



RAMAIAH
UNIVERSITY
OF APPLIED SCIENCES

Programme Specifications

(AS PER NEP-2020)

M.Sc. (Mathematics) Degree Programme

Programme Code: 107

Department of Mathematics and Statistics

Faculty of Natural Sciences

Batch 2026-2028

Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Dean

Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Dean - Academics

M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

University's Vision, Mission and Objectives

The M. S. Ramaiah University of Applied Sciences (MSRUAS) will focus on student-centric professional education and motivates its staff and students to contribute significantly to the growth of technology, science, economy and society through their imaginative, creative and innovative pursuits. Hence, the University has articulated the following vision and objectives.

Vision

MSRUAS aspires to be the premier university of choice in Asia for student centric professional education and services with a strong focus on applied research whilst maintaining the highest academic and ethical standards in a creative and innovative environment

Mission

Our purpose is the creation and dissemination of knowledge. We are committed to creativity, innovation and excellence in our teaching and research. We value integrity, quality and teamwork in all our endeavors. We inspire critical thinking, personal development and a passion for lifelong learning. We serve the technical, scientific and economic needs of our Society.

Objectives

1. To disseminate knowledge and skills through instructions, teaching, training, seminars, workshops and symposia in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to equip students and scholars to meet the needs of industries, business and society
2. To generate knowledge through research in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to meet the challenges that arise in industry, business and society
3. To promote health, human well-being and provide holistic healthcare
4. To provide technical and scientific solutions to real life problems posed by industry, business and society in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences
5. To instill the spirit of entrepreneurship in our youth to help create more career opportunities in the society by incubating and nurturing technology product ideas and supporting technology backed business
6. To identify and nurture leadership skills in students and help in the development of our future leaders to enrich the society we live in
7. To develop partnership with universities, industries, businesses, research establishments, NGOs, international organizations, governmental organizations in India and abroad to enrich the experiences of faculties and students through research and developmental programmes


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Department Vision and Mission

Vision:

To be a premier centre in Mathematics and Statistics, fostering student-centric professional education, innovative multidisciplinary research, and academic excellence.

Mission:

To provide personalized, rigorous education in Mathematics and Statistics, nurturing students' academic and professional growth.

To promote innovative research through active collaboration across disciplines, addressing complex real-world problems.

To cultivate analytical thinking, creativity, and scholarly excellence through high-quality teaching and mentorship.



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Dean

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Bangalore-560 058.**



Dean - Academics

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Bangalore - 560 054**

Programme Specifications: M. Sc. Mathematics

Faculty	Natural Sciences
Department	Mathematics and Statistics
Programme Code	107
Programme Name	M.Sc. Mathematics
Dean of the Faculty	Dr. Sarat Kumar Maharana
Head of the Department	Dr. Somashekhara G

- Title of the Award:** M.Sc. Mathematics
- Mode of Study:** Full-Time
- Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences, Bengaluru
- Joint Award:** Not Applicable
- Teaching Institution:** Faculty of Mathematical & Physical Sciences, M. S. Ramaiah University of Applied Sciences, Bengaluru
- Date of Programme Specifications:** 10 June 2026
- Date of Programme Approval by the Academic Council of MSRUAS:** 10th June 2026
- Next Review Date:** June-2028
- Programme Approving Regulating Body and Date of Approval:**
- Programme Accredited Body and Date of Accreditation:**
- Grade Awarded by the Accreditation Body:**
- Programme Accreditation Validity:**
- Programme Benchmark:**
- Rationale for the Programme**

In the present day, the application of mathematical methods to solve real life problems in a wide variety of disciplines such as physics, chemistry, information science, business management, finance, economics and various branches of engineering has become a necessity. Apart from being an indispensable problem-solving and decision-making tool, mathematics is at the heart of advances in science, engineering and technology. The large scale use of computers in education and industry has given an impetus to the wide use of numerical methods and simulation. There is a need for qualified and competent mathematicians with a sound knowledge in applied mathematics. In our country, teaching/research in Mathematics is being carried out in a number of Universities. However, a vast majority of post graduate degree courses in Mathematics offer more conventional, content-based academic curriculum which inherently lacks application oriented approach, which is essential to make the degree programme more fulfilling and professional from the career perspective.

Somashekhara G
 Head of Department
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Dr. Sarat Kumar Maharana
 Dean
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058

Ramya K.V.
 Dean - Academics
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058

The Faculty of Mathematical and Physical Sciences of MSRUAAS offers the M.Sc. (Mathematics) course with an outcome based curriculum emphasizing the Critical, Analytical and Problem Solving skills to equip the students to pursue their scientific and research career with better preparedness and matured professional outlook. The presence of other allied Faculties of the University provides additional exposure to students the multi-disciplinary approach which is emerging as a key differentiator in the success of modern scientific and engineering endeavors. An expanding job market is open for applied mathematicians since employers value the intellectual rigour and reasoning skills that mathematicians have. Mathematician's familiarity with numerical and symbolic thinking and the analytic approach to problem-solving is highly valued in industry.

15. Programme Mission

The purpose of the programme is to create innovative problem solvers in multi-disciplinary settings, entrepreneurs and leaders that apply their knowledge, understanding, cognitive abilities, practical skills and transferable skills gained through systematic, flexible and rigorous learning in the chosen academic domain.

16. Graduate Attributes (GAs)

- GA-1.** Ability to apply fundamental knowledge of Mathematical and Physical Sciences to solve real life problems in their chosen domain
- GA-2.** Ability to teach in schools, colleges and universities with relevant training and perform administrative duties in government, semi-government, private and public sector organizations
- GA-3.** Ability to understand and solve scientific problems by conducting experimental investigations
- GA-4.** Ability to apply appropriate tools, techniques and understand utilization of resources appropriately in various laboratories
- GA-5.** Ability to conduct scientific research and disseminate the knowledge in the chosen domain
- GA-6.** Ability to understand the effect of scientific solutions on legal, cultural, social, public health and safety aspects, and apply ethical principles to scientific practices and professional responsibilities
- GA-7.** Ability to develop sustainable solutions and understand their effect on society and environment
- GA-8.** Ability to work as a member of a team, to plan and to integrate knowledge of various disciplines and to lead teams in multidisciplinary settings
- GA-9.** Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means
- GA-10.** Ability to adapt to the changes and advancements in science and engage in independent and life-long learning

17. Programme Outcomes (POs)

M.Sc. Mathematics post graduates will be able to:

- PO 1. **Scientific Knowledge:** Apply fundamental knowledge of mathematics to solve real life problems in their chosen domain
- PO 2. **Knowledge, Dissemination and Administration:** disseminate knowledge in educational institutions with relevant training and perform administrative duties in government, semi-government, private and public sector organizations
- PO 3. **Problem Solving:** Understand and solve scientific problems by using analytical techniques.
- PO 4. **Modern Tool Usage:** Apply appropriate tools, techniques and understand utilization of resources appropriately in various laboratories
- PO 5. **Research:** Conduct scientific research and disseminate the knowledge in the chosen domain
- PO 6. **The Science, Society and Ethics:** Understand the effect of scientific solutions on legal, cultural, social, public health and safety aspects, and apply ethical principles to scientific practices and professional responsibilities
- PO 7. **Environment and sustainability:** Develop sustainable solutions and understand their effect on society and environment
- PO 8. **Individual and teamwork:** Work as a member of a team, to plan and to integrate knowledge of various disciplines as individual and to lead teams in multidisciplinary settings
- PO 9. **Communication:** Make effective oral presentations and communicate technical ideas to a broad audience using written and oral means
- PO 10. **Life-long learning:** Adapt to the changes and advancements in science and engage in independent and life-long learning

18. Programme Goal

The goal of the program is to equip students with advanced knowledge and understanding of Applied Mathematics, along with high-level critical thinking, analytical, problem-solving, and research skills. It aims to develop their ability to think rigorously and independently, meeting the advanced expectations of academia and research, while also providing them with a broad range of transferable skills.

19. Program Educational Objectives (PEOs)

The objectives of the M.Sc. (Mathematics) Programme are to:

PEO-1. To provide students' knowledge in mathematics to enable them to deliver efficient solutions for complex Scientific problems using analytical and cognitive skills in their chosen domain

PEO-2. To enable students to apply appropriate tools, techniques and understand utilization of resources in laboratories and computational skills in conducting research in their

chosen domains and work as an individual as well as lead team in multidisciplinary settings

PEO-3. To inculcate communication, soft, and managerial skills for a successful career and to engage in lifelong learning



Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
U.S. Ramiah University of Applied Sciences
Rajkot (Gujarat) 360 058.

20. Programme Specific Outcomes (PSOs)

At the end of the M.Sc. (Mathematics) programme, the graduate will be able to:

PSO-1. Apply the basic principles of mathematics to solve scientific problems, model, simulate and interpret the results.

PSO-2. Develop abstract mathematical thinking, assimilate complex mathematical ideas and arguments and conduct research in applied mathematics.

PSO-3. Demonstrate communication skills and involvement in lifelong learning for the betterment of organization.

21. Programme Structure:**Semester 1**

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	MTC551A	Linear Algebra	3	1	0	100	4
2	MTC552A	Theory of Ordinary Differential Equations	3	1	0	100	4
3	MTC553A	Real Analysis	3	1	0	100	4
4	MTC554A	Numerical Analysis	3	0	2	100	4
5	MTC555A	Statistics and Probability for Data Science	3	1	0	100	4
6	MTMXXX	Skill based course	0	0	2	50	1
Total			15	4	4	550	21

Semester 1 (Skill based course)							
Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTM551A	Basic Scientific Programming	0	0	2	1	50

Semester 2

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	MTC561A	Topology	2	1	0	100	3
2	MTC562A	Theory of Partial Differential Equations	3	1	0	100	4
3	MTC563A	Abstract Algebra	2	1	0	100	3
4	MTC564A	Complex Analysis	3	1	0	100	4
5	MTESXXX	Discipline Specific Elective	3	1	0	100	4
6	MTMXXX	Skill Based Course	0	0	2	50	1
Total			13	5	2	550	19

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Semester 2 (Discipline Specific Electives)							
Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTE561A	Machine learning -1	3	1	0	4	100
2	MTE562A	Mathematical Foundation of Mechanics and Wave Propagation	3	1	0	4	100
3	MTE563A	Statistical inference	3	1	0	4	100
Semester 2 (Skill based course)							
Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTM561A	Python for Data Science	0	00	2	1	50

Semester 3

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	MTC571A	Combinatorics and Graph Theory	3	1	0	100	4
2	MTC572A	Differential Geometry and Multivariable Calculus	3	1	0	100	4
3	MTC573A	Probability, Measure and Integration	3	1	0	100	4
4	MTE5XXX	Discipline Specific Electives	3	1	0	100	4
6	MTI571A/ MTP571A	Internship/ Project	0	0	4	50	2
7	MPF615A	Research Methodology	2	0	0	50	2
Total			14	4	4	500	20

Semester 3 (Discipline Specific Electives)							
Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Total Credits	Max. Marks
1	MTE571A	Machine learning -2	3	1	0	4	100
2	MTE572A	Fundamentals of Fluid Dynamics	3	1	0	4	100
4	MTE573A	Applied Regression Analysis	3	1	0	4	100

Semester 4

Sl. No.	Course Code	Course Title	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks	Total Credits
1	MTC581A	Functional Analysis	3	1	0	100	4
2	MTC582A	Statistics for Data Science using R	3	0	2	100	4
3	MTP581 A	Dissertation			24	300	12
Total			6	1	26	500	20

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Rangappa R.V.

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* Internship can be done during the vacation period for a maximum period of 8 weeks

22. Course Delivery: As per the Timetable

23. Teaching and Learning Methods

1. Face to Face Lectures using Audio-Visuals
2. Workshops, Group Discussions, Debates, Presentations
3. Demonstrations
4. Guest Lectures
5. Laboratory work/Field work/Workshop
6. Industry Visit
7. Seminars
8. Group Exercises
9. Project Work
10. Project
11. Exhibitions
12. Technical Festivals

24. Assessment and Grading

24.1. Components of Grading

There shall be **two components** of grading in the assessment of each course:

Component 1, Continuous Evaluation (CE): This component involves multiple subcomponents (SC1, SC2, etc.) of learning assessment. The assessment of the subcomponents of CE is conducted during the semester at regular intervals. This subcomponent represents the formative assessment of students' learning.

Component 2, Semester-end Examination (SEE): This component represents the summative assessment carried out in the form an examination conducted at the end of the semester.

Marks obtained CE and SEE components have equal weightage (CE: 50% and SEE: 50%) in determining the final marks obtained by a student in a Course.

The complete details of Grading are given in the Academic Regulations.

24.2. Continuous Evaluation Policies

Continuous evaluation and Semester-End Examination depends on the type of the course as discussed below:

24.2.1 Theory Courses


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Theory Course			
CE (Weightage : 50%)		SEEE (Weightage : 50%)	
TSC1 Midterm Exam/Term Test	TSC2 Assignment	TSC3 Innovative	SEE Written Exam
50 Marks	25 Marks	25 Marks	50 Marks

There shall be three subcomponents, first one is midterm exam carrying 50 marks and others carrying 25 marks each.

The innovative TSC3 can be of any of the following types:

- Online Test
- Assignments/Problem Solving
- Field Assignment
- Open Book Test
- Portfolio
- Reports
- Case Study
- Group Task
- Any other

After the three subcomponents are evaluated, the CE component marks are determined as:

CE Component Marks = $\frac{\text{(Total of the marks obtained in all the three subcomponents)}}{2}$

24.2.2 Laboratory Course

For a laboratory course, the scheme for determining the CE marks is as under:

Laboratory Course		
CE (Weightage: 50 %)		SEE (Weightage: 50 %)
LSC1	LSC2	Lab - SEE
25 Marks	25 Marks	50 Marks

The subcomponents can be of any of the following types:

- Laboratory / Clinical Work Record
- Experiments

- c) Computer Simulations
- d) Creative Submission
- e) Virtual Labs
- f) Viva / Oral Exam
- g) Lab Manual Report
- h) Any other (e.g. combinations)

After the subcomponents of CE are evaluated, the CE component Marks are determined as:

$$\text{CE Component Marks} = (\text{Total of the best two subcomponent marks out of the three}) \div 2$$

24.2.3 Course Having a Combination of Theory and Laboratory

For a course that contains the combination of theory and laboratory sessions, the scheme for determining the CE marks is as under:

Course with the combination of Theory and Laboratory			
CE (Weightage: 50 %)			SEE (Weightage: 50 %)
TSC1: (30 %) Midterm exam / Term Test	TSC2: (20 %) Assignment	TSC3: (10 %) Innovative	SEE (25 %) Theory
50 marks	40 Marks	10 Marks	50 Marks

Course with Laboratory		
CE (Weightage: 50 %)		SEE (Weightage: 50 %)
LSC1: (30 %) Midterm exam / Term Test	LSC2: (30 %) Laboratory Manual	SEE (40 %) Theory
50 marks	50 Marks	50 Marks

There shall be four subcomponents, each carrying 25 marks. Out of these, there shall be two term-tests and an assignment to evaluate the students' performance in theory. The fourth subcomponent shall be set to evaluate the students' performance in the laboratory.

The theory assignment can be of any of the following types:

- a) Online Test
- b) Problem Solving
- c) Field Assignment
- d) Open Book Test
- e) Portfolio
- f) Reports
- g) Case Study
- h) Group Task

Sandhya Chandra
Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 St. S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

- i) Any other

The laboratory subcomponent can be of any of the following types:

- a) Laboratory / Clinical Work Record
- b) Experiments
- c) Computer Simulations
- d) Creative Submission
- e) Virtual Labs
- f) Viva / Oral Exam
- g) Lab Manual Report
- h) Any other (e.g. combinations)

After the four subcomponents are evaluated, the CE component marks are determined as:

CE Component Marks = (Total of the marks obtained in all the four subcomponents) ÷ 2

25. Minor Programme

The details of the following aspects of the minor programmes are presented in the **Academic Regulations** for the B. Tech. Degree Programme:

- 1. Programme Structure
- 2. Eligibility to Minor Programme
- 3. Registration to Minor Programme
- 4. Certification for Minor Programme

26. Student Support for Learning

- 1. Course Notes
- 2. Reference Books in the Library
- 3. Magazines and Journals
- 4. Internet Facility
- 5. Computing Facility
- 6. Laboratory Facility
- 7. Workshop Facility
- 8. Staff Support
- 9. Lounges for Discussions
- 10. Any other support that enhances their learning

27. Quality Control Measures

- 1. Review of Course Notes
- 2. Review of Question Papers and Assignment Questions
- 3. Student Feedback
- 4. Moderation of Assessed Work
- 5. Opportunities for students to see their assessed work
- 6. Review by external examiners and external examiners reports
- 7. Staff Student Consultative Committee meetings
- 8. Student exit feedback
- 9. Subject Assessment Board (SAB)
- 10. Programme Assessment Board (PAB)

28. Programme Map (Course-PO-PSO Map)

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Sem.	Course Title	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
1	Linear Algebra	3	3	2		1			2	2	2	3	3	2
1	Theory of Ordinary Differential Equations	3	3	3		1			2	2	2	3	3	2
1	Real Analysis	3	3	2		1			2	2	2	3	3	2
1	Numerical Analysis-(T+P)	3	3	3	3	1			2	2	2	3	3	3
1	Statistics and Probability for Data Science	3	3	3		2			2	2	2	3	3	2
1	Basic Scientific Programming	3	3	2	3	1			2	2	2	3	3	2
2	Topology	3	3	2		1			2	2	2	3	3	2
2	Theory of Partial Differential Equations	3	3	3		1			2	2	2	3	3	2
2	Abstract Algebra	3	3	2					2	2	2	3	3	2
2	Complex Analysis	3	3	3		1			2	2	2	3	3	2
2	Machine learning -1	3	3	2	1	2			2	2	2	3	3	2
2	Mathematical Foundation of Mechanics and Wave Propagation	3	3	3		1			2	2	2	3	3	2
2	Statistical inference	3	3	3		1			2	2	2	3	3	2
2	Python for Data Science	3	3	2	3	2			2	2	2	3	3	2
3	Combinatorics and Graph Theory	3	3	2	1	2			2	2	2	3	3	2
3	Differential Geometry and Multivariable Calculus	3	3	3		2			2	2	2	3	3	2
3	Probability, Measure and Integration	3	3	2		1			2	2	2	3	3	2
3	Machine learning -2	3	3	3	1	2			2	2	2	3	3	2
3	Fundamentals of Fluid Dynamics	3	3	3		2			2	2	2	3	3	2
3	Applied Regression Analysis	3	3	3	1	2			2	2	2	3	3	2
3	Internship/ Project	3	3	2	2	2			2	2	2	3	3	2
3	Research Methodology	3	3	2		2			2	2	2	3	3	2
4	Functional Analysis	3	3	2		1			2	2	2	3	3	2
4	Statistics for Data Science using R	3	3	2	3	2			2	2	2	3	3	2
4	Dissertation	3	3	3	2	3			3	2	2	3	3	2

29. Co-curricular Activities

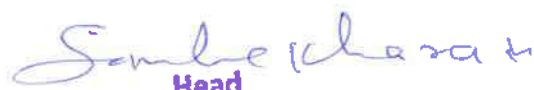
Students are encouraged to take part in co-curricular activities like seminars, conferences, symposia, paper writing, attending industry exhibitions, project competitions and related activities for enhancing their knowledge and networking.

