experiments, including using hand calculations and debugging techniques to ensure accuracy.

CO2: Replicating established numerical methods for approximating derivatives and integrals, analyzing their accuracy and how it varies with grid resolution.

CO3: Applying and practicing the accuracy of matrix-based numerical solutions for linear systems of equations, demonstrating practical skills in using these methods.

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.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

Learning Experience

This lab course will be conducted through hands-on experiments, interactive sessions, and collaborative group work, focusing on the practical application of Partial Differential Equations (PDEs) and the Calculus of Variations.

Methods of Instruction:

- **Lab Experiments :**
  Students will participate in extensive hands-on lab work, solving various PDEs and optimization problems using numerical and analytical methods. Each session will include detailed demonstrations of techniques, followed by supervised practice to ensure accuracy in solving and analyzing complex problems.
- **Interactive Lab Sessions:**
  During lab work, students will have opportunities to ask questions, engage in problem-solving discussions with the instructor and peers, and explore different approaches to solving PDEs and variational problems.

Use of Technology:

- **Lab Software and Tools:**
  Students will use computational tools and software for solving PDEs and variational problems, including MATLAB or equivalent platforms. This will involve using numerical methods, visualizing solutions, and analyzing data.
- **Online Resources:**
  An LMS will be used to provide access to lab manuals, instructional videos, and interactive tutorials. Discussion boards will be available for students to collaborate, seek help, and share insights outside of lab hours.

Textbooks

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. 88 Modes of Eva

Suggested Readings

1. "Introduction to Partial Differential Equations" by David B. Wilson, University of Toronto Press, 2016.
2. "Calculus of Variations" by I. M. Gelfand and S. V. Fomin, Dover Publications, 2000.
3. "Applied Partial Differential Equations" by Richard Haberman, 5th Edition, Pearson, 2012.
4. "Introduction to the Calculus of Variations" by Charles Fox, Dover Publications, 1966.

Open Educational Resources (OER)

https://www.math.washington.edu/~strauss/
http://www.math.csi.cuny.edu/Calculus/ODEs/PDEs/IntroductionPDEs.pdf
https://www.math.ualberta.ca/~kunkel/teaching/calculus-of-variations/
https://archive.org/details/introductiocalcu00foxr

Assessment & Evaluation

Evaluation components	**Weightage**
Internal marks (Practical)	
I. Conduct of experiment	**10 Marks**
II. Lab Record	**10 Marks**
III. Lab Participation	**10 Marks**
IV. Lab Project	**20 Marks**

II. External Marks (Practical): End Term Examination	**50 Marks**

SEMESTER IV					
UDT104	**Data Pre-processing and Visualization using Python**	**L**	**T**	**P**	**C**
Version		2	0	4	4
Category of Course	Minor				
Total Contact Hours	64 Hours				
Pre-Requisites/ Co-Requisites	**Basics of Python Programming**				

Course Perspective

This course is integral to the data science curriculum as it provides students with the foundational skills necessary for effective data analysis and visualization. Mastery of data preprocessing ensures that students can clean and prepare datasets, which is crucial for generating accurate and reliable insights in any data-driven field. Visualization techniques taught in this course empower students to communicate their findings effectively, making complex data understandable to a wide audience. The course emphasizes real-world applicability, allowing students to work with diverse datasets and leverage popular Python libraries to create visualizations that are both informative and aesthetically pleasing. The skills and knowledge gained from this course are essential for careers in data analysis, business intelligence, and any profession requiring data-driven decision-making.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Explaining the significance of data pre-processing in the data analysis pipeline and its role in enhancing the quality of data for machine learning models.

CO2: Identifying and applying appropriate techniques for handling missing data, duplicates, and outliers to ensure data integrity.

CO3: Implementing data transformation processes such as normalization, scaling, and encoding to prepare datasets for analysis.

CO4: Analyzing datasets using exploratory data analysis (EDA) techniques and creating visualizations to uncover patterns, correlations, and trends.

Course Content

Unit 1: Introduction to Data Preprocessing **No. of Hours- 16**

- Understanding the importance of data preprocessing
- Steps involved in data preprocessing
- Handling missing data and outliers

Unit 2: Data Cleaning and Transformation **No. of Hours : 16**

- Removing duplicates and dealing with data inconsistencies
- Data normalization, scaling, and encoding techniques
- Handling categorical variables

Unit 3: Exploratory Data Analysis (EDA) **No. of Hours : 16**

- Data summarization and descriptive statistics
- Data visualization techniques: histograms, box plots, scatter plots
- Correlation analysis, heatmaps, and pair plots

Unit 4: Data Visualization Libraries and Applications **No. of Hours : 16**

- Introduction to Python libraries: Matplotlib, Seaborn, Plotly
- Creating and customizing plots
- Interactive visualizations and real-world data applications through Project.

Learning Experience

This course will blend lectures, practical sessions, and interactive activities to develop skills in data preprocessing and visualization using Python.

Instruction Methods:

- **Lectures:** Key concepts of data preprocessing and visualization will be taught through multimedia presentations and theoretical explanations.
- **Hands-on Sessions:** Practical exercises using Python libraries will allow students to apply data cleaning, transformation, and visualization techniques.
- **Group Work and Projects:** Collaborative projects and case studies will provide real-world data analysis experience and encourage teamwork.
- **Technology Use:**
- **Python Libraries:** NumPy, Pandas, Matplotlib, Seaborn, Plotly for data manipulation and visualization.
- **Jupyter Notebooks:** For coding exercises and project documentation.
- **Online Platforms:** LMS for accessing course materials, recorded lectures, and submitting assignments.
- **Assessments:**
- **Formative:** Regular quizzes, coding exercises, and practical assignments for ongoing feedback.

- **Summative:** Project presentations, case study analyses, and a final assessment to evaluate mastery of data preprocessing and visualization techniques.

Support: The course instructor will provide continuous feedback and be available during office hours. Peer collaboration and group activities will be encouraged to enhance learning. Students will have access to online resources and additional help as needed to achieve course outcomes effectively.

Textbooks

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

Suggested Readings

1. **Python Data Science Handbook** by Jake VanderPlas.
2. **Effective Data Visualization** by Stephanie D. H. Evergreen.
3. **Practical Statistics for Data Scientists** by Peter Bruce and Andrew Bruce.

Open Educational Resources (OER)

1. Data Visualization - Netquest eBook
2. Coursera: Data Visualization
3. Coursera: Python for Data Visualization

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous assessment (30 marks)** Include assignments, lab work, quizzes, and a final project, focusing on the practical application of data preprocessing and visualization techniques.	**30 Marks**

II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER IV					
SEC075	Basic IT Tools	**L**	**T**	**P**	**C**
Version 1.0		**1**	**0**	**4**	**3**
Category of Course	SEC				
Total Contact Hours	45				
Pre-Requisites/ Co Requisites	-				

Course Perspective

The "Basic IT Tools" course equips students with essential skills in information technology, focusing on fundamental concepts and practical applications. It covers the basics of computer hardware, software, operating systems, and internet usage, emphasizing the importance of digital literacy in today's world. Students learn to navigate common productivity software like word processors, spreadsheets, and presentation tools, enabling them to efficiently manage and present information. Additionally, the course introduces basic networking concepts and cybersecurity awareness, preparing students to safely and effectively use IT resources in both academic and professional settings.

Course Outcomes

Upon completion of the ordinary differential equation course, the learner will be able to:

CO1: Remembering and understanding of spreadsheet functions and formulas to manage and analyze data in worksheets and workbooks.

CO3: Applying data evaluation techniques using spreadsheets to make informed decisions and draw conclusions.