30. Cultural and Literary Activities

Annual cultural festivals are held to showcase the creative talents in students. They are involved in planning and organizing the activities.

31. Sports and Athletics

Students are encouraged to take part in sports and athletic events regularly. Annual sports meet will be held to demonstrate sportsmanship and competitive spirit.



Head

Department of Mathematics and Statistics
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Bangalore-560 058.

Course Specifications: Linear Algebra

Course Title	Linear Algebra
Course Code	MTC551A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Faculty of Natural Sciences

1. Course Summary

The aim of the course is to introduce the concepts of linear algebra and its applications.

In this core course the students are taught basic operations of matrices, solutions of linear system of equations, vector spaces, subspaces, linear dependence and independence, span of vectors. Matrix representation of linear transformations, eigenvalue problems and canonical forms are studied in detail. Inner product spaces and operators and their applications are discussed.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO1: Illustrate the concepts of linear system of equations, vector spaces, linear transformation, diagonalization and inner product spaces

CO2: State and prove important theorems in linear algebra

CO3: Solve simple mathematical problems in linear system of equations, matrix theory, vector spaces, linear transformations, diagonalization and inner product spaces

CO4: Solve complex mathematical problems in linear system of equations, matrix theory, vector spaces, linear transformations, diagonalization and inner product spaces

CO5: Apply the concepts of linear algebra to model, solve, and analyze real-world situations

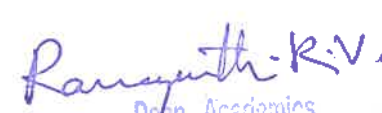

Head

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Faculty of Natural Sciences


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4. Course Contents**Unit 1: (Review of Systems of Linear Equations)****10 Hrs**

Systems of linear equations, Matrices, Elementary row operations, Row-reduced echelon matrices. Vector spaces, Subspaces, Linear dependence and independence, Bases and dimension, Ordered bases and coordinates.

Unit 2 (Linear Transformations):**10 Hrs**

Linear transformations, Rank-nullity theorem, Algebra of linear transformations, Isomorphism, Matrix representation, Linear functional, Annihilator, Double dual, Transpose of a linear transformation.

Unit 3 (Eigenvalues and Eigenvectors):**15 Hrs**

Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation, Cayley-Hamilton theorem, Invariant subspaces, Direct-sum decompositions, Invariant direct sums, The primary decomposition theorem, Cyclic subspaces and annihilators, Cyclic decomposition, Rational and Jordan forms, Singular Value Decomposition.

Unit 4 (Inner Product Spaces):**10 Hrs**

Inner product spaces, Orthonormal bases, Gram-Schmidt process, QR decomposition, Best approximation – Least square solutions, Orthogonal projections, Adjoint operator, Unary operators, Self-Adjoint operators, Normal operators – Spectral theorem.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)								Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PSO-1	PSO-2	PSO-3
CO-1	3	2	2						3	1	
CO-2	2	2	1						3	2	
CO-3	3	3	1	1			1		3	2	
CO-4	2	3	1	1	1		1	2	3	3	1
CO-5	3	3	2	2	2	1	1	1	2	3	2

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	


 Sandhya Chandra
 Head
 Faculty of Natural Sciences
 Department of Mathematics and Statistics
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2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		
1. Case Study Presentation	00	00
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. Mathematics Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document. The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, or TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ►↓	TSC1	TSC2	SC3	
Subcomponent Type ►↓	Mid term /Term Test	Assignment	Innovative	100 Marks
Maximum Marks ►↓	50	25	25	
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester. Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:


Head

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Hoffman, K. and Kunze R., 2015, Linear Algebra, 2nd Ed., Pearson Education India
3. Friedberg, S. H., Insel, A. J., and Spence, L. E., 2022, Linear Algebra, 5th Ed., Pearson Education India

b. Recommended Reading

1. Axler, S. 2016, Linear Algebra Done Right, 3rd Ed., Springer UTM
2. Halmos, P. R., 2011, Finite-Dimensional Vector Spaces, Springer UTM
3. Kumaresan, S., 2004, Linear Algebra: A Geometric Approach, Prentice-Hall of India
4. Ramachandra Rao A. and Bhimasankaram P., 2000, Linear Algebra, Hindustan Book Agency
5. Lang, S. 2010, Linear Algebra, 3rd Ed., Springer UTM
6. Strang, G., 2016, Introduction to Linear Algebra, 5th Ed., Wellesley-Cambridge Press
7. Leon, S. J., 2015, Linear Algebra with Applications, 9th Ed., Pearson
8. Artin, M, 2015, Algebra, 2nd Ed., Pearson India
9. Herstein I. N., 1975, Topics in Algebra, 2nd Ed., John Wiley & Sons

c. Magazines and Journals

1. The Electronic Journal of Linear Algebra (ELA) <http://repository.uwyo.edu/ela/>

d. Websites

1. <https://swayam.gov.in>

2. <https://coursera.org>
3. <http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/>
- 4.

e. Other Electronic Resources

1. <https://www.khanacademy.org/math/linear-algebra>

10. Course Organization

Course Code	MTC551A		
Course Title	Linear Algebra		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.mp@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		


Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Course Specifications: Theory of Ordinary Differential Equations

Course Title	Theory of Ordinary Differential Equations
Course Code	MTC552A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

Theory of Ordinary differential Equations (ODEs) deals with solving ODEs analytically and numerically. Here the students learn the abstract theorems on existence and uniqueness of solution to linear differential equations. This core course introduces the concept of Wronskian and its relevance to linear independence. The course introduces ideas of regular and irregular points and the power series solutions. Students also learn the methods to solve linear system of differential equations and matrix exponential.

Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

2. Course Outcomes (COs)

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

- CO-1.** Illustrate the principles of linear and non-linear differential equations, initial and boundary value problems, Sturm-Liouville problems and system of linear differential equations, autonomous systems
- CO-2.** State and prove theorems on existence and uniqueness of solution, series solutions, of ordinary differential equations and system of differential equations.
- CO-3.** Solve Sturm-Liouville problems, construct special functions as series solutions of some particular ordinary differential equations
- CO-4.** Model real world problems using ordinary differential equations and verify the results of the model
- CO-5.** Solve complex mathematical problems involving linear and non-linear differential equations, initial and boundary value problems, system of linear differential equations, and autonomous systems


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 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.


Dean
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.


Dean - Academics
 M.S. Ramaiah University of Applied Sciences
 Bangalore - 560 054

3. Course Contents

Unit 1 (Adjoint & Self-Adjoint Differential Equation): 8 Hrs

Introduction and origin of ODEs, linear differential equations, initial and boundary value problems. Wronskian, Variation of parameters, second Order Ordinary Differential Equations.

Unit 2 (Sturm-Liouville Problems): 15 Hrs

Existence and uniqueness theorem, eigenvalue problems, Sturm's comparison and separation theorems, Sturm-Liouville problems, orthogonality of eigen functions, eigen function expansion and series of orthonormal functions, Green's function.

Self-adjoint linear operator, Adjoint equations.

Unit 3 (Power Series Solution): 12 Hrs

Classification into regular and irregular singular points, power series solution, Frobenius method, Bessel, Hermite, Laguerre, Chebyshev and Gauss Hypergeometric equations and their general solutions, concept of point at infinity.

Unit 4 (Linear System of Order Linear Differential Equations): 10 Hrs

Linear and Non-linear autonomous system of equations, phase-plane analysis, critical points, stability of critical points and Lyapunov methods, limit cycle and periodic solutions, bifurcation of plane autonomous systems.

4. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)								Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PSO-1	PSO-2	PSO-3
CO-1	3	2							3	2	
CO-2	3	2							3	2	
CO-3	3	2	1			1			3	2	
CO-4	3		2	1	1	1		1	3	2	1
CO-5	3		2	1	1	1		1	3	2	1

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	10	
2. Computer Laboratory	15	
3. Engineering Workshop / Course/Workshop /	00	

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Kitchen		
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

6. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. Mathematics Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2 or TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation			
	Component 1: CE (50% Weightage)		
Subcomponent ►	TSC1	TSC2	SC3
Subcomponent Type ►	Mid term /Term Test	Assignment	Innovative
Maximum Marks ►	50	25	25
CO-1	x	x	
CO-2	x	x	
CO-3	x	x	x
CO-4			x
CO-5			x

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments

2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

8. Course Resources

a. Essential Reading

1. Course notes
2. Walter, W. (1998) Ordinary Differential Equations, Springer.
3. Simmons, G. F. (1974) Differential Equations with Applications and Historical Notes, 2nd edition, McGraw Hill.
4. Ross, S. L. (1984) Differential Equations, Wiley.
5. Eastham, M. S. P. (1970) Theory of Ordinary Differential Equations, Van Nostrand.
6. Ravi P Agarwal, Donal O'Regan (2008) An Introduction to Ordinary Differential Equations(Universitext), Paperback – Illustrated, Springer.

b. Recommended Reading

1. Boyce, W. E. and DiPrima, R. C. (2001) Elementary Differential Equations, 10th Edition, John Wiley and sons.
2. King, A. C., Billingham, J. and Otto, S.R. (2003) Differential Equations, Cambridge University Press.
3. Tenenbaum, M. and Pollard, H. (1985) Ordinary Differential Equations, Dover Publications.
4. Coddington, E. A. and Levinson, N. (1955) Theory of Ordinary Differential Equations, McGraw-Hill.
5. Earl A. Coddington (1989) An introduction to ordinary differential equations, Dover Publications.

c. Magazines and Journals

1. Dynamical Systems & Differential Equations
<http://www.springer.com/mathematics/dynamical+systems/journal/10625>
2. Journal of Differential Equations
<http://www.sciencedirect.com/science/journal/00220396>
3. Journal of Differential Equations
<http://www.journals.elsevier.com/journal-of-differential-equations>

d. Websites

1. <http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/>
2. <http://tutorial.math.lamar.edu/Classes/DE/DE.aspx>

e. Other Electronic Resources

1. <https://www.khanacademy.org/>
2. http://courseware.ku.edu.tr/ahmetkoc/public_html/W.%20E.%20Boyce,%20R.C.%20DiPrima%20-%20Elementary%20Differential%20Equations%20and%20Boundary%20Value%20Problems.pdf

9. Course Organization

Course Code	MTC552A		
Course Title	Theory of Ordinary Differential Equations		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.ns@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		


Head

Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M. G. Ramiah University of Applied Sciences
 Bangalore, India

Course Specifications: Real Analysis

Course Title	Real Analysis
Course Code	MTC553A
Course Type	Core
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of the course is to introduce students the concepts of real analysis. The Real Analysis course introduces foundational concepts in topology, continuity, differentiability, integration, and functions of several variables to students. Students explore continuity, uniform continuity, and classical theorems like the Mean Value and Taylor's theorems. The course covers Riemann and Riemann–Stieltjes integrals, their properties, and fundamental theorems of calculus. Convergence of function sequences and the Stone–Weierstrass theorem are also discussed. Finally, the course examines multivariable calculus concepts such as partial derivatives, the chain rule, and the inverse and implicit function theorems with examples and applications.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Understand and explain fundamental concepts of metric spaces, open, closed, compact, connected sets, continuity, differentiability, integrability and uniform convergence
- CO-2.** Prove statements in the context of real analysis using definitions
- CO-3.** Evaluate Riemann and Riemann–Stieltjes integrals, and understand the relationship between integration and differentiation through the fundamental theorems of calculus
- CO-4.** Solve problems on metric spaces, sequence and series, continuity, differentiability, uniform convergence, integrability, Mean Value theorems, Taylor's theorems and functions of several variables
- CO-5.** Apply concepts of multivariable calculus, including partial derivatives, the chain rule, and the inverse and implicit function theorems to solve the problems relate to real analysis



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Department of Mathematics and Statistics
Faculty of Natural Sciences
S. Baramulla University of Applied Sciences
Baramulla, J&K

4. Course Contents**Unit 1 (Basic Topology):**

Field and order structure in $\mathbb{R}$. Finite, countable and uncountable sets. Elementary theory of metric spaces, open, closed, compact, perfect and connected sets. k -cell and its compactness, Heine - Borel theorem. Bolzano-Weierstrass theorem. **10- hours**

Unit 2 (Continuity and Differentiability):

Introduction, continuity and compactness, continuity and connectedness, uniform continuity and discontinuities. Derivative of real functions, mean value theorems and Taylor's theorem. **6- hours**

Unit 3 (Integration):

Riemann integrals, Riemann - Stieltjes integrals, definition and existence, properties. Integration and differentiation, Fundamental theorems of integral calculus. **7- hours**

Unit 4 (Sequence and Series of Functions):

Point wise convergence, uniform convergence and Weierstrass M-test. Uniform convergence and continuity. Uniform convergence and Riemann - Stieltjes integration. Uniform convergence and differentiation. Uniform convergence and boundedness. The Stone-Weierstrass theorem(Statement only). **12- hours**

Unit 5 (Functions of Several Variables):

Differentiation, partial differentiation, chain rule, directional derivative, Hessian matrix. The inverse function and implicit function theorems, illustration and examples. **10- hours**

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	1	1	2		1				1	2	2	2	1
CO-2	1	1	3		2				2	2	2	3	1
CO-3	2		3		2				2	2	2	3	2
CO-4	2		3		2			1	2	2	2	3	2
CO-5	2		3		2			1	2	3	2	3	2

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. Mathematics Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, or TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ►	TSC1	TSC2	SC3	
Subcomponent Type ►	Mid term /Term Test	Assignment	Innovative	100 Marks
Maximum Marks ►	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X	X	X	X
CO-4	X	X		X
CO-5	X	X		X

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment

8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Rudin, W., 1976, Principles of Mathematical Analysis, 3rd Ed., McGraw Hill.
3. Apostol, T.M., 1988, Mathematical Analysis, 2nd Ed., Narosa publishing house.

b. Recommended Reading

1. Bartle, R.G., 1976, The Elements of Real analysis, 2nd Ed., John Wiley and Son Inc.
2. Pugh, C.C., 2002, Real Mathematical Analysis, Springer.
3. Malik, S.C., 2011, Principle of Real Analysis, 2nd Ed., New Academic Sciences Ltd.
4. Howie, J.M., 2006 Real Analysis, Springer.

c. Websites

1. <https://www.coursera.org/>
2. <http://nptel.ac.in/>
3. <https://ocw.mit.edu/index.htm>

d. Other Electronic Resources

1. <https://www.khanacademy.org/>

10. Course Organization

Course Code	MTC553A		
Course Title	Real Analysis		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.ns@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		



Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Course Specifications: Numerical Analysis

Course Title	Numerical Analysis
Course Code	MTC554A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The course aims at training students in handling various aspects numerical computations. In this course, the students learn the basics of numerical methods to solve linear and non-linear equations. The course describes the different numerical techniques of numerical linear algebra, interpolation, numerical integration and differentiation.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	2:1:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. Illustrate various methods of numerical solution to polynomial and transcendental equations, numerical solution to non-linear system, interpolation and numerical integration
- CO-2. State and prove theorems on convergence and stability of numerical algorithms
- CO-3. Solve simple problems of linear and non-linear root finding methods, system of linear equations, eigenvalues, interpolation methods and quadrature rules
- CO-4. Solve complex problems of linear and non-linear root finding methods, system of linear equations, eigenvalues, interpolation methods and quadrature rules
- CO-5. Solve complex real world problems associated with nonlinear equations, system of equations, interpolation and numerical integration



Head

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Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

4. Course Contents

Unit 1 (Solution of linear and Nonlinear Equations): **7 Hrs**

Mathematical preliminary and error analysis. Numerical solutions of nonlinear algebraic equations: Bisection and Newton-Raphson method, sufficient condition for rate of convergence and error approximation fixed-point iteration.
Iterative methods for nonlinear system of equations: Newton-Raphson method.

Unit 2 (Numerical Linear Algebra): **8 Hrs**

Direct methods for linear system of equations: LU decomposition and Cholesky methods.
Iterative methods for linear system of equations: Matrix norms, Jacobi and Gauss-Seidel methods, relaxation methods.
Computation of eigenvalues and eigenvectors: Power method, Householder's method, QR algorithm.

Unit 3 (Interpolation): **7 Hrs**

Lagrange, Hermite and Cubic-spline interpolations with uniqueness and error term. Numerical differentiation using interpolation and method of undetermined coefficients.

Unit 4 (Numerical Integration): **8 Hrs**

Methods based on interpolation. **Gaussian quadrature, Gauss-Legendre.** Integration over rectangular and general quadrilateral areas and multiple integration with variable limits.

Experiments:

Experiments are based on the concepts to understanding the MATLAB commands and solving the ordinary differential equation to obtain numerical solution.

1. Introduction to MATLAB.
2. Bisection method using MATLAB
3. Newton-Raphson using MATLAB
4. LU decomposition using MATLAB
5. Cholesky methods using MATLAB
6. Jacobi Method using MATLAB
7. Gauss-Seidel method using MATLAB
8. Power method using MATLAB
9. Cubic-spline interpolations using MATLAB
10. Numerical differentiation using MATLAB
11. Gaussian quadrature using MATLAB Pr


Head
Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 075.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)								Programme Specific Outcome (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PSO-1	PSO-2	PSO-3
CO-1	3	3							3		1
CO-2	3	2							3	2	1
CO-3	1	2	3	3		1	1	1	3		1
CO-4	2	2	2	3		1	1	1	3		1
CO-5	1	2	3	3	2	1	1	1	3	2	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		30
1. Course Laboratory	30	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		85

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.


Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Faculty of Natural Sciences

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2 or TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ►	TSC1	TSC2	SC3	
Subcomponent Type ►	Mid term /Term Test	Assignment	Innovative	100 Marks
Maximum Marks ►	50	25	25	
CO-1	x	x		x
CO-2	x	x		x
CO-3	x	x	x	x
CO-4			x	x
CO-5			x	x

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester. Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Class room, assignment
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Sastry, S.S., 1998, Introductory Methods of Numerical Analysis, Prentice-Hall of India.

3. Jain, M.K., Iyengar, S.R.K. and Jain, R.K., 1993, Numerical Methods for Scientific and Engineering Computation, Wiley Eastern.
4. Demmel, J. W., 1997, Applied Numerical Linear Algebra, 1st Ed., SIAM.

b. Recommended Reading

1. Chapra, S.C. and Raymond, P.C., 2000, Numerical Methods for Engineers, Tata McGraw Hill.
2. Burden, R.L. and Faires, J.D., 1989, Numerical Analysis, 4th Ed., P.W.S. Kent Publishing Company
3. Golub, G. H. and Van Loan, C. F., 1996, Matrix Computations, 3rd Ed. Johns Hopkins University Press

c. Websites

1. <https://swayam.gov.in>
2. <https://coursera.org>
3. <http://ocw.mit.edu>

d. Other Electronic Resources**10. Course Organization**

Course Code	MTC554A		
Course Title	Numerical Analysis		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.mp@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		



Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.



Dean
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Statistics and Probability for Data Science

Course Title	Statistics and Probability for Data Science
Course Code	MTC555A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

This specialization module aims at developing basic concepts in probability and statistics. It brings about the idea of the Centre and variability of quantitative data and provides graphical data summaries. This course introduces probability, random variables, mathematical expectation, and probability distributions. The concept of joint distributions, expectations, conditional expectation, conditional variance, and independence were focused in this module.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Explain the concepts of statistics, probability, random variables, probability distributions, and joint distributions.
- CO-2.** State and prove the important theorems in statistics, probability, random variables, probability distributions, and limit theorems.
- CO-3.** Solve simple problems associated with statistics, probability, random variables, probability distributions, and limit theorems.
- CO-4.** Model and solve the real-world problems associated with introductory statistics, probability, random variables, and probability distributions.
- CO-5.** Solve complex problems associated with statistics, probability, random variables, probability distributions, and limit theorems.

4. Course Contents**Unit 1 (Introduction to Statistics):****7 hrs**

Introduction to Statistics, Sample versus Population. Different types of data, measuring the center and variability of quantitative data and graphical summaries of data. Gathering data from experimental and observation studies. Good ways to sample and Experiment.

Unit 2 (Introduction to Probability):**8 hrs**

Random experiments, sample space, discrete and continuous sample space, product of sample spaces, infinite sample spaces, events, probability of events, conditional

probability, multiplication rule, the law of total probability, Bayes' rule, independence, problems.

Unit 3 (Random Variables):**10 hrs**

Random variables, discrete and continuous-valued random variables on discrete and continuous probability spaces. Probability mass and density functions, the cumulative distribution function, transformation of random variables, expected value, and variance of random variables.

Unit 4 (Probability distributions):**12 hrs**

Bernoulli, Binomial, Poisson, Geometric, Uniform, Exponential, and Gaussian/Normal distributions, characteristics (derivation of expected value and variance), and applications.

Unit 5 (Limit Theorems):**8 hrs**

Moments, moment generating function and properties, inequalities involving expectations, Chebychev's inequality, modes of convergence of a sequence of random variables, weak Law of Large Numbers, Strong Law of Large Numbers, Central Limit theorem, applications.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	2									3	2	
CO-2	3	2									3	2	
CO-3	2	2	3								3	2	
CO-4	2	2	3								3	2	1
CO-5	2	2	3								3	2	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	

Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Applied Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
Subcomponent ►	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Innovative	
Maximum Marks ►	25	25	25	25	100 Marks
CO-1	X	X			X
CO-2	X	X			X
CO-3	X	X	X	X	X
CO-4		X	X	X	X
CO-5			X	X	X
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination

6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. J.E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, 2009.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, 11th Ed., Sultan Chand and Sons, 2007.
4. Ross, S. M. (2014). Introduction to Probability and Statistics for Engineers, 5th Edition, Academic Press.

b. Recommended Reading

1. Yates, R. and Goodman, D. (2004) Probability and Stochastic Processes, 2nd edition, Wiley.
2. Johnson, R. (2010). Miller and Freund's Probability and Statistics for Engineers, 8th edition, Pearson.

c. Magazines and Journals

1. Journal of Applied Probability and Statistics (JAPS) <http://www.isoss.net/japs/>
2. Journal of the American Statistical Association www.amstat.org/publications/journals.cfm

d. Websites

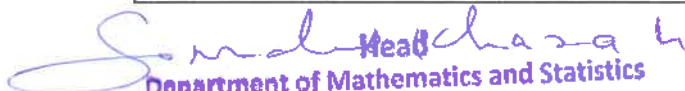
1. <http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2005/>

e. Other Electronic Resources

1. <https://www.khanacademy.org/math/statistics-probability>

10. Course Organization

Course Code	MTC563A	
Course Title	Statistics and Probability for Data Science	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2025	
Next Course Specifications Review Date	June 2027	


 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Faculty of Natural Sciences

Course Specifications: Basic Scientific Programming

Course Title	Basic Scientific Programming
Course Code	MTM551A
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of this course is to introduce students to numerical analysis with MATLAB. Students are taught the method of solving ordinary differential equations by using MATLAB.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:1:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Understand and apply basic algebraic and matrix operations in MATLAB and use built-in and command-line functions.
- CO-2.** Create 2D and 3D plots to visualize and interpret mathematical models and data efficiently and develop and execute scripts and functions by using MATLAB.
- CO-3.** Write and execute MATLAB code for Euler's method, modified Euler's method, Runge-Kutta 4th order method, Adam's Bashforth method and Milne's predictor corrector method.
- CO-4.** Apply numerical methods to solve real world problems using MATLAB code.
- CO-5.** Solve complex real world problems using MATLAB code and compare the exact solution and numerical solutions.

Head

Department of Mathematics and Statistics

Faculty of Natural Sciences

J.S. Ramaiah University of Applied Sciences

4. Course Contents

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Unit 1 (Introduction to MATLAB):**10 hrs**

Introduction to MATLAB, MATLAB environment- Command window, editor window, figure window, workspace, Basic algebraic and matrix operations, keywords, built-in and command line functions, 2D Plots, 3D Plots, Scripts and functions.

Unit 2 (Solution of ODE):**15 hrs**

Numerical solution of ordinary differential equations, Picards iteration method, single-step methods – Euler's method, modified Euler's method and Runge-Kutta 4th order method. Multi-step methods –Milne's predictor corrector method. Solution of boundary value problem: Shooting method. Solution by MATLAB built-in function ode45 and dsolve.

List of MATLAB programs:

1. Introduction to MATLAB.
2. Basic algebraic and matrix operations.
3. Built-in and command line functions.
4. 2D and 3D Plots.
5. Scripts and functions.
6. Euler's Method using MATLAB Program.
7. Modified Euler's Method using MATLAB Program.
8. RK Method using MATLAB Program.
9. Adam's Bashforth Method using MATLAB Program.
10. Milne's Method using MATLAB Program.
11. Solution of boundary value problem: Shooting method.
12. Solution by MATLAB built-in function ode45 and dsolve.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	1		3		1	1	1			3	2	1
CO-2	3	2		3	2	1	1	1	2		3	2	2
CO-3	3	2	3	3	3	1	1	1			3	3	1
CO-4	3	1	3	3	3	1	1	1		2	3	3	1
CO-5	3	1	3	3	3	1	1	1		3	3	3	2

6. Course Teaching and Learning Methods

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Faculty of Natural Sciences
08-9500-550 058.

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		07
Demonstrations		06
1. Demonstration using Videos	01	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	06	00
Numeracy		
1. Solving Numerical Problems	00	13
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	13	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	00
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	04
Term Tests, Laboratory Examination/Written Examination, Presentations		
Total Duration in Hours		30

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent	TSC1	TSC2	SC3	
Subcomponent Type	Mid-term /Term Test	Assignment	Innovative	100 Marks
Maximum Marks	50	25	25	
CO-1	x	x		x

CO-2	x	x		x
CO-3	x	x	x	x
CO-4			x	x
CO-5			x	x

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Laboratory manual.
2. Rudra Pratap. 2013. Getting started with MATLAB. United Kingdom: Oxford University press.
3. Won Y. Yang, Wenwu Cao, Tae S. Chung, John Morris. Applied numerical methods using MATLAB, John Wiley & Sons, Inc.

b. Recommended Reading

1. Dukkipati, R.V. 2011. Applied Numerical Methods using MATLAB. 1st Ed. New Delhi: New Age publication.
2. Jain, M. K., Iyengar, S.R.K. and Jain, R.K. 2008. Numerical Methods. New Delhi: New Age.


Samuel Chelva
 Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Faculty of Natural Sciences
 Bangalore-560 058.

c. Magazines and Journals

d. Websites

1. <https://www.coursera.org/>
2. <http://nptel.ac.in/>

e. Other Electronic Resources

1. <https://www.khanacademy.org/>
2. tutorial.math.lamar.edu/
3. <http://www.sosmath.com/diffeq/diffeq.html>
4. http://serc.carleton.edu/sencer/ode_real_world/index.html

10. Course Organization

Course Code	MTM551A	
Course Title	Basic Scientific Programming	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	July 2026	
Next Course Specifications Review Date	June 2028	


Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Topology

Course Title	Topology
Course Code	MTC561A
Course Type	Core Theory Course
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of the course is to introduce the basic concepts of topological spaces, including open sets, continuity, connectedness, compactness, and separation axioms. Students are taught various topological spaces, such as subspaces, quotient spaces, product spaces and advanced topics like Tychonoff's theorem, Urysohn lemma and paracompactness. They will develop problem-solving skills and the ability to analyze, construct, and classify topological spaces.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. Define and understand basic concepts of general topological spaces, including open and closed sets, connectedness, compactness and separation with suitable examples.
- CO-2. Explain the key properties and theorems related to topological spaces such as subspace, product, metric, and quotient topology.
- CO-3. Apply the properties of topological spaces, theorems and logical reasoning to solve problems, construct examples and verify properties of given space.
- CO-4. Analyze topological spaces using concepts and theorems of compactness, connectedness, countability and separation axioms, and assess their implications for the classification of spaces.
- CO-5. Construct logical proofs and provide relevant examples or counterexamples to validate advanced topological theorems like Tychonoff theorem, Urysohn lemma, and Tietze extension theorem.


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 Bangalore-560 058.

4. Course Contents

Unit 1 (Topological spaces): open sets, closed sets, neighbourhoods, bases, subbases, limit points, closures, interiors, continuous functions, homomorphisms, Subspace topology.

(13 Hours)

Unit 2 (Quotient topology): The product topology, metric topology, quotient topology, product invariant properties of finite products, projection maps.

Unit 3(Connectedness and compactness): Connected spaces, local connectedness, compact spaces, local compactness, Tychonoff theorem.

(12 Hours)

Unit 4 (Axioms of Countability): First countable space, Second countable space and Lindelof property.

(6 Hours)

Unit 5 (Separation axioms): Separation axioms, normal spaces, Urysohn lemma, Urysohn metrization theorem, Tietze extension theorem, one-point compactification, paracompactness.

(14 Hours)

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3		2		1					2	2	2	1
CO-2	3		2		1				1	2	2	2	1
CO-3	3		3		2				2	2	2	3	1
CO-4	3		3		2	1			2	2	2	3	1
CO-5	3		2		3				2	2	2	3	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	30	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	

4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	15	
5. Group Discussions	20	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Sc. (Hons.)(Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
Subcomponent ►	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
	SC1	SC2	SC3	
Subcomponent Type ►	Mid Term	Assignment	Quiz/Innovation	100 Marks
Maximum Marks ►	50	40	10	
CO-1	x			x
CO-2	x			x
CO-3	x			x
CO-4		x	x	x
CO-5		x	x	x
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials,

		Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Munkers, J.R. (2000) Topology, 2nd edition, Pearson education, India.
3. Pervin, W.J. (1964) Foundation of General Topology, Academic Press, New York.

b. Recommended Reading

1. Simmons, J.F. (1963), Introduction to Topology and Modern analysis, Tata Mcgraw-hill, India.
2. Dugundji, J. (1975) Topology, Printice Hall of India, India.
3. Kelley, J. L. (1975) General Topology, 2nd edition, Springer nature, London.

c. Magazines and Journals

1. The College Mathematics Journal, Mathematical Association of America. <https://www.maa.org/press/periodicals/college-mathematics-journal/the-collegemathematics-journal>
2. SIAM Undergraduate Research Online, Society for Industrial and Applied Mathematics, <http://www.siam.org/students/siuro/index.php>
3. Involve – A Journal of mathematics, <https://msp.org/involve/about/journal/about.html>
4. Rose-Hulman Undergraduate Mathematics Journal, Rose-Hulman Institute of Technology. <https://scholar.rose-hulman.edu/rhumj/>

d. Websites

1. <https://www.coursera.org/>
2. <http://nptel.ac.in/>

e. Other Electronic Resources

1. <https://www.khanacademy.org/>
2. tutorial.math.lamar.edu/
3. <http://www.sosmath.com/diffeq/diffeq.html>
4. http://serc.carleton.edu/sencer/ode_real_world/index.html

10. Course Organization

Course Code	MTC561A		
Course Title	Topology		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.mp@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		



Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Theory of Partial Differential Equations

Course Title	Theory of Partial Differential Equations
Course Code	MTC562A
Course Type	Core Theory Course
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of the course is to provide an understanding of the concepts, techniques, and applications of partial differential equations. It begins with the formulation, classification, and solution of first-order linear and quasi-linear PDEs using methods like characteristics. The course then focuses on second-order PDEs, their classification into parabolic, hyperbolic, and elliptic types, and their solutions. Detailed study of the heat, wave, and Laplace equations is included through separation of variables and boundary value problems. Key concepts such as well-posedness, fundamental solutions, and properties of harmonic functions are also introduced.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

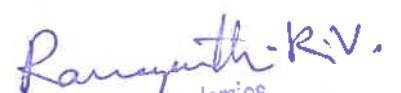
- CO-1.** Identify and classify first- and second-order partial differential equations based on order, linearity, and type, and explain their origin and relevance in physical models. Solve first order, second order linear partial differential equation (PDE).
- CO-2.** Apply analytical techniques such as the method of characteristics to solve first-order linear and quasi-linear PDEs.
- CO-3.** Analyze second-order PDEs, reduce them to canonical forms, and solve equations with constant and variable coefficients using appropriate methods.
- CO-4.** Develop solutions to classical PDEs such as the heat, wave, and Laplace equations using separation of variables and other methods under given boundary and initial conditions.
- CO-5.** Evaluate the properties of solutions such as uniqueness, stability, and regularity, and formulate boundary value problems using fundamental principles like Green's identities and harmonic functions.


Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Faculty of Natural Sciences


Dean
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.


Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

4. Course Contents**Unit 1 (First Order Partial Differential Equations):****8 hrs**

First Order Partial Differential Equations: - Basic definitions, Origin of PDEs, Classification, Geometrical interpretation and physical models. Notion of Well posedness. The Cauchy problem, solutions of first order PDEs by method of characteristics, complete integrals. The general first order equation of two variables and solutions generated as envelopes. Compatible system of first order partial differential equations.

Unit 2 (Second Order Partial Differential Equations):**10 hrs**

Second Order Partial Differential Equations:- Definitions of Linear and Non-Linear Equations, Linear Superposition principle, Classification of second-order linear partial differential equations into hyperbolic, parabolic and elliptic PDEs, Reduction to canonical forms, solution of linear Homogeneous and non-homogeneous with constant coefficients, Variable coefficients, Monge's method.

Unit 3 (Heat Equation):**9 hrs**

Parabolic equation, heat equation as an example of parabolic PDE. The initial value problem, the initial-boundary value problem, and the Cauchy problem for the heat equation. Separation of variables. The maximum principle for the heat equation. The uniqueness and regularity of the solution to the heat equation.

Unit 4 (Wave Equation):**9 hrs**

Hyperbolic equation, wave equation as an example of hyperbolic PDE. The Cauchy problem and the initial-boundary value problems for the wave equation. Separation of variables. Propagation of singularities. Reduction of second-order PDEs into a linear system of first-order PDEs.

Unit 5 (Elliptic Equation):**9 hrs**

Elliptic equation, Laplace equation as an example of elliptic PDE. Green's identity, Fundamental solutions and Poisson's equation. Basic property of harmonic functions. Boundary value problem for the Laplace equation. Separation of variables in polar and spherical coordinates.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3		1								3	2	
CO-2	3		1								3	2	
CO-3	2		3					1	2	2	3	2	
CO-4	2		3		2			1	2	2	3	2	1
CO-5	2		3		2			1	2	2	3	2	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45

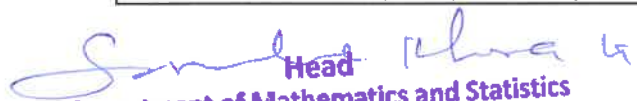
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	15	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Applied Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ▶	TSC1	TSC2	TSC3	100 Marks
Subcomponent Type ▶	Mid Term Test	Assignment	Innovative	
Maximum Marks ▶	50	25	25	
CO-1	x	x	x	
CO-2	x		x	x
CO-3	x	x	x	x
CO-4			x	x
CO-5		x	x	x
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				


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 Bangalore-560 058.

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Colton, D., 2004, Partial Differential Equation an Introduction, Dover Publications.
3. K. Sankara Rao, 2010, Introduction to Partial Differential Equations, PHI Learning Pvt. Ltd
4. Myint, U. T. and Debnath, L., 2007, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Birkhäuser.

b. Recommended Reading

1. Polyanin, A. D., 2001, Handbook of Linear Partial Differential Equations for Engineers and Scientists, CHAPMAN and HALL/CRC.
2. Haberman, R., 2012, Applied Partial Differential Equations with Fourier series and Boundary Value Problems, 5th edition, Pearson.
3. John, F., 1991, Partial Differential Equations, 4th edition, Springer.
4. McOwen, R., 2002, Partial Differential Equations, Methods and Applications, Pearson.
5. Sneddon PDE

c. Magazines and Journals


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Analysis and PDE

<http://msp.org/apde/about/journal/about.html>

d. Websites

<http://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/>

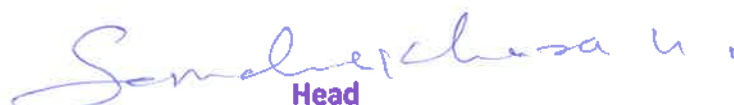
e. Other Electronic Resources

1. <http://www.math.tifr.res.in/~publ/ln/tifr70.pdf>

2. <https://www.khanacademy.org/math/diff...>

10. Course Organization

Course Code	MTC562A	
Course Title	Theory of Partial Differential Equations	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	



Head

Department of Mathematics and Statistics

Faculty of Natural Sciences

M.S. Ramalah University of Applied Sciences

Bangalore-560 058.

Course Specifications: Abstract Algebra

Course Title	Abstract Algebra
Course Code	MTC563A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of the Course is to introduce the fundamentals of abstract algebra. The students are introduced with major building blocks of abstract algebra, namely, group theory and ring theory. This Course trains students to prove abstract theorems in a meaningful way.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. Understand basic concepts of group theory, ring theory, field theory with suitable examples
- CO-2. State and prove important theorems in group theory, ring theory
- CO-3. Solve algebraic problems using appropriate techniques
- CO-4. Demonstrate and understand special groups and rings and their properties
- CO-5. Examine the properties implied by the definitions and theorems of groups, rings

4. Course Contents**Unit 1 (Group Theory and subgroups): 7 hrs**

Introduction to groups: Basic axioms and examples, dihedral groups, symmetric groups, matrix groups, cyclic group, homomorphisms and isomorphism. Definition and examples of subgroups, Subgroups generated by subsets of a group.

Unit 2 (Quotient Groups and Homomorphisms): 10 hrs

Definitions and examples, cosets and Lagrange's theorem, the isomorphism theorems, Permutation groups, Cayley's theorem, the class equation, the Sylow's theorems, the simplicity of A_n , direct products, the fundamental theorem of finitely generated abelian groups.

Unit 3 (Ring Theory): 15 hrs

Fundamentals of rings, integral domains, division rings, fields. Homomorphisms, kernel and image of homomorphisms of rings, isomorphism of rings. Ideals and quotient rings, fundamental theorem of homomorphism of rings. Euclidean domains, principal ideal domains, unique factorization domains. Polynomial rings, polynomial rings over fields, irreducibility criteria.

Unit 4 (Field Theory):**13 hrs**

Field extensions, algebraic extensions, homomorphism of algebraic extension, splitting fields, separable polynomials, perfect fields, group of automorphism of field, fundamental theorem of Galois theory, solvability, finite fields, Galois group, computing Galois group over $\mathbb{Q}$.

Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	2	3			2					1	2	2	
CO-2	2	3	1		2					2	2	3	
CO-3	2	3	1		2	1	1	1		2	2	2	1
CO-4	2	3				1	1	1		2	2	3	1
CO-5	2	3	1		2	1	1	1		2	2	3	1

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	00
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

6. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, or TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
Subcomponent ►	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
	TSC1	TSC2	SC3	
Subcomponent Type ►	Mid term /Term Test	Assignment	Innovative	100 Marks
Maximum Marks ►	50	25	25	
CO-1	☐	☐		☐
CO-2	☐	☐		☐
CO-3	☐	☐	☐	☐
CO-4			☐	☐
CO-5			☐	☐

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester. Course reassessment policies are presented in the Academic Regulations document.

7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work

13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

8. Course Resources**a. Essential Reading**

1. Class notes.
2. Dummit, D.M. and Foote, R.M., 2011, Abstract Algebra, 3rd Ed., Wiley.
3. Herstein, I.N., 2006, Topics in Algebra, 2nd Ed., Wiley.

b. Recommended Reading

1. Artin, M., 2015, Algebra, 2nd Ed., Pearson Education India.
2. Fraleigh, J.B., 2013, A first course in abstract algebra, 7th Ed., Pearson Education India.
3. Gallian, J.A., 2013, Contemporary Abstract Algebra, 8th edition, Cengage.
4. Jacobson, N., 2009, Basic Algebra – I, 2nd Ed., Dover Publications.
5. Lang, S., 2002, Algebra, 3rd Ed., Springer.
6. Singh, S. and Zameeruddin, Q., 2006, Modern Algebra, 8th Ed., Vikas Publishing House.

c. Magazines and Journals**d. Websites**

1. <https://swayam.gov.in>
2. <https://ocw.mit.edu/index.htm>

e. Other Electronic Resources**9. Course Organization**

Course Code	MTC555A	
Course Title	Abstract Algebra	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	

Course Specifications: Complex Analysis

Course Title	Complex Analysis
Course Code	MTC564A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Faculty of Natural Sciences

1. Course Summary

The aim of the module is to lay foundation on concepts such as complex analytic, meromorphic functions, complex integration and residue calculus.

The course provides a detailed analysis of analytic functions and its applications in mathematics and other disciplines. The module also emphasizes on the expansion of analytic and meromorphic functions in the form of power series, and conformality of analytic functions. The module illustrates the application of conformal mappings to fluid mechanics and residue integration method to mathematical transforms.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	70
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Understand and define the underlying concepts of analyticity, complex integration, power series, residue calculus
- CO-2.** State and prove important theorems such as Cauchy's theorem, Taylor's and Laurent's theorems, Rouché's theorem, maximum modulus theorem, Phragmen-Lindelof theorem and so on
- CO-3.** Solve simple problems involving functions of a complex variable, analyticity, complex integration, power series, residue calculus, maximum modulus theorem
- CO-4.** Apply properties of analytic functions to evaluate improper integrals and definite integrals on the real line using contour integration and key theorems in complex analysis
- CO-5.** Solve complex mathematical problems arising from complex analysis

4. Course Contents**Unit 1 (Introduction):****10 hrs**

Complex numbers and functions, limits, complex differentiability and Cauchy-Riemann


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equations in Cartesian and polar coordinates, Analytic functions, Harmonic conjugates. Analysis of elementary functions, Bilinear transformations, Conformal mappings.

Unit 2 (Complex integration):**7 hrs**

Complex line integral, Cauchy's theorem and Cauchy's integral formula, Cauchy's theorem for rectangle and triangle, Morera's theorem, Cauchy's inequality, Liouville's Theorem, Fundaments theorem of algebra, Open mapping theorem.

Unit 3 (Series):**7 hrs**

Power series, Radius of convergences, Power series representation of analytic functions, Taylor series, Laurent Series.

Unit 4 (Residue Calculus):**7 hrs**

Poles and zeros, Singularities, types of singularities. Residue calculus, Cauchy's residue theorem, Evaluation of improper integrals and definite integrals on real line, zeros of analytic functions, number of Argument principle, Rouché's theorem.

Unit 5:**7 hrs**

Maximum modulus theorem and their applications - Schwartz lemma. Convex functions, Hadamard's three circle theorem. Phragmen-Lindelof theorem.

Unit 6:**7 hrs**

Statements only of The Riemann mapping theorem, Weierstrass factorization theorem, Mean Value theorem, Poisson's formula, Poisson's Integral formula, Jensen's formula.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	3	3		2			1		1	3	2	1
CO-2	3	2	2		3			1		1	3	3	1
CO-3	3	2	3		2			2		1	3	2	1
CO-4	3	2	3		2			2		1	3	3	1
CO-5	3	2	3		2			2		1	3	3	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		15
1. Solving Numerical Problems	30	
Practical Work		00
1. Course Laboratory	00	

2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain-Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2 or TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
Subcomponent ►	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
	TSC1	TSC2	SC3	
Subcomponent Type ►	Mid-term /Term Test	Assignment	Innovative	100 Marks
Maximum Marks ►	50	25	25	
CO-1	x	x		x
CO-2	x	x		x
CO-3	x	x	x	x
CO-4			x	x
CO-5			x	x

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester. Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments

2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Conway, J. B. (1995) *Functions of one complex variable*, 2nd edition, Springer.

b. Recommended Reading

1. Ahlfors, L.V. (1979) *Complex Analysis*, 3rd edition, McGraw Hill.
2. Ponnusamy, S. (2005) *Foundations of Complex Analysis*, 2nd edition, Narosa Publishing House
3. Lang, S. (1999) *Complex Analysis*, 4th edition, Springer.
4. Brown, J.W. and Churchill, R.V. (2013) *Complex Variables and Applications*, 9th edition, Mc Graw-Hill.
5. Palka, B. C., (2012), *An Introduction to Complex Function Theory*, Springer

c. Magazines and Journals

1. The College Mathematics Journal, Mathematical Association of America.
<https://www.maa.org/press/periodicals/college-mathematics-journal/the-collegemathematics-journal>

d. Websites

1. <https://www.coursera.org/>
2. <http://nptel.ac.in/>

e. Other Electronic Resources

1. <https://complex-analysis.com/>

10. Course Organization

Course Code	MTC564A	
Course Title	Complex Analysis	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	


 Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Machine Learning – 1

Course Title	Machine Learning – 1
Course Code	MTE561A
Course Type	Core Elective Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

This Machine Learning course provides a solid foundation in core algorithms and concepts spanning regression, classification, and unsupervised learning. Students will acquire theoretical understanding of topics such as linear and logistic regression, neural networks, support vector machines, decision trees, ensemble methods, clustering, and dimensionality reduction. Emphasis is placed on performance evaluation and algorithm selection based on data characteristics.

Aim of the Course:

1. To equip learners with a strong understanding of fundamental machine learning principles and techniques.
2. To develop the ability to analyze and evaluate model performance, and to select and apply appropriate algorithms based on data characteristics and problem context.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Identify and recall the foundational concepts, terminology, and scope of machine learning.
- CO-2.** Describe and differentiate supervised and unsupervised learning approaches, including linear/logistic regression, neural networks, SVMs, decision trees, K-means, and PCA.
- CO-3.** Apply appropriate machine learning algorithms to solve basic classification, regression, and clustering problems.
- CO-4.** Analyze the performance of machine learning models using standard evaluation metrics and validation techniques.
- CO-5.** Select and apply suitable machine learning techniques to model moderately complex real-world problems with justified choices.

4. Course Contents


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Unit 1: Regression and Classification**(19 hours)**

Introduction to Machine Learning: Types of learning (supervised and unsupervised), applications of ML in various domains.

Data exploration and visualization, data cleaning and preprocessing, feature engineering.

Linear Regression: Simple and multiple linear regression, cost functions, gradient descent algorithm, Bias-Variance Trade-off, Model Evaluation Metrics, Regularization: Ridge regression, LASSO regression.

Logistic Regression: Binary classification using sigmoid, cost function, decision boundary

Multiclass Classification, Regularized Logistic Regression,

Evaluation and Model Diagnostics: Bias-Variance Trade-off, model evaluation metrics.

Unit 2: Supervised Learning Algorithms**(16 hours)**

Artificial Neural Networks: Single-layer perceptron and perceptron learning rule, Multi-layer perceptron (MLP), forward and backward propagation, Loss functions and gradient descent optimization.

Support Vector Machines (SVMs): Concept of margin, linear SVM, hinge loss, Soft-margin classification, Introduction to kernels: polynomial and RBF kernels.

Decision Trees: Entropy, information gain, overfitting, handling numeric and categorical attributes

Ensemble Methods - Random Forest: Bootstrap sampling, feature bagging, Boosting, Feature importance analysis and visualization. C

Model selection Techniques: Cross-validation.

Unit 3: Unsupervised Learning**(10 hours)**

Clustering: Introduction and motivation, K-means algorithm, Hierarchical clustering, Curse of dimensionality and clustering limitations

Dimensionality Reduction: Principal Component Analysis (PCA), Covariance matrix, eigenvectors, explained variance, Geometric interpretation of PCA.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	2							1	1	3		
CO-2	3	2							1	1	3		
CO-3	3	2	3	2							3		
CO-4	3	2		3	2	1	1	1		1	3	1	1
CO-5	3	2	3	3	2	1	1	1		1	3	1	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		07
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	07	
Numeracy		08

1. Solving Numerical Problems	08	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	SC1	SC2	SC3	100 Marks
Subcomponent Type ▶	Term Test (25 % Weight)	Assignment (12.5 % Weight)	Innovative (12.5 % Weight)	
Maximum Marks▶	50	25	25	
CO-1	X		X	
CO-2	X		X	
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X

The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

S. Mahalingam
 Head of Department
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 Bangalore University
 Bangalore

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Laboratory
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes.
2. James G., Witten, D., Hastie, T., Tibshirani, R., and Taylor, J., 2024, An Introduction to Statistical Learning with Applications in Python, Springer Nature.

b. Recommended Reading

1. Deisenroth, M. P., Faisal, A. A., Ong C. S., 2020, Mathematics for Machine Learning, Cambridge University Press.
2. Aggarwal, C., 2023, Neural Networks and Deep Learning, 2nd Ed., Springer.
3. Murphy, K.P., 2022, Probabilistic Machine Learning: An Introduction, MIT Press.
4. Bishop, C.M., 2007, Pattern Recognition and Machine Learning, Springer.
5. Hastie, T., Tibshirani, R., and Friedman, J.H., 2009, The Elements of Statistical Learning, 2nd Ed., Springer.
6. Raschka, S., Liu, Y., and Mirjalili, V, 2022, Machine Learning with PyTorch and Scikit-Learn. Packt Publishing.
7. Géron, A., 2022, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, O'Reilly.
8. Montgomery, D. C., Peck, E. A., Vining, G. G., 2024, Introduction to Linear Regression Analysis, 6th Ed., Wiley

c. Magazines and Journals

1. Foundations and Trends in Machine Learning

2. IEEE Transactions on Pattern Analysis and Machine Intelligence
3. Neural Networks by Elsevier

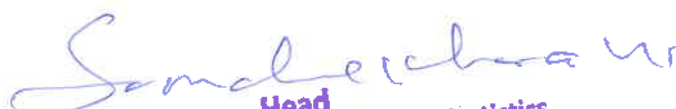
d. Websites

1. <https://dsai.iitm.ac.in/~ravi/nptel-courses/>
2. <https://nipunbatra.github.io/ml2024-fall/>

e. Other Electronic Resources

10. Course Organization

Course Code	MTE561A		
Course Title	Machine Learning - 1		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.ns@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		


Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Mathematical Foundation of Mechanics and Wave Propagation

Course Title	Mathematical Foundation of Mechanics and Wave Propagation
Course Code	MTE562A
Course Type	Discipline Specific Electives
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of the Course is to introduce the fundamentals of mechanics of solid and wave propagation. The students are introduced with major building blocks of mechanics of wave propagation in smart materials. This Course trains students to demonstrate the ability to study analytically the wave propagation in composite materials, interpret and analyze data, and report results.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** To understand the theory of elasticity including stress, strain and displacement
- CO-2.** To understand the Hooke's law and strain energy relationships.
- CO-3.** To understand the basic of seismic wave propagation.
- CO-4.** To be able to formulate the wave propagation problem with different composites.
- CO-5.** To be able to analyze and interpret the wave propagation problem results.