CO4: Analyzing data to create meaningful representations through charts and pivot tables for enhanced data analysis.

Course Content

Unit 1: Introduction to Spreadsheets **Lecture: 15 hours**

Spreadsheets: Concept of worksheets and workbooks, creating, opening, closing and saving workbooks, moving, copying, inserting, deleting and renaming worksheets, working with multiple worksheets and multiple workbooks, controlling worksheet views, naming cells using name box, name create and name define; Exchanging data using clipboard, object linking and embedding; Printing and Protecting worksheets: Adjusting margins, creating headers and footers, setting page breaks, changing orientation, creating portable documents and printing data and formulae; Implementing file level security and protecting data within the worksheet; Understanding absolute, relative and mixed referencing in formulas, referencing cells in other worksheets and workbooks, correcting common formula errors, working with inbuilt function categories like mathematical, statistical, text, lookup, information, logical, database, date and time and basic financial functions.

Unit 2: Data Analysis in Spreadsheets **Lecture: 15 hours**

Consolidating worksheets and workbooks using formulae and data consolidate command; Choosing a chart type, understanding data points and data series, editing and formatting chart elements, and creating sparkline graphics, Analysing data using pivot tables: Creating, formatting and modifying a pivot table, sorting, filtering and grouping items, creating calculated field and calculated item, creating pivot table charts, producing a report with pivot tables. Introduction to recording and execution of macros.

Unit 3: Word Processing **Lecture: 15 hours**

Introduction: Creating and saving your document, displaying different views, working with styles and character formatting, working with paragraph formatting techniques using indents, tabs, alignment, spacing, bullets and numbering and creating borders; Page setup and sections: Setting page margins, orientation, headers and footers, end notes and foot notes, creating section breaks and page borders; Working with tables: Creating tables, modifying table layout and design, sorting, inserting graphics in a table, table math, converting text to table and vice versa; Create newspaper columns, indexes and table of contents, Spell check your document using inbuilt and custom dictionaries, checking grammar and style , using thesaurus and finding and replacing text; Create bookmarks, captions and cross referencing, adding hyperlinks, adding sources and compiling and bibliography; Mail merge: Creating and editing your main document and data source, sorting and filtering merged documents and using merge instructions like ask, fill-in and if-then-else; Linking and embedding to keep things together.

his course will integrate lectures, interactive sessions, and hands-on projects to build a foundational understanding of essential IT tools and their applications.

Instruction Methods:

Lectures: Core concepts of IT, including computer basics, software applications, and internet usage, will be taught using multimedia presentations and real-life scenarios.

- **Interactive Sessions:** Q&A sessions, live demonstrations, and group discussions will encourage active learning and reinforce practical skills.

Technology Use:

Online Platforms: A Learning Management System (LMS) will host course materials, recorded lectures, assignments, and discussion forums, promoting extended learning and collaboration.

Assessments:

- **Formative:** Regular quizzes, practical assignments, and online discussions will provide ongoing feedback and help students monitor their progress.

Summative: Exams, project submissions, and peer reviews will evaluate students' understanding and practical application of IT tools.

Support: The instructor will provide additional help through office hours, and peer collaboration will be fostered through group projects and review sessions, ensuring continuous feedback and improvement in achieving course objectives.

Textbooks

1. Swinford, E., Dodge, M., Couch, A., Melton, B. A. (2013). Microsoft Office Professional 2013. United States: O'Reilly Media.
2. Wang, W. (2018). Office 2019 For Dummies. United States: Wiley. Microsoft Lambert, J. (2019). Microsoft Word 2019 Step by Step. United States: Pearson Education.
3. Jelen, B. (2013). Excel 2013 Charts and Graphs. United Kingdom: Que.

Suggested Readings

1. Alexander, M., Jelen, B. (2013). Excel 2013 Pivot Table Data Crunching. United Kingdom: Pearson Education.
2. Alexander, M., Kusleika, R. (2018). Access 2019 Bible. United Kingdom: Wiley

Open Educational Resources (OER)

http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-00sc-introduction-to-computer-science-and-programming-spring-2011

http://learn.saylor.org/course/cs101

http://openstax.org/books/introduction-to-computer-applications-for-business

Evaluation Scheme

Evaluation components	Weightage
Internal marks (Theory) **I. Continuous assessments (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

SEMESTER-V

SEMESTER V					
SCMA301	**Numerical Methods**	**L**	**T**	**P**	**C**
Version		**4**	**0**	**0**	**4**
Category of Course	Core				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co -Requisites	Basic Mathematics				

Course Perspective

This course provides a comprehensive introduction to numerical methods, equipping students with essential tools for solving a wide range of mathematical problems encountered in science and engineering. It covers techniques for finding roots of algebraic and transcendental equations, such as the bisection and Newton's methods, along with strategies for solving linear systems using LU decomposition and iterative methods like Gauss-Seidel. Interpolation methods, including Lagrange and cubic spline, are explored for estimating values between data points. The course also delves into numerical differentiation and integration, discussing rules like the trapezoidal and Simpson's rules, alongside advanced extrapolation techniques. Finally, it addresses solving differential equations through methods like Euler's and Runge-Kutta, with applications extending to real-world problems such as weather forecasting and search engine algorithms.

Course Outcomes

This course will enable the students to:

CO1: Understanding numerical methods to solve algebraic and transcendental equations.

CO2: Applying numerical methods to solve systems of linear equations effectively.

CO3: Analyzing interpolating and extrapolating methods for various data sets.

CO4: Evaluating and applying numerical methods to solve initial and boundary value problems in differential equations.

Course Content

Unit I 15 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 15 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, Gauss-Jacobi, Gauss-Seidel and successive over-relaxation (SOR) methods.

Unit III 15 lecture hours

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

Unit IV 15 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. Initial and Boundary Value Problems of Differential Equations Euler's method, Runge-Kutta methods, Milne's Method, Finite difference method. Real life examples: Google search engine, 1D and 2D simulations, Weather forecasting.

Learning Experience

Students will engage in both theoretical understanding and practical application of numerical methods, working on real-world problems and case studies. The course will emphasize hands-on computational work and critical thinking to apply the correct numerical techniques in diverse scenarios.

Instruction Methods

The course will use a blend of lectures, hands-on lab sessions, and group discussions. Interactive problem-solving sessions and demonstrations will be incorporated to facilitate better understanding. Students will also be encouraged to work on projects and collaborate in teams.

Technology Use

Students will utilize computational tools and software such as MATLAB software to implement algorithms, perform calculations, and visualize results. These tools will help bridge the gap between theory and practical application.

Assessments

Assessments will include a combination of assignments, quizzes, lab exercises, and project work. Mid-term and final exams will evaluate both theoretical knowledge and practical application skills. Projects will focus on real-life problem-solving using numerical methods.

Support

Students will have access to office hours for one-on-one help from instructors, tutoring sessions, and online forums for peer-to-peer assistance. Additional resources such as lecture notes, sample codes, and tutorial videos will be provided to aid learning.

Textbooks

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. 5.Robert J. Schilling & Sandra L. Harris (1999). Applied Numerical Methods for Engineers Using MATLAB and C. Thomson-Brooks/Cole.

Suggested Readings

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

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER V					
SCMA351	**NUMERICAL METHODS LAB**	**L**	**T**	**P**	**C**
Version		0	0	4	2
Category of Course	Core				
Total Contact Hours	30 Hours				
Pre-Requisites/	**Nil**				

Co-Requisites	

Course Perspective

In this lab course, students engage with fundamental numerical methods and algorithms essential for solving a variety of computational problems. The practicals cover a range of topics from basic operations and sorting algorithms to advanced numerical techniques such as root-finding methods (Bisection, Newton-Raphson, Secant, Regula-Falsi), matrix decomposition (LU), iterative methods (Gauss-Jacobi, SOR/Gauss-Seidel), and interpolation techniques (Lagrange, Newton). Additionally, students explore numerical integration (Simpson's Rule) and the solution of ordinary differential equations (ODEs). This hands-on experience equips students with the skills to implement and understand key computational methods, enhancing their problem-solving abilities and preparing them for real-world applications in science, engineering, and data analysis.

Course Outcomes

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

CO1: Observing and understanding the principles behind summation of series, absolute value computation, and basic array operations, including sorting algorithms.

CO2: Imitating and applying iterative methods such as the Bisection Method, Newton-Raphson Method, Secant Method, and Regula-Falsi Method for solving nonlinear equations.

CO3: Practicing matrix factorization and system solving techniques through LU Decomposition, as well as iterative solution methods including Gauss-Jacobi and SOR/Gauss-Seidel Methods.

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**

Learning Experience

Engage in hands-on practical exercises to apply fundamental numerical methods and algorithms. Develop problem-solving skills through implementing and analyzing various computational techniques.

Instruction Methods:

Utilize a combination of lectures, demonstrations, and interactive labs to explain concepts and methods. Encourage active participation through guided problem-solving and real-world examples.

Technology Use:

Employ computational software and programming tools to perform numerical calculations, simulations, and data analysis. Tools may include MATLAB, Python, or other relevant software.

Assessments:

Evaluate understanding through practical assignments, coding exercises, and lab reports. Assess comprehension of methods and their applications through quizzes, practical tests, and project work.

Support: Provide additional resources such as tutorials, online forums, and office hours for personalized guidance. Offer supplementary materials and peer support to reinforce learning and address challenges.

Textbooks

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.

Suggested Readings

1. M. K. Jain, S. R. K. Iyengar & R. K. Jain (2012). *Numerical Methods for Scientific and Engineering Computation* (6^{th} edition). New Age International Publishers

2. Robert J. Schilling & Sandra L. Harris (1999). *Applied Numerical Methods for Engineers Using* MATLAB *and C*. Thomson-Brooks/Cole.

Open Educational Resources (OER)

https://www.coursera.org/learn/numerical-methods-engineers
https://www.wolframalpha.com/

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Practicals) **I. Conduct of experiment** **II . Lab Record** **III. Lab Participation** **IV. Lab Project**	 **10 Marks** **10 Marks** **10 Marks** **20 Marks**
II. External Marks (practicals): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER V					
SCMA303	**Metric Spaces**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Major				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	--				

Course Perspective

The undergraduate course "Metric Spaces" explores the foundational concepts of set theory and metric space topology. It begins with the theory of sets, cardinality, countability, and key theorems such as Cantor's and Schröder-Bernstein. The course then introduces metric spaces, focusing on concepts like open and closed spheres, neighborhoods, and bounded sets. Students will study complete metric spaces and continuous functions, including Cauchy sequences, the Banach contraction principle, and the concepts of uniform continuity and homeomorphism. The course also explores compactness and connectedness, examining compact spaces, sequential compactness, and connected subsets, alongside related theorems and properties.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Explaining the key properties and principles of metric spaces, including Cauchy sequences, Cantor's intersection theorem, and the relationship between compactness and sequential compactness.

CO2: Utilizing the concepts of metric spaces to solve problems involving distance, convergence, continuity, the Heine-Borel theorem, and the Banach contraction principle.

CO3: Analyzing the properties of metric spaces by evaluating different types of sets, including dense sets, nowhere dense sets, and totally bounded sets.

CO4: Critically evaluating and comparing various metrics and topological properties to determine their implications for continuity, compactness, and connectedness.

Course Content

Unit I: **lecture hours 15**

Theory of Sets: Finite and infinite sets, Countable and uncountable sets, Cardinality of sets, Schröder 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 15**

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.

Learning Experience

The Metric Spaces course will be conducted through a mix of interactive lectures, multimedia presentations, and activities. Students will engage in case studies, problem-solving sessions, and group projects to apply theoretical principles in practical contexts. Assignments will include both individual tasks and collaborative group work, with opportunities for peer review and mutual support. Outside the classroom, students will work on research projects and practice problems. The course in charge will provide additional support during office hours, and students are encouraged to seek help and collaborate to enhance their understanding and performance.

Textbooks

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.

Suggested Readings

1. Satish Shirali & Harikishan L. Vasudeva (2006). Metric Spaces. Springer-Verlag.
2. 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

Evaluation Scheme

Evaluation components	**Weightage**
Internal marks (Theory) **I. Continuous assessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/attendance/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER V

SCMA305	**ADVANCED ALGEBRA**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Minor				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

This course provides a comprehensive introduction to key concepts in abstract algebra, focusing on group theory, ring theory, and field theory. Students will explore the structure and properties of groups through group actions, class equations, and Sylow's theorems, gaining insight into symmetry and classification of finite groups. The course also covers fundamental aspects of rings and fields, including ring homomorphisms, ideals, polynomial rings, and their properties, alongside key theorems like Gauss' lemma and Eisenstein's criterion. Additionally, it introduces field extensions and the structure of finite fields, which are essential for understanding algebraic equations and applications in areas such as cryptography and coding theory. Overall, this course lays the groundwork for more advanced studies in algebra and its applications.

Course Outcomes

Upon completion of the course, the learner will be able to:
CO1: Recalling the fundamental definitions of group actions, orbits, stabilizers, and automorphisms in abstract algebra.

CO2: Applying polynomial properties and Euclidean division to factor polynomials over various fields, including rational fields and finite fields.

CO3: Analyzing the decomposition of a group into its conjugacy classes and using the class equation to extract information about its structure.

CO4: Evaluating the significance of the orbit-stabilizer theorem in understanding the sizes of orbits and stabilizers in group actions.

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: **15 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: **15 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.

Learning Experience

Students will engage in a rigorous study of abstract algebra, gaining a deep understanding of algebraic structures such as groups, rings, and fields. Through this course, they will develop critical thinking and problem-solving skills as they explore theoretical concepts and their applications. The course is designed to challenge students and enhance their ability to reason abstractly and mathematically.

Instruction Methods:

Instruction will primarily consist of lectures that introduce key concepts, supported by interactive discussions to clarify complex topics. Problem-solving sessions and tutorials will be integral, providing hands-on experience with algebraic problems and theorems. Collaborative group work may be used to encourage peer learning and to explore different perspectives on the material.

Technology Use:

Technology will play a role in enhancing the learning experience, with the use of mathematical software tools (such as Mathematica or MATLAB) to visualize algebraic structures and solve complex problems. Online resources, including lecture notes, problem sets, and supplementary materials, will be accessible through a learning management system (LMS). Virtual whiteboards and presentation tools may also be used for interactive teaching.

Assessments:

Assessment will be a mix of formative and summative approaches, including regular homework assignments, quizzes, and problem sets to reinforce learning and provide continuous feedback. Mid-term and final exams will evaluate students' understanding of key concepts and their ability to apply algebraic principles to solve problems. Participation in discussions and problem-solving sessions may also contribute to the overall grade.

Support: Students will have access to a variety of support resources, including office hours with the instructor for one-on-one guidance and clarification of concepts. Teaching assistants may offer additional tutoring sessions. Online forums and study groups will be encouraged for peer support. Access to library resources and academic counseling will also be available to support students throughout the course.

Textbooks

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.