4. Course Contents**Unit 1 (Mechanics of Solid, Stress Analysis): 12 hrs**

Strength of material versus the theory of elasticity, Isotropy, Heterogeneity, Elasticity, and Plasticity Visco-elasticity, Elastic, Plastic, and Viscous Models, Definition of stress, Types of stress, Principal Stress, and Principal Plain, Notation of Stress, Sign Convention, Symmetry of stress Tensor, Equation of Equilibrium.

Unit 2 (Analysis of Strain and Stress-Strain Relationship): 15 hrs

Definition of strain, Types of strain, and strain-displacement relation, Components of strain tensor and geometrical interpretation of shear strain and body rotation terms, Properties of strain tensor, Small strains, and linear elasticity, Stress-strain relationship, Generalized Hooke's law, and number of constants, Bulk modulus and Lamé's constant, Hooke's law for isotropic

materials.

Unit 3 (Introduction to Wave Propagation):

8 hrs

Essential Components of a Wave, Concept of Wavenumber, Group Speeds and Phase Speeds, The general form of the wave equation and their characteristics, Overview of seismic waves and their importance, Types of seismic waves.

Unit 4 (Wave Propagation in Homogeneous and Layered Media):

10 hrs

Wave equations for homogeneous and layered media, Analytical solutions for wave propagation in simple media and layered media, Snell's law and reflection and refraction of seismic waves at interfaces analytical solutions for wave propagation in anisotropic media.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)								Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PSO-1	PSO-2	PSO-3
CO-1	2	3			2				2	2	
CO-2	2	3	1		2				2	3	
CO-3	2	3	1		2	1	1	1	2	2	1
CO-4	2	3				1	1	1	2	3	1
CO-5	2	3	1		2	1	1	1	2	3	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	00
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	

Term Tests, Laboratory Examination/Written Examination, Presentations	10
Total Duration in Hours	70



Head

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Faculty of Natural Sciences

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7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, or TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (60% Weightage)			Component 2: SEE (40% Weightage)
Subcomponent ►	TSC1	TSC2	SC3	
Subcomponent Type ►	Mid term /Term Test	Assignment	Innovative	100 Marks
Maximum Marks ►				
CO-1	☐	☐		☐
CO-2	☐	☐		☐
CO-3	☐	☐	☐	☐
CO-4			☐	☐
CO-5			☐	☐

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester. Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work

13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources**a. Essential Reading**

1. S M A Kazimi. Solid Mechanics, McGraw Hills 2015.
2. Srinivasan Gopalakrishnan, Elastic Wave Propagation in Structures and Materials, ISBN: 0367637576, CRC Press 2023.
3. Lay, T., & Wallace, T. C, Modern Global Seismology, Academic Press 1995.
4. Nayfeh, A. H, Wave Propagation in Layered Anisotropic Media, North-Holland Elsevier 1995.

b. Recommended Reading

1. Yuan-Cheng Fung, *Foundations of Solid Mechanics*, ISBN- 0133299120, Prentice Hall 1965.
2. 6. José M. Carcione, *Wave Fields in Real Media Wave Propagation in Anisotropic, Anelastic, Porous and Electromagnetic Media*, Fourth Edition, ISBN- 0323983433, Elsevier 2022.

c. Magazines and Journals**d. Websites****10. Course Organization**

Course Code	MTE562A	
Course Title	Mathematical Foundation of Mechanics and Wave Propagation	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	July 2025	
Next Course Specifications Review Date	July 2027	


 Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Statistical Inference

Course Title	Statistical Inference
Course Code	MTE563A
Course Type	Discipline Specific Elective
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The course aims to provide an understanding of inferential Statistics. The course introduces students to the basic definitions and concepts of inferential statistics. Students are taught the confidence intervals for mean, variance, and standard deviation. This course discusses the hypothesis testing for means, proportions, and variances of small and large samples and the applications of Chi-Square distribution, student t-distribution, and F-distribution.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Explain the concept and principles of estimation, sampling distributions and testing of hypothesis.
- CO-2.** State and prove the important theorems in estimation, sampling distributions and hypothesis testing.
- CO-3.** Solve simple mathematical problems associated with estimation, sampling distributions and hypothesis testing.
- CO-4.** Model and solve the real world problems associated with estimation, sampling distributions and hypothesis testing.
- CO-5.** Solve complex problems associated with estimation, sampling distributions, and hypothesis testing.

4. Course Contents:**Unit 1 (Introduction to Estimation):****10 hrs**

Concepts of estimation: point and interval estimation, unbiasedness, consistency and efficiency. Factorization theorem. Complete statistic, Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators (statement and applications). Confidence interval construction for true population parameters for single population with large samples.

Samir Kumar
 Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Dr. R. V. Ramesh
 Dean
 Faculty of Natural Sciences
 Faculty of Applied Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Ramesh R.V.
 Dean - Academics
 M.S. Ramaiah University of Applied Science
 Bangalore - 560 054

Unit 2 (Methods of Estimation):**7 hrs**

Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Bayes estimators.

Unit 3 (Sampling distributions):**8 hrs**

Introduction to sampling distributions. Sampling distribution of a statistic, sampling distribution of sample mean, and sample proportion. Introduction to the exact sampling distributions: t, F and Chi-Square distributions and their properties.

Unit 4 (Testing of hypothesis-1):**10 hrs**

Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests, use of CLT for testing proportions, means for single and two populations.

Unit 5 (Testing of hypothesis-2):**10 hrs**

Tests of significance and confidence intervals based on t, F, and Chi-Square distributions for single and two populations.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	2									3	2	
CO-2	3	2									3	2	
CO-3	2	2	3								3	2	1
CO-4	2	2	3								3	2	1
CO-5	2	2	3								3	2	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	

6. Model Studio	00	
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B.Sc. (Hons) in Mathematics Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of Cos on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Innovative	
Maximum Marks ►	25	25	25	25	100 Marks
CO-1	x	x	x	x	x
CO-2	x	x	x	x	x
CO-3	x	x	x	x	x
CO-4		x	x	x	x
CO-5			x	x	x

The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination


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6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Miller, I. and Miller, M., 2002, John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall of India.
2. S.C.Gupta and V.K.Kapoor., 2002, Fundamentals of Mathematical Statistics, 11th ed., Sultan Chand and sons, New Delhi.
3. Sheldon Ross, 2010, A First Course in Probability, 8th edition, Pearson.

b. Recommended Reading

1. Dudewicz, E. J., and Mishra, S. N., 1988, Modern Mathematical Statistics. John Wiley & Sons.
2. Goon A.M., Gupta M.K.: Das Gupta.B., 2005, Fundamentals of Statistics, Vol. I, World Press, Calcutta.
3. Rohatgi V. K. and Saleh, A.K. Md. E., 2009, An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.

c. Magazines and Journals

d. Websites

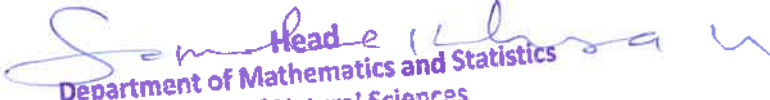
1. <http://nptel.ac.in/>
2. <https://ocw.mit.edu/index.htm>

e. Other Electronic Resources

1. <https://www.khanacademy.org/>
2. tutorial.math.lamar.edu/

10. Course Organization

Course Code	MTE563A	
Course Title	Statistical Inference	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	July 2028	


 Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Python for Data Science

Course Title	Python for Data Science
Course Code	MTM561A
Course Type	Core Laboratory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of this introductory Python course is to equip learners with essential programming skills and foundational data analysis capabilities. Students will develop proficiency in core Python constructs, including data types, control flow, functions, and basic object-oriented programming. The course introduces modules and exception handling, followed by visualization techniques using Matplotlib. Learners will also gain hands-on experience with NumPy and Pandas for array manipulation, DataFrame operations, and data cleaning—key skills required for advanced coursework in data science and machine learning.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:1:1
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

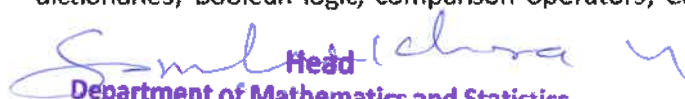
3. Course Outcomes (COs)

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

- CO-1.** Define fundamental Python syntax, data types, and core constructs (variables, loops, functions).
- CO-2.** Explain the usage of built-in data structures, function patterns, and the role of modules/packages in Python programming.
- CO-3.** Implement algorithms and execute simple programs using Python.
- CO-4.** Examine and interpret data by creating visualizations with Matplotlib, and analyze array manipulations in NumPy.
- CO-5.** Assess different approaches to data handling in Pandas, justify selection of data-cleaning methods, and evaluate the effectiveness of various solutions for real-world data sets.

4. Course Contents**Unit 1: Python Fundamentals****(10 hours)**

Basic Python syntax, variables, and I/O, Data types: strings, lists, tuples, sets, dictionaries, Boolean logic, comparison operators, Control flow: if-elif-else, for loops,

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while loops, List/Dictionary comprehensions

Unit 2: Functions, Modules (4 hours)

Defining functions (def), return statements, default arguments, Tuple unpacking, anonymous functions (lambda), Importing built-in/custom modules

Unit 3: Basic OOP & Error Handling (4 hours)

Concept of classes and objects, Attributes and methods, Exception handling with try-except-finally

Unit 4: Data Visualization (4 hours)

Introduction to Matplotlib, Creating basic plots (line, bar, scatter, histograms), Customizing plots (labels, legends, styles)

Unit 5: NumPy & Pandas for Data Handling (8 hours)

NumPy: array creation, indexing, slicing, operations, sorting, basic math/stats functions

Pandas: creating DataFrames, indexing/slicing/filtering, adding/deleting columns,

handling missing data, importing/exporting data (CSV, Excel), basic group-by operations

List of Laboratories:

Lab 1:	Getting Started with Python: - Environment setup, Basic syntax, variables, data types, - Simple input/output exercises
Lab 2:	Data Structures in Python - Manipulating lists, tuples, sets, dictionaries, - Practice with comprehensions (list/dict)
Lab 3:	Control Flow & Logic - if-elif-else, for loops, while loops - Combining Booleans and comparison operators
Lab 4:	Functions & Lambda Expressions - Writing functions (def) with parameters and return values - Using lambda and built-in functions (map, filter)
Lab 5:	Working with Modules and Exception Handling - Importing built-in modules (e.g., math, random) - Using try-except blocks in a small program
Lab 6:	Introduction to Classes Defining a simple class with attributes/methods
Lab 7:	Basic Plotting with Matplotlib - Generating line plots, scatter plots, and bar charts - Adding titles, labels, legends, and customizing styles
Lab 8:	NumPy Arrays & Operations - Creating arrays (from lists, zeros, ones, random) - Indexing, slicing, reshaping arrays - Performing basic arithmetic and statistical operations
Lab 9:	Advanced NumPy and Matplotlib integration - Combining NumPy computations with Matplotlib visualizations - Plotting numeric datasets
Lab 10:	Pandas DataFrames & Data Cleaning - Creating DataFrames (from dicts, CSVs) - Filtering, indexing, handling missing data - Summarizing and exporting cleaned data

5. Course Map (CO-PO-PSO Map)

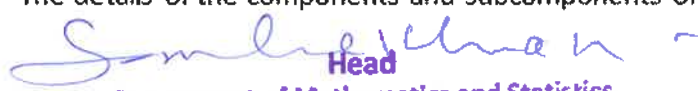
	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	3	1		1						3	3	1
CO-2	3	2	2		2						2	2	1
CO-3	3	1	2		2						2	3	1
CO-4	3	2	2		2						3	2	1
CO-5	3	2	2		2						2	2	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		07
Demonstrations		06
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	06	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		13
1. Course Laboratory	00	
2. Computer Laboratory	13	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		04
Total Duration in Hours		30

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the


Head
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 Faculty of Mathematical and Physical Sciences
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 Bangalore-560 058.

Programme Specifications document pertaining to the B. Sc. (Hons.)(Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Assignment	
Maximum Marks ►	25	25	25	25	100 Marks
CO-1	x	x			x
CO-2	x	x			x
CO-3	x	x			x
CO-4			x	x	x
CO-5			x	x	x
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

S. Ramaiah
 Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Faculty of Mathematical and Physical Sciences

a. Essential Reading

1. Laboratory manual and class notes
2. Matthes, E., 2023, Python Crash Course, No starch press
3. McKinney W., 2022, Python for Data Analysis, O'Reilly Media

b. Recommended Reading

1. Grus, J., 2019, Data Science from Scratch: First Principles with Python, O'Reilly Media
2. Lutz, M., 2013, Learning Python, O'Reilly Media
3. Sweigart, A., 2019, Automate the Boring Stuff with Python, No starch press
4. M. Dawson, 2010., Python programming for the absolute beginner, Boston, Mass, Course Technology.
5. Ceverance, C. R., 2016, Python for everybody
6. Raschka, S., Liu, Y., and Mirjalili, V, 2022, Machine Learning with PyTorch and Scikit-Learn. Packt Publishing.

c. Magazines and Journals

- 1.

d. Websites

1. <https://www.coursera.org/>
2. <http://swyam.ac.in/>

e. Other Electronic Resources

1. <https://www.khanacademy.org/>

10. Course Organization

Course Code	MTM561A		
Course Title	Python for Data Science		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.mp@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		


Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.


Dean
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.


Dean - Academics
 M.S. Ramaiah University of Applied Sciences
 Bangalore - 560 054

Course Specifications: Combinatorics and Graph Theory

Course Title	Combinatorics and Graph Theory
Course Code	MTC581A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of this course is to discuss the advanced concepts of Combinatorics and Graph theory. Students are taught the concepts of recurrence relation, generating function, graph isomorphism, and advanced counting techniques. It trains students to understand the variants of Dijkstra's algorithm to find the shortest distance paths in graphs and digraphs.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. Explain the basic concepts of Combinatorics and Graph Theory
- CO-2. State and prove important theorems in Combinatorics and Graph Theory
- CO-3. Solve simple problems of Combinatorics and Graph Theory
- CO-4. Apply Combinatorics and Graph Theory to solve real world phenomenon's
- CO-5. Solve complex problems of Combinatorics and Graph Theory

4. Course Contents**Unit 1****(12 Hours)**

Introduction to Discrete Mathematics, Peano's Axioms, Distribution problems, Derangements-Bijection Principle. Generating functions, definition with examples, solving recurrence relations using generating functions,


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Unit 2**(12 Hours)**

Advance Counting, Stirling Numbers and Their Combinatorial Roles, Applications of the Pigeonhole and Generalized Pigeonhole Principles. Erdős–Szekeres Theorem on Ordered Subsequences, Counting with the Principle of Inclusion and Exclusion,

Unit-3**(10 Hours)**

Modeling computation, Languages and Grammars, Finite State Machines with Output, Finite State Machines with no output, Language Recognition, Turing Machines, Computational Complexity

Unit 4**(11 Hours)**

Introduction to graph theory, Distinct classes of Graphs, Trees, Graph isomorphism. Connectedness in simple graphs. Vertex cut, Edge cut, Vertex connectivity, Edge connectivity, Variants of Dijkstra's algorithm to find the shortest distance paths in graphs and digraphs.

Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3		2								3	2	
CO-2	3		2								3	2	
CO-3	3	2	3								3	2	1
CO-4	3	2	3					1	1	1	3	2	1
CO-5	3	2	3					1	1	1	3	2	1

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	



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Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

6. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the B. Sc. (Hons.)(Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
Subcomponent ►	Component 1: CE (60% Weightage)				Component 2: SEE (40% Weightage)
	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Assignment	50 Marks
Maximum Marks ►	25	25	40	10	
CO-1	x	x			x
CO-2	x	x			x
CO-3	x	x			x
CO-4			x	x	x
CO-5			x	x	x
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

7. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment

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5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

8. Course Resources

a. Essential Reading

- i. Class notes
- ii. Kenneth Rosen, Discrete mathematics and its applications, WCB McGraw-Hill, 6th edition, 2004.

b. Recommended Reading

- i. J.P. Tremblay and R.P. Manohar: Discrete Mathematical Structures with applications to computer science, McGraw Hill (1975).
- ii. J.H. Van Lint & R.M. Wilson, "A course on Combinatorics", Cambridge University Press (2006)
- iii. L. Liu: Elements of Discrete Mathematics, Tata McGraw-Hill, 2000.
- iv. Allan Tucker, "Applied Combinatorics", John Wiley & Sons (1984).
- v. F. Harary: Graph Theory, Addition Wesley, 1969.

c. Magazines and Journals

d. Websites

- i. <http://nptel.ac.in/>
- ii. <https://ocw.mit.edu/index.htm>

e. Other Electronic Resources

- i. <https://www.khanacademy.org/>
- ii. tutorial.math.lamar.edu/

Sankar Chandra

Head

Department of Mathematics and Statistics

Faculty of Natural Sciences

M.S. Ramaiah University of Applied Sciences

Bangalore-560 058.