Suggested 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

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER V					
SCMA307	**LINEAR PROGRAMMING**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Minor				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

This course offers a comprehensive introduction to linear programming, focusing on optimization techniques and mathematical problem-solving methods. Beginning with foundational concepts such as convexity, basic feasible solutions, and graphical methods, the course moves into more advanced topics, including the Simplex Method, with a focus on optimality criteria and handling cases of unboundedness and multiple solutions. The curriculum then explores duality in linear programming, delving into dual problems, duality theorems, and the Dual-simplex method. Finally, practical applications are examined, including the Transportation and Assignment Problems, utilizing methods like the Northwest-corner rule, Vogel approximation, and the Hungarian method. The course concludes with an introduction to Game Theory, emphasizing the solution of two-person zero-sum games using linear programming techniques.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Understanding the origin and development of operations research and linear programming.

CO2: Analyzing real-life systems with constraints, identifying and formulating the underlying problems.

CO3: Applying the theory of the simplex method and its various cases to solve optimization problems.

CO4: Evaluating solutions through the duality of the simplex method and the two-phase method.

Course Content

UNIT – I **14 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 **14 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 **14 lecture hours**

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

Unit IV: **16 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.

Learning Experience

Students will engage in problem-solving exercises that emphasize real-world applications of linear programming and optimization techniques. The course will foster analytical thinking and provide opportunities to apply mathematical concepts to practical scenarios.

Instruction Methods:

The course will be delivered through a combination of lectures, where theoretical concepts will be explained, and hands-on problem-solving sessions to reinforce learning. Interactive discussions and group activities will be encouraged to facilitate a deeper understanding of the material.

Technology Use:

Software tools such as MATLAB, Excel Solver, or other optimization software will be utilized to solve linear programming problems, simulate scenarios, and visualize solutions. Online resources and interactive platforms will also be used for supplementary learning.

Assessments:

Students will be evaluated through a mix of assignments, quizzes, and exams. Practical assignments will involve solving optimization problems using both manual methods and software tools. A final project or exam will assess students' overall understanding and application of course concepts.

Support:

Students will have access to additional resources such as office hours, tutoring sessions, and online forums for discussion. Instructors will provide guidance and feedback throughout the course to help students master the material.

Textbooks

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

Suggested Readings

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

Open Educational Resources (OER)

Linear Programming Lecture Notes

Open Textbook Library

MIT Open CourseWare - Applied Linear Programming

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER V					
UDT105	**Time series analysis and forecasting using Python**	**L**	**T**	**P**	**C**
Version		2	0	4	4
Category of Course	Minor				

Total Contact Hours	60 Hours
Pre-Requisites/ Co-Requisites	**Nil**

Course Perspective

This course is designed to equip students with essential skills in Time Series Analysis and Forecasting, crucial for making accurate predictions based on temporal data. Students will learn to analyze time series data, apply various forecasting models, and evaluate their performance to support decision-making across diverse fields. The course covers foundational concepts, including autocorrelation, statistical inference in regression models, and advanced techniques such as ARIMA and seasonal ARIMA models. By integrating theoretical knowledge with practical application, students will be able to address real-world forecasting challenges, enhancing their analytical capabilities and making informed contributions in areas such as finance, economics, and business strategy.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Understanding the fundamental concepts of time series data, including key patterns, trends, and seasonality, as well as various statistical methods used for time series analysis.

CO2: Applying forecasting models such as regression models and ARIMA to predict future values based on historical time series data in practical scenarios.

CO3: Analyzing and interpreting time series data through graphical displays, numerical descriptions, and techniques such as smoothing, transformations, and adjustments for enhanced analysis.

CO4: Evaluating the accuracy and performance of different forecasting models using statistical techniques, ensuring reliable predictions and continuous model monitoring.

Course Content

Unit 1: Introduction of Time series Analysis Statistical Methods: No. of Hours: 15

- 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: No. of Hours: 15

- 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: No. of Hours: 15

- 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: No. of Hours: 15

- Autoregressive Moving Average (ARIMA) Models
- Stationarity and Invertibility of ARIMA 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 Data Model Selection Criteria
- Impulse Response Function to Study the Differences in Models Comparing Impulse Response Functions for Competing Models

List of Practicals

- **Time Series Data Cleaning:** Apply techniques to clean time series data, including handling missing values and outliers.
- **Loading and Handling Time Series Data:** Import time series data from various sources and manage it using appropriate tools.
- **Preprocessing Techniques:** Implement preprocessing techniques such as normalization and transformation to prepare time series data for analysis.
- **How to Check Stationarity:** Use statistical tests (e.g., ADF test) to determine if a time series is stationary.
- **Making a Time Series Stationary:** Apply techniques such as differencing and transformation to achieve stationarity.

- **Estimating & Eliminating Trend:** Use aggregation, smoothing, and polynomial fitting to estimate and remove trends.
- **Eliminating Seasonality:** Apply decomposition methods to separate and remove seasonal effects from the time series.
- **Moving Average Time Analysis:** Apply moving average techniques to smooth time series data and identify patterns.
- **Smoothing Time Series Data:** Use various smoothing methods (e.g., simple, weighted) to reduce noise and highlight trends.
- **Checking Linear and Non-Linear Trends:** Analyze time series data to identify and model both linear and non-linear trends.
- **Creating a Time Series Model:** Develop a time series model based on observed patterns and trends.
- **Moving Average Model:** Implement and evaluate a moving average model to forecast time series data.
- **Exponential Smoothing:** Apply exponential smoothing methods to forecast time series data and assess model performance.
- **ARIMA Model:** Develop and validate an ARIMA model for time series forecasting.
- **Seasonal ARIMA Model (ARIMA):** Create and test a SARIMA model to account for seasonality in time series data.

Learning Experience

This course will blend lectures, interactive sessions, and hands-on projects to deepen understanding and application of time series analysis and forecasting techniques.
Instruction Methods:

- **Lectures:** Core time series analysis and forecasting concepts will be taught using multimedia presentations and real-world case studies.
- **Interactive Sessions:** Q&A, practical exercises, and group discussions will actively engage students in applying time series models and forecasting techniques.
- **Technology Use:**
- **Python:** Primary tool for statistical analysis and data visualization.
- **Online Platforms:** LMS for accessing resources, recorded lectures, and discussion forums.
- **Assessments:**
- **Formative:** Regular quizzes, practical exercises, and assignments for continuous feedback.
- **Summative:** Case study analyses, project presentations, and a final exam to evaluate students' grasp of statistical methods.

Support: The course instructor will be available for guidance during office hours, and students are encouraged to collaborate through peer reviews and group work. Regular feedback will be provided to help students refine their skills and meet course outcomes effectively.

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)

Suggested Readings

1. Time Series Analysis and Its Applications: With R Examples by Robert H. Shumway and David S. Stoffer.
2. Applied Time Series Analysis by Wayne A. Woodward, Henry L. Gray, and Alan C. Elliott.
3. The Elements of Statistical Learning: Data Mining, Inference, and Prediction by Trevor Hastie, Robert Tibshirani, and Jerome Friedman.

Open Educational Resources (OER)

1. **Khan Academy - Time Series Analysis**
2. Time Series Regression Analysis - University of California, Irvine
3. Time Series Analysis and Forecasting - Coursera

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Test/Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER V					
UDT109	**Data Structures and Algorithms**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Minor				
Total Contact Hours	64 Hours				
Pre-Requisites/ Co-Requisites	**Nil**				

Course Perspective

The Data Structures and Algorithms course provides students with a deep understanding of fundamental data structures and the algorithms used to manipulate them. Students will learn to design, analyze, and implement efficient algorithms to solve complex computational problems. The course covers topics such as arrays, linked lists, trees, graphs, sorting, searching, and optimization techniques. By mastering these concepts, students will develop the skills to write optimized code, improve problem-solving abilities, and prepare for advanced studies or careers in computer science and software development.

Course Outcomes

Upon completion of the course, the learner will be able to:

Course Content

CO1: Understanding and remembering key data structures such as arrays, linked lists, stacks, queues, trees, and graphs for effective data management.

CO2: Applying knowledge to design, implement, and analyze algorithms for various computational tasks, assessing their efficiency in terms of time and space complexity.

CO3: Analyzing complex real-world problems and selecting appropriate data structures and algorithms to optimize performance and resource usage.

CO4: Evaluating and improving existing algorithms, enhancing their efficiency and preparing them for more advanced studies or professional challenges in computer science.

Unit I: Oops Concepts **12 hours**

Class, Object, Constructors, type of variables, type of methods. Inheritance: single, multiple, multi-level, hierarchical, hybrid. Polymorphism: with functions and objects, with class methods, with inheritance. Abstraction: abstract classes.

Unit II: Introduction to Data Structures and Basic Algorithms **15 hours**

Overview of Data structures and their importance. Introduction to arrays and lists-understanding linear data structures. Implementing arrays and lists in Python. Basic operations on arrays and lists: insertion, deletion, searching. Implementing stack and queues in Python. Stack Operations: push, pop, peek. Queue Operations: enqueue, dequeue, peek. Time complexity, amortize time complexity and space complexity analysis: Big O notation, Big omega notation and Big theta notation.
Problem-Solving Exercise: Parenthesis Matching, Tower of Hanoi, implementing a stack-based algorithm (Reversing a string).

Unit III: Advanced Data Structures and Sorting Algorithms 20 hours

Introduction to Linked Lists and trees, Implementing Linked lists and Binary trees in Python. Introduction to searching algorithms: Linear search, Binary search. Introduction to sorting algorithms: Bubble sort, selection sort, insertion sort. Divide and Conquer algorithms: Merge Sort and quick sort algorithms.
Problem-Solving Exercises: Longest Common Subsequence, Longest Increasing Subsequence, Word Break Problem, Subset Sum Problem, Binary Search, Merge Sort, Quick Sort.

Unit IV: Graph Algorithms and Dynamic Programming 17 hours

Introduction to graphs: representation and traversal. Depth-First Search (DFS) and Breadth-First Search (BFS). Shortest Path Algorithms: Dijkstra's Algorithm, Bellman-Ford Algorithm. Introduction to Dynamic Programming: Principles and Applications. Solving problems using dynamic programming.

Problem-Solving Exercises: Travelling Salesman Problem, Floyd-Warshall Algorithm, Knapsack Problem, Longest Increasing Subsequence (LIS) using Dynamic Programming.

Learning Experience

The *Data Structures and Algorithms* course offers a dynamic learning experience focused on both theory and practical application. Students will engage in interactive lectures, hands-on programming exercises, and collaborative projects to master key data structures and algorithms. Algorithmic challenges and real-world case studies will enhance problem-solving skills and demonstrate practical applications. Continuous feedback through quizzes and coding reviews will guide students' progress. The course emphasizes the use of industry-standard tools, encouraging students to write, optimize, and reflect on their code, preparing them for advanced studies and professional challenges.

Textbooks

1. Michael T. Goodrich: Data structures and algorithms in Python
2. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein: Introduction to Algorithms

Suggested Readings

1. Aaron M. Tenenbaum,YedidyahLangsam and Moshe J. Augenstein “Data Structures Using C and C++”, PHI Learning Private Limited, Delhi India
2. Berztiss, A.T.: Data structures, Theory and Practice :, Academic Press.
3. Jean Paul Trembley and Paul G. Sorenson, “An Introduction to Data Structures with applications”, McGraw Hill.

Open Educational Resources (OER)

1. https://www.coursera.org/specializations/data-structures-algorithms
2. https://www.khanacademy.org/computing/computer-science/algorithms
3. https://www.coursera.org/specializations/algorithms

Evaluation Scheme

Evaluation components	Weightage
Internal marks (Theory) **I. Continuous assessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

Student Activity

Create a simple sorting algorithm, such as Bubble Sort or Insertion Sort, and implement it in your preferred programming language. Write a program to sort an array of integers and analyze its time complexity. After implementation, discuss with peers how different sorting algorithms compare in terms of efficiency and practical use cases. Submit both your code and a brief report on your findings.

SEMESTER V					
SCMA4021	**SPECIAL FUNCTIONS**	**L**	**T**	**P**	**C**
Version		5	1	0	6
Category of Course	Core				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-					

Requisites	

Course Perspective

This course offers an in-depth study of special functions in mathematical analysis, emphasizing their properties, applications, and interrelations. It covers the fundamental concepts of complex numbers and entire functions, including Gamma and Beta functions with their integral representations and special formulas. The course explores advanced functions such as the Riemann Zeta function and Gauss Hypergeometric function, addressing their asymptotic expansions, convergence, and transformation properties. It also includes a focus on Generalized Hypergeometric Functions and Legendre polynomials, with an emphasis on their integral representations, differential equations, and generating functions. Additionally, the course covers Bessel functions and Hermite polynomials, examining their differential equations, solutions, recurrence relations, and generating functions.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Identifying and describing concepts of asymptotic expansions, Euler product formulas, and Riemann functional equations, properties and integral representations of special functions, including Gamma and Beta functions.

CO2: Applying transformation techniques to special functions like the Riemann Zeta and Gauss Hypergeometric functions.

CO3: Analyzing convergence conditions and interrelations among special functions.

CO4: Evaluating the effectiveness of integral representations and asymptotic expansions in solving mathematical problems.

Course Content

Unit I: 15 lecture hours

Infinite product of complex numbers, Factorization of entire functions, Gamma functions, Beta functions, Factorial function, Legendre's duplication formula, Gauss's multiplication formula, Integral representations for Gamma function and Beta functions.

Unit II: 15 lecture hours

Asymptotic expansion, Riemann Zeta functions, Euler product formula, Riemann Functional equations, Gauss Hypergeometric Function, Elementary Properties, Conditions of convergence, Contiguous function relations , Simple transformation, Quadratic transformation.

Unit III: 15 lecture hours

Generalized Hypergeometric Functions, Integral representation, Elementary Properties, Integral Representation, Legendre polynomials and functions, Solution of Legendre's differential equations, Generating Functions, Rodrigue's Formula , Recurrence relations.

Unit IV: 15 lecture hours

Bessel functions, Bessel differential equation and it's solution, Recurrence relation, Generating functions, Integral representation, Hermite Polynomials.

Learning Experience

Students will engage in a detailed exploration of special functions, integrating theoretical understanding with practical applications. They will develop a deep grasp of complex functions, differential equations, and integral representations.

Instruction Methods:

Instruction will be delivered through lectures that provide foundational knowledge and interactive sessions that encourage problem-solving and application of concepts.

Technology Use:

Online platforms will be utilized for access to course materials, interactive simulations, and additional resources to enhance learning and facilitate remote engagement.

Assessments:

Formative assessments will include quizzes and problem sets to gauge understanding throughout the course, while summative assessments will consist of exams and projects to evaluate comprehensive knowledge and application of concepts.

Support:

Additional support will be available through office hours, discussion forums, and online tutoring to assist students in grasping complex topics and solving challenging problems.