9. Course Organization

Course Code	MTC581A	
Course Title	Combinatorics and Graph Theory	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	



Head

**Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.**

Course Specifications: Differential Geometry and Multivariable Calculus

Course Title	Differential Geometry and Multivariable Calculus
Course Code	MTC572A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

This course integrates multivariable differentiation and constrained optimization with the rigorous study of the Frenet–Serret apparatus for space curves. It unifies classical vector theorems using the modern framework of differential forms and the exterior derivative. The syllabus explores surface geometry through the Weingarten map and Gaussian curvature, highlighting the intrinsic nature of space via Gauss’s Theorema Egregium.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. State foundational definitions and properties of total derivatives, the Frenet–Serret apparatus, differential forms, and surface curvatures.
- CO-2. Explain the geometric and structural meanings of linear mappings, path independence, coordinate patches, and Gauss’s Theorema Egregium.
- CO-3. Compute curve invariants like curvature and torsion, evaluate multiple integrals using the Jacobian, and solve constrained optimization problems.
- CO-4. Analyze the behavior of multidimensional functions and spaces by investigating critical points via the Hessian, tangent spaces of level sets, and geometric properties of special curves.
- CO-5. Evaluate complex multidimensional integrals and vector fields by justifying and applying Green’s, Stokes’, and Divergence theorems formulated through differential forms.

4. Course Contents**Unit 1: Differential Calculus and Optimization****(14 Hours)**

Fundamental concepts of differentiability in $\mathbb{R}^n$, focusing on the geometry of mappings. Topics include directional derivatives, the total derivative as a linear map, and the Chain Rule. Analytical study of Level Sets and the construction of Tangent Spaces. Geometric approach to optimization using Lagrange Multipliers for constrained extrema and the classification of critical points using the Hessian and Taylor series expansions in higher dimensions.

Head

Sandeep Kumar

Department of Mathematics and Statistics

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Ranjith K.V.

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Unit 2: Geometry of Curves in $\mathbb{R}^3$ **(9 Hours)**

Theory of parametrized curves and their local invariants. Topics include velocity, speed, and arc length reparametrization. Rigorous derivation of the Frenet–Serret Apparatus: the Tangent (T), Normal (N), and Binormal (B) vectors. Detailed analysis of Curvature (κ) and Torsion (τ) through the Frenet–Serret differential equations. Characterization of special curves, including plane curves, helices, and spherical curves.

Unit 3: Multiple Integration and Surface Area**(12 Hours)**

Integration in higher dimensions: Double and Triple Integrals, Fubini's theorem, and the Change of Variables formula with the Jacobian determinant. Calculation of Surface Area for parametrized surfaces in $\mathbb{R}^3$. Line integrals of scalar and vector fields, work, circulation, and path independence.

Unit 4: Differential Forms and Vector Theorems**(15 Hours)**

Calculus of differential forms in $\mathbb{R}^n$. 1-forms, 2-forms, and the Wedge Product. The Exterior Derivative (d) and its properties. Integration of differential forms and the Pull-back of forms under mappings. Green's Theorem, Stokes' Theorem, and the Divergence Theorem formulated through differential forms.

Unit 5: Geometry of Surfaces and Curvature**(10 Hours)**

Geometry of smooth surfaces in $\mathbb{R}^3$. Coordinate Patches and surfaces of revolution. The Shape Operator (Weingarten Map) and the Gauss Map. Principal, Gaussian (K), and Mean (H) curvatures. Geodesics and Geodesic Curvature. Gauss's Theorema Egregium and the intrinsic nature of Gaussian curvature.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	2	1	1								2	2	1
CO-2	2	2	2								2	3	2
CO-3	3	1	3								3	2	1
CO-4	3		3								2	3	1
CO-5	3	2	3								3	3	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	20
Numeracy		
1. Solving Numerical Problems	20	
Practical Work		00

1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		75

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent ►	TSC1	TSC2	TSC3	100 Marks
Subcomponent Type ►	Midterm	Assignment	Quiz/Innovative	
Maximum Marks ►	50	25	25	
CO-1	X		X	
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following

teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Barrett O' Neil (1966) Elementary Differential Geometry, Academic press, New York and London.
3. Sean Dineen (2014), Geometry and Multivariate Calculus, Springer.

b. Recommended Reading

1. Thomas J. Wilmore, (1959) An Introduction to differential geometry, Clarendon Press, Oxford. India.
2. Andrew Pressley, (2004) Elementary Differential Geometry
3. Christian B. (2010), Elementary Differential Geometry, Cambridge University Press, UK.

c. Magazines and Journals

1. The College Mathematics Journal, Mathematical Association of America. <https://www.maa.org/press/periodicals/college-mathematics-journal/the-collegemathematics-journal>
2. SIAM Undergraduate Research Online, Society for Industrial and Applied Mathematics, <http://www.siam.org/students/siuro/index.php>
3. Involve – A Journal of mathematics, <https://msp.org/involve/about/journal/about.html>
4. Rose-Hulman Undergraduate Mathematics Journal, Rose-Hulman Institute of Technology. <https://scholar.rose-hulman.edu/rhumj/>

d. Websites

1. <https://www.coursera.org/>
2. <http://nptel.ac.in/>

e. Other Electronic Resources

1. <https://www.khanacademy.org/>
2. tutorial.math.lamar.edu/
3. <http://www.sosmath.com/diffeq/diffeq.html>
4. http://serc.carleton.edu/sencer/ode_real_world/index.html

10. Course Organization

Course Code	MTC572A		
Course Title	Differential Geometry and Multivariable Calculus		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.mp@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		


Head**Department of Mathematics and Statistics****Faculty of Natural Sciences****M.S. Ramaiah University of Applied Sciences**

Bangalore-560 058.

Course Specifications: Probability, Measure and Integration

Course Title	Probability, Measure and Integration
Course Code	MTC573A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

This course introduces the foundations of measure theory, Lebesgue measure, and Lebesgue integration, emphasizing measurable sets, measurable functions, and convergence theorems. It develops probability theory using measure-theoretic concepts such as probability spaces, random variables, expectations, and product measures. The course also covers independence, laws of large numbers, and characteristic functions with applications in analysis and statistics.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Apply the concepts of measurable sets, measurable functions, Lebesgue measure, and Lebesgue integration to analyze problems in real analysis and probability theory.
- CO-2.** Demonstrate understanding of convergence theorems, product measures, probability spaces, and expectations, and use them in solving theoretical and applied problems.
- CO-3.** Analyze stochastic concepts such as independence, modes of convergence, laws of large numbers, and characteristic functions within a rigorous measure-theoretic framework.
- CO-4.** Apply measure-theoretic probability concepts to study random variables, expectation, product measures, and Fubini's theorem.
- CO-5.** Analyze independence, modes of convergence, laws of large numbers, and characteristic functions in probability and statistical applications.

4. Course Contents**Unit 1: Lebesgue Outer Measure and Set Systems****(10 Hours)**

Lebesgue theory: Algebra of sets, sigma algebras, open subsets of real line, F_σ and G_δ sets, Borel sets.

(Lebesgue) Outer measure of a subset of $\mathbb{R}$, existence, non-negativity and monotonicity of Lebesgue outer measure, Relation between Lebesgue outer measure and length of an interval; Countable subadditivity of Lebesgue outer measure; translation invariance.

Unit 2: Measurable Sets and the Lebesgue Measure

(12 Hours)

(Lebesgue) measurable sets, (Lebesgue) measure, Complement, union, intersection and difference of measurable sets, denumerable union, and intersection of measurable sets; Countable additivity of measure; The class of measurable sets as an algebra, sigma-algebra, the measure of the intersection of a decreasing and increasing sequence of measurable sets; measures of limit superior, limit inferior of sequences of measurable sets.

Unit 3: Measurable Functions and Lebesgue Integration

(14 Hours)

Measurable functions: Scalar multiple, sum, difference, and product of measurable functions. Measurability of a continuous function and measurability of a continuous image of measurable function.

Lebesgue Integral: Characteristic function of a set, simple function, Lebesgue integral of a simple function, Lebesgue integral of a bounded measurable function, Lebesgue integral and Riemann integral of a bounded function defined on a closed interval; Lebesgue integral of a non-negative function; Lebesgue integral of a measurable function, Properties of Lebesgue integral.

Convergence theorems and Lebesgue integral; The bounded convergence theorem, Fatou's lemma, Monotone convergence theorem, Lebesgue convergence theorem.

Unit 4: Probability Spaces and Product Measures

(12 Hours)

Random variables, Distribution function, inverse distribution function, the Fundamental Theorem of Probability. Concept of "almost surely (a.s)". Change of variable formula. Expectation of a random variable, law of unconscious statistician.

Product space, basic definitions, sections. Product measure, existence and uniqueness. Fubini's Theorem, applications.

Unit 5: Independence and Limit Laws

(12 Hours)

Independence. Borel-Cantelli Lemmas. Tail σ -algebra, Kolmogorov's 0-1 Law. Various modes of convergence and their interrelations. WLLN, SLLN. Fundamental Theorem of Statistics (Glivenko-Cantelli Lemma). Kolmogorov's maximal inequality and applications. Kolmogorov's Three Series Theorem, proof of the sufficiency part. Characteristic functions, definition, examples. Moment expansion, characteristic function for Normal distribution. Inversion formula, uniqueness theorem, density formula.

5. Course Map (CO-PO-PSO Map)



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	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	1	2							1	2	3	1
CO-2	3	3	2							1	2	3	1
CO-3	3	3	3							2	2	3	1
CO-4	3	3	3		2			2	2	2	2	3	1
CO-5	3	3	3		2			2	2	2	2	3	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	00
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	10
Term Tests, Laboratory Examination/Written Examination, Presentations		
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Head *Sandhya Chandra*

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058

Dean *M. S. Ramaiah*
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058

Dean *Ranjith R.V.*
Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	100 Marks
Subcomponent Type▶	Term Test	Assignment	Innovative	
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. Billingsley, P., 1995, Probability and Measure (3rd ed.), Wiley-Interscience.

3. Durrett, R., 2019. Probability: Theory and examples (5th ed.), Cambridge University
4. Royden, H.L., 1963, Real Analysis, Macmillan Publishing Company.
5. Jain, P. K., Gupta, V. P., & Jain, P., 2011, Lebesgue Measure and Integration, New Age International.

b. Recommended Reading

1. Halmos, P.R., 1962, Measure theory, East West Press.
2. Rudin, W., 1966, Real and Complex Analysis, Mc Graw Hill.
3. Athreya, S., & Sunder, V. S., 2019, Measure and Probability (1st ed.), CRC Press.
4. Parthasarathy, K. R., 2005. Introduction to Probability and Measure, Hindustan Book Agency.

c. Magazines and Journals

d. Websites

1. <http://ocw.mit.edu/>

e. Other Electronic Resources

10. Course Organization

Course Code	MTC573A	
Course Title	Probability, Measure and Integration	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2027	



Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
 M.G. Ramaiah University of Applied Sciences

Course Specifications: Machine Learning – 2

Course Title	Machine Learning – 2
Course Code	MTE571A
Course Type	Core Elective Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of this course is to provide students with a rigorous conceptual and computational understanding of deep learning models and their applications. It introduces foundational architectures such as multi-layer perceptrons (MLPs), convolutional neural networks (CNNs) for image data, and recurrent neural networks (RNNs) for sequential data. The course also covers essential topics in natural language processing (NLP), including lexical, syntactic, and semantic processing, word embeddings, and attention mechanisms. Emphasis is placed on core principles such as forward and backward propagation, optimization algorithms, hyperparameter tuning, and regularization techniques. By integrating theoretical foundations with practical implementation, the course equips students to model and analyze a variety of real-world problems in domains such as classification, prediction, and language processing.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Recall and identify the essential concepts and terminologies in deep learning and natural language processing
- CO-2.** Explain key mechanisms of deep neural networks and basic NLP processes
- CO-3.** Implement and apply fundamental deep learning models (MLPs, CNNs, RNNs) and NLP to solve simple problems
- CO-4.** Analyze the performance of deep learning algorithms, compare different architectures, and interpret results to identify improvements
- CO-5.** Apply suitable deep learning models to real-world problems, justify hyperparameter choices, and interpret solution effectiveness in image and NLP tasks

4. Course Contents


Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
S.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Faculty of Natural Sciences

**Unit 1: Deep Learning Foundations
Hours)****(15**

Introduction to deep neural networks, Forward and backward propagation, Activation functions, Loss functions, Parameters vs. hyperparameters, Optimization algorithms: SGD, Momentum, NAG, AdaGrad, RMSProp, Adam, Hyperparameter tuning, Regularization techniques: L2, dataset augmentation, dropout, adding noise to inputs and outputs, and early stopping.

**Unit 2: Convolutional Neural Networks
Hours)****(10**

Introduction to Convolutional Neural Networks (CNNs), Image processing basics. Convolutions, strides, padding. Feature maps and pooling. Architectures of standard CNNs (AlexNet, VGG, ResNet). Transfer learning: feature extraction and fine-tuning.

**Unit 3: Recurrent Neural Networks
Hours)****(10**

Introduction to sequence models. Recurrent Neural Networks (RNNs) and backpropagation through time. Challenges in training RNNs: vanishing and exploding gradients. Variants of RNNs: Long Short-Term Memory (LSTM) and Gated Recurrent Unit (GRU). Introduction to encoder-decoder models. Applications in language modeling and sequence prediction.

**Unit 4: Natural Language Processing
Hours)****(10**

Introduction to Natural Language Processing and its applications. Lexical, syntactic, and semantic processing. Word vector representations (Word2Vec). Introduction to attention mechanisms. Basics of Transformer architecture.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	2							1	1	3		
CO-2	3	2							1	1	3		
CO-3	3	2	3	2							3		
CO-4	3	2		3	2	1	1	1		1	3	1	1
CO-5	3	2	3	3	2	1	1	1		1	3	1	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		07
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	07	
Numeracy		08
1. Solving Numerical Problems	08	

Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	SC1	SC2	SC3	100 Marks
Subcomponent Type▶	Term Test (25 % Weight)	Assignment (12.5 % Weight)	Innovative (12.5 % Weight)	
Maximum Marks▶	50	25	25	
CO-1	X		X	
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Laboratory
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources**a. Essential Reading**

1. Course notes
2. Goodfellow, I., Bengio, Y., and Courville, A., 2016, Deep Learning, MIT Press

b. Recommended Reading

1. Aggarwal, C., 2023, Neural Networks and Deep Learning, 2nd Ed., Springer.
2. Zhang, A., Lipton, Z. C., Li, M., Smola, A. J., 2023, Dive into Deep Learning, Cambridge Univ Press
3. Chollet, F., 2021, Deep learning with Python, Manning Publications Co
4. Raschka, S., Liu, Y., and Mirjalili, V., 2022, Machine Learning with PyTorch and Scikit-Learn. Packt Publishing

c. Magazines and Journals

1. Foundations and Trends in Machine Learning
2. IEEE Transactions on Pattern Analysis and Machine Intelligence
3. Neural Networks by Elsevier

d. Websites

1. https://onlinecourses.nptel.ac.in/noc23_cs110/preview
2. <https://uni-tuebingen.de/fakultaeten/mathematisch-naturwissenschaftliche-fakultaet/fachbereiche/informatik/lehrstuehle/autonomous-vision/lectures/deep-learning/>

e. Other Electronic Resources

10. Course Organization

Course Code	MTES71A	
Course Title	Machine Learning – 2	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	


Head

Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M. S. Ramalah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Fundamentals of Fluid Dynamics

Course Title	Fundamentals of Fluid Dynamics
Course Code	MTE572A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

This course provides a comprehensive introduction to the mathematical and physical principles governing fluid motion. It begins with a study of coordinate transformations and tensor mathematics, essential tools for describing fluid behavior. The course covers the fundamental properties of fluids, flow visualization techniques, and types of flows, establishing a strong foundation in fluid kinematics and dynamics. The governing equations of fluid motion, including continuity, momentum, and energy equations, are derived and applied to analyze fluid systems. Advanced topics such as boundary layer theory, flow stability, and integral theorems are explored, equipping students with the analytical tools necessary for solving real-world fluid dynamics problems.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	70
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Illustrate the basic properties of Cartesian tensors, including gradient, divergence, curl, and integral theorems, and their role in fluid dynamics.

CO-2. Explain the properties of fluids, continuum hypothesis, flow visualization techniques, and classification of different types of fluid flow.

CO-3. Illustrate the fundamental governing equations of fluid motion, including the continuity equation, momentum theorem, and Bernoulli equation.

CO-4. Analyze the behavior of fluid flow in boundary layers, evaluate flow stability, and assess conditions for various flow types using stability criteria.