Textbooks

1. Rainville E. D., 1960, *Special Functions, The MacMillan Comp.*

2.Bell W.W., 1968, *Special Functions for Scientists and Engineers, D. Van Nostrand Comp. Ltd.*

3.Andrews G.E., Askey R. and Roy R., 1999, *Special Functions, Encyclopedia of Mathematics and Its Applications,* Cambridge University Press.

Suggested Readings

1. "Special Functions and Their Applications" by N. N. Lebedev

2. Bessel Functions for Beginners" by R. B. Paris and D. K. Anagnostopoulos

Open Educational Resources (OER)

https://math.mit.edu/~gs/cse/websections/cse41.pdf

https://reference.wolfram.com/language/guide/FourierAnalysis.html

Evaluation Scheme

Evaluation components	Weighage

Internal marks (Theory) **I. Continuous assessment (30 marks)** Include assignments, lab work, quizzes, and a final project, focusing on the practical application of data preprocessing and visualization techniques.	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER-VI

SEMESTER VI					
SCMA302	**Probability and Statistics**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Minor				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

This course provides a comprehensive understanding of probability theory and its applications through a structured approach across four key units. In Unit I, students delve into fundamental probability concepts, including random variables and moment-generating functions, laying the groundwork for more complex topics. Unit II expands on this foundation by exploring both univariate discrete and continuous distributions, such as Binomial and Normal distributions, essential for statistical analysis. Unit III introduces bivariate distributions, focusing on joint and marginal distributions, and the mathematical expectations of two random variables, enriching students' understanding of multivariate scenarios. Finally, Unit IV integrates concepts like correlation, regression, and the central limit theorem, bridging the gap between theory and practical statistical modeling. The course concludes with advanced topics on modeling uncertainty, including entropy and random graph models, providing students with the tools to analyze and interpret complex probabilistic systems.

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

CO1: Understanding and applying key concepts of probability, including discrete and continuous random variables, probability distributions, conditioning, independence, expectations, and variances.

CO2: Defining and explaining the different statistical distributions and the typical phenomena that each distribution often describes.

CO3: Analyzing and calculating probabilities, as well as deriving the marginal and conditional distributions of bivariate random variables.

CO4: Evaluating the covariance and correlation between jointly distributed variables to assess their relationship.

Course Content

UNIT-I **15**
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 **15**
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
15Lectures

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 **15**
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.

Learning Experience

The course is designed to offer a robust learning experience by progressively building students' understanding of probability and statistical concepts, from fundamental principles to advanced applications. Students engage with theoretical material through lectures, problem-solving sessions, and real-world examples that illustrate the practical implications of probability theory and statistical methods.

Instruction Methods: Technology Use

Instructional methods include traditional lectures complemented by technology-enhanced learning tools. Presentations, statistical software, and online simulations may be used to demonstrate complex concepts like distributions, regression analysis, and the central limit theorem. This integration of technology aids in visualizing abstract concepts and provides hands-on experience with statistical modeling and analysis.

Assessments

Assessments are designed to evaluate both theoretical understanding and practical application of course content. These may include regular quizzes, problem sets, mid-term and final exams, and potentially project-based assessments where students apply statistical methods to real data. These varied assessment methods ensure a comprehensive evaluation of students' grasp of the material.

Support

Support mechanisms include office hours, discussion forums, and access to additional learning resources such as online tutorials and peer study groups. Instructors may also provide guidance on using statistical software, ensuring that students have the necessary skills to succeed in both the coursework and assessments.

Textbooks

1. **Probability and Statistics for Engineers and Scientists" by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, and Keying Ye**
2. **Introduction to Probability" by Dimitri P. Bertsekas and John N. Tsitsiklis**
3. **A First Course in Probability" by Sheldon Ross**

Suggested Readings

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.

Open Educational Resources (OER)

MIT OCW - Probability and Statistics

OpenStax - Introductory Statistics

LibreTexts - Statistics and Probability

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER III					
SCMA352	**PROBABILITY AND STATISTICS LAB**	**L**	**T**	**P**	**C**
Version		**0**	**0**	**4**	**2**
Category of Course	Core				
Total Contact Hours	30 Hours				
Pre-Requisites/ Co-Requisites	**Nil**				

Course Perspective

This lab syllabus focuses on equipping students with practical skills in statistical analysis and data interpretation. By covering a range of topics from graphical data representation to advanced statistical techniques like correlation, regression, and fitting distributions, the course aims to build a comprehensive understanding of data behavior. Students will learn to handle various types of data, apply measures of central tendency and dispersion, and use statistical methods to draw meaningful conclusions. The inclusion of both theoretical

concepts and real-world application problems ensures that students develop both the analytical and problem-solving skills necessary for data-driven decision-making.

Course Outcomes

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

CO1: Observing and identifying different methods for graphically representing data and measuring central tendency and dispersion.

CO2: Imitating the process of calculating statistical measures such as correlation coefficients, regression lines, and moments by working through practical problems.

CO3: Practicing fitting various statistical distributions (binomial, Poisson, normal) and performing goodness-of-fit tests, reinforcing understanding through repeated exercises.

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.

Learning Experience

Students will engage in hands-on activities to explore statistical concepts, gaining practical skills in data analysis. They will work with real and simulated data to observe patterns, practice calculations, and interpret results, thereby enhancing their analytical abilities and understanding of statistical methodologies.

Instruction Methods:

The course will utilize a mix of lectures, demonstrations, and guided lab sessions. Students will initially observe and imitate procedures demonstrated by the instructor and gradually move to independent practice and adaptation of statistical techniques to solve problems.

Technology Use:

tudents will use statistical software (such as R, Python, or SPSS) and tools like spreadsheets for data analysis, graphical representation, and simulation of statistical problems. These tools will help in efficiently conducting complex calculations and visualizations.

Assessments:

Assessment will include practical assignments, lab reports, and exams that test the ability to perform statistical analysis, interpret results, and apply theoretical knowledge to practical scenarios. Students may also be evaluated based on group projects and presentations.

Support:

Students will receive support through one-on-one mentoring during lab sessions, office hours with the instructor, and access to online resources such as tutorials, documentation, and forums. Peer collaboration will also be encouraged for shared learning and problem-solving.

Textbooks

2. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7th edition), Pearson Education.
3. Irwin Miller & Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8thedition). Pearson. Dorling Kindersley Pvt. Ltd. India.
4. Jim Pitman (1993). *Probability*, Springer-Verlag.

Suggested Readings

1. 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.

Open Educational Resources (OER)

https://socviz.co/

Python for Data Science and Machine Learning Bootcamp

https://onlinestatbook.com/

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Practicals) **I. Conduct of experiment** **II . Lab Record** **III. Lab Participation** **IV. Lab Project**	 **10 Marks** **10 Marks** **10 Marks** **20 Marks**
II. External Marks (practicals): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SCMA402	RESEARCH ETHICS AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
Version 1.0		4	0	0	4
Category of Course	Core Course				
Total Contact Hours	60				
Pre-requisites/ Co-requisites					

Course Perspective

This course provides a comprehensive overview of the fundamental principles of research methodology, data analysis, technical writing, and intellectual property rights. It is designed to equip students with the necessary skills to conduct high-quality research, present their findings effectively, and understand the legal framework surrounding intellectual property.

Course Outcomes (CO)

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CO1: Explaining the importance of scientific methodology in recording results and differentiate between various types of data analysis methods (objective, subjective, analytical).

CO2: Applying the principles of effective technical writing to draft a research manuscript or report and prepare a research proposal for assessment by a review committee.

CO3: Analyzing research data to differentiate between true results and artifacts, and assess their relevance in forming hypotheses, concepts, and theories.

Course Content

Unit I: Research methodology Contact Hour: 15

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 Contact Hour: 15

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 Contact Hour: 10

Effective technical writing, how to write a manuscript/ response 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 Contact Hour: 10

Nature of Intellectual Property: Patents, Designs, Trademark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT.

Unit V: Patent Rights and New Developments in IPR Contact Hour: 10

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.

Learning Experience:

This course provided a comprehensive understanding of research methodology, covering the essential aspects of identifying and framing research problems, as well as the ethical considerations and challenges involved in the research process. Through discussions on data collection, analysis, and the significance of both positive and negative results, I gained insights into the scientific methods necessary for producing reliable outcomes. The emphasis on technical writing improved my ability to effectively communicate research findings, respond to peer reviews, and prepare high-quality research proposals. Additionally, the course introduced me to the complexities of intellectual property rights, including the processes of patenting, licensing, and the latest developments in the field. Overall, the course equipped me with valuable skills in research execution, documentation, and protection of intellectual assets.

Instruction Methods:

- Lectures
- Interactive Discussions
- Case Studies
- Workshops
- Assignments
- Guest Lectures
- Assessment and Feedback

Technology Use:

- **Online Platforms:** An LMS will host resources, recorded lectures, assignments, and discussion forums to facilitate extended learning.

Assessments:

- **Formative:** Regular quizzes, assignments, and online discussions will provide continuous feedback.
- **Summative:** Exams, project presentations, and peer reviews will assess students' mastery of the material.

Support:

Support for this course is crucial to ensure that students fully grasp the complex and multifaceted topics covered. Providing access to a well-curated selection of textbooks, research articles, and online resources will enable students to deepen their understanding of research methodology, technical writing, and intellectual property rights. Additionally, offering hands-on workshops and practical sessions will allow students to apply theoretical concepts in real-world scenarios, reinforcing their learning. Guidance from experienced faculty, guest lecturers, and industry experts will further enhance the learning experience by providing diverse perspectives and up-to-date knowledge. Regular feedback and peer review sessions will support continuous improvement, while access to digital tools, such as plagiarism checkers and patent databases, will facilitate practical exercises and research tasks. Overall, a combination of academic resources, practical tools, and expert guidance will create a supportive learning environment that empowers students to excel in their research and academic pursuits.

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.

Suggested Readings

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.

Open Educational Resources (OER)

https://nptel.ac.in/courses/106/105/106105077/

Evaluation Scheme

Evaluation components	Weighage
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals (minimum of five components to be evaluated)	**30 Marks**
II. Internal marks (Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade

SEMESTER VIII					
SCMA4010	**q-SERIES AND FRACTIONAL CALCULUS**	**L**	**T**	**P**	**C**
Version		5	1	0	6
Category of Course	Core				
Total Contact Hours	60 Hours				
Pre-Requisites/ Co-Requisites					

Course Perspective

This course provides an advanced study of specialized mathematical functions, including q-shifted, q-gamma, and q-beta functions, and their integral representations. It covers the q-binomial theorem, q-analogue formulas, and fractional calculus concepts like Mittag-Leffler functions and fractional derivatives. The course also explores Meijer's G-functions and H-functions, focusing on their definitions, properties, and transformations.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Understanding and defining q-shifted, q-gamma, and q-beta functions in various mathematical contexts, including their properties and applications.

CO2: Applying the q-binomial theorem and q-analogues of key transformation formulas to derive results and solve mathematical problems.

CO3: Analyzing and computing fractional derivatives and integrals, including understanding the applications of Mittag-Leffler functions in different contexts.

CO4: Evaluating and applying integral representations and recurrence relations of specialized functions to complex mathematical and theoretical problems, demonstrating their significance in advanced studies.

Course Content

Unit I: 15 lecture hours

q-shifted functions ,q-gamma and q-beta functions ,definitions of basic hypergeometric function, elementary q-identities, deductions from integral representations.

Unit II: 15 lecture hours

q-binomial theorem, q-analogue of gauss's transformation formula, q-analogue of Vandermonde's formula, q-derivative operator.

Unit III: 15 lecture hours

Introduction to fractional calculus , mittag-Leffler functions of one and two parameters , Leibnitz's formula for fractional derivative and integral, fractional derivative and integral of an arbitrary order of elementary function.

Unit IV: 15 lecture hours

Meijer's G-Functions: definitions, multiplication formulas, derivatives, recurrence relation, Mellin and Laplace transform. Definition of H-function of one variable, special cases, differentiation formula, recurrence relation.

Learning Experience

Students will engage in a deep exploration of advanced mathematical functions through lectures, problem-solving sessions, and practical applications.

Instruction Methods:

The course will use a mix of lectures, interactive discussions, and hands-on exercises to facilitate understanding of complex mathematical concepts.

Technology Use:

Students will utilize software tools for symbolic computation and mathematical modeling to analyze functions and perform calculations.

Assessments:

Evaluation will include quizzes, assignments, and exams focused on applying theoretical knowledge and solving problems related to q-functions, fractional calculus, and special functions.

Support:

Additional support will be provided through office hours, online resources, and collaborative study groups to assist with course materials and problem-solving strategies.

Textbooks

1. "q-Series and q-Identities" by George E. Andrews (2000)

2. "Fractional Calculus: An Introduction for Physicists" by Richard A. Ross (2010)

3. "Special Functions and Their Applications" by N. N. Lebedev (1972)

4. "Meijer's G-Functions and H-Functions" by A. A. Kilbas, H. M. Srivastava, and J. J. Trujillo (2006)

Suggested Readings

1. "Advanced Mathematical Methods for Scientists and Engineers" by C. A. J. Fletcher (2009)

2. "Fractional Calculus: Theory and Applications" by Igor Podlubny (1999)

Open Educational Resources (OER)

https://instr.iastate.libguides.com/oer/math
https://onlinelibrary.wiley.com/doi/10.1155/2010/375858

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous assessment (30 marks)** Include assignments, lab work, quizzes, and a final project, focusing on the practical application of data preprocessing and	**30 Marks**

visualization techniques.	
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER VI					
SCMA304	**Applied Mechanics**	**L**	**T**	**P**	**C**
Version		4	0	0	4
Category of Course	Minor				
Total Contact Hours	65 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

This course on Mechanics of Rigid Bodies focuses on understanding the behavior of bodies under various force systems, emphasizing equilibrium, friction, and motion. It begins with the study of forces in equilibrium, including the analysis of moments and couples in two and three dimensions. Students then explore friction, the center of gravity, and moments of inertia, applying these concepts to both simple and composite bodies. The course also covers the principles of energy conservation and the application of work-energy equations. Finally, the motion of rigid bodies is examined, with an emphasis on translation, rotation, and the relationships between different reference frames. This course provides a comprehensive foundation in mechanics, essential for analyzing and solving complex physical problems.

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

CO1: Understanding the significance of mathematics in describing physical quantities and their practical applications.

CO2: Analyzing cause-effect relationships in physical phenomena to predict outcomes based on these relationships.

CO3: Applying mathematical and physical principles to observe, interpret, and relate real-world situations and structures.

CO4: Evaluating the motion of multiple particles in constrained motion using appropriate models and theories.

Course Content

Unit 1: Forces in Equilibrium (Lectures: 15)

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.

Learning Experience

Students will engage in a variety of hands-on and theoretical activities to deepen their understanding of mechanics. The course will emphasize active learning through problem-solving sessions, collaborative group work, and the use of simulations to visualize complex concepts. Real-world examples and case studies will be incorporated to bridge theory with practical applications, allowing students to connect abstract principles with tangible outcomes.