CO-5. Apply non-dimensionalisation techniques, boundary conditions, and conservation laws to solve real-world fluid dynamics problems effectively.



Head

Department of Mathematics and Statistics

Faculty of Natural Sciences

J.S. Ramaiah University of Applied Sciences

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Faculty of Natural Sciences

4. Course Contents

Unit 1 (Coordinate Transformations): 05 Hrs

Cartesian tensors: Basic properties, transpose, symmetric and skew tensors, isotropic tensors, and deviatoric tensors, gradient, divergence and curl of a tensor field, integral theorems.

Unit 2 (Introduction to Fluid Dynamics): 15 Hrs

Overview of Fluid Mechanics: Definition and classification of fluids, properties of fluids, continuum hypothesis, Kinematics of Fluids: Description of fluid flow – Eulerian and Lagrangian methods, velocity field, streamlines, pathlines, and streaklines, Types of Fluids and Flow: Compressible vs incompressible flows, viscous vs inviscid flows, steady vs unsteady flows, laminar vs turbulent flows.

Unit 3 (Governing Equations of Fluid Motion): 10 Hrs

Control mass system, control volume system, isolated system. Material derivative and acceleration, temporal derivative, convective derivative. Conservation of mass - the continuity equation. Conservation of momentum: momentum theorem. Conservation of energy. The Bernoulli equation.

Unit 4 (Boundary Layer Dynamics, Stability, and Integral Theorems): 15 Hrs

Non-dimensionalisation, Boundary Conditions: No-slip condition, pressure and velocity boundary conditions. Boundary Layer Theory: Concept of boundary layer, Prandtl's boundary layer equations, Blasius solution for flat plate. Hydrodynamic Stability: Basics of linear stability analysis, Rayleigh's stability criterion, Kelvin-Helmholtz instability. Integral Theorems: Divergence theorem, Stokes' theorem, and Green's theorem in the context of fluid flow.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	2	2							1	3	3	1
CO-2	3	2	2							1	3	3	1
CO-3	3	2	3							1	3	3	2
CO-4	3	2	3		2			2	2	2	3	3	2
CO-5	3	2	3		2			2	2	2	3	3	2

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	
Practical Work		00

1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. Mathematics Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (60% Weightage)			Component 2: SEE (40% Weightage)
Subcomponent	TSC1	TSC2	TSC3	100 Marks
Subcomponent Type	Midterm exam	Assignment	Innovative	
Maximum Marks	50	30	20	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

Head
Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Faculty of Natural Sciences

Dean
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes
2. R. K. Rathy (1976) An Introduction to Fluid Dynamics, Oxford and IBH
3. Yunus A. Çengel and John M. Cimbala (2006) Fluid mechanics: fundamentals and applications, McGraw-Hill,
4. Chandrasekharaiah, D. S. and Debnath, L. (1994) Continuum Mechanics, Academic Press.

b. Recommended Reading

1. Chorlton, F. (1967) Text book of Fluid Dynamics, Van Nostrand.
2. Philip J. Pritchard and John C. Leylegian (2011) Introduction to Fluid Mechanics (8th edition), John Wiley and Sons Inc.
3. Frank M. White, (2011) Fluid Mechanics (7th edition), McGraw Hill.
4. Yuan, S. W. (1976) Foundations of Fluid Mechanics, Prentice Hall.
5. Kundu, P. K. and Cohen, I. M. (2008) Fluid Mechanics, Academic Press

c. Magazines and Journals

1. <https://nptel.ac.in/courses/112104118>
2. Journal of Fluid Mechanics.
<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/fluid-mechanics>

d. Websites

<https://theteche.com/basic-concepts-of-fluid-mechanics-and-flow-of-fluids/>

Head

Department of Mathematics and Statistics

Faculty of Natural Sciences

M.S. Ramaiah University of Applied Sciences

Faculty of Natural Sciences

Bangalore-560 058.

e. Other Electronic Resources

<https://www.khanacademy.org/science/physics/fluids#fluid-dynamics>

10. Course Organization

Course Code	MTE572A	
Course Title	Fundamentals of Fluid Dynamics	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	



Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Course Specifications: Applied Regression Analysis

Course Title	Applied Regression Analysis
Course Code	MTE573A
Course Type	Discipline Specific Elective
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

The aim of this course is to introduce students to both simple and multiple regression models, as well as generalized linear models. It covers the estimation of coefficients using ordinary least squares estimation and maximum likelihood estimation methods. Additionally, the course includes the construction of confidence intervals. Students will learn the concept of residual analysis to validate the properties of regression models and to identify influential observations within the data. The course also teaches how to validate regression models for future predictions. Furthermore, non-linear regression models and generalized linear regression models will be discussed throughout the module.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	45
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. Explain the basic concepts of simple, multiple regression models, residual analysis, and non-linear regression models.
- CO-2. State and prove the theorems associated with simple, multiple, and generalized linear models
- CO-3. Solve the simple real world problems using simple, multiple, and generalized linear models
- CO-4. Model and solve the real world problems associated with simple, multiple and generalized linear models
- CO-5. Solve complex real world problems using simple, multiple, generalized and resampling methods

4. Course Contents**Unit 1(Simple Linear Regression):****15 Hours**

Introduction to linear and non-linear models, simple linear regression model; least squares, properties of the least squares estimators, model assumptions, interpretation of model parameters, inference on the slope and intercept, prediction, maximum likelihood estimation, the coefficient of determination, ANOVA for regression.

Head

Unit 2 (Multiple Linear Regression):**10 Hours**

Introduction to Multiple Linear Regression model, matrix notation, properties of the least squares estimators, inference on model parameters, estimation and prediction, interpretation of output, standardized regression coefficients, multicollinearity.

Unit 3 (Residual Analysis):**10 Hours**

Residuals analysis, Residual analysis, standardized and studentized residuals, residual plots, partial regression and partial residual plots, outliers, lack of fit tests, and their analysis for test of departure from the assumptions such as normality, homogeneity of variances, detection of outliers, Influential observations, Power transformation of dependent and independent variables.

Unit 4 (Non-linear regression models)**10 Hours**

Nonlinear regression, different methods for estimation (Least squares and Maximum likelihood), and asymptotic properties of estimators. Generalized linear models (GLM), Analysis of binary and grouped data using logistic and log-linear models.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3		1							1	3	2	
CO-2	3		1							1	3	2	
CO-3	2		3							1	3	2	1
CO-4	2		3		2			2	2	2	3	2	1
CO-5	2		3		2			2	2	2	3	2	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	00	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	00
Others		
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	

Term Tests, Laboratory Examination/Written Examination, Presentations	10
Total Duration in Hours	70

Sandesh Chandra

Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
(Bangalore-560 055).

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the Ph.D Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation					
Subcomponent ►	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)
	SC1	SC2	SC3	SC4	
Subcomponent Type ►	Term Test	Term Test	Assignment	Innovative	100 Marks
Maximum Marks ►	25	25	25	25	
CO-1	x	x	x	x	x
CO-2	x	x	x	x	x
CO-3	x	x	x	x	x
CO-4		x	x	x	x
CO-5			x	x	x
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--


 Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.
 Faculty of Natural Sciences

9. Course Resources

a. Essential Reading

1. Class notes
2. D.C Montgomery, E.A Peck and G.G Vining, 2003, Introduction to Linear Regression Analysis, John Wiley and Sons, Inc. NY
3. Norman R. Draper and Harry Smith, 1998, Applied Regression Analysis, John Wiley and Sons, Inc.

b. Recommended Reading

1. Kleinbaum, D.G., Kupper, L.L., Nizam, A. and Rosenberg, E.S., 2013, Applied regression analysis and other multivariable methods. Cengage Learning.
2. Lewis-Beck, C. and Lewis-Beck, M., 2015, Applied regression: An introduction (Vol. 22). Sage publications.

c. Magazines and Journals

d. Websites

- a. <https://www.coursera.org/>
- b. <http://nptel.ac.in/>

e. Other Electronic Resources

- a. www.e-booksdirectory.com

10. Course Organization

Course Code	MTES73A	
Course Title	Applied Regression Analysis	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	



Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Course Specifications: Internship

Course Title	Internship
Course Code	MTI571A
Course Type	Laboratory Course
Department	Mathematics and Statistics
Faculty	Faculty of Natural Sciences

1. Course Summary

The aim of this course is to give students an exposure to the environment in an industry / research organization. Student can undergo internship in an industry, business organization, research organization or any other university on a topic of relevance during vacation after 4th semester with prior approval from the department head and faculty dean.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. Understand industry problem to provide solution by Mathematical/ Statistical knowledge
- CO-2. Write a report on the problem identified and method described to provide solution by Mathematical/ Statistical knowledge during internship

4. Course Contents

- Choose a problem relevant to the industry
- Work towards providing a solution using mathematical or statistical knowledge
- Undergo an internship
- Prepare a report and present it


Head

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Faculty of Natural Sciences
A.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

5. Course Map (CO-PO-PSO Map)

1.	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3		3	2	3			2	2	1	3	3	1
CO-2	3		3	2	3			2	2	1	2	3	2
3-Very Strong Contribution; 2-Medium Strong Contribution; 1-Strong Contribution													

2. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		
1. Demonstration using Videos		
2. Demonstration using Physical Models / Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit	60	60
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Tests, Laboratory Examination/Written Examination, Presentations		5
Total Duration in Hours		65

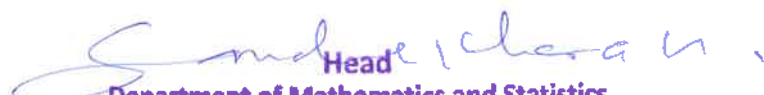
3. Course Assessment and Reassessment

Component-1 (CE): 60% weight

Presentation: 60% weight

Presentation to a committee of examiners consisting of 2 members appointed by the Academic Registrar in consultation with the Head of the Department.

Component-2: 40% weight


Head
Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Faculty of Natural Sciences
Bangalore-560 058.

Report submitted will be evaluated by a committee of examiners consisting of 2 members appointed by the Academic Registrar in consultation with the Head of the Department.

Assessment questions are set to test the learning outcomes. In each component certain learning outcomes are assessed. The following table illustrates the focus of learning outcomes assessed in each component.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1), COs are assessed as illustrated in the following Table.

Focus of COson each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage)	Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	
Subcomponent Type ►	Report	Presentation
Maximum Marks ►	25 Marks	25 Marks
CO-1	X	
CO-2		X
The details of SC1 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

4. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Internship
2.	Understanding	Internship
3.	Critical Skills	Internship
4.	Analytical Skills	Internship
5.	Problem Solving Skills	Internship
6.	Practical Skills	Internship
7.	Group Work	Internship
8.	Self-Learning	Internship
9.	Written Communication Skills	Technical Report
10.	Verbal Communication Skills	Presentation, Interaction with the group and at industry
11.	Presentation Skills	Presentation
12.	Behavioral Skills	Internship
13.	Information Management	Internship

14.	Personal Management	Internship
15.	Leadership Skills	Internship

5. Course Resources

a. Essential Reading

1. Industry Website / Literature – News Articles related to the chosen industry
2. Deliberations with the assigned trainer in the industry

b. Recommended Reading

c. Magazines and Journals

d. Websites

e. Other Electronic Resources

6. Course Organization

Course Code	MTIS71A	
Course Title	Internship	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	080-49065555 Extn. 5013
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	July 2025	
Next Course Specifications Review Date	July 2027	


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 Bangalore-560 058.

Course Specifications: Project

Course Title	Project
Course Code	MTP571A
Course Type	Laboratory
Department	Mathematics and Statistics
Faculty	Faculty of Natural Sciences

1. Course Summary

The aim of this course is to train students to conduct independent study a topic of relevance and deliver a seminar.

The student is expected choose a topic of relevance and conduct independent study. The student is also expected to submit a report and give a presentation on the chosen topic.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	0:0:2
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

CO-1. Understand the literature Survey , literature gap and possible future research work on the chosen topic

CO-2. Write a report on the chosen topic

4. Course Contents

1. Choose the relevant topic for research
2. Critical review on the chosen topic
3. Study literature on the selected topic
4. Find the literature gap and bring the possible future work
5. Prepare a report



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6. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO9	PO10	PSO-1	PSO-2	PSO-3
CO -1	3		3	1	3	1		2		2	3	3	2
CO -2	3		3	1	3	1		2	2	2	3	3	2
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution													

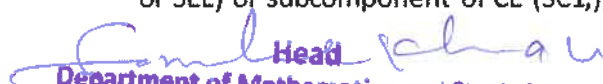
7. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	00	
2. Computer Laboratory	60	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		05
Total Duration in Hours		35

8. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Applied Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1), COs are assessed as illustrated in the following Table.


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Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage)	Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	
Subcomponent Type ►	Report	Presentation
Maximum Marks ►	25 Marks	25 Marks
CO-1	X	
CO-2		X
The details of SC1 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

9. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report
14.	Personal Management	Course work
15.	Leadership Skills	---

10. Course Resources

a. Essential Reading

1. Research Articles /Dissertation Reports / Books

11. Course Organization

Head

Course Code MTP571A

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Faculty of Natural Sciences

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Dean - Academics

M.S. Ramaiah University of Applied Sciences

Bangalore - 560 054

Course Title	Project		
Course Leader's Name		As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.mt.mp@msruas.ac.in	
Course Specifications Approval Date		June 2026	
Next Course Specifications Review Date		June 2028	


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Course Specifications: Research Methodology

Course Title	Research Methodology
Course Code	MPF615A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Faculty of Natural Sciences

1. Course Summary

The aim of the course is to introduce students to the principles of research, research methodology and significant phases of research.

Students are taught the significant role of Literature Review in a research cycle and the expectations from good literature review as well as procedure for systematic literature review. The essential aspects of technical communication to develop desirable writing skills for the preparation of research document including research paper as well as the skills for an effective presentation are also discussed. The module also emphasizes the desirable close knit relation between innovation and concept of out of the box thinking. Students will get an insight into the privilege, honour and the associated responsibilities of a researcher.

2. Course Size and Credits:

Number of Credits	02
Credit Structure (Lecture: Tutorial: Practical)	2:0:0
Total Hours of Interaction	30
Number of Weeks in a Semester	15
Department Responsible	Chemistry
Total Course Marks	50
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Describe the value, scope, relevance and mandatory steps of research as well as principles of effective research
- CO-2.** Discuss and demonstrate the application and utility of the Systematic approach and out of box thinking concepts for research to be effective
- CO-3.** Explain and apply the procedures outlined for a systematic Literature Review
- CO-4.** Outline the principles to prepare a well-structured research proposal and research paper
- CO-5.** Identify and apply the essential skills desirable for an effective technical presentation


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4. Course Contents

Foundations of Research:

Definitions of Research, Mandatory Steps in Research, Types of Research, Relevance of Research for Innovation and Technology Development, Effective Research and Self Discipline. Out of the Box Thinking and Systematic approach in Research – Transformation to Impossible Thinking, Convergent and Divergent Thinking, Generation, Evaluation and Selection of Ideas.

Literature Review:

Importance of Literature Review, Constituents of Good Literature Review, Strategies for Literature Search, Referencing, Paraphrasing, and Summarizing Academic Standards and Ethics. Statistical Methods and Data Analysis

Research Proposal:

Structure of a Good Research Proposal, Getting Started, Tips for Compilation of Good Research Proposal. Technical Communication - Research Paper for Publication- Significance of Problem Statement and its scope, Formulation of Hypothesis, Adequacy of Methodology, Significance of Presentation and Discussion of Results, Relevance and Importance of references.

Effective Presentation:

Preparation, Templates, Balance between Good Design and Good Content, Planning and Sequencing, PAMPERS (Projection, Articulation, Modulation, Punctuation, Enunciation, Repetition and Speed) rule, PEOPLE (Position & Gestures, Eye Contact, Orientation, Proximation, Looks & Appearance, and Expressions & Emotion) rule, 4P's Rule (Plan, Prepare, Practice and Present), Essentials of Effectiveness, Effective Pausing and Inclusive Answering.

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Outcomes (PSOs)			Specific
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3	
CO-1	3		2		1					2	2	2	1	
CO-2	3		2		1				1	2	2	2	1	
CO-3	3		3		2				2	2	2	3	1	
CO-4	3		3		2	2		2	2	2	2	3	1	
CO-5	3		2		3	2		2	2	2	2	3	1	
3: Very Strong Contribution, 2: Strong Contribution, 1: Moderate Contribution														

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures 35		30
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		05
Total Duration in Hours		35

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M.Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2), COs are assessed as illustrated in the following Table.

	Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (50% Weightage)		Component 2: SEE (50% Weightage)
Subcomponent ►	SC1	SC2	
Subcomponent Type ►	Midterm Test	Assignment	50 Marks
Maximum Marks ►	25	25	
CO-1	X		X
CO-2	X		X
CO-3	X	X	X
CO-4	X	X	X
CO-5	X		X
	The details of SC1 and SC2 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, Self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	Group discussions, assignment
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--


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11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Booth, W. C, Colomb and G.G Williams., (2005) The Craft of Research, Chicago University Press, USA
3. William M.K and Trochim. (2003) Research Methods, 2nd Edition, Biztantra Publicshres, New Delhi
4. Jonathan Grix. (2004) The Foundation of Research, Palgrave Macmillan; Study Guide edition, USA

b. Recommended Reading

1. Wisker Gina. (2001) The Post Graduate Research Handbook, , Palgrave Macmillan, USA.
2. Rugg G. and Petre M. (2004) The Unwritten Rules of Ph.D Research, Open University Press, UK

c. Other Electronic Resources

1. <http://nptel.ac.in/>

10. Course Organization

Course Code	MPF615A		
Course Title	Research Methodology		
Course Leader's Name	As per Timetable		
Course Leader's Contact Details	Phone:	+91-804-906-5555	
	E-mail:	hod.cy.mp@msruas.ac.in	
Course Specifications Approval Date	June 2026		
Next Course Specifications Review Date	June 2028		


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Department of Mathematics and Statistics
Faculty of Natural Sciences
S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Course Specifications: Functional Analysis

Course Title	Functional Analysis
Course Code	MTC581A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Mathematical and Physical Sciences

1. Course Summary

It aims at improving abstract and analytical thinking of students. This course begins with basic functional analysis concepts such as Banach Spaces, Hilbert spaces, are introduced and some applications to linear algebra are discussed. Further Linear Operators, bounded operators, spectrum of linear and the compact operators in Hilbert space are also discussed. It lays a foundation to operator theory and their spectral analysis.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:1:0
Total Hours of Interaction	60
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1. Illustrate the principles of functional analysis
- CO-2. Elucidate the fundamental concept of Banach spaces and prove the relevant theorems
- CO-3. Demonstrate the principle concept of Hilbert spaces and discuss the theorems
- CO-4. Analyze the Linear Operators, bounded operators, spectrum of linear and the compact operators in Hilbert space.
- CO-5. Apply the concept of Hann Banach theorem and discuss the consequences of Hann Banach theorem.


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4. Course Contents

Unit 1: Banach spaces and Hahn - Banach theorem

10 Hrs

Hahn - Banach theorem and its consequences, Projections on a Banach Space. The open mapping theorem and the closed graph theorem. The uniform boundedness theorem. The conjugate of an operator, properties of conjugate operator

Unit 2: Banach Space

8 Hrs

Banach Space, Normed linear spaces and convexity; convergence, completeness, Linear transformation, and bounded linear transformation of a normed linear spaces, conjugate spaces, natural imbedding, reflexive spaces.

Unit 3: Hilbert Space

12 Hrs

Inner product spaces - Bessel's inequality and Schwarz inequality, Parseval's Theorem, the Riesz Representation Theorem, Orthogonality, Complete Orthonormal sets,

Unit 4: Bounded Operators

15 Hrs

Bounded operators, Adjoints of bounded operators, self adjoint, Hermitian, normal, unitary operators, Projections and orthogonal projections in Hilbert spaces. Linear Operators and spectral theory of linear operators. Spectrum of compact operators

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	1	1		1					1	2	3	1
CO-2	3	3	3		2					2	2	3	1
CO-3	3	3	3		2					2	2	3	1
CO-4	3	3	3		2			2	2	2	2	3	1
CO-5	3	3	3		2			2	2	2	2	3	1
CO-6	3	3	3		2			2	2	2	2	3	1

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	15
Numeracy		
1. Solving Numerical Problems	15	00
Practical Work		
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	


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4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		70

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (TSC1, TSC2, TSC3), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation				
	Component 1: CE (50% Weightage)			Component 2: SEE (50% Weightage)
Subcomponent▶	TSC1	TSC2	TSC3	100 Marks
Subcomponent Type ▶	Term Test	Assignment	Innovative	
Maximum Marks▶	50	25	25	
CO-1	X		X	X
CO-2	X		X	X
CO-3	X		X	X
CO-4		X	X	X
CO-5		X	X	X
The details of TSC1, TSC2, TSC3 are presented in the Programme Specifications Document.				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials,

Semalath Chandra
Head
Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Ranjith R.V.
Dean
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Ranjith R.V.
Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

		Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Course notes.
2. Balmohan V Limaye, 1995, Functional Analysis, New Age International Limited.
3. Kreyszig, E., 1989, Introductory Functional Analysis with Applications, 1st Ed., Wiley.
4. Simmons, G.F., 2017, Introduction to Topology and Modern Analysis, McGraw Hill Education.

b. Recommended Reading

1. Jain, P.K., Ahuja, O.P. and Ahmed, K., 1995, Functional Analysis, New Age International Ltd.
2. Reed, M. and Simon, B., 1980, Methods of Modern Mathematical Physics I: Functional Analysis, 1st Ed., Academic Press.
3. Rudin, W., 2015, Real and complex analysis, McGraw Hill Education.
4. C. Gaoeffman and G. Pedrich, 2002, First Course in Functional Analysis, AMS Chelsen Publisher.

c. Magazines and Journals

1. <https://www.sciencedirect.com/journal/journal-of-functional-analysis>
2. <https://www.springer.com/journal/43034>

d. Websites

1. <http://www.journals.elsevier.com/journal-of-functional-analysis/>
2. <http://www.springer.com/mathematics/analysis/journal/10688>
3. <http://www.emis.de/journals/AFA/>

e. Other Electronic Resources

1. https://www.math.ucdavis.edu/~hunter/measure_theory/measure_theory.html

10. Course Organization

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Department of Mathematics and Statistics
Faculty of Natural Sciences
K.S. Rangish University of Applied Sciences
Faculty of Natural Sciences
Bangalore-560 058.

Course Code	MTC571A	
Course Title	Functional Analysis	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2025	
Next Course Specifications Review Date	June 2027	



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 Department of Mathematics and Statistics
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Course Specifications: Statistics for Data Science using R

Course Title	Statistics for Data Science using R
Course Code	MTC582A
Course Type	Core Theory
Department	Mathematics and Statistics
Faculty	Natural Sciences

1. Course Summary

This specialization module focuses on developing data analysis skills through the use of statistical methods for data science. The R programming language is utilized to analyze data, employing descriptive statistics, joint distributions, correlation, and inferential statistics. Additionally, statistical modeling techniques, such as regression and time series models, are introduced using R. The module also covers storytelling techniques to effectively present the results in data science.

2. Course Size and Credits:

Number of Credits	04
Credit Structure (Lecture: Tutorial: Practical)	3:0:1
Total Hours of Interaction	75
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	100
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Explain the basic concepts in R programming, descriptive statistics, inferential statistics, joint distributions, correlation and regression, time series modelling, and storytelling
- CO-2.** State and prove the important theorem with descriptive statistics, joint distributions, inferential statistics, and time series analysis
- CO-3.** Solve simple problems associated with descriptive statistics, inferential statistics, joint distributions, correlation and regression, and time series analysis
- CO-4.** Model and solve the real-world problems associated Solve simple problems associated with descriptive statistics, inferential statistics, correlation and regression, and time series analysis using R
- CO-5.** Solve complex problems associated with inferential statistics, joint distributions, correlation and regression, and time series analysis

4. Course Contents**Unit 1 (Introduction to R):****6 hrs**

Introduction to R programming, R Studio, understanding R data structure, importing data, manipulating data, data visualization, and descriptive statistics.


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Unit 2 (Testing of hypothesis):**10 hrs**

Introduction to hypothesis testing, concept of p-value, developing hypotheses for various real-time problems, and testing the hypotheses using Z, t-test, F, and Chi-Square tests. Analysis of Variance (ANOVA) and post-hoc tests. Introduction to non-parametric tests: sign test, test for randomness, Mann-Whitney test, Friedman test, and Kruskal-Wallis test.

Unit 3 (Joint Distributions and Independence):**6 hrs**

Joint distributions of discrete and continuous random variables, Independent random variables, expectation, covariance, conditional probabilities, conditional expectations, and distribution of the sum of random variables.

Unit 4 (Correlation and Regression Modelling):**8 hrs**

Introduction to Correlation, curve estimation for linear, polynomial, and exponential curves, simple and multiple regression analysis, modelling and prediction, introduction to non-linear regression models.

Unit 5 (Time Series Modelling):**10 hrs**

Introduction to time series analysis, components of time series, elimination of trend and seasonality, exponential smoothing, ARIMA models, modelling time series data and predictions.

Unit 6 (Storytelling in Data Science):**5 hrs**

Definition of Storytelling, Characteristics of a Good Story, Creating Data Stories, Components of Data Storytelling, Types of Data, Types of Charts for Data Visualization, and Future of Data Storytelling.

Practicals using R:

1. Graphical representation
2. Descriptive statistics
3. Testing of the hypothesis for a single population
4. Testing of the hypothesis for two populations
5. Testing of the hypothesis using non-parametric tests
6. Scatter plot, correlation coefficient, and rank correlation coefficient
7. Curve estimation
8. Analysis of Variance and post-hoc tests
9. Simple and multiple regression modelling and predictions
10. Time Series Modelling and Predictions

5. Course Map (CO-PO-PSO Map)

	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	2									3	2	
CO-2	3	2									3	2	
CO-3	2	2	3	3	2					2	3	2	1
CO-4	2	2		3	2			2	2	2	3	2	1
CO-5	2	2	3	3	2			2	2	2	3	2	1


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6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		00
1. Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		30
1. Course Laboratory	00	
2. Computer Laboratory	30	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		00
1. Case Study Presentation	00	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		85

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Mathematics) Programme. The procedure to determine the final course marks is also presented in the Programme Specifications document.

The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1, SC2, SC3 or SC4), COs are assessed as illustrated in the following Table.


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Focus of COs on each Component or Subcomponent of Evaluation						
Subcomponent ►	Component 1: CE (50% Weightage)				Component 2: SEE (50% Weightage)	
	SC1	SC2	SC3	SC4	SEE Theory - 35%	SEE Lab - 15%
Subcomponent Type ►	Term Test	Term Test	Lab Test	Lab Record		
Maximum Marks ►	25	25	25	25	100	50
CO-1	x	x			x	x
CO-2	x	x			x	
CO-3	x	x	x	x	x	x
CO-4		x	x	x	x	x
CO-5			x	x	x	x
The details of SC1, SC2, SC3 or SC4 are presented in the Programme Specifications Document.						

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

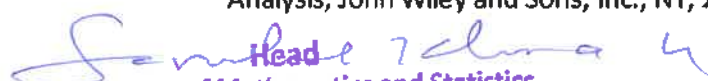
The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures, tutorials, Assignments
2.	Understanding	Classroom lectures, tutorials, Assignments
3.	Critical Skills	Classroom lectures, Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	--
7.	Group Work	Assignment
8.	Self-Learning	Self-study, Assignment
9.	Written Communication Skills	Assignment, Examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	Course work
13.	Information Management	Assignment, Examination
14.	Personal Management	Course work
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class Notes
2. Thomas Mailund, Beginning Data Science in R: Data Analysis, Visualization, and Modelling for the Data Scientist, Apress; 1st ed. Edition, 2017
3. D.C Montgomery, E. A Peck and G.G. Vining, Introduction to Linear Regression Analysis, John Wiley and Sons, Inc., NY, 2003


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4. D.C Montgomery, Jennigs C.L and M. Kulachi, Introduction to Time Series analysis and Forecasting, Wiley InterScience, 2006.
5. S. Chatterjee and A Hadi, Regression Analysis by Example, 4th Edn, John Wiley and Sons, Inc, 2006

b. Recommended Reading

1. Rice, J. A. (2007). Mathematical Statistics and Data Analysis, 3rd edn., Thomson Books/Cole.
2. R.H Shumway and D.S Stoffer, Time Series Analysis and its Applications with R Examples, Springer, 2011.

c. Magazines and Journals

1. Journal of Applied Probability and Statistics (JAPS) <http://www.isoss.net/japs/>
2. Journal of the American Statistical Association
www.amstat.org/publications/journals.cfm

d. Websites

1. <http://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2005/>

e. Other Electronic Resources

1. <https://www.khanacademy.org/math/statistics-probability>

10. Course Organization

Course Code	MTC582A	
Course Title	Statistics for Data Science using R	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	July 2025	
Next Course Specifications Review Date	July 2027	


Head
 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 M.S. Ramaiah University of Applied Sciences
 Bangalore-560 058.

Course Specifications: Dissertation

Course Title	Dissertation
Course Code	MTP581 A
Course Type	Laboratory
Department	Mathematics and Statistics
Faculty	Faculty of Natural Sciences

1. Course Summary

The aim of this course is to train a student to carry out research work.

The research work will be carried out at MSRUAS or in any other laboratory of student's choice under the supervision of a senior researcher. The duration of the research work is for six months. The student is expected to submit a dissertation and make a presentation to the examiners in the faculty.

2. Course Size and Credits:

Number of Credits	12
Credit Structure (Lecture: Tutorial: Practical)	0:0:20
Total Hours of Interaction	300
Number of Weeks in a Semester	15
Department Responsible	Mathematics and Statistics
Total Course Marks	300
Pass Criterion	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

3. Course Outcomes (COs)

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

- CO-1.** Recognize the need for developing a new or improving an existing scientific problem through an organized survey of literature
- CO-2.** Define scientific problem
- CO-3.** Design and perform the experiments
- CO-4.** Analyse the results obtained
- CO-5.** Write a technical Report and give presentation

4. Course Contents

1. Selection of topic for research
2. Critical review on the chosen topic
3. Performance of experiments
4. Collection of relevant data
5. Interpretation of data
6. Preparation of dissertation report and presentation of the same


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 Department of Mathematics and Statistics
 Faculty of Natural Sciences
 J. S. Ramiah University of Applied Sciences,
 Faculty of Natural Sciences
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5. Course Map (CO-PO-PSO Map)

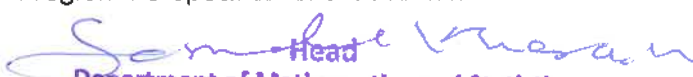
	Programme Outcomes (POs)										Programme Specific Outcomes (PSOs)		
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO-1	PSO-2	PSO-3
CO-1	3	3	3		3						3	3	1
CO-2	3	3	3		3						3	3	1
CO-3	3	3	3		3		2		3		3	3	1
CO-4	3	3	3	3	3		2	3	3	2	3	3	2
CO-5	3	3	3	3	3		2	3	3	2	3	3	2

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		00
Demonstrations		00
1.Demonstration using Videos	00	
2. Demonstration using Physical Models / Systems	00	
3. Demonstration on a Computer	00	
Numeracy		00
1. Solving Numerical Problems	00	
Practical Work		00
1. Course Laboratory	00	
2. Computer Laboratory	00	
3. Engineering Workshop / Course/Workshop / Kitchen	00	
4. Clinical Laboratory	00	
5. Hospital	00	
6. Model Studio	00	
Others		300
1. Case Study Presentation / Solving Research Problem	300	
2. Guest Lecture	00	
3. Industry / Field Visit	00	
4. Brain Storming Sessions	00	
5. Group Discussions	00	
6. Discussing Possible Innovations	00	
Term Tests, Laboratory Examination/Written Examination, Presentations		10
Total Duration in Hours		310

7. Course Assessment and Reassessment

The details of the components and subcomponents of course assessment are presented in the Programme Specifications document pertaining to the M. Sc. (Applied Mathematics) Programmes. The procedure to determine the final course marks is also presented in the Programme Specifications document.


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The evaluation questions are set to measure the attainment of the COs. In either component (CE or SEE) or subcomponent of CE (SC1), COs are assessed as illustrated in the following Table.

Focus of COs on each Component or Subcomponent of Evaluation		
	Component 1: CE (33% Weightage)	Component 2: (67% Weightage)
Subcomponent ►	SC1	
Subcomponent Type ►	Pre-project (40 marks) and Mid Term (60 Marks) Presentation	Final Project Presentation (50 Marks), Report (100 Marks) Journal Article (50 Marks)
Maximum Marks ►	100	200
CO-1	X	X
CO-2	X	X
CO-3	X	X
CO-4	X	X
CO-5		X
The details of SC1 are presented in the Programme Specifications Document.		

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of COs in each component of assessment in the above template at the beginning of the semester.

Course reassessment policies are presented in the Academic Regulations document.

8. Achieving COs

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Literature reading
2.	Understanding	Literature reading
3.	Critical Skills	Literature reading
4.	Analytical Skills	Literature reading
5.	Problem Solving Skills	Drawing conclusions from the literature
6.	Practical Skills	Literature reading, preparation of report
7.	Group Work	
8.	Self-Learning	Literature reading, preparation of report
9.	Written Communication Skills	Preparation of report
10.	Verbal Communication Skills	Presentation of report
11.	Presentation Skills	Presentation of report
12.	Behavioral Skills	Course work
13.	Information Management	Presentation of report
14.	Personal Management	Course work
15.	Leadership Skills	---

Sandhya K.
Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Faculty of Natural Sciences

[Signature]
Dean
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.

Ranjith K.V.
Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

a. Essential Reading

1. Research Articles / Dissertation Reports / Books
2. Lecture Sessions on individual project, Thesis Preparation delivered by the concerned Head of Department.

10. Course Organization

Course Code	MTP581 A	
Course Title	Dissertation	
Course Leader's Name	As per Timetable	
Course Leader's Contact Details	Phone:	+91-804-906-5555
	E-mail:	hod.mt.mp@msruas.ac.in
Course Specifications Approval Date	June 2026	
Next Course Specifications Review Date	June 2028	


Head

Department of Mathematics and Statistics
Faculty of Natural Sciences
M.S. Ramaiah University of Applied Sciences
Bangalore-560 058.


Dean

Faculty of Natural Sciences
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Bangalore-560 058.