Instruction Methods

Instruction will include a mix of lectures, interactive discussions, and problem-solving workshops. Lectures will provide foundational knowledge, while discussions will encourage critical thinking and deeper exploration of topics. Problem-solving workshops will be used to reinforce concepts through practical applications, with students working individually or in groups. Additionally, lab sessions or virtual simulations may be utilized to provide hands-on experience with the principles being taught.

Technology Use

Technology will play a significant role in enhancing the learning experience. Students will have access to simulation software for visualizing force systems, equilibrium, and rigid body motion. Online resources such as video tutorials, interactive models, and problem-solving platforms will be integrated to support independent learning. Learning management systems (LMS) will be used to distribute course materials, manage assignments, and facilitate communication between students and instructors.

Assessments

Assessment will be conducted through a combination of formative and summative methods. Formative assessments, such as quizzes, homework assignments, and in-class problem-solving exercises, will provide ongoing feedback to students and help instructors gauge their understanding. Summative assessments will include midterm and final exams, as well as project-based evaluations where students apply course concepts to real-world scenarios. Additionally, participation in discussions and workshops may contribute to the overall assessment.

Support

Support for students will be provided through a variety of channels, including office hours, online discussion forums, and peer tutoring sessions. Instructors will be available to answer questions and provide guidance on challenging topics. Additional resources, such as supplementary readings, video lectures, and practice problems, will be available through the course's online platform. Students will also be encouraged to form study groups to collaborate and support each other in mastering the course material.

Textbooks

1. **Hibbeler, R. C. (2016). Engineering Mechanics: Statics & Dynamics (14th ed.). Pearson PrenticeHall (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.**

Suggested Readings

1 Engineering Mechanics: Statics and Dynamics" by J.L. Meriam and L.G. Kraige

2 "Vector Mechanics for Engineers: Statics and Dynamics" by Ferdinand P. Beer, E. Russell Johnston Jr., and David Mazurek

4. "Fundamentals of Applied Dynamics" by James H. Williams Jr.

Open Educational Resources (OER)

LibreTexts - Engineering Mechanics

Walter Lewin's Lectures - Classical Mechanics

LibreTexts - Statistics and Probability

Evaluation Scheme

Evaluation components	**Weighage**
Internal marks (Theory) **I. Continuous accessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade.

SEMESTER VI					
SCMA306	**Mathematical Modeling**	**L**	**T**	**P**	**C**
Version		5	1	0	6
Category of Course					
Total Contact Hours	64 Hours				
Pre-Requisites/ Co-Requisites	Nil				

Course Perspective

Mathematical Modeling explores the translation of real-world problems into mathematical language, enabling students to apply various mathematical tools and techniques to analyze and solve these problems. The course emphasizes the development of models that represent physical, biological, economic, and social systems. By combining theoretical knowledge with practical application, students learn to make predictions, optimize outcomes, and understand the limitations of models. This course nurtures critical thinking, problem-solving skills, and the ability to communicate complex ideas, preparing students for advanced studies or careers where mathematical modeling is integral.

Course Outcomes

Upon completion of the course, the learner will be able to:

CO1: Formulating mathematical models to represent real-world scenarios, demonstrating understanding and remembering of mathematical concepts.

CO2: Applying mathematical techniques to analyze and solve models, showcasing the application of relevant methods.

CO3: Interpreting the results of models in the context of the original problem, emphasizing analysis and understanding.

CO4: Evaluating optimal solutions for complex systems using appropriate mathematical tools, highlighting critical evaluation skills.

Course Content

Unit I **16 hours**

Need, Techniques, Classifications, Characteristic and Limitations of Mathematical Models. Mathematical Modelling through Ordinary Differential Equation of First Order: Linear Growth and Decay Models, Non-Linear Growth and Decay Models, Compartment Models, Dynamics Problems

Unit II **16 hours**

Mathematical Modelling through systems of Ordinary Differential Equation of First Order: Population Dynamics, Epidemics and Compartment Models. Modelling in Economics, Medicine, Arms Race, Battles and International Trades.

Unit III **16 hours**

Mathematical Modelling through Ordinary Differential Equation of Second Order: Planetary Motion, Circular Motion and Motion of Satellites.

Unit IV **16 hours**

Mathematical Modelling through Graphs: Directed and Signed graphs, Weighted Di-graphs.

Learning Experience

Course Integration Approach:

This course focuses on building a strong theoretical foundation in mathematical modeling, enabling students to understand and apply various modeling techniques across different disciplines. The instructional approach emphasizes lectures, interactive sessions, and problem-solving exercises to ensure that students develop a deep comprehension of mathematical concepts and their applications without involving hands-on or practical work.

Instruction Methods:

Lectures:

Core concepts of mathematical modeling will be taught using multimedia presentations, detailed explanations of theories, and in-depth explorations of mathematical frameworks. The focus will be on understanding key principles, formulating mathematical models, and solving complex problems analytically.

Interactive Sessions:

Students will actively participate in Q&A sessions, group discussions, and problem-solving exercises. These interactive components will reinforce the theoretical content by encouraging students to engage with the material, ask questions, and discuss various approaches to modeling.

Case Study Analysis:

Real-world case studies will be analyzed to illustrate the application of mathematical modeling in different fields such as economics, engineering, biology, and social sciences. Students will critically evaluate these models to understand the assumptions, limitations, and results.

Technology Use:

Online Platforms:

The course will utilize a Learning Management System (LMS) to host resources such as recorded lectures, reading materials, assignments, and discussion forums. This platform will facilitate extended learning and allow students to access course materials at their convenience.

Assessments:

1. **Formative Assessments**:
    - **Quizzes and Assignments**: Regular quizzes and assignments will assess students' understanding of the mathematical theories and their ability to apply these theories to model real-world situations.
    - **Problem-Solving Sessions**: Students will engage in problem-solving exercises that challenge their grasp of concepts and allow for continuous feedback on their progress.
2. **Summative Assessments**:
    - **Exams**: Written exams will evaluate students' mastery of mathematical modeling techniques, including their ability to formulate and solve models accurately.
    - **Analytical Essays**: Students will be required to write essays analyzing the strengths and weaknesses of different mathematical models, demonstrating their critical thinking and theoretical understanding.

Support:

- **Instructor Guidance**: The course instructor will provide additional support through office hours and review sessions, offering personalized feedback on assignments and helping students navigate complex concepts.
- **Peer Collaboration**: Group discussions and peer evaluations will be encouraged to foster collaborative learning and allow students to benefit from diverse perspectives on mathematical problems.

Textbooks

J. N. Kapur, Mathematical Modelling, New Age International Publishers.

Suggested Readings

1. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modeling, Thomson Learning, London and New York.

2. ReinhardIllner, Mathematical Modelling: A Case Studies Approach, Indian Editions of AMS Titles.

Open Educational Resources (OER)

1. https://sysbio.mx/wp-content/uploads/2021/02/MATHEMATICAL-MODELS-IN-BIOLOGY_Allman.pdf
2. https://ncert.nic.in/textbook/pdf/kemh1a2.pdf
3. https://www.youtube.com/watch?v=zw9Y4t-Nh3E

Evaluation Scheme

Evaluation components	**Weightage**
Internal marks (Theory) **I. Continuous assessment (30 marks)** All the components to be evenly spaced Project/quizzes/assignment and essays/presentation/ participation/case studies/reflective journals(minimum of five components to be evaluated)	**30 Marks**
II. Internal marks(Theory): Mid Term Examination	**20 Marks**
III. External Marks (Theory): End Term Examination	**50 Marks**

It is compulsory for a student to secure 40 % marks in Internal and End Term Examination separately to secure minimum passing grade